Circumpolar Flaw Lead System Study (CFL)

International Polar Year (IPY)

CCGS *Amundsen*

27 September 2007 – 7 August 2008

Scientific Cruise Reports Compendium

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*Team reports were prepared by each of the science teams at the end of each leg. Parties interested in the data should contact the pertinent network investigator or the people who collected the data.
Please note the following:

i) the data files presented are illustrative only and are not to be used without first discussing this with the PI;
ii) data presented here have not been quality checked.

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Leg 3

27 September – 7 November 2007

edited and compiled by Jean-Éric Tremblay
(Chief Scientist)

1. General overview

1.1. Introduction

The participants of leg 3 express their gratitude to captain Lise Marchand and the officers and crew of the CCGS Amundsen for their unrelenting support and comprehension throughout the expedition. The present report covers both the ArcticNet (Leg 3A, 27 September – 18 October) and CFL (Leg 3B, 18 October – 7 November) portions of IPY leg 3 of the *CCGS Amundsen*. A SOLAS (Surface Ocean Lower Atmosphere Study) contingent was also present on board, bringing an additional atmospheric component to a predominantly ocean and ice-based science program. More than 20 distinct science operations were conducted on a daily basis and we successfully completed the inaugural dives of the ROV (remotely operated vehicle), which is now operational for scientific surveys (bottom and ice) and the recovery of moored instruments.

1.2. Science personnel

A total of 57 participants affiliated with at least one of the ArcticNet, CFL and SOLAS programs joined Leg 3 at one point. Most participants boarded in Resolute and stayed for the whole duration. The media crew from the Dan Rather Report (Dillon, Marx and Jones) disembarked in Nanisivik on 6 October. Three journalists from the BBC (Shukman, Georgiou and McGee) and a team from McGill (Lemieux and Tremblay B.) joined the ship in Resolute on 8 October. The BBC crew was flown to Kugluktuk on 13 October. Twelve scientists disembarked in Sachs Harbour at the end of Leg 3A on 18 October. At this time, 9 other scientists and the official CFL photographer (D. Barber) came on board for Leg 3B.

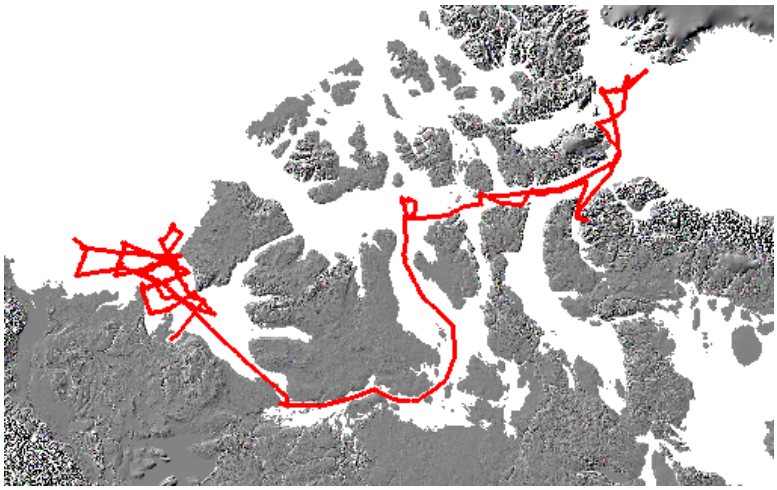
Program	Name	Embarked		Disembarked	
		Place	Date	Place	Date
ArcticNet-CFL	Tremblay, Jean-Eric	Resolute	27 Sep	Paulatuk	08 Nov
ArcticNet-CFL	Martin, Johannie	Resolute	27 Sep	Paulatuk	08 Nov
ArcticNet-CFL	Gagnon, Jonathan	Resolute	27 Sep	Paulatuk	08 Nov
ArcticNet-CFL	Tremblay, Geneviève	Resolute	27 Sep	Paulatuk	08 Nov
ArcticNet-CFL	Pabi, Sudeshna	Resolute	27 Sep	Sachs	18 Oct
ArcticNet-CFL	Lago, Véronique	Resolute	27 Sep	Paulatuk	08 Nov
ArcticNet-CFL	Sévigny, Caroline	Resolute	27 Sep	Paulatuk	08 Nov
ArcticNet-CFL	Janin, Amélie	Resolute	27 Sep	Paulatuk	08 Nov
ArcticNet-CFL	Levesque, Keith	Resolute	27 Sep	Paulatuk	08 Nov

ArcticNet-CFL	Forest, Alexandre	Resolute	27 Sep	Paulatuk	08 Nov
ArcticNet-CFL	Bourque, Mylène	Resolute	27 Sep	Paulatuk	08 Nov
ArcticNet-CFL	Gagné, Jacques	Resolute	27 Sep	Sachs	18 Oct
ArcticNet-CFL	Michaud, Luc	Resolute	27 Sep	Paulatuk	08 Nov
ArcticNet-CFL	Massot, Pascal	Resolute	27 Sep	Paulatuk	08 Nov
ArcticNet-CFL	Gagne, Steve	Resolute	27 Sep	Paulatuk	08 Nov
ArcticNet-CFL	Letourneau, Louis	Resolute	27 Sep	Stays	20 Dec
ArcticNet-CFL	Ben-Mustapha, Sélima	Resolute	27 Sep	Paulatuk	08 Nov
CFL	Johnson, Bruce	Resolute	27 Sep	Paulatuk	18 Oct
ArcticNet-CFL	MacHutchon, Allison	Resolute	27 Sep	Paulatuk	08 Nov
ArcticNet-CFL	Delaronde, Joanne	Resolute	27 Sep	Paulatuk	08 Nov
ArcticNet-CFL	Prowe, Frederike	Resolute	27 Sep	Paulatuk	08 Nov
ArcticNet	Lehnherr, Igor	Resolute	27 Sep	Sachs	18 Oct
ArcticNet-CFL	Poulin, Michel	Resolute	27 Sep	Paulatuk	08 Nov
ArcticNet-CFL	Belt, Simon	Resolute	27 Sep	Sachs	18 Oct
ArcticNet-CFL	Massé, Guillaume	Resolute	27 Sep	Sachs	18 Oct
ArcticNet-CFL	Vare, Lindsay	Resolute	27 Sep	Paulatuk	08 Nov
ArcticNet - SOLAS	Luce, Myriam	Resolute	27 Sep	Paulatuk	08 Nov
ArcticNet - SOLAS	Michaud, Sonia	Resolute	27 Sep	Sachs	18 Oct
ArcticNet - SOLAS	Royer, Sarah-Jeanne	Resolute	27 Sep	Sachs	18 Oct
ArcticNet - SOLAS	Rempillo, Ofelia	Resolute	27 Sep	Paulatuk	08 Nov
ArcticNet - SOLAS	Norman, Ann-Lise	Resolute	27 Sep	Sachs	18 Oct
ArcticNet - SOLAS	Seguin, Allison Michelle	Resolute	27 Sep	Sachs	18 Oct
ArcticNet - SOLAS	Sjostedt, Steve	Resolute	27 Sep	Paulatuk	08 Nov
ArcticNet - SOLAS	Chang, Rachel	Resolute	27 Sep	Sachs	18 Oct
ArcticNet-CFL	Cartwright, Doug	Resolute	27 Sep	Paulatuk	08 Nov
ArcticNet-CFL	Brucker, Steve	Resolute	27 Sep	Paulatuk	08 Nov
CFL	Faye Woods, Sarah	Resolute	27 Sep	Paulatuk	08 Nov
ArcticNet	Simard, Yvan	Resolute	27 Sep	Resolute	08 Oct
ArcticNet	Magee, Robert	Resolute	08 Oct	Kugluktuk	13 Oct
ArcticNet	Danielson, Brad	Resolute	27 Sep	Resolute	08 Oct
ArcticNet-CFL	Tremblay, Bruno	Resolute	08 Oct	Sachs	18 Oct
ArcticNet	Auger, Vincent	Resolute	27 Sep	Resolute	08 Oct
ArcticNet	Lemieux, Jean-Francois	Resolute	08 Oct	Sachs	18 Oct
ArcticNet	Marx, Willem	Resolute	27 Sep	Nanisivik	06 Oct
ArcticNet	Dillon, Dennis	Resolute	27 Sep	Nanisivik	06 Oct
ArcticNet	Georgiou, Mark	Resolute	08 Oct	Kugluktuk	13 Oct
ArcticNet	Jones, Edward	Resolute	27 Sep	Nanisivik	06 Oct
ArcticNet	Shukman, David	Resolute	08 Oct	Kugluktuk	13 Oct
ArcticNet - SOLAS	Scarratt, Michael	Sachs	18 Oct	Paulatuk	08 Nov
CFL	Maranger, Roxanne	Sachs	18 Oct	Paulatuk	08 Nov
CFL	Leitch, Dan	Sachs	18 Oct	Paulatuk	08 Nov
CFL	Collin, Pascal	Sachs	18 Oct	Paulatuk	08 Nov
CFL	Guignard, Constance	Sachs	18 Oct	Paulatuk	08 Nov
CFL	Swystun, Kyle	Sachs	18 Oct	Paulatuk	08 Nov
CFL	Gupta, Mukesh	Sachs	18 Oct	Stays	20 Dec
CFL	Hwang, Phil	Sachs	18 Oct	Stays	20 Dec

CFL	Pucko, Monika	Sachs	18 Oct	Stays	20 Dec
CFL	Barber, Doug	Sachs	18 Oct	Paulatuk	08 Nov

1.3. Cruise track

The map below was prepared by the Bottom Mapping Group and shows the ship's track from Resolute to Baffin Bay and from Baffin Bay to the Beaufort Sea. Sampling details (station coordinates, operations) and maps of the different regions are given in appendices. The break down of science operations in the different regions is given in the General Operation Log that follows.



1.4. General Operation Log

The charter flight left Quebec City on time at 06h00 on 27 September, despite some complications with the cargo. Contrary to the plan, supernumerary pallets of food had been loaded at the back of the cargo section early at night, which left little space for other scientific and Coast Guard cargo. Some of the supplies had to be left behind in Quebec City and plans were made to have a military Hercule plane deliver the supplies to resolute on 8 October. This plan never materialized and the initial loading incident had repercussions for the ship and the science program later during Leg 3. The exchange of personnel in Resolute went very smoothly, all the science and Coast Guard personnel was on board the ship for dinner time. The ship left Resolute on schedule at 18h00. A general meeting was held at 19h00 to introduce the captain, her senior officers and cruise participants to one another and discuss the chain of events for the leg and the next few days. A Power Point presentation detailing the various aspects of life, work and safety on board the *Amundsen* was also given.

The sea ice in the northeastern portion of Lancaster Sound and along Ellesmere Island considerably slowed our approach to station 101, which we reached 9 hours behind schedule. We did not have the option to start the North Water transect from the Greenland Side since the mooring instruments needed to be calibrated on Canadian land. The 40 hours of transit gave people the chance to prepare the laboratories, tune their instruments and get ready for sampling. A fire drill was also held. The liquid N_2 plant was switched on but was not operational before 30 September due to an electrical problem. We stopped only once to collect water for the drifting sediment traps and various teams that needed seawater for their initial preparations. After sunrise on the 29th the helicopter left early to bring Luc, Louis, Steve and Pascal on land for the calibration of compasses on the current meters (find position). They left early in the morning to make use of daylight while the ship was still miles away from station 101. Sampling operations began at 11h30 slightly off of station 101, where the ice conditions were impractical. Sampling activities were interrupted for mooring recovery attempt at 13:30. The ship slowly crawled to the mooring location, which was filled with aggregated flows of solid old ice (9+). Our assessment was that the ship would not be able to open and maintain a

sufficiently large hole to pop this long mooring safely. It was decided to postpone the operation for 5 days until the NOW transect had been completed (in case the wind turned and some of the ice cleared in the interval). We then crawled our way to Nutrient station 103 and Basic Station 105, which we completed successfully amidst the ice floes.

By then, we had realized that a freezer in which precious isotopes and chemicals had been stored frozen (microscopy room) in Quebec had been unplugged during the previous leg. The solutions were lost and the concerned people down south were informed of what had happened. Plans were made to bring new chemicals at the November 8 crew change. The SOLAS team lead by Ann-Lise Norman was not allowed to use the O_2 cylinder located next to the smoking area, which was considered a hazard by the captain. The cylinder had to be moved in the open space between the paleo lab and the benthos lab, which required soldering brackets on the bulkhead and drilling a hole through it. The whole adjustment took nearly two days to complete, delaying the start of Norman's gas chromatrograph.

On 30 September an examination of the moonpool in preparation for the ROV deployment at station 115 revealed the presence of a 2-feet thick slab of ice at the bottom. The ice was melted with hot water and salt water and the lower hatch was open to flush the ice residues once the ship got underway in ice-free waters. The MVP was deployed during the evening and we opted to tow it at 8 knots to keep on schedule (there was no requirements for this transect to be done at low speed and a high resolution). The deployment was plagued with many problems, the spots were out at the back and it took nearly 45 minutes to change the light bulbs. Then just after we put the fish in the water we lost one engine and it took another 30 minutes to get up to speed. The first half of the section went well, but then the system started to give a flurry of error messages. The system was re-initialized many times to no avail. The inital diagnostic was a sensor malfunction in the arm of the whinch.

Before arriving at mooring site BA-01 (sation 115), we held a meeting with Luc, Pascal, Vincent Auger, Michel (chief officer) captain Marchand and myself to discuss the ROV procedures and safety issues. Vincent had prepared a power point with the detail of the procedure. It was decided to operate with 2 deck hands (hold the cage and sub to stabilize), 1 winch operator, 1 crane operator and the Chief Officer or the Bosun (depending on the shift) to supervise from the moonpool and maintain a radio link with the Bridge. We deployed the floating sediment traps 2 miles west of station 115, which we reached early in the morning on October 1st. The location was surrounded by icebergs of various sizes, with several huge ones in relative proximity. The two acoustic releases on mooring BA-01-06 answered and were a few hundred feet away from the ship. We also got a response from BA-01-05. The exact location of BA-01-06 was determined over the next 45 minutes and the release command was finally issued. Both releases confirmed the command but nothing came up to the surface. The zodiac was deployed and we searched visually for the moorings during the next two hours, but saw nothing. Later the ship made a pass over the mooring coordinates (once in the morning and once just before we left station) and no line of instruments was visible on the EK60 echosounder. This is not a robust test, but given the presence of numerous huge icebergs it is plausible that the upper portion of the mooring was carried away.

We attempted the inaugural ROV deployment after lunch that day. Although a shallow dive of the cage and sortie of the sub was planned, glitches occurred during operations in the moonpool and it was decided to fix those before attempting a real dive. Specifically, the cage was not well balanced and tipped on its lateral vertical axis, which would have made it difficult for the sub to align the cage with the moonpool and could have made recovery extremely difficult or impossible. The time required to make the adjustments was estimated to one day, postponing the deployment until the next full station (108). Our tight sampling schedule did not make it possible to stay idle at station 115. The full suite of operations planned for that station was completed successfully and the ship sailed east.

After completing Nutrient station 113 and Basic station 111, we arrived at Full station 108 at 16h45 on 2 October. After discussing the mooring program with Louis Fortier and Yves Gratton it was decided to cancel the deployment of instruments initially planned for station BA02. This decision was

motivated by the modest success rate of recoveries in the North Water and the need to keep a margin of maneuver for the Beaufort Sea program. Because ice map showed that the Belcher Glacier and approaches were surrounded by ice, making bottom mapping impossible, 5 hours of mapping were inserted into the schedule of station 108 to make up for the lost opportunity and prepare for a future mooring recovery dive with the ROV. All the operations planned for this station were performed successfully, albeit for the failure of the 500 HP winch. By the time station 108 was done ice conditions at the site of the BA-03 mooring had not improved (9+ of old ice on October 3rd). These conditions and our tight schedule made a second journey and recovery attempt impractical. The ship headed for the Belcher Glacier while we performed MVP tests.

Waters close to the Belcher Glacier were ice-covered on 4 October, which made the bottom mapping attempt moot. We established the Basic station in Jones Sound to the southeast of the entrance to the Belcher Glacier. The visibility was poor and the ceiling was very low at sunrise. We waited another hour for more daylight and then launched the helicopter and the operations scheduled by Brad Danielson on the glacier were carried out successfully, but Brad experienced a problem with his met station and was unable to download data. Meanwhile we continued to perform typical operations for a basic station. A mishap then occurred with one of the Rosette cast. The captain and her third officer were on the bridge as the small hole the ship was in started closing in on the rosette - a large chunk of thick ice was coming directly at the cable while the rosette was near the surface. The chief officer on deck retracted the A-frame and the mutli-conductor cable leaned directly against the ship. No damage was done to the cable and the piece of ice was avoided.

During the evening of 4 October, the Rosette planned for station 300 was cancelled by the captain due to heavy wind, swell and currents, which made station keeping and a safe deployment very difficult. We then sailed for Nanisivik and docked on October 5 at lunch time. Dan Rather and his senior producer boarded the ship and performed two interviews and shots of the ship. In the afternoon several scientists and crew took a walk up the mountain in a large group. That night we organized a formal diner in the officers lounge. The tables were disposed in a u-shape fashion to allow people to interact. A balance was struck between senior scientists, officers, and students to make a representative cross-section of the participants. The diner was a success and Dan Rather and his producer left soon after to reach Arctic Bay before the snow storm got too thick to allow the truck's passage. The refueling *per se* was completed at 5 am on Saturday, but the seasonal draining of the tank and ferry of fuel to the ship by truck delayed our departure until 15h30. Nevertheless the operation was completed in 29 hours (30 were allotted). In the morning, a small bus came to the ship and picked up scientists and crew for a quick tour of Arctic Bay. A few Arctic foxes came close to the ship and seemed totally unafraid. In the afternoon a game was improvised with a homemade Frisbee. In the officers lounge we held a meeting with the captain, chief officer, Luc, Jacques Gagné and myself to discuss the upcoming deployment of the experimental mesopelagic trawl. Jacques presented a Power Point detailing the maneuvers. After some discussion concerning operations and safety we agreed to make the attempt. We left Nanisivik on October 6th, after 29 hours of refueling operations. We moved away from the dock and prepared to deploy the trawl. The deployment was slow and tedious, in part due to the nature of the operation and to the difficulties encountered to position the ship in the narrow passage. However, once the net was in the water the rest of the operation went smoothly and the retrieval was uneventful. Several hundred junevile Arctic cod were caught.

After the trawl we proceeded with the second deployment of the ROV in Admiralty Bay. The dive was very successful, the ship was able to maintain minimal drift, which allowed the pilots to dive on the bottom (see ROV section for detailed report). There they practiced observation and landing maneuvers over the sediment, which was thriving with epifauna. Near the end of the sortie it was Pascal's turn to dock the sub in its cage – he too passed with flying colors. The cage was brought back to the moonpool uneventfully. Congratulations were offered to the bridge for their navigation performance.

We performed additional MVP tests after the ship left Admiralty Bay. This time the problem was in the control box, where a connector was apparently not working. The ship then sailed toward Basic

station 301, which had been previously visited in 2006. We selected this station to make up for the lost opportunity at 300. We had planned a boxcore but it was cancelled due to an inadequate substrate. The team was allowed to look for an appropriate site and try again during the transit toward full station 302, but no adequate sediment was found. Full station 302 was completed successfully but some operations (VMP, RMT LAWAS, Phytoflash) were abandoned due to a mounting wind and snow storm. The substrate was also inappropriate for the boxcore, but the agassiz sled was highly successful, bringing on board a high biomass of diverse organisms. Soon after the ship started sailing toward Nutrient Station 304 the seas rose dramatically and the ship was rocked rudely. The bridge informed me they would make a turn and I awoke several scientists to make sure once more that all their equipment was well fastened. The ship then took a bend to the south and sailed under the relative protection of Prince Reagent Inlet until early morning, when a direct course was set for resolute. We lost roughly 6 hours because of the bad weather. Along the way, station 304 was cancelled and replaced by station 305 to make sure we would have enough time to ferry all the cargo and personnel from McGill and the BBC during daylight on 8 October.

The ship left Resolute for station 305 at 17h. A general meeting was held to introduce the new scientists and media crew, we discussed plans for the next few days and I gave the Life on Board power point to the new comers. During the discussions we considered the possibility of skipping station 312 and replace it by another west of Kugluktuk. Most people preferred to increase sampling resolution along the east-west gradient instead of getting a latitudinal section across McClintock Channel. Newcomers were taken on a familiarization tour of the ship the next morning (9 Oct) just before we began with the operations on Basic Station 308. The BBC crew then went into the zodiac to film Caroline's deployment of the SCAMP. Bruno's operation was not ready at that time and we were too far away from suitable ice flows. We decided to do it the next day and use the night to sail to the west in order to work in Viscount-Melville Sound. Later that evening the Radarsat image showed that the ice floes had compacted and we headed north and slightly west to avoid being trapped against the land south of Melville. We transited in a mixture of old heavy ice that needed to be rammed and thinner, soft ice. The ship halted at a safe distance from a large flow at around 3 am on 10 Oct and we started a basic station at this location. At daybreak the ship repositioned, we waited for the fog to lift and the helicopter left with Bruno, Jean-Francois and all their equipment for a nearby ice flow. They installed their first station and came back to the ship after lunch. The helicopter soon left again with Bruno, Jean-Francois, the BBC science correspondent (David Shuckman) and cameraman (Rob McGee). The operation was nearly 6 hours longer than anticipated (difficulty to locate an adequate site, drill problems) , but we compensated by sailing south much before the helicopter came back on board. Two polar bears were again sighted in front of the ship and people gathered on the foredeck to take pictures. The helicopter came back on board during diner and we held a steering committee meeting at 19h00. Bruno's operation was a success despite some technical problems. We decided to go to station 310 after a brief stop at an ad-hoc Box Core station (Boxcore A; 73 32.844; 103 17.934) to make up for the boxcore for the lost opportunity at station 309. Once station 310 was concluded we decided to cancel 312 (as expected) and sailed directly to station 314, where a short basic station was done. The shallow waters made it possible to satisfy the requirements of all teams with one rosette cast. We also deployed the Agassiz sled and the boxcore. The zooplankton team had no sampling interest there. That evening the scientists and crew gathered in the officer's lounge at 19h00 and said farewell to the BBC team. Gifts were exchanged and then a short video prepared by Rob was shown for the benefit of everyone. We were all very pleased with the humor and quality of that short piece of art. I then gave a talk on the general objectives of ArcticNet and the work done by the marine productivity team on board.

We then transited straight to a sheltered position to the northwest of Kugluktuk in order to tie up with the Louis Saint-Laurent. We were supposed to arrive on 13 October in early morning but the very high seas again delayed us by 5 hours. We tied up to the Saint-Laurent at noon and spent the next six hours bringing cargo and pumping our oily waters on the Saint-Laurent. Meanwhile, David, Rob and Mark from the BBC were flown to Kugluktuk. I held a short meeting to discuss plans for the next few days. Because the high seas, Bruno's operation and meeting with the St-Laurent had already used up our contingency time after departing Nanisivik and it was decided to sail directly for the westernmost

line (400) in the Beaufort Sea. On the morning of the 14th Jacques was standing by to deploy the trawl if significant fish biomass appeared on the echosounder, which unfortunately did not happen. The ship slowed down at ca. 11h00 to allow the DMS team (121 13) to take a bucket of water for their experiments.

The weather forecast was once again not very good with winds from the north east turning to the north east with gusts in excess of 35 knots. We made use of the transit time to fix the 500 HP winch and test the MVP again. This time there were problems with the main terminal connections in the box. We arrived at Basic station 434 at 9 am on 15 October and launched the helicopter with the 3 mooring technicians for calibrations on land. In the mean time we finished operations at station 434 at 15h00 and waited a little to hear back from the helicopter which had a minor mechanical problem on its way back from Inuvik (where our logistics officer, Lyne, left the ship for family reasons) to pick up the mooring technicians. We started sailing to station 433 as soon as 434 was done and the helicopter met us along the way. The line of CTD stations went well and we did a boxcore at station 428. Then we started operations at mooring station 435. The winds were picking up but things were still manageable until a rogue wave drenched the aft deck at around 07h00. It totally submerged the MVP control unit and flooded the aft labs via the ventilation system. Fortunately, no electrical problems were detected then. A deck hand was hurt in the process as he was swept by the wave and knocked his calf. He fully recovered. The Hydrobios cable was strained when the instrument slammed against the wave. Science operations were immediately put on hold and the CO_2 flux tower was brought done as we turned west and drifted for a few hours while tending to the ship. During the wind event a door slammed into the oxygen regulator (new installation, see above) and smashed it. There were no replacements on board but the SOLAS teams was able to use compressed air instead. Meanwhile we tried to communicate with the Tug in charge of the barges, but to no avail. We heard from the Coast Guard radio in Inuvik that the tug was southwest of Sachs Harbour but his could not be confirmed. Meanwhile we recovered parts of Geneviève's traps (the reflector, beacon and Argo float). These instruments were drifting seperately and no longer joined by a rope, which was presumably cut by a piece of drifting ice. Since we could not ascertain the position and status of the barge we waited for the winds to abate and the weather to improve sufficiently to attempt the mooring recovery. During the evening we sailed to mooring CA-04 and interrogated the releases. We had an erratic answer that suggested the mooring was nearly 2 kilometers off the mark. The weather was still too bad to attempt a recovery so we waited until the morning to try to get a more accurate location. In the morning one of the release answered only once with a signal that did not make much sense. We spent the next 2 hours searching for it with the ship and the zodiac which had the second deck unit. A salvage operation with the ROV was not feasible given the persisting wind and swell. We then prepared the new mooring while finishing the other operations planned for that station. The zodiac had problems with the cold and we could not do the SCAMP – it was fixed later during the day and was ready on time for the mooring deployment, which went very well. As soon as we finished triangulating the mooring we interrupted the rest of line 400 and sailed directly for Sachs harbour. Due to the time lost to bad weather and in the off chance that we would find the tug in Sachs Harbour, the community visit was postponed.

Once in Sachs we sent the mooring technicians on land to calibrate their instrument and started helicopter flights to exchange the people that left and came to the ship. Six of the newcomers did not have their scientific equipment and personal luggage when they came on board. These items were lost by First Air on the way in. All attempts at communicating with the airline on that day and later during the weekend were vain. In the mean time we located the barges, which were anchored in Summer Harbour. There was a Gale Warning and freezing spray warning in effect for this region and we were told that the tug would wait until conditions improved to cross the Gulf. We raised the anchor at 22h30 and proceeded to mooring station 437. We started with a series of nets but the sea state degenerated rapidly under the influence of easterly winds and we had to stop operations at around 3 am.

Given the equally bad weather forecast for the next day we headed north to do the line from station 1806 to 1800 under the protection of Banks Island. According to the coordinates given in the cruise

plan, these stations were much too shallow (less than 20 m of water under the keel) to conduct most science operations. The line was moved 18 miles to the west in order to have enough water to work. The first officer decided not to put the Zodiac in the water (SCAMP) due to cold weather and the rapid formation of new ice (a hazard when the zodiac is idle). We completed full station 1806 and proceeded to the south until we reached station 1800, which was done as a basic. In the morning we headed to station 437 (CA-16) to assess conditions. Things were still rocky but the mooring deployment was feasible. We resumed the sampling ops that had been cancelled the night before (rosettes) while the technicians prepared the mooring. CA-16-2007 was deployed successfully. The weather was still too rough to deploy the adjacent MMP in darkness and in order to save time we proceeded to the south and sampled a few CTD stations until daylight. We returned on site MW-2 to deploy the MMP. The deployment went smoothly except near the end when the ship was drifting over deeper waters. Luc expressed the will to release the weights in shallower waters, but this seemed to be problematic for the bridge so we dropped the wheels in 303 m before drifting over deeper waters. We then resumed sampling along line 400 until we reached mooring station 437 (CA-05). All the operations typically done at full stations were performed and the new mooring was deployed and triangulated. A CTD cast was done soon after the deployment. We then moved to site MW-1 for the MMP deployment, wich was done in darkness in 304 meters of water (target = 305 m). As several CTD cast had been done in the past 24 hr around the position we did not have time for another one.

We then proceeded east along the central line and reached mooring station 407 (CA-08) in the morning. The mooring did not answer and we started planning a ROV dive for the next day, while performing all the other operations on site. A survey of the bottom was done during the night, both for mapping purposes and to identify potential pitfalls for the ROV dive. After recovering the traps and performing a last rosette cast for the DMS people we proceeded with the maneuvering tests and ROV deployment. The dive went very well, all the bottom area around the assumed position of the mooring was surveyed visually and with the sonar, but the train wheels were not found (see separate dive report). Some traces that could have been produced by a dragged mooring were seen, but the evidence is inconclusive. All we could determine was that the mooring no longer resided within a 100-m radius of its triangulated position (which has a precision of 10 meters). A RCM-11 current meter initially positioned higher up on the line showed an abrupt descent from 120 to 340 meters on 16 May 2007. Since we were getting short on instruments, we did not deploy a new mooring at CA-08 right away, waiting to see what would be recovered on CA-18.

We proceeded along a series of CTD and nutrient station toward the next mooring site, 405 (CA-18). Sampling operations began during the night and paused in the morning for mooring recovery. The releases answered and the mooring was triggered. It took a long time to come up and, unfortunately, the white mid-water buoy came up first. It turned out that the upper section of the mooring were no longer present. The Kevlar rope was damaged and the rings on the buoys were deformed by strain – a possible sign that the ice ablated the top portion of the mooring. So far, the evidence gathered at CA08 and CA18 points toward an unusual year when rafting may have been more intense than usual. The decision was taken to lower the top instruments by 10 meters on the new CA-18-2007 in order to increase our safety margin. The new mooring was deployed smoothly in the evening of 25 October and we proceeded east with CTD stations and Basic station 1000.

Then we moved close to Banks Island to do Basic station 1100 and proceeded south with a series of CTD and Nutrient stations. We then completed Basic station 1110, a CTD and a Nutrient station and arrived at Full station 1116 in the middle of the night on 28 October. There was a fair amount of new ice at this station and some operations were canceled (Tucker, RMT). As it was impractical to use the zodiac, the SCAMP was deployed from the moonpool. Once the station was completed it was not possible to deploy the MVP in ice, and so we added three new CTD stations (1118, 1120, 1122) on the way to full station 1216. Boxcores were done at stations 1120 and 1122 to see if a spatial gradient in benthos community richness existed toward the hotspot. On arrival we spent 8 hours mapping the target ROV deployment site, which was slow and tedious with the ice and strong currents. These strong currents were oriented to the northwest and, along with winds of 25-30 knots and drifting ice floes, made it impossible to hold the ship in position for the ROV deployment. This activity was

canceled and other operations planned for that station were moved forward. We then started line 1200 towards Bank Island (series of CTD and Nut stations). While doing so we heard from the tug captain that he would leave Holeman in the late evening and possibly be in Summer's harbour in the evening of Oct 31, so we made plans to go meet them once station 1200 was completed. Mooring CA08-06 was interrogated from stations 1210 and 1208 and 1206 in case it had drifted south or north from its triangulated position. The mooring answered at station 1208 and we spent the next 2 hours triangulating it. The operation was difficult amidst winds of 40 knots and drifting ice and it look a long time to obtain a valid set of coordinates. The new ice and strong winds made any recovery attempt unthinkable at the time, but the coordinates can be used next year as a starting point for the search. Based on the new triangulated position the mooring has been dragged north by x miles. From there we proceeded north along the line of CTD and nutrient stations and completed station 1200. We experienced problems with the valve of the 500 HP, which had frozen again. Plans were also discussed during the day to improve the system used to thaw ice in the moonpool.

Upon completing station 1200 we learned that NTCL had not instructed the tug to meet with us in Summer's Harbour and a series of actions were taken to make sure that the proper authorities push the file. It appears the NTCL had decided to leave the barges in Summer's harbour weeks ago and did not inform anyone at Coast Guard, ArcticNet or CFL. Since we did not hear anything more for NTCL we decided once again to carry out the science program and move west to complete lines 1500 and 1600.

On November 1st we contacted Paulatuk to see if there was an interest for a community visit and the response was very enthusiastic. We also completed line 1500, but were slowed down by a rosette malfunction (the carousel skipped several position) and then twice by engine problems (a total of about 1 hour altogether). With the high winds and cold temperatures we had been experiencing several glitches with the Rosette. We looked into solutions that had been used during leg 8 of CASES – but the heater in the Rosette shack did not seem to be able to maintain proper temperatures. Since the complete grid of stations planned for the open water leg has been completed anyway we decided to migrate rosette ops to the moonpool after the completion of line 1600. The migration was performed during a period of 24 hr (November 2, 3). This time was also used to build a new shed for the Dave's instrument – the original shed was taken apart during the health survey, presumably to provide the bridge with a better visibility for barge operations. We used this welcome break in sampling activities to hold a Halloween party on Saturday night. The splicing, installation and testing of probes took most of Sunday and activities on line 1900 resumed during the evening of the 3rd. Operations were interrupted at around 2h30 am due to engine problems. A low water level in the sea bay caused one engine to overheat. It took almost 3 hours to fix the problem, run tests and sail back to Basic Station 1908 (the ship had drifted during the interruption). This station was completed in the morning of 5 November and we performed two CTD stations on the way to our last Basic station, 1916. We were supposed to receive the new 212 helicopter that day, but the bad weather in Inuvik delayed its flight to Paulatuk. Early in the evening the multi-conductor cable of the rosette got stuck in the cable guide and was kinked in a few places. The cable also made a dent on the side of the guide. As the necessary repairs (re-splicing, machining of a new part of the guide etc…) could not be completed until the next day we canceled rosette operations for Basic Station 1916 and the last two CTD stations of line 1900. Once other operations were completed at 3 am on 6 Novemberr, the ship sailed for Paulatuk.

Preparations were made for the community visit and the new 212 helicopter arrived on board just after lunch. In the evening we hosted 14 elders. Activities included a tour of the ship, shopping at the canteen, a formal diner (mix of community members, HTC, coast guard and scientists) and a presentation of the CFL project and the Amundsen. The event was very pleasant and the interactions were rich and positive. Teenagers from the local school came on board in the morning of 7 November and were taken on a tour of science and navigation stations around the ship. In the afternoon we started moving cargo to Paulatuk in order to fill the twin otter that returned to Inuvik later during the night. Videos and a slide show were presented in the evening and everyone resumed their packing for the crew change wich started early in the morning of 8 November.

2. Team reports

2.1. Seabed Mapping (ArcticNet 1.6)

PI: John Hughes Clark (University of New Brunswick)
Participants: Steve Brucker & Doug Cartwright (University of New Brunswick)

Introduction
The Ocean Mapping Group (OMG) was on board Leg 3 to perform seabed mapping as part of its role in the ArcticNet project. The primary purpose of the mapping on this leg was to collect as much bathymetry and sub-bottom information as possible while transiting between science stations throughout northern Baffin Bay, the Northwest Passage, and Amundsen Gulf / Beaufort Sea. Inclement weather was fairly common, as was the presence of both multi-year and newly formed ice. These attributed to the loss and/or degradation of data.

Equipment
CCGS Amundsen
Kongsberg-Simrad EM300 30 kHz multibeam echosounder
Knudsen K320R 3.5 kHz sub-bottom profiler
Applanix POS/MV 320 motion and orientation sensor
C&C Technologies CNAV GPS
Surface sound speed probe (temporary replacement)
Seabird SBE911 CTD, deployed from rosette

Onboard Logging and Processing Procedures
Multibeam and sub-bottom profiler collection began upon boarding the Amundsen near Resolute. CNAV GPS was logged separately, first on the SIS PC, then on the Knudsen PC. Both the multibeam and sub-bottom systems were logged continuously throughout the entire leg save for two days (Nov. 1 & 2) when the sub-bottom transducers were being acoustically isolated.

The EM300 data were logged in the Kongsberg-Simrad raw format and converted to the OMG format after line completion (new survey lines were automatically generated every half hour). The soundings were cleaned and inspected in near real-time with the two crew members maintaining a 24-hour watch throughout the cruise. Backups of the raw and processed data were made every few days onto DVDs (though they were copied to the processing computer in near real-time and mirrored to a second internal hard drive on a nightly basis).

The K320R data were logged in the Knudsen binary format (.keb). Data were converted to OMG format and then backed up in the manner mentioned earlier.

The CNAV data consisted of NMEA strings and was captured to a text file using HyperTerminal, with a new files being created at approximately midnight (GMT) every day. At the end of each day (GMT), this data was backed up to the processing computer and converted to OMG format. The data were then plotted geographically for visual inspection.

For surface sound speed, the probe data was logged and utilized real time by SIS at the beginning of the trip, with the probe malfunctioning about a week in. Sound speed profiles (Rosette CTD) were collected at each station. Raw files (collected in binary format) were converted to text files, copied to the processing PC and finally converted to OMG format, at which time the profiles were visually inspected for spurious data points. High resolution CTD casts were decimated to 1-metre bins using a median filter. Profiles were tagged with time and ship's position in real-time. If CTD profiles did not extend to full ocean depth, they were extended using the SVP editor in the SIS software package before being input to the EM300 logging software. Post-processing of the multibeam soundings with respect to sound speed profiles will be done upon return to UNB.

Mapping Procedures & System Performance
During transit between stations, coverage from previous transits was loaded into Aldebaran. This allowed the helmsman to steer coverage and build upon the previously collected data.

Several surveys were accomplished at the following locations:

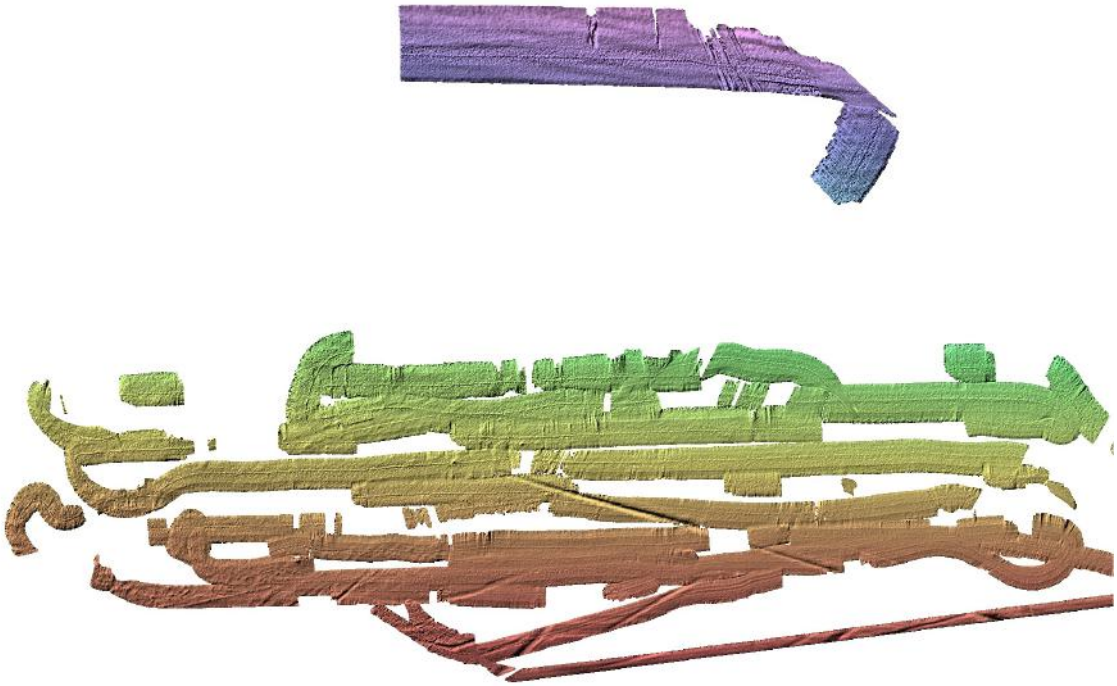
- Northern Baffin Bay, NE of Stn. 108.
- Stn. 1216, Franklin Bay

Multibeam data quality was good in most cases, but severely degraded or even non existent during heavy swell and sea ice. Sub bottom data was generally good under most circumstances including ice breaking and heavy seas. Survey line running was at times freehand, with the helmsman steering coverage to maintain overlap between adjacent lines, but mostly performed with the use of survey lines plotted on either Aldebaran or SIS.

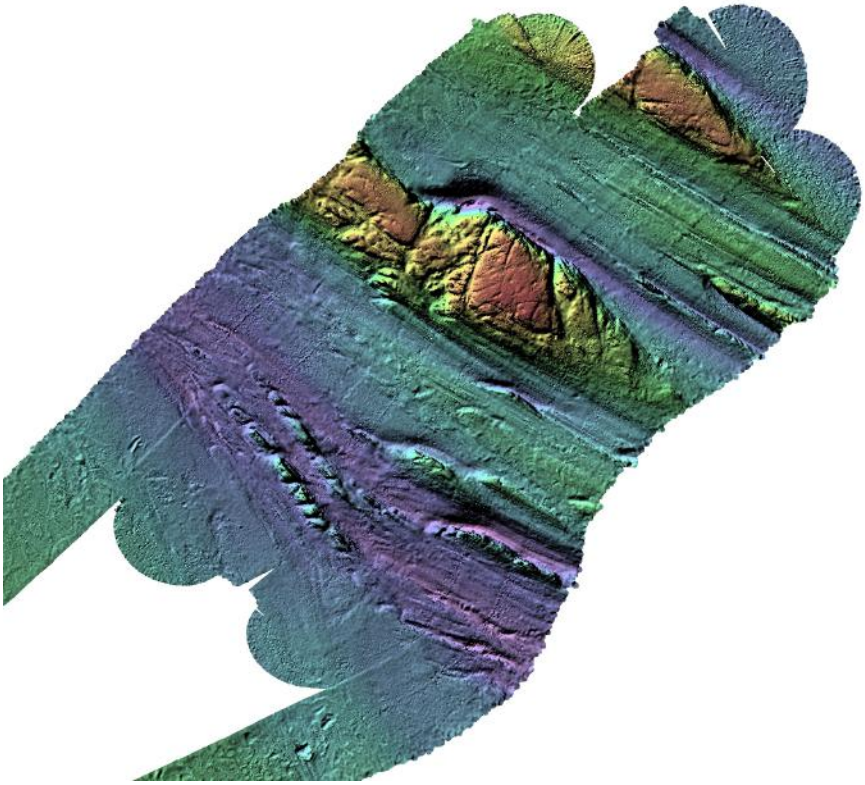
The SIS (EM 300) PC crashed on Thursday, October 4 at approximately 0900 utc. We were not able to power up the PC and after several hours of debugging by OMG and Laval staff, the PC was declared dead. We installed SIS on a spare laptop, entered the necessary offsets and successfully logged data. The laptop was used until 0200 utc on October 24th when a spare Kongsberg PC (HWS-11) was found aboard. This was an upgrade to the previous PC (HWS-10).

Survey Maps

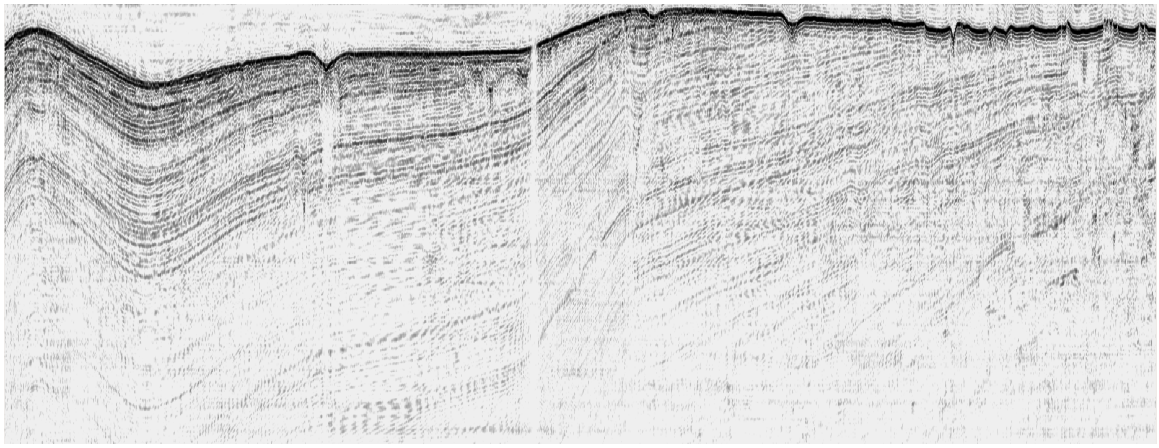
Station 108 multibeam bathymetry



Station 1216 multibeam bathymetry



50 – 90 metres



2.2. Team 1

2.2.1. Physical Oceanography

PIs: Yves Gratton[1], Peter Galbraith[2], Daniel Bourgault[3] & Rick Marsden[4]
Participants: Caroline Sévigny, Véronique Lago & Amélie Janin[1]

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Water structure and ocean circulation

Véronique Lago & Amélie Janin

Objective

To describe water masses and the general oceanic circulation in the North Water Polynya, the Northwest Passage and the Beaufort Sea.

Methods

Water from the rosette was collected by different teams. Here are examples of usual depths of bottle closure.

- *Nutrients* (Jean-Éric Tremblay team): chlorophyll maximum, 10m above and 10m under chlorophyll maximum, salinity of 33.1, 5, 10, 20, 30, 40, 50, 60, 70, 80, 100, 120, 140, 160, 180, 200, 250, 300 and every 100 m up to the bottom.
- *Primary Production* (Michel Poulin, Gosselin and Christine Michel team): chlorophyll maximum, 100m, 75m, 100%, 50%, 30%, 15%, 5%, 1% and 0.2% of light mesured with a secchi disk before the cast.
- *Contaminants* (Gary Stern team): 4, 5, 7.5, 10, 25, 50, 100 and 200 m
- *Mercury* (Gary Stern team): three water masses, one at the top, one at the middle and the last one at bottom.
- *DMS* (Maurice Levasseur team): chlorophyll maximum, 50%, 15%, 5% and 0.2% of light measured with a secchi disk before the cast.
- *DIC* (Helmut Thomas team): 0, 5, 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300 and every 100m up to the bottom.
- *CDOM* (Pierre Larouche team): 60m, 50%, 30%, 10% and 1% of light measured with a secchi disk before the cast.

Physical parameters were recorded using a ship mounted RD Instruments Ocean Surveyor ADCP, a Brooke MVP 300 and a rosette frame equipped with 24 bottles of 12 L and the following sensors:

Table 1 : Sensors used on the Rosette

Item	Manufacturer	Type	Serial Number	Max. depth [m]
CTD	SeaBird	SBE-911		6800
Temperature			4204	
Conductivity			2696	
Pressure			90584	

Oxygen	SeaBird	SBE-43	0427	7000
pH	SeaBird	SBE-18	0452 switched to 0444 on cast 024	1200
Nitrates	Satlantic	MBARI ISUS	132 switched to 134 on cast 143	1000
PAR	Biospherical		4664	
SPAR	Biospherical		20147	
Fluorometer	Sea Point		2465	
Transmisometer	WetLab		CST-558DR	
Altimeter	Benthos		1044 switched to 1061 on cast 028	

Sampling regions

CTD cast were done in Baffin Bay in NOW study area, outside Belcher glacier, along Northwest Passage and in Beaufort Sea, in the CFL study area. MVP was used once in Baffin Bay, but the transect have not been completed because of problems with the MVP. The hull ADCP recorded all the time from Resolute Bay to Paulatuk.

Figures 1, 2 and 3 show CTD cast positions in Baffin Bay, Northwest Passage and in Beaufort Sea. Figure 4 show positions of every CTD cast that have been done during cruise.

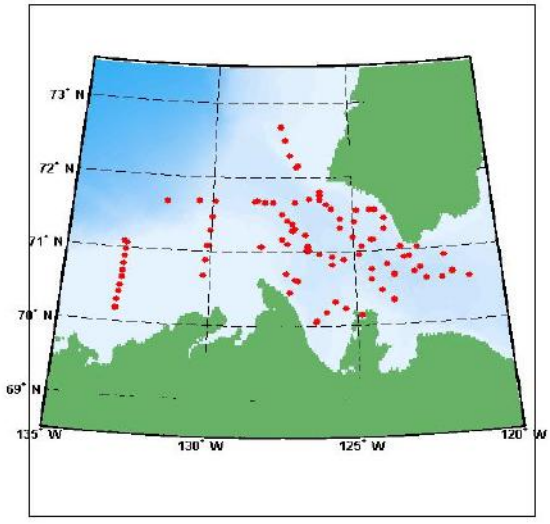

Figure 3: CTD casts in Beaufort Sea

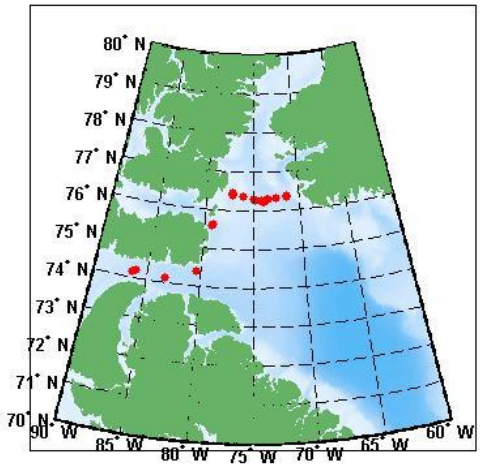

Figure 1: CTD casts in Baffin Bay

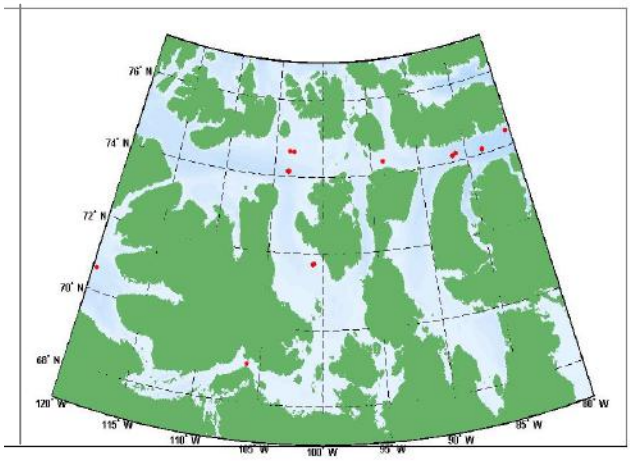

Figure 2: CTD casts along Northwest Passage

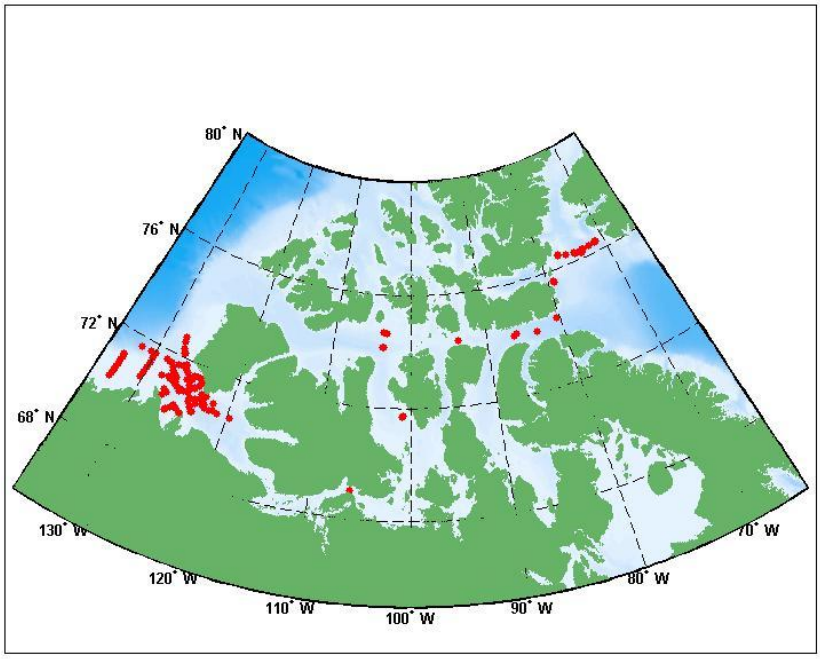

Figure 4: CTD cast done on leg3, cruise 0706

Available data
All information concerning the Rosette casts are summarized in the CTD Logbook. It includes cast and station numbers, date and time of sampling in UTC, latitude and longitude, bottom and cast depth, comments concerning the cast and its name. A Rosette sheet was also created for every single cast. It includes the same information than the CTD Logbook plus the bottle distribution among every sampling team. The weather information is written in every Rosette Log as well as in a meteorological logbook. For every cast, data recorded at the moment of bottle closure were averaged and recorded in the so-called 'bottle files'. Averaged data are those recorded between 3 seconds before bottle closure and 7 seconds after it. It includes the bottle position, time and date, pressure, temperature, salinity, transmissivity, chlorophyll, oxygen, irradiance and pH measurements. All those files are available on the 'Shares'.

- Rosette sheets and the CTD logbook : Shares\leg3\Rosette\logs
- Bottles files : Shares\Leg 3\CTD_Cast \BtlFiles
- Plots of every cast including salinity, temperature, oxygen, transmissometer, nutrients, fluorometer and irradiance : Shares\Leg3 \CTD_Cast\plots

Between September 28th and November 8th, 2007:
- 143 CTD casts were performed with the rosette
- ADCP data have been taken all along North Water Polynya, Lancaster Sound, McClintock Channel and Beaufort Sea
- A portion of the transect crossing North Water Polynya from Ellesmere Island and Greenland have been done by the MVP

Probes calibration
pH: Tests were done twice using two buffers. One is pH 4 and the other is pH 7. Results were quite good and consistent.
Salinity: Samples were taken on many contaminant's sampling casts as well as mooring stations nutrients casts. They have been analysed with a GuildLine autosal in October. Results were not very much satisfying. A rosette cast (cast 139) have been compared with a SCAMP cast and conclusions are that there is probably an offset on salinity data from the rosette. The data would probably need to be corrected.

Oxygen: Oxygen calibration was perform using Winkler's method and a Mettler Toledo titration machine. Reagent Blanks were performed twice, results show that chemicals are good (m<4). Oxygen samples were taken seven times, results are quite good.

Problems
- Sensors

Most of the sensors worked well for the whole cruise. The pH got some problems because of water intrusion in cables, the altimeter got some problems for a still unknown reason and the nitrate sensor stopped working properly by the end of the leg.

- Bottles

Two bottles have not closed a few times on the beginning of the leg, bottles 13 and 23.

- Deck material (winch, A-frame, etc.)

The winch overheated once. We already had the same problem on previous legs.

Turbulence

Caroline Sévigny

Introduction and General Objectives

The turbulence is usually defined as the irregular, random component of the fluid motion. In the seas and the oceans, this phenomenon is mainly associated with sheared flow induced by breaking internal waves. The resulting ”eddies” generated by this flow them-shelf induced strain that enhanced the production of overturns at smaller scales and so on to viscosity. This energy cascade (primarily directed toward smaller scales) promote scalar mixing, the ending of turbulence. While this process occurs in the upper ocean layer (< 100 – 150 m), it promotes pollutants dispersion, growth and vitality of marine organisms (especially plankton) and transfer of momentum, heat and gases across the surface.

To date, only few studies have tried to understand and to quantify the turbulent processes in the Arctic Ocean. Most of them deal with the special case of Barrow Strait [Melling *et al.*, 1984, Crawford *et al.*, 1999,Marsden *et al.*, 1994], a strait knew as highly active in term of vertical transport and mixing. Some other projects as the *Coordinated Eastern Arctic Experiment* (CEAREX, conducted east of Greenland; [Padman & Dillon, 1991]) and the *Lead Experiment* (LAEDEX, conducted north of Alaska; [McPhee & Stanton, 1996]) had also focus on the physical characteristics of turbulence in other arctic regions. Those works had brought some answers (i.e. the role of diurnal tides and high frequency internal waves), but did not clarify the problem for the whole Arctic. The general objectives of this study is then (i) to sketch a general pattern of active turbulence in the High Arctic and the Baffin Bay, (ii) to identified the main physical processes responsible of the observed mixing and (iii) to specified the role of turbulence in term of biological production.

Methods

The turbulence act first on the velocity field: the propagating waves create line vortices which continuously advect each other in complex ways. As those complexes structures are relatively stable, the mixing meanly occurs in region of intense strain created between any nearby vortices. The large resulting velocity gradients at small scales (1 mm to 1 cm) can be detected by air-foil shear probe, a piezo-ceramic bender that generates an electrical charge in response to cross-axial forces. The signal collected by this probe (u') and then, the deducted shear (du'/dz) can be used to estimated the rate of loss of kinetic energy under turbulent event ($\varepsilon \propto (\partial u'/\partial z)^2$, Wkg^{-1} or m^2s^{-3}), a parameter ranging from 10^{-10} Wkg^{-1} in the deeper part of the oceans to 10^{-1} Wkg^{-1} in the more active regions. A *Vertical Microstructure Profiler* (VMP) equipped with two similar probes have been used in this ArcticNet/CFL cruise to sample the turbulent vector field in open water. This profiler was deploying at each basic (30 min) and full stations (60 min) for a sequence of profiling. As the turbulence is most understood by statistical analysis, the profiling sequence is essential to predict the intensity and the characteristics of the turbulent flows. The VMP falls at a rate of $0.6ms^{-1}$ and has a sampling rate of 512Hz, which allows a measure at each millimetre. It is also equipped with a conventional Sea-Bird CTD (*Conductivity, Temperature and Depth* sensor, sampling rate: 64 Hz) and two fast response thermistors (sampling rate: 512 Hz).

As the vortices are created, the scalars fields (i.e. temperature) are compressed by the strain create between the turbulent structures of the flow. The scalar variance is then driven to smaller scales via eddies as the energy cascade goes on. As soon as they are formed, those thermal anomalies are blend into the background by molecular diffusivity at a rate χ, the rate of loss of thermal variance ($°C^{-2}s^{-1}$). It is the far end of turbulence, the smaller possible tracks of overturns. This turbulent mark can be detected by the *Self-Contained Autonomous Profiler* (SCAMP), a profiler designed to directly estimate the thermal variance produced by diapycnal mixing. This instrument has two fast response thermistors to measure the temperature gradient at every 0.01 s. As it falls at a rate of 0.1ms−1, the resulting precision is of 1mm, which is sufficient to resolve the complete scalar spectrum and to estimate $\chi \propto (\partial T'/\partial z)^2$. The SCAMP is also fitted with PAR, accurate T, accurate C, pressure and fluorometer sensors. This complementary instrument has been used in profiling sequence mode at some basic (deployed from the moon pool, 90 min) and full stations (deployed from the zodiac, 120

min, or the moon pool, 90 min) in this ArcticNet/CFL cruise. The figure 1 gives an example of the expected results.

Sampling

In total, 66 profiles have been taken with the SCAMP and 100 with the VMP in 27 different stations. The table below shows the details of this sampling.

SATATION	DATE	LOCATION	LAT	LON	MEASURE
101	29-SEP-07	Baffin Bay	76.2675	-77.26669	SCAMP
101	30-SEP-07	Baffin Bay	76.2997	-77.2294	VMP
105	30-SEP-07	Baffin Bay	76.1902	-75.3268	VMP
115	01-OCT-07	Baffin Bay	76.2212	-71.19	SCAMP
111	02-OCT-07	Baffin Bay	76.1801	-73.0684	VMP
108	03-OCT-07	Baffin Bay	76.1364	-74.4094	SCAMP
108	03-OCT-07	Baffin Bay	76.1309	-74.5035	VMP
302	07-OCT-07	North-West Passage	74.0899	-86.1330	SCAMP
308	09-OCT-07	North-West Passage	74.0792	-103.0791	SCAMP
308	09-OCT-07	North-West Passage	74.0744	-103.0284	VMP
309	10-OCT-07	North-West Passage	74.40127	-103.07749	VMP
434	15-OCT-07	Amundsen Gulf	70.1087	-133.3248	VMP
435	17-OCT-07	Amundsen Gulf	71.0408	-133.4134	VMP
1806	19-OCT-07	Amundsen Gulf	72.43806	-127.12199	VMP
1800	20-OCT-07	Amundsen Gulf	72.0821	-127.4035	VMP
437	21-OCT-07	Amundsen Gulf	71.4713	-126.3432	VMP
408	22-OCT-07	Amundsen Gulf	71.1700	-127.3218	SCAMP
408	22-OCT-07	Amundsen Gulf	71.1686	-127.3218	VMP
407	23-OCT-07	Amundsen Gulf	71.0085	-125.5759	SCAMP
407	24-OCT-07	Amundsen Gulf	71.0231	125.5786	VMP
405	25-OCT07	Amundsen Gulf	70.3997	-123.0193	SCAMP
405	25-OCT-07	Amundsen Gulf	70.3934	-123.0113	VMP
1000	26-OCT-07	Amundsen Gulf	70.3584	-120.5899	VMP
1100	27-OCT-07	Amundsen Gulf	71.0230	-123.1547	VMP
1110	27-OCT-07	Amundsen Gulf	70.1909	-124.5432	VMP
1116	28-OCT-07	Amundsen Gulf	70.0383	-126.2075	SCAMP
1124	29-OCT-07	Amundsen Gulf	70.3953	-127.4292	SCAMP
1124	30-OCT-07	Amundsen Gulf	70.4263	-127.4955	VMP
1200	31-OCT-07	Amundsen Gulf	71.32713	-124.13839	VMP
1200	31-OCT-07	Beaufort Sea	71.3292	-124.2591	SCAMP
1600	02-NOV-07	Beaufort Sea	71.3301	-130.5776	SCAMP
1600	02-NOV-07	Beaufort Sea	71.4124	-130.4905	VMP
1606	02-NOV-07	Beaufort Sea	71.0474	-130.3107	SCAMP
1902	03-NOV-07	Amundsen Gulf	71.3345	-126.5600	SCAMP
1908	05-NOV-07	Amundsen Gulf	71.08865	-124.1922	SCAMP
1916	06-NOV-07	Amundsen Gulf	70.5400	-122.0858	SCAMP

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2.3. Team 2

2.3.1. Ice dynamics

PI: David Barber
Participants: Monika Pucko, Phil B.J. Hwang, Pascale Collin, Mukesh Gupta, Dan Leitch (all at CEOS, University of Manitoba)

Ice physical-microstructure (Ice Raid)
Monika Pucko, Phil Hwang & Pascale Collin

General ice conditions:
During Leg 3B we encountered pancake ice very frequently. This large number of pancake ice is likely due to strong south-eastern wind which prevailed during most of the period in Leg 3B. As air temperature quickly decreased to about -20°C on Nov. 3, we frequently encountered frost flowers on the bare ice surface.

Physical sampling:
A field program (Ice Raid) was designed to obtain the physical-microstructure properties of snow/sea ice. To access the ice surface during Leg 3B, we used ice cage (see Figure 1.1), lowered from the starboard side of the ship. Air and ice temperatures were measured by a hand-held temperature probe (Traceable, Digital Thermometer, 4000C).

Ice surface condition (i.e., snow, frost flower or slushy layer) was recorded. In case of slushy layer, we scraped the surface slushy layer and put the scarped sample into a whirlpak bag for the salinity measurement. We also measured the thickness of the slushy layer if it is thick enough. In case of frost flower, the standard procedure are 1) to take the photos of frost flowers using a digital camera (Pentax, Potio W30) mounted on a purpose-made camera stand to estimate spatial coverage of frost flower, 2) and to take micro-scale photos of frost flowers with macro setting. We described the presence of slushy layer underneath frost flowers. In case of snow, we measured the snow depth and described the characteristics of snow (i.e., the presence of slushy layer), and also took some pictures of snow. Standard procedure also includes taking photos of snow grain size and capacitance (snow wetness) measurements. Two ice cores were taken: one for microstructure analysis and the other for salinity measurements. To measure bulk ice salinity we cut an ice core into several pieces for 2.5 - 5 cm interval and put the ice piece in a waterproof bag until it's melting. We recorded conductivity, temperature and salinity from a conductivity meter.

We set up the cold lab (-20°C) to take ice microstructure photography: thick and thin sections (see Figure 1.2). The temperature of the cold lab varied between -15°C and -20°C, but occasionally increased up to -8.0°C. The crew fixed the problem around Nov. 3. Since then the temperature of the cold lab was constant around -20°C. To take thick section photography, we cut an ice core into pieces and attached the piece on a glass plate, and fixed the ice piece by applying three layers of freshwater around the piece. Once, the ice piece firmly fixed on the plate, we prepared a thick section by shaving down the ice piece to about 5-10 mm thick. Then, we took pictures of the thick section by a digital camera (Canon, PowerShot G2) to see air bubble or brine pocket/tube distribution. A stereomicroscopy may be used to see more detailed distribution of air bubble or brine inclusions in a higher resolution. Once thick section pictures were taken, we shaved down the ice piece to a few millimeter thick (called a thin section). Then, we took cross- and parallel-polarization images from the

thin section by putting polarized sheets under the ice section and between the ice section and the digital camera.

Total 14 ice samples were collected for physical-microstructure analysis (Table 1.1). Ice thickness varied between 5 cm and 30.5 cm, and the ice samples included nilas, consolidated pancake and grey ice.

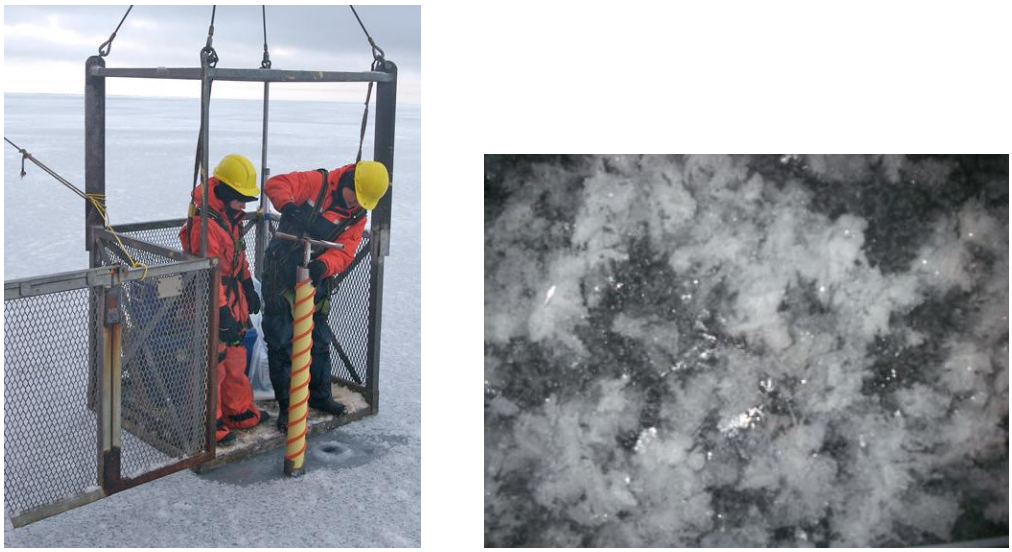


Figure 1.1 Ice cage (left) used for "Ice Raid" to obtain the physical-microstructure properties of snow/sea ice, and a picture of frost flowers (right) during ice raid on Nov. 6.

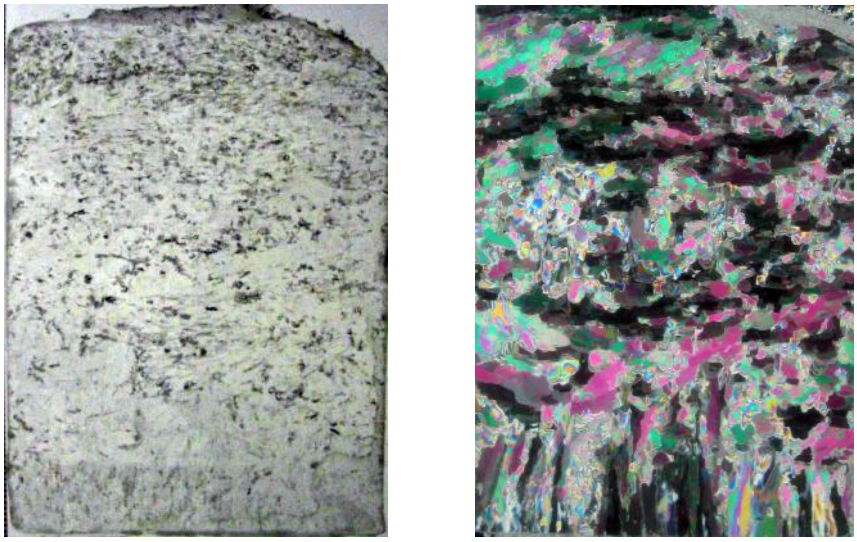


Figure 1.2 Thick (left) and thin (right) section

Table 1.1 Summary of ice physical-microstructure measurement.

	Station	Local time	Type of ice	Ice mciro
Date	**#**	**(hh.mm)**		
06-11-2007	1916	01.00	Grey ice (12 cm)	thick (x), thin (x)
05-11-2007	1908	09.45	Consolidated pancake (30.5 cm)	thick (x), thin (x)
05-11-2007	1908	09.00	Grey ice (12 cm)	thick (x) , thin (x)

03-11-2007	1902	10.45	Consolidated pancake (22 cm)	thick (v), thin (x)
03-11-2007	1902	10.45	Nilas (5 cm)	thick (v), thin (v)
02-11-2007	1606	11.30	Consolidated pancake (6 cm)	thick (v), thin (v)
31-10-2007	1200	11.00	Consolidated pancake (10 cm)	thick (v), thin (v)
31-10-2007	1200	11.00	Consolidated pancake (14.5 cm)	thick (v), thin (v)
30-10-2007	1208	13.30	Consolidated pancake (8-9 cm)	thick (v), thin (v)
30-10-2007	1208	13.31	Nilas (??)	N/A
29-10-2007	1216	12.00	Nilas with snow/frost flower cover (10 cm)	thick (v), thin (v)
28-10-2007	1116	12.30	Nilas (6 cm)	thick (v), thin (v)
27-10-2007	1110	16.45	Nilas (8-9 cm)	thick (v), thin (v)
26-10-2007	1000	14.30	Slush/grease ice (unconsolidated)	N/A

Thick (v): vertical thick section, thin (v): vertical thin section

Surface EM measurements

Mukesh Gupta & Phil Hwang

Objectives:

Ship-based ice-EM measurements were conducted to investigate the interactions between microwave signatures (both active and passive) and sea ice thermophysical properties. The observed data will be used to calibrate sea-ice products from the satellite sensors and to evaluate the theoretical microwave emission/scattering models. This result will provide more advanced knowledge of how microwave signature reacts to the evolution of sea ice thermo-physical properties on small scales during the fall freeze-up period.

Instrumentation and methods:

The radiometers are dual polarized (vertical and horizontal) radiometers at 37 and 89 GHz with 6° beamwidth antennas (Radiometrics). The radiometers were mounted about 12 m above the sea surface on the portside of the ship (Figure 2.1). During transect, the radiometers were fixed at the incident angle of 55°. Whenever the ship was stationary, we changed the incident angle of the radiometers from 30° to 150° at a 5° interval. A network camera (Canon, VB-C10R) was mounted on a rail right beside the wheelhouse. The initial set-up for the camera was pan=0.00°, tilt=-25.00° and zoom=43.40° and was changed to tilt=-40.00° from Nov. 1. The pictures were taken every 10 seconds to 1 minutes depending on surface conditions. A hand-held digital camera was also used to record the visual surface condition.

A C-band polarmetric (VV, VH, HV, HH) scattereometer system (PROSENSING) was deployed about 7.56 m above the sea surface (Figure 2.1). Whenever the ship was stationary, measurements from the ship were done from -30° to 30° in the azimuth, with the 0° reference at a perpendicular line to the ship side and from 20° to 60° in elevation at 5° increment. An infrared transducer (Everest, 4000L) was mounted on a rail in the shed for the C-band scattereometer system (Figure 2.1). Ice thickness camera was set up on the main deck at the port side.

We investigated the feasibility of Laser Wave Slope (LAWAS) in estimating sea ice surface roughness in collaboration with Sara Woods.

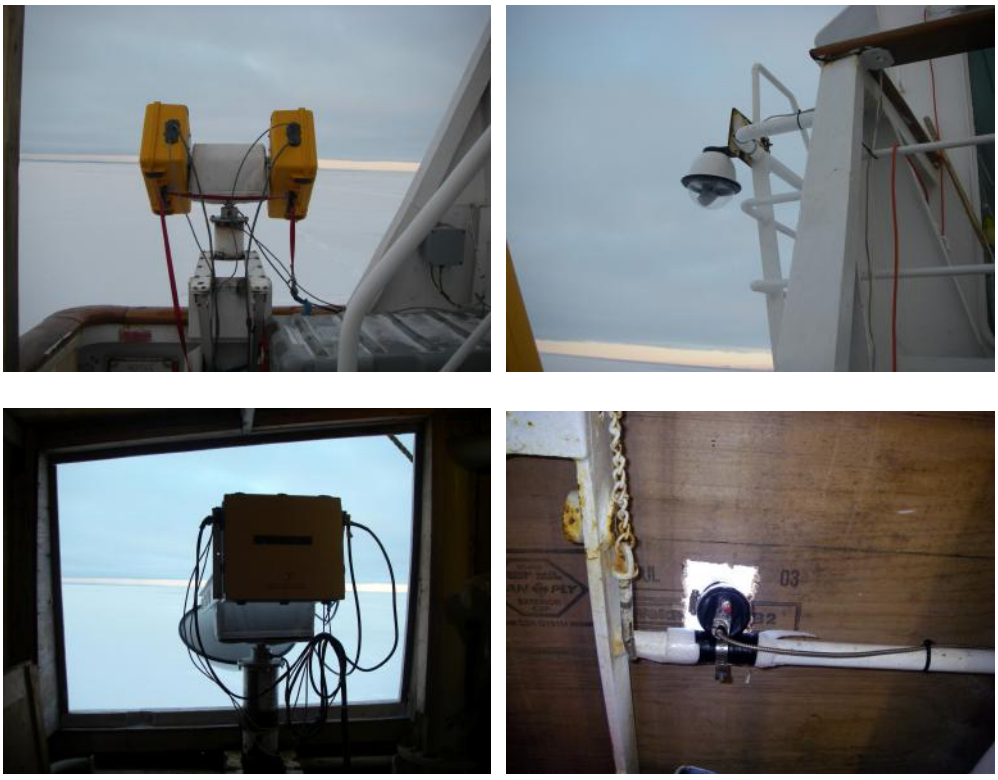


Figure 2.1 Microwave radiometer system (top left), webcam (top right), scattereometer (bottom left) and infrared transducer (bottom right).

Color dissolved organic matter (CDOM), fluorescence of dissolved organic matter (FDOM), salinity and oxygen isotope ($\delta^{18}O$)

Pascale Collin & Dan Leitch

Water and ice were collected onboard using the rosette and the ice cage at selected stations (see Table 1.1 and 3.1). The water was collected at 0 m, 5 m, 10 m, 25 m, 50 m, 100 m and 200 m on contaminant casts. The surface samples were always collected using a bucket during the rosette cast on the forward deck. $\delta^{18}O$ was collected by team 5 during basic and full station on the rosette at depth 0 m, 5 m, 7.5 m, 10 m, 25 m, 50 m, 100 m, 200 m and bottom.

The surface water was collected directly on the ice by scooping the surface with a bottle for each ice station. The CDOM and FDOM sample were collected at selected stations. For the ice station selected for CDOM and FDOM analysis, $\delta^{18}O$, HCH, salinity has been collected, physical properties of sea ice has been noted and vertical microstructure analysis of the ice has been processed. Due to problems with the spectrophotometer Cary 50, the CDOM samples has been store at $4^{o}C$ and measurements of CDOM will be completed at University of Manitoba.

Preliminary Results:

CDOM and FDOM analysis will be performed after the cruise in laboratories at the University of Manitoba. Stable isotope analysis of water and ice samples will be analyze outside of the university.

Hexachlorocyclohexanes (HCHs) concentration and enantiomeric composition in the sea ice

Monika Pucko

Ice samples for HCHs concentration and enantiomeric composition were collected at each basic and full station where the newly formed ice was present (except from 30th of October 2007). The samples for oxygen isotope composition ($\delta^{18}O$) and salinity were taken along with all ice samples. The ice samples were collected in collaboration with team 8 (Gary Stern, contaminants) in order to link HCHs

concentration and chiral composition in different parts of the environment with the Arctic climate changes (see team 8 cruise report). In cases where more than one type of ice was present, 2 ice samples were collected. The total of 12 samples of newly formed sea ice for HCH analysis was collected (see Table 1.1 and 3.1).

Ice samples for HCH analysis were collected from the ice cage [refer to Section 1. Ice physical-microstructure (Ice Raid)]. When the ice was thin enough, the ice chipper was used. In case of thicker ice (>15 cm) the ice cores were taken. The total of 4-8 L of melted ice was pumped through a glass-fiber filter followed by an ENV+ solid-phase extraction (SPE) cartridge using peristaltic pumps. The cartridges and GFFs were stored in -80 °C and brought to the DFO (Winnipeg) for further chemical analysis.

Table 3.1 Summary of CDOM, FDOM and HCH sampling.

	#	Type of station	Optical	Optical	HCH	Microstructure
Date	**Station**		**water**	**ice**	**ice**	
06-11-2007	1916	Basic		x	x	x
05-11-2007	1908	Basic		x	x (2 types)	x
01-11-2007	1600				x	
02-11-2007	1606				x	x
03-11-2007	1902	Full	x	x	x	x
29-10-2007	1216	Full	x		x	x
30-10-2007	1212	Nutrients	x			
30-10-2007	1208	Basic		x		x
31-11-2007	1204	Basic				
31-10-2007	1200	Full	x	x	x (2 types)	x
28-10-2007	1116	Full	x		x	x
27-10-2007	1110	Basic	x	x	x	x
27-10-2007	1108	Nutrients	x			
07-10-2007	1104	CTD-Nutrients	x			
24-10-2007	1016	CTD-Nutrients	x			
24-10-2007	1012	CTD-Nutrients	x			
26-10-2007	1002	CTD-Nutrients	x			
26-10-2007	1000	Basic	x	x	x	x
20-10-2007	437	Mooring/Full	x			
22-10-2007	420	Mooring/Full	x			
21-10-2007	415	Nutrients	x			
21-10-2007	414	Nutrients	x			
22-10-2007	408 CA-1507	Mooring/Full	x			
23-10-2007	407 CA08-06	Mooring/Full	x			
25-10-2007	405	Full	x			
		Total	**18**	**7**	**12**	**10**

Logistics:

Recommendations:
The temperature of the cold room (lab 555) and the refrigerated room (lab 554) **needs to be verified more often and constantly**. **The temperatures of both labs are fluctuating with the change of air temperature outside.** A periodic reading could be done e.g each 2 hours. A log sheet should be posted outside of the labs with the time and temperature reading and the initials of the person responsible of the readings. We need to insure the constancy of the temperature to avoid samples to melt or to be in improper storage temperature.

2.3.2. Canadian Arctic Buoy Program

PI: Bruno Tremblay
Participants: Jean-François Lemieux & Bruno Tremblay

Funded by: Canadian Foundation for Innovation - McGill Excellence fund from the Faculty of Science and matching funds from the department of Atmospheric and Oceanic Sciences at McGill.

The Canadian Arctic Archipelago (CAA) is expected to become navigable in the near future. Current estimates are based on simulation results from General Circulation Models (GCMs). The spatial resolution of GCMs, however, only allows for a coarse representation of the CAA. To this end, higher resolution models are needed in order to better predict the future evolution of the sea ice in the CAA. Until now, sea-ice dynamic models have been calibrated against buoy drift data in the Arctic Ocean from the International Arctic Buoy Program (IABP) - IABP has no buoys deployed in the CAA. Whether the calibration of these models and the continuum assumption upon which they are based, are still valid at high resolution remain an open question. To address this, we propose to make in-situ measurements within the narrow passages of the CAA. In particular, we will monitor the temporal evolution of sea-ice deformations, internal ice stress and ice thickness. These measurements will be used to calibrate/validate a high resolution sea-ice model that is being developed in our group. The sea-ice model is based on the granular material rheology (Tremblay and Mysak, 1997). The dynamical part of the model is now solved using the Generalized Minimum Residual method (GMRES), with a line Successive Overrelaxation (LSOR) preconditioner. This new implementation constitutes a significant improvement in numerical efficiency and allows for the integration of the model at high resolution over a domain including both the CAA and the Arctic Ocean.

We will deploy 3 ice buoys each year for 3 years in the M'Clintock or the Viscount-Melville Channels within the CAA. The buoys are manufactured by METOCEAN (Dartmouth, Nova Scotia). They are tested and pre-programmed in house prior to deployment. Three types of buoys will be used: a Spherical Drifter (SVP), an Ice Stress Buoy (ISB), and an Ice Mass Balance Buoy (IMBB). The SVP includes a Global Positioning System (GPS) and an Iridium transmitter. The ISB includes a Campbell scientific data-logger, a Global Positioning System (GPS), an ARGOS transmitter, 2-meter barometric pressure and surface air temperature, and a set of Geokon strain gauges for sea-ice stress measurements. The IMBB include a GPS, a Campbell scientific data-logger, a Global Positioning System (GPS), an ARGOS transmitter, 2-meter barometric pressure and surface air temperature, a thermistor string within sea ice, and above-ice and below-ice acoustic sounders measuring the height of the surface and bottom.

During Leg 3A we successfully deployed three SVP and 1 IMBB and are presently transmitting data via Iridium and ARGOS – this data is available online upon request. This year the ISB was not deployed - the buoy is currently in development at METOCEAN and will be deployed starting next year. A third SVP was deployed instead. The buoys were deployed using the logistic support of the *CCGS Amundsen* and its helicopter. The proposed buoy arrangement will allow the direct measurement of sea-ice thermodynamic growth/melt (using the IMBB), growth through sea-ice convergence (ridging) by monitoring the changes in area enclosed by the three buoys, sea-ice mechanical properties (using the internal ice stress measurements from the ISB, together with a knowledge of the wind forcing from local weather stations and reanalysis data), and sea-ice deformation using the stress and strain-rate information for the set of three buoys. The life expectancy of a buoy is approximately 2 years. The 3-year buoy deployment effort will therefore provide four years of data. This data will feed into a longer-term modeling effort by the PI who is working together with PhD students and postdocs on the validation of the high resolution sea-ice model of the Canadian Arctic Archipelago (including the Arctic Ocean).

Currently, sea-ice drift data from the CAA are quasi non-existent. The IABP focuses mainly on the Arctic Ocean, and of its 39 presently active buoys, one is located at the mouth of the Nares Strait

(between Greenland and Ellesmere Island), and one at the mouth of the Lancaster Sound. Also, sea-ice drift estimates from passive microwave imagery SSM/I are not possible in the CAA due to the small deformations present over the usual 3-day swath period. Our buoy deployment effort will complement the IABP. The Buoys also provide surface air temperature and pressure. These data are being assimilated in reanalysis products and weather prediction models such as National Centers for Environmental Prediction - National Center for Atmospheric Research, and European Center for Medium-Range Weather Forecasts. The calibration/development of the high resolution model for this region will give us a unique opportunity to address questions such at the timing of the opening of the North-West Passage to navigation, and the future of the sea-ice cover in the CAA in a warming world. This is crucial for Canada for the management of its interior waters and economic planning/development of the High Arctic.

2.4. Team 3

2.4.1. Remote sensing

PI: Pierre Larouche (DFO-IML)
Participant: Sélima Ben Mustapha (Université de Sherbrooke)

Rationale:
To understand and to monitor biophysical processes in complex coastal waters it is necessary to use remote sensing methods. CASES measurements showed that optical properties of the Beaufort Sea and the Amundsen Gulf region are dominated by the freshwater outflow from the Mackenzie River leading to a bias in the estimation of phytoplankton biomass using remote sensing data. There is thus a need to develop specific methods to make more effective use of remote sensing data. The building of a database of inherent optical properties relating a wide variety of physical and biological conditions is a crucial step towards this goal.

Objectives:
The general objective of our team is to study the relationship between the spatial and temporal distribution of the phytoplankton and the physical environment in the Canadian Arctic with an emphasis on the Beaufort Sea and the Baffin Sea using remote sensing data.

Specific objectives for the Arcticnet/CFL 2007-08 cruise are:

- The estimation of the ability of current bio-optical algorithms to measure chlorophyll-a concentration;
- The development of specific algorithms for a variety of ocean color sensors which will in turn provide a better understanding of the Beaufort Sea and the Baffin Sea physical and biological processes;
- The analysis of light absorption properties of arctic phytoplankton.

To reach these objectives, we will measure the following parameters:

(1) the transparency of the water with a Secchi disk;
(2) profiles of light in the water column with a Profiler of Natural Fluorescence (PNF 300);
(3) the pigment composition of phytoplankton with the high performance liquid chromatography method (HPLC);
(4) the algal pigments;
(5) the total suspended matter;
(6) the chromophoric dissolved organic matter (CDOM).

Methods:
Light profiles in the water column were done with a PNF-300 and we measured the water transparency with a Secchi disk at every station to determine the photic depths, except for some stations that were sampled during the night.

Water samples were taken at each station using Niskin bottles attached on the CTD rosette system. Samples were taken at 6 photic depths corresponding to 100%, 50%, 10%, 1% light levels, at the chlorophyll maximum as determined from the downcast fluorometer profile and at 60 metres to provide reference data under the pycnocline.

Filtrations were performed for chlorophyll determination (HPLC techniques), a_{ph}, total suspended matter (TSM) and chromophoric dissolved organic materiel (CDOM).

Surface water was collected using a clean bucket at all stations. Sub-samples were immediately collected to measure CDOM, chlorophyll-a, algal pigments and suspended matter concentrations.

For chlorophyll-a, and algal pigments, water samples were filtered through 25 mm GF/F filters, flash freezed and stored in liquid nitrogen on the ship. Samples will be transported south for analysis at the end of the leg.

CDOM samples were filtered using 0.2 µm Anotop® syringe filters (Whatman) and collected into 60 ml acid-cleaned amber glass bottles. The bottles were stored frozen (-20 ˚C) in the dark on the ship. Samples will be transported south for analysis at the end of the leg.

Total suspended matter was measured by filtering up to 2 litres of water using pre-weighted 25 mm GF/F filters. The filters were stored on the ship at –80 ˚C, to arrest pigment degradation (Sosik, 1999), and will be transported south at the end of the leg to complete the analysis.

Detailed sampling activities are summarized in the Appendix.

Conclusion:
The Arcticnet / CFL LEG3 operations were successfully completed between September 27 and November 8, 2007. This was a successful cruise with more samples gathered than previously planned.
We have 33 Stations with a total of 617 samples.
The chief scientist was comprehensive of the particular needs of the optics team, and the captain and crew members were professional and cooperative for scientific operations.

Remarks:
At the beginning of the cruise, it was planned to process CDOM samples [$a_{CDOM}(\square)$] on board using a Cary 50 spectrophotometer. Unfortunately that piece of equipment broke between legs 1 and 3 forcing us to store the samples and bring them back at the end of the leg. Obviously, this is not the best strategy as the effect of a long storage on data quality is not known and as this puts additional pressure on the already limited airplane capacity. A solution must be found to bring a replacement spectrophotometer on board to measure samples of CDOM in future legs.

We recommend finding best ways to transport samples at the end of legs.

Acknowledgements:
We thank the captain and the crew of the CCGS Amundsen for enthusiastic and professional assistance on board. We are particularly indebted to the crew members who helped with some operations.We are grateful to the scientific chief, Jean-Éric Tremblay, for his devotion and professional work during the expedition.

References:
Sosik, H., 1999. Storage of marine particulate samples for lightabsorption measurements. Limnology and Oceanography 44 (4), 1139–1141.

List of stations and variables collected during the leg3-2007 Arcticnet- CFL cruise (Number of depths sampled for each variable)

Leg	Date	Station	Latitude	Longitude	Chl-a (HPLC)	Algal pigments	TSM	CDOM
3	2007-09-29	101	76°24.223	-77°25.227	5	5	5	5
3	2007-09-30	105	76°17.722	-75°44.075	6	6	6	6
3	2007-10-01	115	76°22.224	-71°18.236	3	6	6	6
3	2007-10-02	111	76°18.054	-73°5.908	3	6	6	6
3	2007-10-03	108	76°17.722	-74°40.309	3	6	6	6
3	2007-10-04	134	75°35.526	-79°28.192	3	6	6	6
3	2007-10-07	301	74°7.226	-83°19.632	2	2	2	2
3	2007-10-07	302	74°9.9019	-86°11.981	3	6	6	6
3	2007-10-09	308	74°7.565	-103°1.634	3	6	6	6
3	2007-10-10	309	74°38.58	-103°33.346	3	6	6	6
3	2007-10-11	310	71°42.383	-101°44.785	3	6	6	6
3	2007-10-12	314	68°59.966	-106°36.186	3	6	6	-
3	2007-10-14	Golfe d'Amundsen	70°106.4	-121°02.14	1	1	1	1
3	2007-10-15	434	70°104.14	-133°30,948	3	5	5	5
3	2007-10-17	435	71°4.741	-133°38.872	3	6	6	6
3	2007-10-19	1806	72°40.68	-127°7.16	3	6	6	6
3	2007-10-20	1800	72°9.254	-127°44.921	3	6	6	6
3	2007-10-20	437	71°48.126	-126°30.319	3	5	5	5
3	2007-10-21	MW2	71°45.237	-126°30.422	1	1	1	1
3	2007-10-22	408	71°16.86	-127°32.53	3	6	6	6
3	2007-10-23	420	71°4.42	-128°25.099	2	4	4	4
3	2007-10-23	407	71°1.042	-126°1.933	3	5	5	5
3	2007-10-25	405	70°40.198	-123°0.772	2	5	5	5

3	2007-10-26	1000	70°35.842	-120°59.738	3	6	6	6
3	2007-10-27	1100	71°2.424	-123°15.229	3	6	6	6
3	2007-10-27	1110	70°19.333	-124°56.148	2	5	5	5
3	2007-10-28	1116	70°3.916	-126°19.043	3	6	6	6
3	2007-10-29	1216	70°35.84	-127°42.26	2	3	3	3
3	2007-10-31	1200	71°132.652	-124°27.656	3	6	6	6
3	2007-11-01	1600	71°39.952	-130°46.056	2	5	5	5
3	2007-11-02	1606	71°39.952	-130°46.056	3	5	5	5
3	2007-11-03	1902	71°23.47	-125°41,513	3	5	5	5
3	2007-11-05	1908	71°8,64	-124°20,803	3	6	6	6
	TOTAL	**33**			**95**	**176**	**176**	**170**

2.5. Team 4

2.5.1. Zooplankton, fish, acoustics & moored Sediment Traps

PIs: Louis Fortier (Laval University), Yvan Simard (ISMER) & Jacques Gagné (DFO – IML)
Participants: Alexandre Forest, Keith Lévesque, Louis Létourneau (all at Laval University), Jacques Gagné and Yvan Simard, with the help of Joanne Delaronde & Alisson MacHutchon (DFO-FWI), Luc Michaud, Pascal Massot & Steve Gagné (Laval)

General objective and field program
The general objective of our team is related to the overarching goal of ArcticNet project 1.4 led by Professor J.-É. Tremblay (U. Laval) 'Marine productivity and sustained exploitation of emerging fisheries' which is to assess the impact of sea-ice cover reduction and increasing sea temperatures on biological productivity, fisheries resources and marine mammal populations of the coastal Canadian Arctic. This assessment aims to document and anticipate the present and future biodiversity/availability of marine renewable resources, and to propose management strategies for a sustainable exploitation. Aboard the *CCGS Amundsen*, we collect key indices of the ecosystem maturity at the end of the biological production season (September to November) and we re-deploy automated instruments that record all year-long the vertical flux of biogenic matter and marine mammal distribution. The ArcticNet-CFL 2007 (leg 3) expedition consisted thus mainly of a monitoring cruise following the previous ArcticNet 2005 and 2006 cruises.

However, the 2007 cruise differed from the previous missions, since it is a component of the 15-months Amundsen's expedition as part of Canada's contribution to the International Polar Year (IPY) 2007-2008. In particular, the second half of leg 3 (18 October – 8 November) was the beginning of the Circumpolar Flaw Lead System Study (CFL) which will examine on an annual cycle how the physical processes moderate biogeochemical processes within the changing northern flaw lead ecosystem nearby Banks Island (Beaufort Sea). Therefore, the sampling during this period can be seen as a pre-winter survey of the flaw lead area to get an indication of the status of the marine ecosystem at the end of the growth season and associated physical forcing. Our multidisciplinary ArcticNet team

is thus strongly linked with Team 4 (Pelagic and Benthic Foodwebs – Fortier) and Team 7 (Carbon Fluxes – Tremblay) of the CFL program.

Operations during the ArcticNet-CFL leg 3 were spread on the East-West gradient of the Canadian Arctic. This represented a large spectrum of sampling conditions and three oceanographic regions were visited: 1) the NOW polynya of Baffin Bay (Eastern Arctic), 2) the Northwest (NW) Passage, including opportunistic sampling nearby Nanissivik, and 3) the south-eastern Beaufort Sea (Western Arctic) comprised of the Mackenzie and Banks Shelves, and of the Amundsen Gulf area (the CFL study region).

The main field objectives of our multitask ArcticNet Theme 1.4 sub-team were:
1) To assess zooplankton / fish abundance and diversity by using various plankton nets.
2) To track zooplankton / fish biomass and distribution with the EK60 Echosounder.
3) To turnover the automated sediment traps and hydrophones deployed on the moorings.

In addition, zooplankton samples collected during leg 3 are also of use in other ArcticNet-CFL subprojects such as the cycling of contaminants (G. Stern). As well, part of the samples collected will be used in a study to identify the sources and pathways of omega-3 in the arctic marine food chain (J. Michaud, E. Dewaily and L. Fortier) and is linked to the ArcticNet theme 1.5 that is focussing on the importance of omega-3 fatty acid in the traditional diet of Inuit communities. Also as part of the CFL Team 4 on the pelagic food web, the assessment of the respiration rates of the zooplankton community by the Electron Transfer System (ETS) activity method was performed at chosen stations (G. Darnis and L. Fortier). At some stations, zooplankton samples were also collected for genetic studies at Woods Hole Oceanographic Institution (Victoria Starczak) and at UQAR (France Dufresne and Adriana Radulovici).

In total, 32 stations were visited for zooplankton & fish sampling. However, the ice conditions (multiyear ice floes or fast-growing sea ice) severely constrained the sampling at many stations during leg 3. Acoustics EK60 monitoring was done continuously during the whole cruise. On the moorings, 1 automated sediment trap was recovered (CA-18C) and 9 were deployed (in Beaufort Sea only). The Table 1 (p. 3) summarizes the sampling activities at each of the 32 stations. And the details of the operations are fully described in the following sections: 1- Zooplankton & fish sampling (p. 4); 2- Acoustic monitoring (p. 7); 3- Mooring operations (p. 9).

Table 1: Summary of station-collections of the ArcticNet-CFL leg-3 Expedition

Date	Station		Sampling gear						Use of sample							# of BOSA
	Number	Type	Tucker Net	4X1m^2 (Monster)	Hydrobios	RMT	Trawl	Sediment traps	Taxo. (Fortier)	Contam. (Stern)	Lipids (Michaud)	DNA (UQAR)	Genetic (WHOI)	ETS/Bio. (Darnis)	Swimmers (Sampei)	
30-Sep	101	Full	ICE	X	X	ICE			X	X	X			X		-
30-Sep	105	Basic	X	X					X	X	X	X				2
30-Sep	106	Nuts.				X			X	X						-
01-Oct	115	Full	X	X	X	X			X	X	X	X	X		X	-
02-Oct	111	Basic	X	X					X	X	X	X				-
02-Oct	108	Full	X	X	X	X			X	X	X	X	X	X		6
04-Oct	133	Basic	ICE	X					X	X	X	X	X			-
06-Oct	Nanissivik	Trawl					X		X	X	X					247
07-Oct	302	Full	ICE	X	X	ICE			X	X	X	X	X			1
09-Oct	308	Basic	X	X					X	X	X	X	X	X		-
10-Oct	309	Basic	ICE	X	X				X	X	X	X	X			-
11-Oct	310	Basic	X	X					X	X	X	X	X	X		5
15-Oct	434	Basic	X	X					X	X	X		X			3
16-Oct	435 (CA04)	Full	X	X	X	STORM		2 deployed	X	X	X		X			2
19-Oct	437 (CA16)	Full	X	X	BROKEN	STORM			X	X	X		X	X		2
19-Oct	1806	Full	X	X	BROKEN	X			X	X	X	X	X			15
20-Oct	1800	Basic	X	X					X	X	X		X			3
21-Oct	437 (CA16)	Full			X			2 deployed	X		X					-
22-Oct	408 (CA05)	Full	X	X	X	X		1 deployed	X	X	X		X	X	X	2
23-Oct	420	Basic	X	X					X	X	X					-
23-Oct	407 (CA08)	Full	X	X	X	X			X	X	X		X	X	X	1
25-Oct	405 (CA18)	Full	X	X	X	X		1 recovered 3 deployed	X	X	X	X	X	X	X	1
26-Oct	1000	Basic	X	X					X	X	X		X	X		-
27-Oct	1100	Basic	X	X					X	X	X		X	X		-
27-Oct	1110	Basic	X	X					X	X	X	X	X			3
28-Oct	1116	Full	ICE	X	X	ICE			X	X	X		X	X		-
30-Oct	1216	Full	X	X	X	BROKEN			X	X	X		X			-
31-Oct	CA08	Mooring						1 deployed								-
31-Oct	1200	Full	ICE	X	X	ICE			X	X	X		X	X		-
2-Nov	1600	Basic	X	X					X	X	X	X	X			-
2-Nov	1606	Full	ICE	X	ICE	ICE			X	X	X					-
3-Nov	1902	Basic	ICE	X					X	X	X					-
5-Nov	1908	Full	ICE	X	X	ICE			X	X	X					-
6-Nov	1916	Basic	ICE	X					X	X	X					-

Zooplankton & Fish Sampling

a) Vertical tows (4X1m^2- Monster Net, Hydrobios)

4x1-m^2 Square (Monster Net, Figure 2a): Frame rigged with four square 1m^2 opening nets (3 x 200, 2 x 500 µm mesh), out-rigged with a 10 cm diameter net (50 µm) and equipped with flowmeters (2 GOs and 2 TSKs). These nets were used for integrated water column sampling. When deploying, winch speed down was <30 m/min to avoid mixing of the nets, and winch speed up was 40m/min. The content of one 200 µm (TSK-QT) and the 50 µm mesh-net were preserved in formaldehyde for taxonomy (Fortier). The content of the three other nets were sorted for contaminants, lipids and genetics studies. At some stations, ETS assays were performed using one of the integrated tows (see Table 2 for details). This gear was systematically deployed at all basic and full stations.

Hydrobios Multi plankton sampler (Figure 2b) equipped with nine 200 µm-mesh nets (opening 0.5 m^2). This was allowing for depth specific sampling of the water column. The *Hydrobios* is also equipped with a CTD to record water column properties while collecting biological samples. When deploying, winch speeds down and up were both 40m/min. The *Hydrobios* was deployed at full stations in every region when conditions were favourable. At some stations, the content of each net was divided between preservations (4% buffered formaldehyde) and ETS assays were performed (see Table 2 for details). Please note that the recurrent problem with the *Hydrobios*'s flowmeters has not been resolved yet (they do not work in the water, while they work on deck).

Table 2: Details of the ETS/biomass assays performed during leg 3

			Vertical profiles (Hydrobios)		Integrated (Monster Net)		Stage-specific (Monster Net)	INT solution (#)
Date	Station	Sampling	ETS	Biomass	ETS	Biomass	ETS	
30-Sep	101	275 - 0 m	X	X				1
2-Oct	108	430 - 0 m	X	X				1
9-Oct	308	335 - 0 m				X		-
11-Oct	310	169 - 0 m				X		-
19-Oct	437	340 - 0 m			X	X	X	1
22-Oct	408	185 - 0 m			X	X	X	1
24-Oct	407	380 - 0 m	X	X				2
25-Oct	405	580 - 0 m	X	X				2
26-Oct	1000	350 - 0 m			X	X	X	2
27-Oct	1100	240 - 0 m			X	X		2
28-Oct	1116	220 - 0 m	X	X				2
31-Oct	1200	190 - 0 m			X	X		2

b) Oblique tows (Tucker, RMT and Trawl)

Double 1-m^2 (Tucker Net, Figure 2c): Type gear rigged with two 1m^2-opening nets (500 µm mesh each), out-trigged with a 10 cm diameter net (50 µm mesh) and equipped with flowmeters (1 GO & 1 TSK) and a temperature-depth recorded (TDR). When towed, ship speed was 2-2.5 knots and winch speed down was around 30 m/min and around 20m/min on the way up. This gear was mainly use to catch fish larvae (see Figure 1 for details of the catches) and to provide water column zooplankton samples from the upper 100 m layer. One of the 500 µm mesh net was preserved in 4% buffered formaldehyde for taxonomy and the other 500 µm mesh met was sorted for contaminants, lipid and genetics studies. This gear was deployed at both basic and full stations when ice conditions were favourable.

RMT: Rectangular Mid-water Trawl (Figure 2d) of an opening of 9 m^2 fitted with a 1600 µm mesh-net and equipped with a flowmeter and a TDR. When towed, ship speed was typically 2-3 knots; and winch speed down was 30 m/min and around 20m/min on the way up. This net, only deployed at full stations (ice dependent), was used to catch larval and juvenile fish (see Figure 1 for details). Collected zooplankton was equally divided for taxonomic and contaminant studies.

Trawl: Experimental Mid-water Trawl (Figure 2e) fitted with multiple mesh size; flexible mouth opening; depth, fish counting & aperture probes; tried to be used to catch adult fish. (validation of the EK-60 echosounder). The pelagic trawl was deployed once at an opportunistic location nearby Nanissivik (Lancaster Sound). No adult fish were caught but several juvenile Arctic Cod (~250) got caught by the trawl (see next section for details).

Figure 1: Summary of the young fish catches (larvae & juvenile) during ArcticNet-CFL leg 3: (a) total number of fish; (b) length classes of Arctic cod (*Boreogadus saida*)

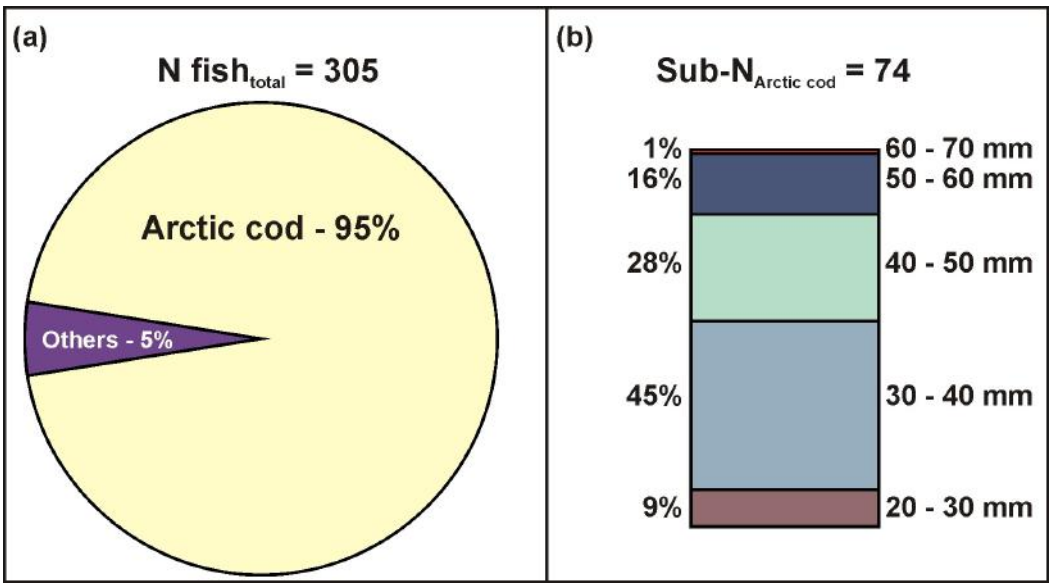
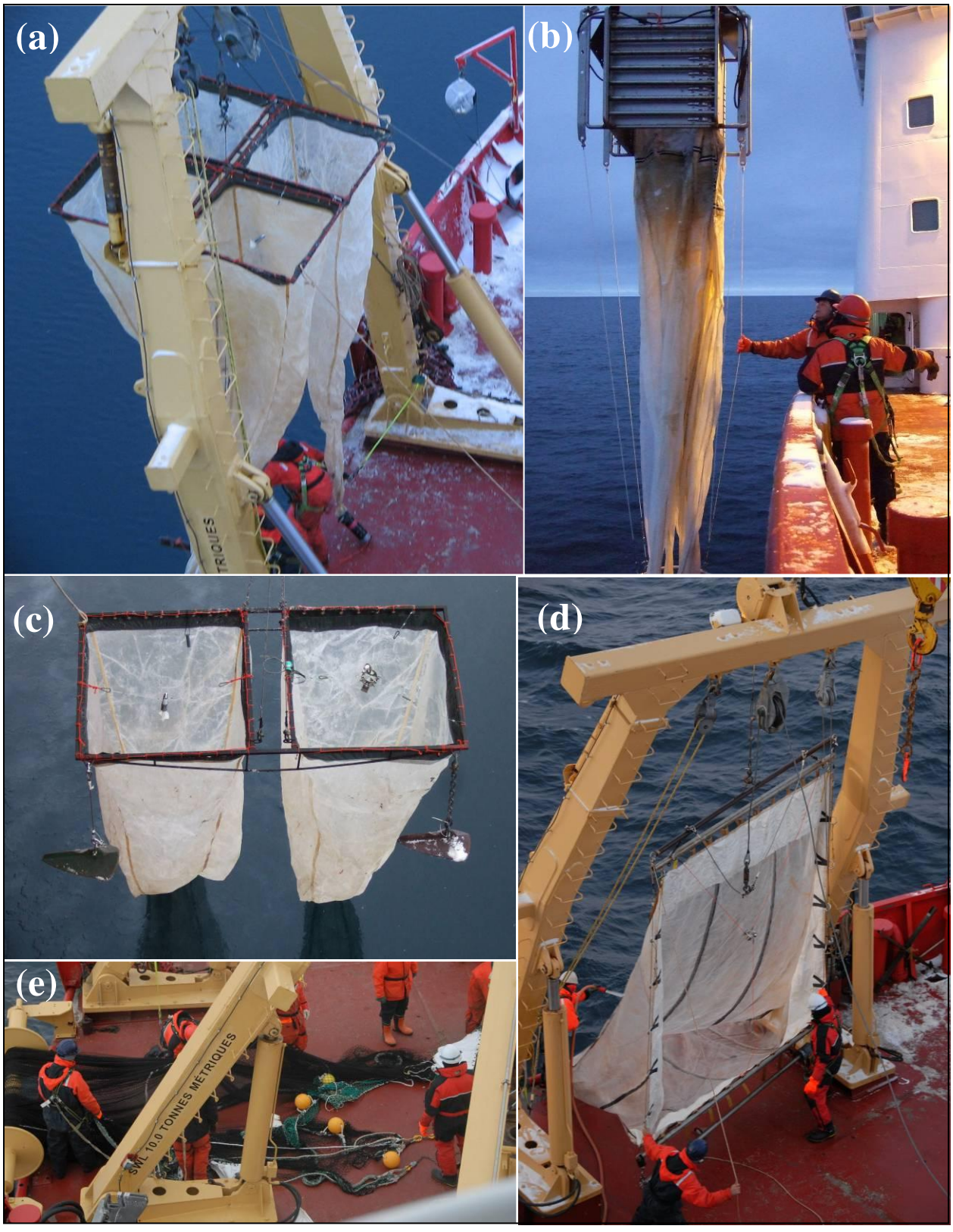
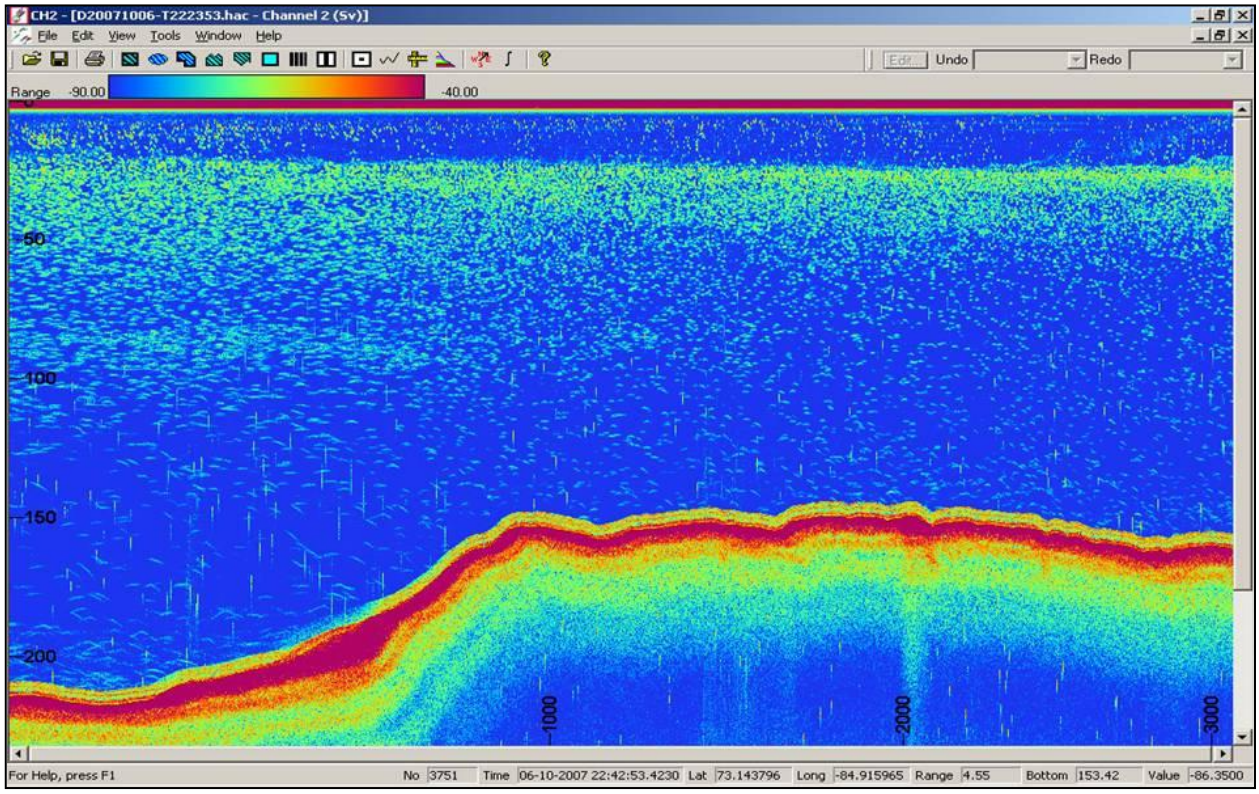


Figure 2: The different instruments used to sample zooplankton & young fish during leg 3



The Amundsen is equipped with a scientific echosounder, the EK-60, to continuously monitor the distribution of zooplankton and fish. A particular attention is devoted to Arctic cod, *Boreogadus saida*, which plays a key role in the Arctic marine ecosystem. During the first part of leg 3, an acoustic layer was detected between 20 and 100 m below the surface (Figure 3) everywhere along the route of the vessel from Resolute to the Greenland coast. Based on the analysis of the split-beam information, it seemed to contain mostly small fish and large zooplankton. When comparing the vertical distribution of the echoes to that of the water column characteristics obtained from Rosette casts, the acoustic layer appears to be associated with an intrusion of warmer waters below the surface. Another acoustic layer likely resulting from the presence of larger fish and associated with different water mass was present between 250 and 500 m. This layer, which according to its multifrequency acoustic signature also contains zooplankton, was more concentrated in the western part of Lancaster Sound. It settled on the bottom of the NOW polynya around the 350 m depth contour, especially on the Canadian side.

Figure 3: Typical EK-60 feature in Eastern Arctic (taken nearby Nanissivik, 6 Oct-2007)



An experimental pelagic trawl is also available on the Amundsen to sample concentrations of juvenile and adult fish for ecological studies and EK-60 echo validation. This trawl was deployed on October 6 off Nanisivik in the upper acoustic layer between 25 and 50 m. The catch consisted mainly of small Arctic cod about 4-5 cm long and large amphipods (Figure 4), confirming our interpretation of the echograms based on the TS (Target Strength) – size relation published by Crawford and Jorgenson (1996) for *B. saida*. It thus appears that juvenile Actic cod might represent the main source of this extensive epipelagic layer detected also during previous ArcticNet surveys. Juveniles of that key prey species could therefore be widely distributed slightly below the surface over immense expenses of the eastern Arctic Ocean, at least at this time of the year, in association with specific water masses.

Figure 4: The catch of Nanissivik

Zooplankton and fish biomasses were much less important west and south of Lancaster Sound based on the acoustic records for the Eastern entrance of Melville Sound and from M^{c}Clintock Channel to Queen Maud Gulf. They increased in Coronation Gulf to reach high values again through to the Amundsen Gulf. Based on the analysis of the EK-60 data obtained during previous ArcticNet surveys, this area and the Lancaster Sound – Baffin Bay region had been identified as *hot spots* for the sampling of juvenile and adult Arctic cod. Unfortunately, we could not deploy the pelagic trawl again because of logistic and operational constraints. Biomasses returned to a low level in the Beaufort Sea survey area.

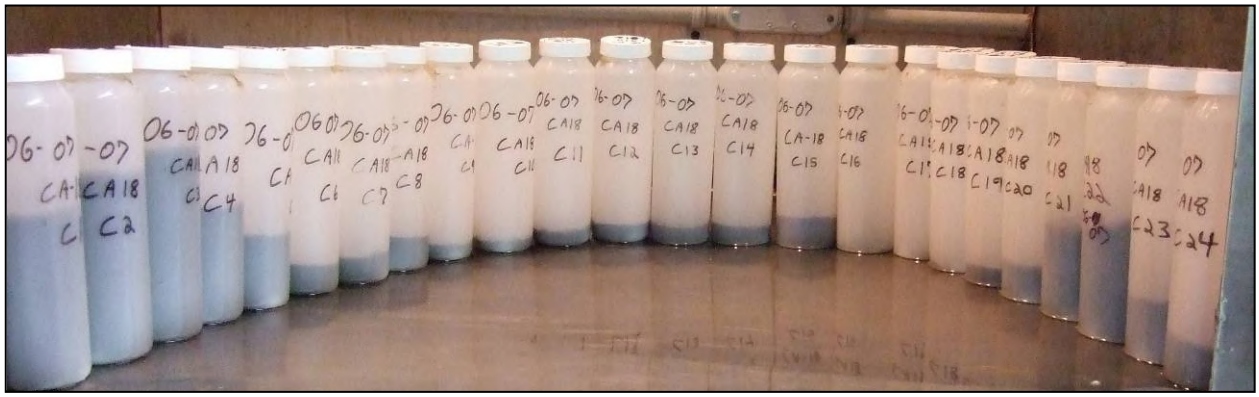
Mooring operations

The automated sediment traps installed on the moorings collect sequentially over the year the vertical flux of sinking particles (e.g. senescent plankton, excrements and detritus). The characterization of the vertical particle flux is key information to understand the marine ecosystem dynamics and the impact of environmental changes. By example, the magnitude of the flux's biogenic component (the organic fraction) is directly linked to the surface biological production and food web activities. In coastal shelf areas (such as Beaufort Sea), the collection of sinking particles serves also to estimate the input of terrigenous material (the inorganic fraction) into the Arctic Ocean. Both biological production and terrigenous inputs are expected to increase as sea ice reduces and temperature increases in the Arctic. The consequences of these environmental changes on the food web and carbon cycling are unknown. Hence, the sediment trap deployments are a crucial element of the ArcticNet monitoring science program that aims to establish a long-term series of marine observatories in the Canadian Arctic.

The mooring program suffered from a **very** serious drawdown during the leg 3 of ArcticNet-CFL 2007. We did not recover any of the two mooring deployed in Baffin Bay in 2006; and we recovered only the lower third of CA-18, one the three moorings deployed last year in Beaufort Sea. As a result, we retrieved only one sequential sediment trap out of the 11 traps deployed in these two regions

during the ArcticNet 2006 expedition (Figure 5 and 6a). In both regions, the primary problem seemed to be the ice cover that hit the moorings (icebergs or thick sea ice). A second hypothesis is that the batteries of the acoustic releasers experienced a major technical failure. For a complete report on the mooring problems and the way they were faced, we refer the reader to the official report by Senior Mooring Technician Mister Luc Michaud (SMTMLM).

Figure 5: The single sediment trap time-series retrieved during leg 3 (from CA-18, 490m)

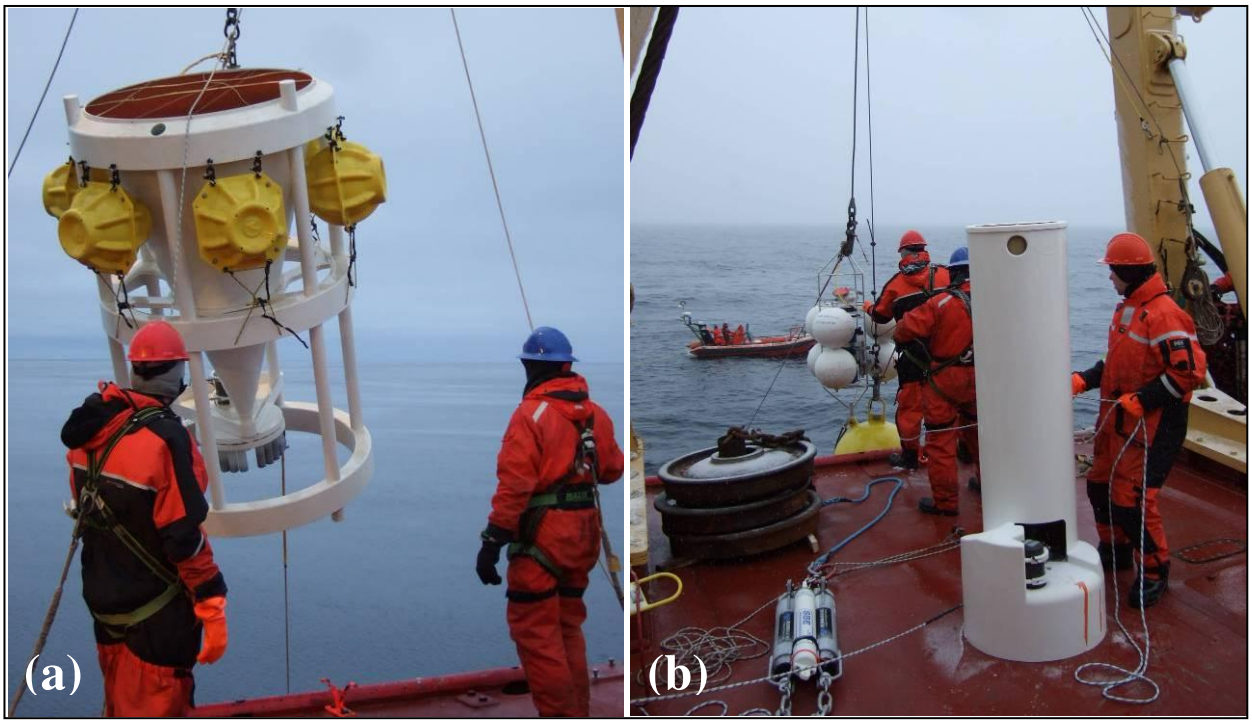


On the other hand, the pool of mooring equipment provided by the new CFI grant allowed us to maintain the marine observatories in Beaufort Sea as part of the CFL-IPY overwintering program. The 5 planned moorings equipped with sediment traps were therefore deployed in Beaufort Sea as scheduled (as the two planned MMP moorings). However, we did not deploy any moorings/sediment traps in Baffin Bay this year. As a result of the sediment trap shortage, we also decided to deploy the trap that was reserved for an under-ice experimental time-series in spring 2008 as part of the CFL study. Thus, we deployed all the new Technicap PPS-3/3-24cups that were brought onboard the CCGS Amundsen (e.g. Figure 6b). The Table 3 presents a summary of the recovery/deployments performed during ArcticNet-CFL leg 3.

Table 3: Summary of the recovery/deployments of moored sediment traps during leg 3

Date	Mooring	Operation	Latitude	Longitude	Sediment trap	Depth
18-Oct	CA-04	Deployment	71° 04.842' N	133° 37.97' W	Technicap PPS 3/3-24	112 m
					Technicap PPS 3/3-24	205 m
21-Oct	CA-16	Deployment	71° 47.403' N	126° 29.742' W	Technicap PPS 3/3-24	113 m
					Technicap PPS 3/3-24	214 m
22-Oct	CA-05	Deployment	71° 18.8' N	127° 35.4' W	Technicap PPS 3/3-24	112 m
25-Oct	CA-18	Recovery	70° 39.897' N	122° 59.563' W	Technicap PPS 5/2-24	490 m
26-Oct	CA-18	Deployment	70° 40.05' N	122° 59.563' W	Technicap PPS 3/3-24	105 m
					Technicap PPS 3/3-24	203 m
					Technicap PPS 5/2-24	490 m
31-Oct	CA-08	Deployment	71° 03.229' N	126° 1.384' W	Technicap PPS 3/3-24	101 m

Figure 6: (a) The large PP5 retrieved at CA18; (b) a new PP3-24cups deployed at CA05



2.5.2. Sediment and benthos

PIs: Archambault, P. (ISMER) and Massé, G. (U. Plymouth)
Participants: Mylène Bourque (UQAR)Guillaume Massé (U. Plymouth), Simon Belt (U. Plymouth), Michel Poulin (CMN), Lindsay Vare (Plymouth)

Objective 1: An investigation into the use of compound specific biomarkers from sea ice diatoms to determine the presence of past Arctic sea ice – high resolution studies using box core sediments.

Background
Previously, the Plymouth team (GM, SB and LV) have demonstrated that an unusual chemical biomarker, derived from sea ice diatoms, can be detected in sediments below sea ice, thus providing a proxy measure for sea ice cover in the past. Analysis of sediment material collected with the help of Dr. A Rochon (UQAR) and his colleagues during the 2005 ArcticNet cruise revealed the presence of this biomarker across the entire Canadian Arctic Archipelago from the NOW region through to the Beaufort Sea. Notably, analysis of extracted sediments showed significant temporal and spatial variations in the concentration of the sea ice biomarker, indicating variations in sea ice cover in the past and between different locations. The aim of the current fieldwork was to obtain a series of box core sediments across the CAA in order that similar measurements of biomarker concentration could be made during the more recent periods of deposition (10s to 100s of years). These data would then be calibrated against known satellite records of sea ice over the last 30 years, before applying a suitable calibration model to more extended historical datasets obtained previously.
A further aim of the current fieldwork was to collect sufficient amounts of representative species of the Arctic ecosystem in order to be able to perform analyses of their lipid contents and study the transfer of sea ice biomarkers across food chains. Benthic specimens were to be collected using a purpose built Agassiz trawl which was tested for the first time on board.

Sampling
Box core sediments were collected from a range of locations including the NOW region, the eastern edge of Viscount Melville Sound, McClintock Strait, Dease Strait and the Beaufort Sea. Cores

suitable for sectioning were obtained from 12 sites, with surface sediment obtained from a further location in the McClintock Strait (see listing below). Following retrieval, each core was mounted using newly designed and constructed sectioning equipment brought by the team from Plymouth. In general, cores were sectioned according to the following:

0 (surface) – 2.0 cm	1 mm/slice
2.0 – 5.0 cm	2 mm/slice
5.0 – core bottom (15-25 cm)	10 mm/slice

For high resolution sampling, all sections were collected as single samples, bagged and taken by GM and SB to the UK for analysis. Low resolution samples (> 5.0 cm) were divided into 2 portions (A and B); Samples 'A' were taken by GM and SB to Plymouth, samples 'B' were left on-board the Amundsen. In addition to the box cores obtained during Leg 3, the team sectioned 3 box cores obtained during Leg 1. These were at Stations 701, 617 and 707 though only the Station 701 core was sectioned at high resolution (2 mm/slice).

Agassiz: This trawl was deployed for the first time at station 115 and during this deployment; it was felt that additional weight would improve the efficiency of the equipment. It was decided that no weight should be added to the equipment as this first attempt resulted in a net which was full of mud. The correct procedure for deploying the trawl therefore consists in deploying a length of cable corresponding to the depth of the investigated area plus around 40m of extra cable so that the instrument remains at the sea bed during the operations. The trawling operations were usually performed during 5 to 15 minutes (site dependant) at around 1-1.5 knot.
The specimens collected were frozen and taken to the UK by GM and SB for analysis. Briefly, those will be freeze dried and the samples obtained will be extracted and analysed using a combination of open column chromatography and gas chromatography techniques (GC-MS).

Summary of box core locations

LEG 3

Station 115

Sectioning: 0-5.2 cm @ 0.2 cm/slice
5.2-15.2 cm @ 1.0 cm/slice

Station 111

Sectioning: 0-1.0 @ 0.1 cm/Slice
1.0-5.0 @ 0.2 cm/slice
5.0-25.0 @ 1.0 cm/slice

Station 308

Sectioning: 0-2.0 @ 0.1 cm/slice
2.0-5.0 @ 0.2 cm/slice
5.0-20.0 @ 1.0 cm/slice

Station "312"

Sectioning: Surface only

Station 314

Sectioning: 0-2.0 @ 0.1 cm/slice
2.0-5.0 @ 0.2 cm/slice
5.0-25.0 @ 1.0 cm/slice

Station 434

Sectioning: 0-2.0 @ 0.1 cm/slice
2.0-5.0 @ 0.2 cm/slice
5.0-25.0 @ 1.0 cm/slice

Station 428

Sectioning: 0-2.0 @ 0.1 cm/slice
2.0-5.0 @ 0.2 cm/slice
@ 1.0 cm/slice

Station 1806

Sectioning: Surface only

Station 1800

Sectioning: 0-2.0 @ 0.1 cm/slice
2.0-5.0 @ 0.2 cm/slice
@ 1.0 cm/slice

Station 408

Sectioning: 0-2.0 @ 0.1 cm/slice
2.0-5.0 @ 0.2 cm/slice
@ 1.0 cm/slice

Station 1000

Sectioning: 0-2.0 @ 0.1 cm/slice
2.0-5.0 @ 0.2 cm/slice
@ 1.0 cm/slice

Station 1116

Sectioning: 0-2.0 @ 0.1 cm/slice
2.0-5.0 @ 0.2 cm/slice
@ 1.0 cm/slice

Station 1122

Sectioning: 0-2.0 @ 0.1 cm/slice
2.0-5.0 @ 0.2 cm/slice
@ 1.0 cm/slice

Station 1214

Sectioning: 0-2.0 @ 0.1 cm/slice
2.0-5.0 @ 0.2 cm/slice
@ 1.0 cm/slice

Summary of species collected for lipid analyses

Ophiura sarsi, Ophiura robusta, Ampharete acutiformis, Ctenodiscus crispatus, Nymphon sp., Und. Amphipods, Mya sp., Sclerocrangon sp., Asterias rubens, Sclerocrangon boreas, Yoldia sp., Gorgonocephalus arcticus, Und. Isopods., Und. Mytilidae.

Further identification work will be carried out at the Université du Québec à Rimouski.

Summary of Agassiz trawl locations

See table below

Objective 2: Biodiversity and secondary productivity of benthic communities in areas of enhanced and reduced ("hot spots" and "cold spots") productivity and diversity in the Canadian Arctic.

Background

It is widely recognized that wide areas of the Arctic are changing from arctic to subarctic conditions. Rapid warming is causing higher water temperatures and reduced ice cover, two factors that will certainly provoke severe ecosystem changes propagating through all trophic levels. Over the past decade, a geographical displacement of marine mammal population distribution has been observed, that coincides with a reduction of benthic prey populations. According to a widely accepted conceptional model, the relative importance of sea-ice, pelagic and benthic biota in the overall carbon and energy flux will shift from a sea-ice algae-benthos to a phytoplankton-zooplankton dominance. In the context of the potential benthic community changes, it is essential to establish benchmarks in biodiversity at key locations in the Canadian Arctic prior to (a) the expected changes in ice cover, ocean chemistry and climate and (b) the future human activities (transport, trawling or dredging, drilling, etc) that are likely to happen in response to the predicted environmental changes. Unlike Canada's two other oceans, we have the opportunity to document pristine conditions before ocean change and exploitation occur. **Our objective** was to describe and compare the biodiversity and secondary productivity of benthic communities in areas of enhanced and reduced ("hot spots" and "cold spots") productivity and diversity in the Canadian Arctic.

Sampling

For the determination of macrofauna structure and composition, sediments were collected with box cores. At each station, a sediment sub-sample of 0.125 m^2, varying to 10-15 cm depth, was passed through a 500 mesh sieve and preserved in a 10 % buffered seawater formalin solution for further identification in the laboratory. The specimens collected in the Agassiz were identified to the lowest taxonomic level and counted. Some species were frozen for further identification.

Preliminary results

Catches in the Agassiz consisted mainly of brittle stars, worms, fishes, molluscs and amphipods. In Viscount Melville Sound, an unexpected sea spider (Fig. 1) was collected, which is only distributed in the Arctic. We also collected an octopus (Fig. 3), some big shrimps (Fig. 2) and sea stars.

Fig. 1

Fig. 2

Fig. 3

Summary of box cores, Agassiz sledge and Van Veen grab stations of the ArcticNet Leg 3 expedition.

		Box Core			Agassiz sledge						Van Veen Grab			
					Start position		End position							
Station	Date	Lat N	Long W	Depth (m)	Lat N	Long W	Lat N	Long W	Trawling time (min)	Depth (m)	Lat N	Long W	Depth (m)	Comments
101	2007-09-30	76°31.30	077°23.25	252										Gravel and cobbles
105	2007-09-30	76°15.30	075°53.64	366							76°15.66	075°53.28	357	
115	2007-10-01	76°18.20	071°39.54	682	76°19.14	071°29.03	76°18.80	071°28.83	5	681				
111	2007-10-02	76°18.17	073°05.99	611										
108	2007-10-03				76°12.72	074°44.4	76°12.64	074°44.63	5	445				
134	2007-10-04										75°34.13	079°28.19	550	Grab empty
302	2007-10-07				74°12.59	086°38.57	74°13.00	086°59.44	10	490				
308	2007-10-09	74°07.774	103°04.17	341	74°07.59	103°09.38	74°06.99	103°09.68	10	355				
309	2007-10-10				74°38.47	103°06.05	74°38.07	103.04.61	10	168				
314	2007-10-12	69°00.49	106°34.67	114	69°00.21	106°35.78	69°00.49	106°25.12	10	110				Agassiz empty
434	2007-10-15	70°10.19	133°34.73	38	70°10.54	133°35.64	70°10.21	133°36.12	10	38				First Agassiz empty
428	2007-10-15	70°47.26	133°43.74	70										
1806	2007-10-19	72°45.02	127°18.08	138	72°44.42	127°13.75	72°44.96	127°14.91	10	133				Agassiz empty (2 times)
					72°45.06	127°15.61	72°44.98	127°17.72	5	137				
1800	2007-10-20	72°11.73	127°49.08	356	72°10.97	127°46.98	72°11.42	127°49.95	10	358				
437	2007-10-20	71°46.77	126°30.01	326	71°47.94	126°34.91	71°48.42	126°36.15	5	339				
408	2007-10-21	71°19.26	127°39.14	193	71°18.71	127°38.26	71°19.02	127°38.69	5	190				
420	2007-10-23				71°03.68	128°24.20	71°03.89	128°23.60	5	42	71°03.87	128°23.27	45	First Agassiz empty, Grab empty
407	2007-10-24	71°01.86	126°02.71	399	71°01.41	126°01.89	71°01.79	126°02.92	5	400				Agassiz empty
405	2007-10-25				70°39.338	123°02.13	70°38.94	123°01.41	10	615				
1000	2007-10-26	70°35.66	120°55.28	359	70°35.54	120°57.29	70°36.11	120°56.15	10	364				
1100	2007-10-27	71°01.86	123°15.92	272	71°02.26	123°15.48	71°01.94	123°15.79	10	277				
1110	2007-10-27	70°20.65	124°57.56	88										Box damaged by a big rock
1116	2007-10-28	70°02.56	126°17.39	230										
1120	2007-10-28	70°20.19	127°01.50	205										
		70°20.84	127°03.09	197										
1122	2007-10-29	70°28.55	127°26.01	55	70°27.76	127°24.51	70°27.82	127°24.59	5	56				Agassiz empty
		70°29.34	127°28.35	42										
1216	2007-10-29				70°44.67	127°54.46	70°45.12	127°55.11	5	73				
1214	2007-10-30	70°43.64	127°21.34	211	70°42.38	127°18.86	70°42.73	127°19.80	5	218				
1200	2007-10-31	71°33.99	124°18.86	197										
411	2007-11-01	71°37.99	126°43.59	434										
		71°38.12	126°44.50	435										
1600	2007-11-01	71°39.83	130°48.65	527	71°39.20	130°44.48	71°39.71	130°47.30	5	457				Agassiz empty
1606	2007-11-02	71°03.82	130°37.49	48	71°03.88	130°36.63	71°03.85	130°37.06	5	48				
1902	2007-11-03	71°33.19	125°45.61	350										
1916	2007-11-06	70°53.92	122°07.49	420										

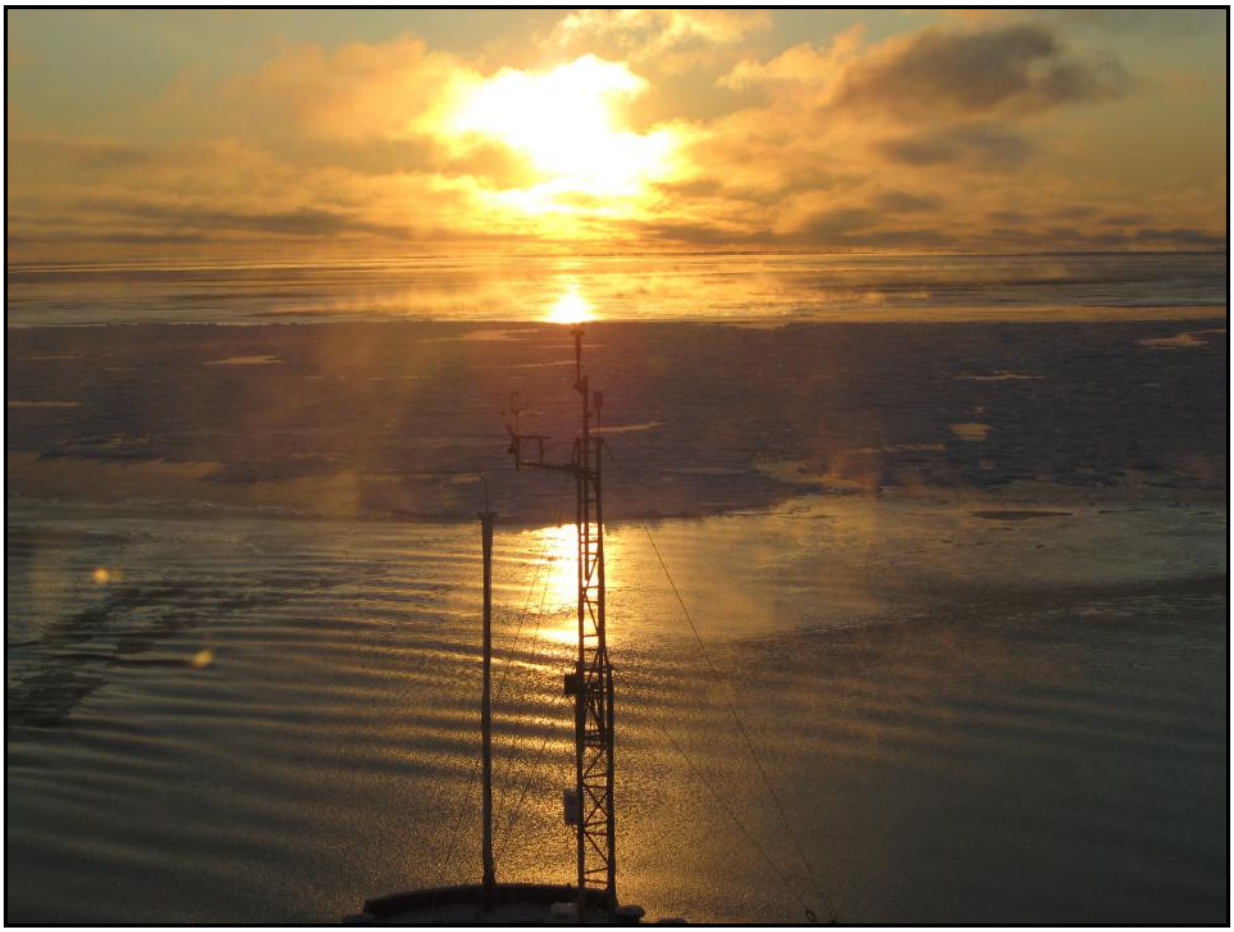
2.6. Team 6

2.6.1. Surface Meteorology and Flux Program

PI: Tim Papakyriakou (University of Manitoba)
Participants: Bruce Johnson, Kyle Swystun

Introduction
The instruments deployed on the CCGS Amundsen as part of the surface meteorology and flux program of the Circumpolar Flaw Lead System Study (CFL, Team 6) provide information on:

(i) bulk meteorology and microclimatology
(ii) detailed information on the air-sea exchange of momentum, heat, radiation and CO_2
(iii) pertinent near surface and surface sea water (sea ice) properties.

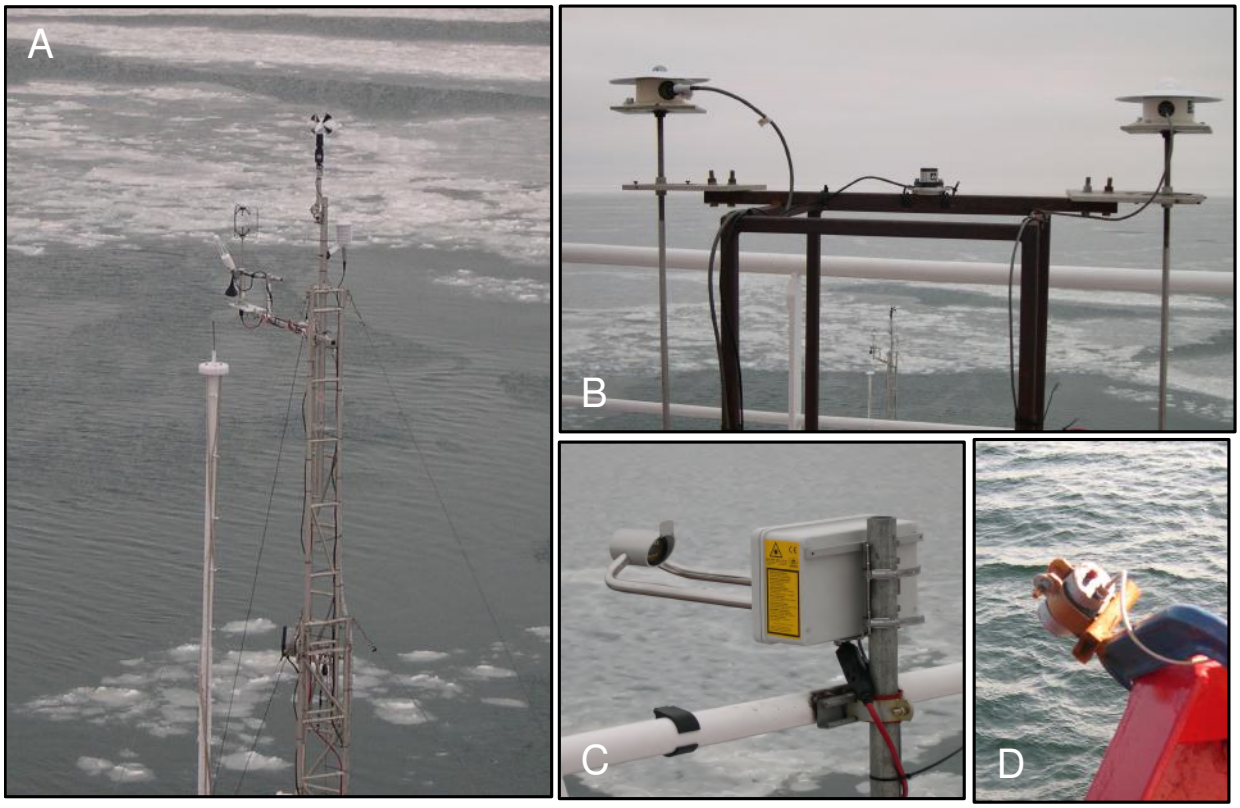


The surface fluxes constitute the upper and lower boundary forcing for the ocean and atmosphere, respectively, and therefore provide a spatial and temporal measure of air-sea coupling across the study sampling region. The objective of the measurement program is to quantify the spatial and temporal rates (and associated variability) in the exchange of energy, momentum and mass (H_2O and CO_2). The objective of the research program, through collaboration with other project researchers, is to better understand the atmosphere's contribution in determining ocean properties (physical, biological, and chemical) through its effect on those oceanic biophysical and biogeochemical processes that are affected by near surface flows of heat, radiation, momentum and CO_2.

Eddy Correlation Flux System

A tower-based eddy correlation flux and surface meteorology system was installed on the foredeck of the CCGS Amundsen during ArcticNet Leg 1 in July 2007. The tower was damaged during Leg 2, so the system was re-installed during the first half of Leg 3 with some modifications (Figure 1a). The base of the tower was strengthened using 4 foot long steel rods that were inserted approximately 2 feet inside the aluminum legs of the tower. Meteorological sensors installed on the 8 m tower measured bulk air temperature, relative humidity, wind speed, wind direction and atmospheric pressure.

Figure 1: Eddy correlation flux and surface meteorology system. a) flux tower on foredeck; b) radiometers on top of wheelhouse; c) laser precipitation monitor on top of wheelhouse; d) infrared temperature transducer on foredeck rail.

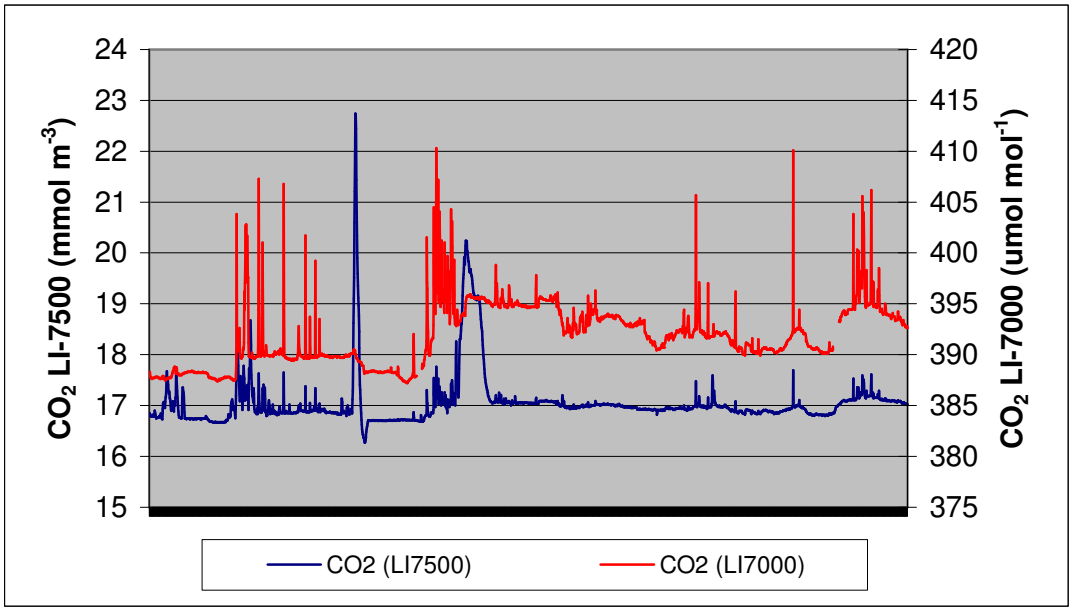


The radiometers for measuring incoming solar (wavelengths 0.3 - 3 μm), long-wave (wavelengths 3 - 50 μm) and photosynthetically active radiation (PAR, wavelengths 0.4 - 0.7 μm) were mounted on a frame installed on the top of the wheelhouse (Figure 1b). An infrared transducer was mounted on the starboard-side of the foredeck to measure surface skin temperature (Figure 1d). A laser precipitation monitor was mounted facing forward on the front rail on top of the wheelhouse (Figure 1c).

The eddy correlation system consists of fast response sensors to measure fluctuations in air temperature, H_2O and CO_2 concentrations, wind speed and ship motion along each of the three principal coordinate axes. Wind speed is measured using a Gill Wind Master Pro sonic anemometer and gas concentrations are measured using two infrared gas analyzers. An open-path IRGA (LI-COR LI-7500) was mounted on the tower at the same height as the sonic anemometer, and a closed-path IRGA (LI-COR LI-7000) was housed in the acquisition container on the foredeck of the ship. A heated and insulated sample tube is used to draw air from the tower to the IRGA inside the container.

Sensor output was collected on Campbell Scientific data loggers. A CR5000 was used for the fast response sensors (sonic anemometer, IRGA's, Motion Pak), with data collected at a frequency of 10Hz and stored on a compact flash card connected to the data logger. Data from the remaining sensors were collected with a CR1000 (foredeck) and a CR23X (wheelhouse) scanned at 2sec intervals and archived as 1 minute averages. Data was retrieved from the data loggers at regular intervals and stored on a computer in the acquisition container.

Figure 2. CO2 molar density (LI7500) and molar fraction (LI7000) for the period 0130h Oct 23, 2007 to 1850h Oct 24, 2007, showing effect of ship's exhaust (all times UTC)

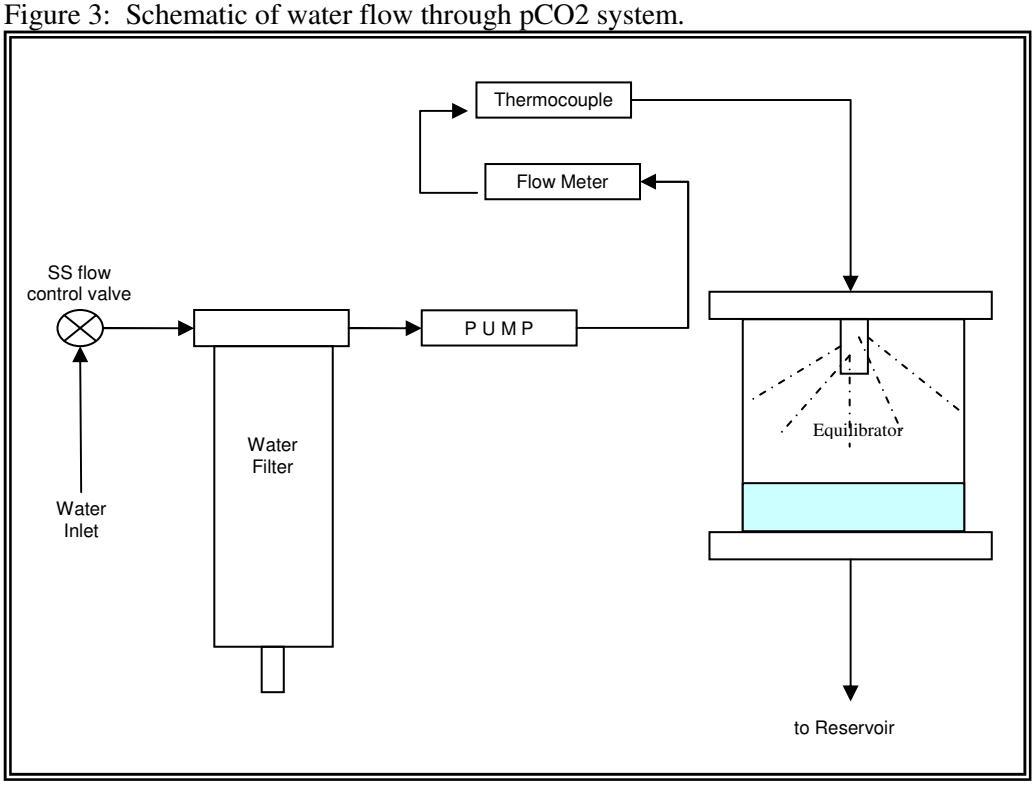


A network of valves, constructed during Leg 1, is used to facilitate the flow of reference gases and calibration gases to the LI-7000 inside the acquisition container. Ultra-high pure N_2 gas is continuously supplied to the reference cell of the gas analyzer at a flow rate of 70-80 mL/min. By manually opening and closing valves, N_2 can be supplied to the reference and sample cells at the same time for zeroing the analyzer, and a calibrated CO_2 gas can be passed through the sample cell for setting the CO_2 span of the analyzer. This system of valves is also used for calibrating the open-path IRGA. To calibrate the LI-7500, the sensor head and electronic control box are removed from the tower and set up in the acquisition container. Calibration of the LI-7000 was done once per day, while calibration of the LI-7500 was done at weekly intervals, or as necessary.

Sea Water pCO_2 Flow-through System

An under-way pCO_2 system, hooked up to the ship's sea water intake, was installed in the forward engine room of the ship during Leg 1 in August 2007. Alterations were made to the set-up, and the system became fully operational on October 23. The principal of the pCO_2 measurement is based on the equilibration of carrier air with sea water and subsequent determination of the CO_2 concentration in the carrier air. In our system, a continuous flow of seawater passes through an equilibration tank (Figure 3). A fixed volume of air is re-circulated continuously through the system to maintain near equilibrium in terms of gas concentration with the flowing seawater. After circulating through the equilibration tank, the air is passed through an infrared gas analyzer (LI-COR LI7000) to measure CO_2 concentration. A network of valves was added to the system to facilitate setting the CO_2 zero and span of the gas analyzer without interrupting the air flow within the equilibration tank. Calibration of the IRGA was done daily in a similar manner to that described for the eddy correlation flux system.

Figure 3: Schematic of water flow through pCO2 system.

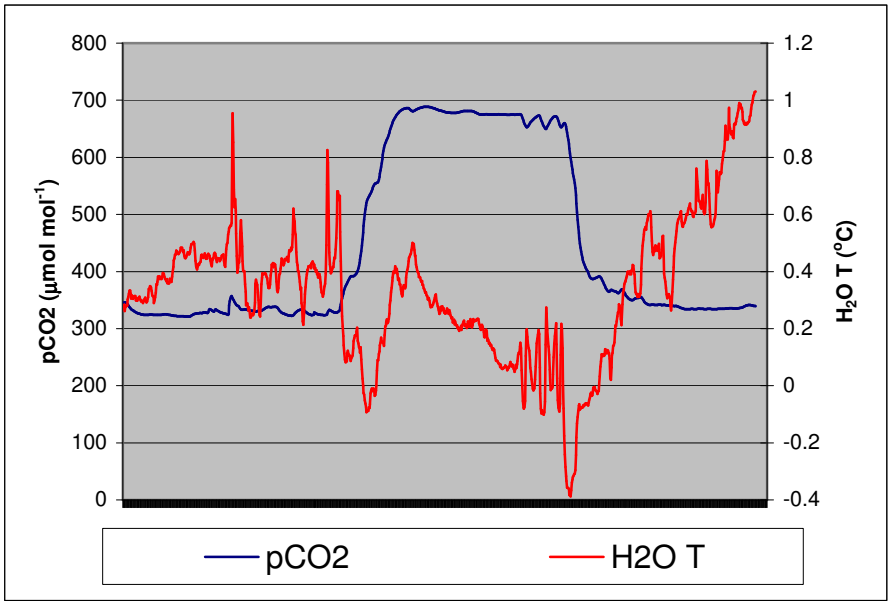


The equilibration tank is constructed with clear acrylic tubing (9"OD, 8½" ID) inset into 1" thick squares of high density polyethylene (HDPE). The internal volume of the tank is 10.5 L (r = 10.8 cm; h = 28.6 cm). Water was drawn from the ship's sea water intake using a centrifugal pump, passed through an 800 micron nylon mesh filter bag, and pumped into the equilibration tank through a "shower head" (Figure 4). The incoming sea water passes through a vortex flow meter and a thermocouple junction before entering the equilibration tank.

Sea water drains from the tank by gravity through an outlet in the bottom HDPE plate into a stainless steel holding reservoir, and then the water is pumped into the ship's waste water outlet. There was ~6 cm (2.2 L) of water maintained in the bottom of the tank, and water flow through the system was maintained at ~2 L/min. Air flow through the remaining headspace (8.3 L) was maintained at 3.5 L/min, providing a residence time of air in the tank of ~2.5 minutes. Output from the gas analyzer, thermocouple and flow meter were recorded by a CR1000 data logger (Campbell Scientific) with a scan interval of 2 sec and archived as 1 minute averages.

Figure 4. Sea water pCO2 flow-through system in the forward engine room.

Figure 5: Sea water pCO_2 and H_2O temperature for the period 2230h Oct 22, 2007 to 1640h Oct 23, 2007 (UTC)



2.6.2. Estimates of arctic air-sea CO2 transfer using QuikSCAT scatterometer

PI: Darek Bogucki & Will Drennan (RSMAS, University of Miami)
Participant: Sarah Woods

Introduction

In order to quantify CO2 exchange on a regional or global scale it is useful to relate the exchange to parameters that are readily measured with remote sensing techniques since satellites can provide global coverage on a daily timescale. Although remote sensing methods allow for better comparison of ocean carbon uptake over changing locations and seasons, there is also variability in oceanic CO2 uptake estimates depending upon how the exchange calculation is formulated, since it is not measured directly by this technique. Many satellite-derived estimates have been obtained using wind speed, but uncertainties of this relationship grow at higher wind speeds. Wave slope, a less commonly measured parameter, may hold a stronger relationship with CO2 exchange than wind speed, providing an opportunity to lower estimate uncertainties.

Current air-sea flux measurements by our group will allow us to determine the air-sea CO2 exchange along the ship track. With a relation between this shipboard exchange measurement and concurrent satellite measurements of wave slope, the satellite wave slope measurements can be used to extrapolate the shipboard CO2 transfer estimates in location and time. As a way of validating this correlation, we are also concurrently measuring wave slope locally by extending a set of laser altimeters (LAWAS) off the side of the ship. The wave slope measurements are timed to coincide with QuikSCAT satellite passes so that we can make a comparison between the wave slopes derived from the satellite signal and the shipboard measured wave slopes, providing a check of the satellite measurement and ensuring that it can be appropriately correlated with the shipboard air-sea CO2 exchange measurement.

During Leg 3, LAWAS was deployed from the foredeck of the CCGS Amundsen to measure wave slope while the QuikSCAT microwave scatterometer passed overhead, taking concurrent surface roughness measurements. The system consists of four RIEGL near infrared (0.9 µm) laser range finders, whose optical heads are mounted 30 cm apart at the corners of a square. Each laser acquires a

time series of the waves directly beneath it. Combining the four data sets, the wave slope will be determined. A motion pack is mounted on top of the deployed optical head to account for movement of the instrument during deployment.

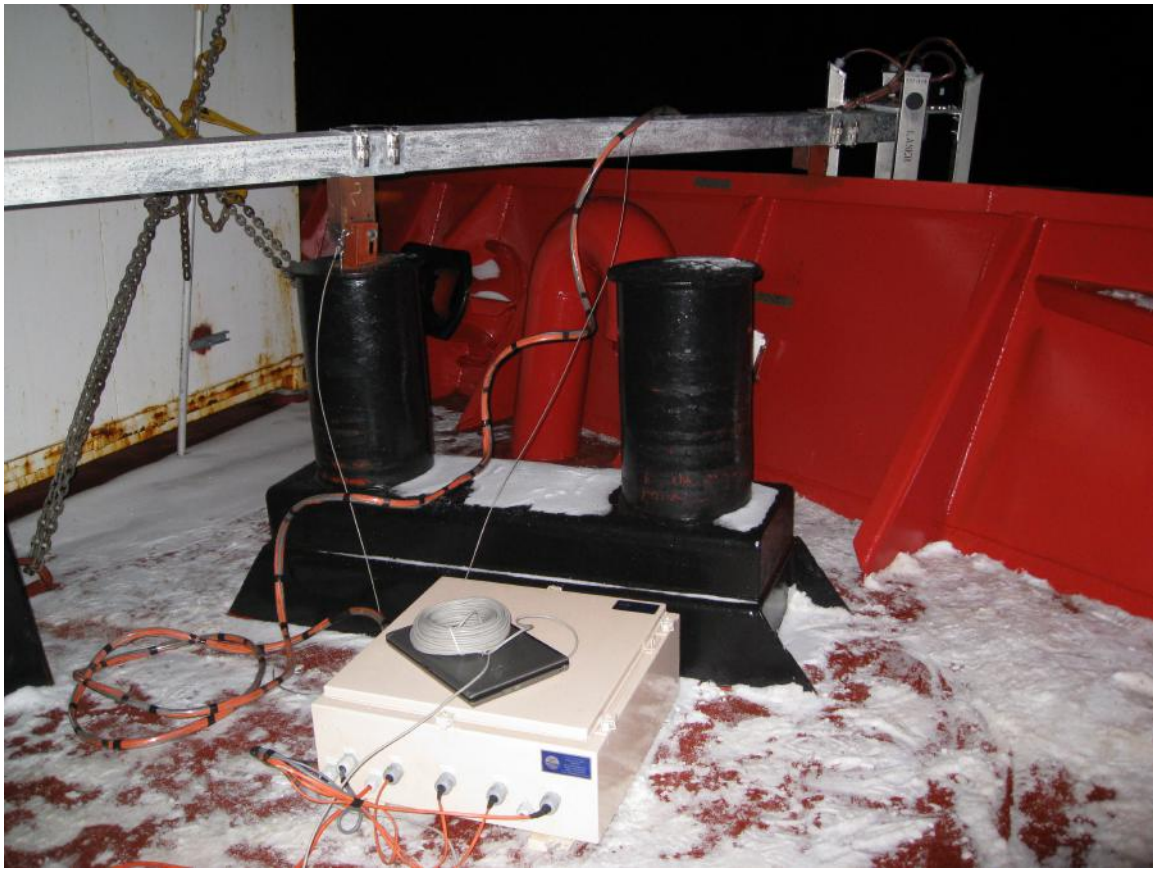


Figure 1: LAWAS deployment setup

Figure 2: LAWAS Optical Head and footprint

Sampling
Each sample consists of four wave height time series given by LAWAS, which will later be converted to a wave slope time series. Each sample is correlated with a QuikSCAT overpass.

Table 1: Leg 3 LAWAS deployments

Date	Station	Lat (N)	Lon (W)	QuikSCAT Pass (UTC)
Sep 29	101	76 38	77 40	00:18 Sep 30
Oct 1	115	76 18	71 17	01:07 Oct 2
Oct 2	108	76 14	74 34	23:00 Oct 2
Oct 2	108	76 13	74 38	00:41 Oct 3
Oct 4	133	75 37	79 28	10:13 Oct 4
Oct 15	434	70 10	133 30	15:30 Oct 15
Oct 20	1804	72 12	127 50	15:00 Oct 20
Oct 20	437	71 47	126 33	04:35 Oct 21
Oct 21		71 33	127 03	14:33 Oct 21
Oct 21	417	71 18	127 36	04:09 Oct 22
Oct 22		71 16	127 32	14:07 Oct 22
Oct 23	407	71 00	126 01	15:22 Oct 23
Oct 23	1018	71 04	125 54	04:58 Oct 24
Oct 24	1018	70 49	124 48	04:32 Oct 25
Oct 25	410	70 39	123 00	14:30 Oct 25
Oct 26		70 36	121 08	14:03 Oct 26
Oct 26		70 36	120 59	15:44 Oct 26
Oct 26	1100	71 03	123 15	05:20 Oct 27
Oct 27	1104	70 44	123 56	15:18 Oct 27
Oct 28		70 04	126 20	14:52 Oct 28
Oct 28		70 04	126 20	16:33 Oct 28
Oct 28		70 21	127 04	04:28 Oct 28
Oct 29		70 41	127 47	04:02 Oct 30
Oct 30	1212	70 49	126 53	14:00 Oct 30
Oct 30	1210	70 57	126 28	15:41 Oct 30
Oct 30	1208	71 04	126 03	05:16 Oct 31
Oct 31		71 29	124 30	13:33 Oct 31
Oct 31	1200 F	71 33	124 21	15:14 Oct 31
Nov 1		71 40	128 49	16:29 Nov 1
Nov 1		71 39	131 05	04:24 Nov 2
Nov 2		71 05	130 29	16:03 Nov 2
Nov 3		71 33	125 43	13:56 Nov 3
Nov 3		71 33	125 49	15:37 Nov 3
Nov 4		71 17	124 45	04:46 Nov 5
Nov 5	1908 B	71 10	124 14	16:25 Nov 5

2.6.3. Atmospheric Group (SOLAS)

PI: Ann-Lise Norman
Participants: Ann-Lise Norman, Alison Michelle Seguin & Ofelia Rempillo (University of Calgary)

Aerosol measurements:
Atmospheric aerosols were collected on board the CCGS Amundsen using two high volume samplers (hi-vols). The hi-vols were installed above the bridge. One was equipped with SO_2 and particulate filter for the collection of bulk aerosols and their precursors. The other was equipped with a 5-stage cascade impactor for the collection of size-segregated aerosols. Collection of bulk aerosol were done for a period of 24 hours, while collection of size segragated aerosols were done for a period of 3 days. "Field blanks" were also obtained.

DMS measurements:
Atmospheric DMS measurements were also made during the Leg 3 cruise. Samples were collected through a Tenax tube using a portable, battery-operated sampler equipped with flow controller. Samples were collected on the deck containing the hi-vols. For the first half of the leg (Arctic Net) samples were collected every hour for 24 hours. During the second half of the leg (CFL), samples were taken every one to one and a half hour for 6 to 12 hours a day. All samples were analysed on board using a gas chromatograph fitted with a sulphur chemiluminescence detector provided by the Meterological Service of Canada (Sangeeta Sharma).

During the first half (Arctic Net) of the leg. Surface water samples were collected every two hours for DMS analysis. Morning water samples were collected by Sarah-Jeanne Royer (DMS water group) while Night samples were collected by Michelle Seguin and Ofelia Rempillo.

Other Measurements:
CO_2 in the atmosphere was also measured using a LICOR CO_2 analyzer. The difference between CO_2 in the atmosphere and CO_2 in an cylinder of compressed air (yet to be calibrated to international standards) was used to determine the persence of ship stack emissions. Relative humidity and temperature sensors were placed at the level 5 on the exterior of the ship to obtain temperature measurements at two heights so that boundary layer heights could be calculated. Unfortunately, interference from the ship's radio and radar signals rendered the temperature measurements useless.

Preliminary Results:
Chemical and stable isotope analysis of the aerosol samples will be performed after the cruise in laboratories at the University of Calgary.

Logistics:
Jan Bottenheim (Enviornment Canada) expressed an interest this past October in measuring atmospheric DMS between this fall and next when C-SOLAS will use the equipment. Additional cylinders of H_2 and O_2 aboard the ship would facilitate use of the GC-SCD and DMS samplers by Jan Bottenheim's group during the spring. However, due to weight restrictions, spare cylinders were not placed on board. This is unfortunate, as data from the spring would be very interesting to have in addition to the two fall periods, particularly if another group will measure DMS in the water at that time.

Recommendations:

1. The fume hood in the Paleolab needs to be fixed. Putting the ozone exhaust outside causes ice to form in the tubing that blocks the exhaust.
2. Incineration time should be logged
3. A shielded cable and thermometer assembly should be installed in place of the current thermometer outside of deck 5.

2.6.4. Aerosol and Trace Gases (SOLAS)

PI: Richard Leaitch (University of Toronto)
Participants: Steve Sjostedt and Rachel Chang (University of Toronto)

Study Goal:
The primary goal of this study was to follow the sulfur cycle in the atmosphere in collaboration with the other SOLAS groups on board who looked at ocean-atmosphere sulfur exchange. Gas-phase dimethyl sulfide, measured on board with the proton transfer mass spectrometer (PTR-MS), can be oxidized to form sulfur dioxide, also measured on board, which can be further oxidized to sulfuric acid and either nucleate to form new particles or condense onto existing particles. This was monitored using various aerosol size distribution instruments as well as a time-of-flight aerosol mass spectrometer (ToF-AMS). Secondary goals were to measure other trace gases and characterize the aerosol population in a polar marine environment.

Measurement Location:
All of the instruments except for the MOUDI were located in a temperature controlled structure located behind the bridge of the CCGS Amundsen. Approximately 30 ft of ⅜ in stainless steel line was run out to the mast ~10 ft above the bridge for aerosol sampling. A ¼ in teflon line was run parallel to the aerosol sampling line to measure the trace gases. A second shorter line ~ 10 ft was situated above the structure housing the instruments. The PTR-MS measurements were split between the two sampling locations.

Trace Gas Measurements:
An Ionicon PTR-MS was employed to measure multiple volatile organic carbon and sulfur compounds. Some of the species measured were acetaldehyde, acetone, acetic acid, benzene, dimethyl sulfide, hydrogen sulfide, methanol, methacrolein, methyl ethyl ketone, methyl vinyl ketone and toluene. Measurements were obtained continuously on 30 second intervals. Ozone (Thermo Environmental U.V. Photometric Analyzer Model 49) and sulfur dioxide (Thermo Environmental Pulsed Fluorescence Analyzer Model 43 S) were also measured continuously from the mast sampling site.

Aerosol Measurements:
Size distributions of aerosols between 10 – 500 nm were obtained with a sizing mobility particle sizer, total fine particles (> 3 nm) were measured with a condensation particle counter and size distributions for the coarse fraction (0.5 – 20 μm) were measured with an aerodynamic particle sizer. Real-time continuous measurements of aerosol composition were obtained with a ToF-AMS for the first 3 weeks of the measurement campaign. Aerosol composition was also obtained from a MOUDI impactor placed above the bridge.

Preliminary Results:
The data needs to be quality checked due to frequent fumigation of the inlet lines of smoke stack emissions.

Recommendations:
1. An incineration log would be helpful
2. Samples of the fuel and engine lubricants used on board would also be good

2.6.5. DMS(P) Cycling (SOLAS)

PIs: Maurice Levasseur et Michael Scarratt
Participants: Sonia Michaud (IML-DFO), Sarah-Jeanne Royer (Université Laval), Myriam Luce (Université Laval), Michael Scarratt (IML-DFO)

Nous avons mené deux projets à bord de l'Amundsen. Le premier est la collecte de donnée pour la maîtrise de Myriam Luce. Ce projet vise une meilleure compréhension de la distribution du diméthylsulfure (DMS), un gaz produit par le phytoplancton et bactérioplancton marin à partir du diméthylsulfoniopropionate (DMSP). Une fois oxydé dans l'atmosphère, ce gaz sert de noyau de condensation des nuages et ainsi diminue la quantité de lumière qui atteint le sol. Nous tentions de

déterminer quels facteurs déterminent la production de DMS dans l'océan Arctique. Pour ce faire, notre équipe a effectué plusieurs mesures et expériences à bord de l'Amundsen.

D'abord, nous avons mesuré la concentration du DMS et de DMSP à plusieurs profondeurs de la colonne d'eau : 100% de lumière incidente, 50%, 5%, 0.2% et au maximum de chlorophylle profond. En surface, nous avons prélevé de l'eau pour préserver du phytoplancton et du bactérioplancton afin de déterminer leur taxonomie et abondance. Le phytoplancton sera identifié par observation au microscope de retour au laboratoire. Les communautés bactériennes seront caractérisées au moyen de la technique CARD-FISH, qui est une hybridation des cellules avec des sondes fluorescentes spécifiques à divers clades bactériens. Nous avons également fait des incubations d'eau de mer avec des ajouts en concentrations traces de DMSP marqué radioactivement au ^{35}S. Ces incubations de trois heures nous permettent de mesurer la consommation de DMSP et déterminer la vitesse de transfert du soufre vers divers réservoirs. Nous avons mesuré la production de DMSP particulaire, l'incorporation dans les macromolécules, la production de DMS et la production de composés soufrés dissous. Finalement, nous avons effectué des incubations de 22 heures en présence de DMSP marqué pour la technique MAR-CARD-FISH. Cette technique nous permet de déterminer quelle proportion de chaque clade bactérien consomme le DMSP.

Nous avons également échantillonné le DMS en continu du 8 au 14 octobre. Nous mesurions le DMS dans les eaux de surface à toutes les deux heures en prélevant de l'eau à la pompe de la salle des machines. L'objectif était de permettre à l'équipe d'Ann-Lise Norman, étudiant le DMS dans l'atmosphère, d'avoir des données de DMS dans l'eau concordant avec son échantillonnage. Ce monitorage en continu nous a permis de constater la présence d'un fort cycle jour-nuit dans les concentrations de DMS. Trouvant le phénomène intéressant, nous avons décidé de suivre la concentration de DMS dans l'eau à une station fixe pendant 24 heures. Nous l'avons fait les 23 et 24 octobre à la station 407. Nous avons fait quatre profils verticaux de DMS et DMSP répartis sur 24 heures. Nous avons préservé des bactéries pour la technique CARD-FISH sur les mêmes rosettes. Deux fois, soit une fois le jour et une fois la nuit, nous avons préservé du phytoplancton et avons incubé de l'eau de mer avec du ^{35}S. Nous avons aussi prélevé de l'eau de surface à l'aide d'un seau aux deux heures pour connaître la concentration de DMS et DMSP.

Distribution de l'oxyde nitreux (N_2O) dans l'arctique (Scarratt)

Le second projet est mené par Michael Scarratt et concerne l'étude de l'oxyde nitreux, aussi nomme le protoxyde d'azote, ou N_2O. Ce gaz biogène est produit par l'activité bactérienne comme sous-produit du cycle d'azote lors de la nitrification et la denitrification. Dans l'atmosphère, le N_2O est un puissant gaz à l'effet de serre, troisième en importance après le gaz carbonique et le méthane. Il est présent aux concentrations moyennes d'environ 300 ppm dans l'air, et environ 8 nM dans les eaux de surface, mais la concentration dans l'eau est très variable selon les conditions océanographiques et biologiques. L'objectif principal de l'étude en 2007 est de déterminer la distribution du N_2O dans les eaux de surface sur une radiale est-ouest traversant l'archipel arctique canadien. Des échantillons ont été récoltées aux mêmes stations et aux mêmes profondeurs que pour le DMS, incluant quelques stations ou des profils complètes jusqu'au fond ont été réalisé. Un total d'environ 275 échantillons seront ramenées à l'IML pour l'analyse, car le système GC à bord est configure pour détecter uniquement les molécules contenant le soufre. Pour détecter le N_2O et d'autres composées de l'azote, une modification du détecteur est requise. Notre système GC à l'IML sera modifié ainsi, et les données seront disponibles pendant l'hiver. Une coordination a été faite avec Roxanne Maranger du programme CFL qui échantillonne aussi le N_2O, et à deux stations (1606 et 1902) nous avons échantillonné ensemble aux mêmes profondeurs afin de permettre une inter-calibration de nos deux systèmes.

Échantillonnage effectué:
Nous avons effectué le travail suivant aux stations suivantes

Station	DMS + DMSP	N_20	Phyto + bactério	CARD-FISH	^{35}S	MAR-CARD-FISH
115 (01/10)	x	x	x	x	x	x
108	x	x	x	x	x	x
134	x	x	x	x	x	x
302	x	x	x	x	x	x
308	x	x	x	x	x	x
309	x	x	x	x	x	x
310	x	x	x	x	x	x
314	x	x	x	x	x	x
Seau	x	x	x	x	x	x
434	x	x	x	x	x	x
435	x	x	x	x	x	
1806	x	x	x	x	x	
437	x	x				
408	x	x	x	x	x	
407	4 fois	4 fois	2 fois	4 fois	2 fois	2 fois
1000	x	x	x	x	x	
1116	x	x	x	x	x	
1216	x	x	x	x	x	
1200	x	x	x	x	x	
1600	x	x	x	x	x	
1606	x	x	x	x	x	
1902	x	x				

Résultats préliminaires :
La page suivante contient quelques résultats intéressants que nous avons déjà obtenus.

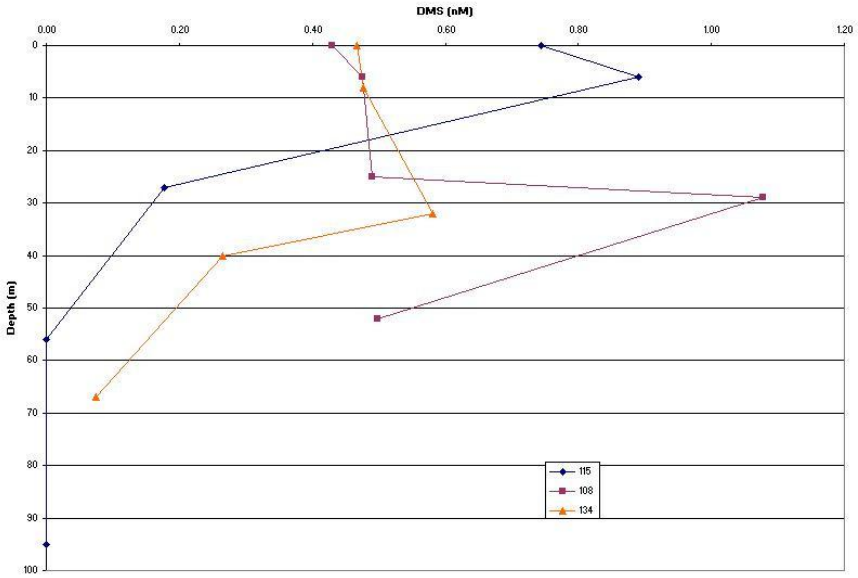


Figure 1. Profils verticaux de DMS à trois stations.

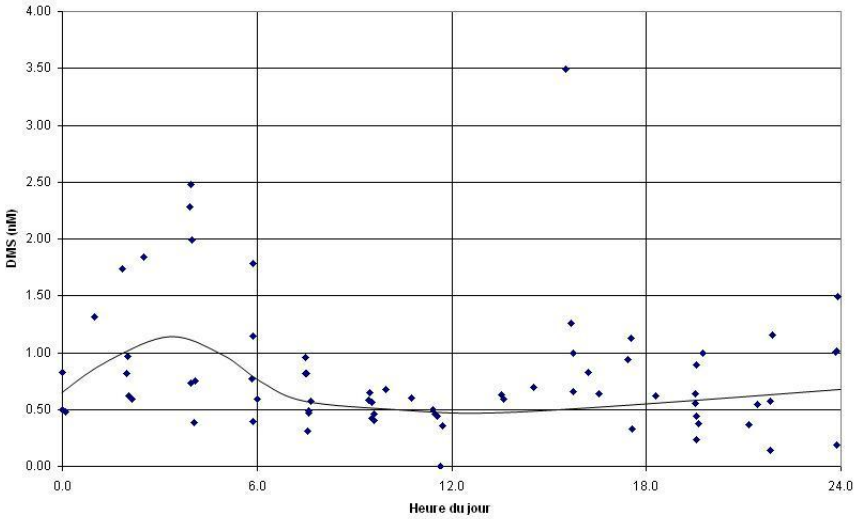


Figure 2. Cycle journalier du DMS.

2.7. Team 7

2.7.1. Barium

PI: Helmuth Thomas
Participant: Friederike Prowe (Dalhousie University)

In the Canadian Arctic, barium (Ba) is mainly released from the North American continent and can therefore be used as a tracer for terrestrial freshwater input. Together with ^{18}O, a tracer for freshwater input from precipitation and ice melt, all freshwater sources to the Arctic can be quantified.

Throughout Leg 3, samples for barium were taken from the rosette parallel to samples for ^{18}O, at approximate depths 5, 10, 25, 50, 75, 100, 150, 200 and 500 m. 15 ml nalgene bottles were rinsed three times, then filled and spiked with 15 µl concentrated HCl. Sample bottles were sealed with parafilm and taken for later analysis using isotope dilution mass spectrometry.

Table 1: Stations sampled for Barium

station	LAT	°N min	LON	°W min	cast #	date
101	76	26.057	77	27.409	0706003	29/09/07
105	76	15.391	75	54.549	0706008	30/09/07
115	76	19.873	71	14.452	0706009	01/10/07
111	76	17.380	73	18.379	0706014	02/10/07
108	76	15.467	74	37.379	0706017	03/10/07
301	74	7.226	83	19.632	0706022	07/10/07
302	74	9.011	86	13.186	0706024	07/10/07
305	74	19.828	94	58.834	0706026	08/10/07
308	74	8.297	103	6.713	0706028	09/10/07
309	74	39.234	103	6.870	0706030	10/10/07
310	71	43.772	101	53.616	0706033	11/10/07
314	68	59.966	106	36.186	0706034	12/10/07
435	71	3.532	133	42.678	0706048	17/10/07
437	71	46.642	126	31.183	0706057	21/10/07
408	71	17.000	127	32.166	0706069	22/10/07
407	71	0.931	126	0.744	0706075	23/10/07

2.7.2. Carbon system (CFL Teams 6 & 7)

PIs: Helmuth Thomas & Al Mucci
Participants: Constance Guignard (McGill University) and Friederike Prowe (Dalhousie University)

The ocean's exchange of carbon dioxide with the atmosphere is governed by the biogeochemical cycling of carbon and physical processes throughout the water column, which determine the concentration of dissolved inorganic carbon in the surface waters. Of the seven relevant carbon system parameters, a minimum of two are needed to calculate the others and fully describe inorganic carbon chemistry, overdetermination of the system being beneficial. During ArcticNet/CFL leg 3, a total of 445 samples were analyzed for dissolved inorganic carbon (DIC) and total alkalinity (TA), pH was determined for 248 samples, yielding two/three relevant parameters.

During the first half of leg 3 (Sep 27 to Oct 18), 500 ml water samples were collected from the rosette at several depths for determination of DIC and TA. Samples were usually first to be taken from the niskin bottles, or preceded only by dissolved oxygen at individual casts and depths. Due to the presence of a group analysing for mercury, with the exception of three stations samples were not spiked with $HgCl_2$, but stored in the dark at 4 deg C and analyzed within 24 hours of sampling.

DIC and TA were analyzed on board using a VINDTA 3C (Versatile Instrument for the Determination of Titration Alkalinity) by marianda. TA was determined by titrating a volumetrically accurate subsample using HCl as titrant, and a set of three electrodes, a Ross pH electrode,a reference AgCl electrode and an auxillary platinum electrode. For measuring DIC, a volumetrically determined subsample was acidified with 8.5% H_3PO_4 to convert all inorganic carbon into gaseous CO_2. The CO_2 was stripped out of the sample using ultra-pure N_2 gas, transferred into a coulometric titration cell and detected using the coulometric method (Johnson et al., 1993).

During the second half of leg 3 (Oct 18 to Nov 08), 500 ml water samples were collected as before, but spiked with 200 µl of saturated $HgCl_2$ solution and analyzed on board before the end of the leg. DIC was determined as before using the VINDTA. Afterwards, TA was determined using a TIM 865 automatic titrator from Radiometer Analytical. All TA samples were analyzed in duplicates.

In addition to DIC and TA, water samples for pH were taken from the same bottles directly after DIC/TA samples. pH samples were collected in plastic bottles and analyzed immediately using a HP 8453 spectrophotometer. pH will be calculated using the absorbances measurements obtained from the coloration of water samples with Phenol Red and Cresol Purple.

Table 1: Stations sampled for DIC, TA and pH

station	LAT°N min	LON°W min	cast #	date	samples taken
101	76 26.057	77 27.409	0706003	29/09/07	DIC & Alk
105	76 15.391	75 54.549	0706008	30/09/07	DIC & Alk
115	76 19.873	71 14.452	0706009	01/10/07	DIC & Alk
108	76 15.467	74 37.379	0706017	03/10/07	DIC & Alk
134	75 38.267	79 29.094	0706020	04/10/07	DIC & Alk
301	74 7.226	83 19.632	0706022	07/10/07	DIC & Alk
302	74 9.011	86 13.186	0706024	07/10/07	DIC & Alk
308	74 8.297	103 6.713	0706028	09/10/07	DIC & Alk
309	74 39.234	103 6.870	0706030	10/10/07	DIC & Alk
310	71 43.772	101 53.616	0706033	11/10/07	DIC & Alk
314	68 59.966	106 36.186	0706034	12/10/07	DIC & Alk
434	70 10.781	133 32.774	0706037	15/10/07	DIC & Alk
428	70 47.174	133 41.684	0706043	16/10/07	DIC & Alk
435	71 3.532	133 42.678	0706048	17/10/07	DIC & Alk
1806	72 39.786	127 7.026	0706050	19/10/07	DIC & Alk, pH
1800	72 8.290	127 41.207	0706054	20/10/07	DIC & Alk, pH

437	71	46.642	126	31.183	0706057	21/10/07	DIC & Alk, pH
408	71	17.000	127	32.166	0706069	22/10/07	DIC & Alk, pH
420	71	3.863	128	27.282	0706072	23/10/07	DIC & Alk, pH
407	71	0.931	126	0.744	0706075	23/10/07	ph, DIC & Alk
405	70	39.958	123	0.623	0706085	25/10/07	DIC & Alk, pH
1000	70	36.097	120	59.180	0706092	27/10/07	DIC & Alk, pH
1100	70	2.675	123	15.446	0706094	27/10/07	DIC & Alk, pH
1110	70	20.256	124	57.496	0706100	28/10/07	DIC & Alk, pH
1116	70	2.577	126	16.722	0706103	28/10/07	DIC & Alk, pH
1216	70	36.892	127	34.854	0706109	30/10/07	DIC & Alk, pH
1200	71	2.900	124	16.501	0706119	31/10/07	DIC & Alk, pH
1600	71	38.767	131	1.414	0706127	02/11/07	DIC & Alk, pH
1606	71	4.236	130	33.046	0706130	02/11/07	DIC & Alk, pH
1610	70	40.451	130	26.509	0706133	03/11/07	DIC & Alk
1902	71	32.773	125	47.921	0706135	03/11/07	DIC & Alk, pH
1908	71	9.319	124	16.232	0706140	05/11/07	DIC & Alk, pH

References:

Johnson, K. M., K. D. Wills, D. B. Butler, W. K. Johnson and C. S. Wong. Coulometric total carbon dioxide analysis for marine studies: maximizing the performance of an automated gas extraction system and coulometric detector. Marine Chemistry, Vol. 44, pp. 167-187, 1993.

2.7.3. Carbon & nutrients fluxes

PI: Jean-Éric Tremblay
Participants: Jean-Éric Tremblay, Jonathan Gagnon & Johannie Martin (all at Department of Biology, Laval University)

Rationale

The Arctic climate displays high inter-annual variability and decadal oscillations that modulate growth conditions for marine primary producers. Much deeper perturbations recently became evident in conjunction with globally rising CO_2 levels and temperatures (ACIA 2004; Comiso 2003). The thickness and extent of Arctic sea-ice decrease rapidly (Johannessen et al. 1999; Rothrock et al. 1999) and the ice-free season is extending both in the Arctic (Laxon et al. 2003) and subarctic (Stabeno & Overland 2001). Models predict further reductions in ice cover (ACIA 2004). These changes entail a greater penetration of light into surface waters, which is expected to bolster phytoplankton production (Rysgaard et al. 1999), food web productivity and CO_2 drawdown by the ocean. At present, phytoplankton production varies by two orders of magnitude across the Canadian Arctic, but the forcing mechanisms are poorly understood and quantified. In the Canadian Archipelago, the productivity of phytoplankton is likely to be limited by light or the supply of allochtonous nitrogen, depending on ice conditions. The supply of allochtonous nitrogen is influenced by climate-driven processes, mainly the large-scale circulation, river discharge, upwelling and regional mixing processes. Over most of the western Arctic, and especially the Beaufort Sea, the concentrations of inorganic nitrogen (i.e. nitrate, nitrite and ammonia) at surface remain low throughout the year and the phytoplankton possibly depend on local recycling and the dissolved organic nitrogen (DON; e.g. urea, amino acids and primary amines) supplied by rivers. A large portion of the phytoplankton biomass is typically located within subsurface chlorophyll maxima (SCM). SCM productivity is possibly in balance with the episodic supply of nitrate across the halocline and/or the supply of ammonium and nitrate by local recycling and nitrification, respectively. Despite the importance of SCM for the food web and CO_2 fluxes, little is known about their structure, turnover and susceptibility to environmental variability and change.

Objectives

The main goals of our team for leg 3 of ArcticNet 2007&CFL were to **(1)** establish the horizontal and vertical distributions of phytoplankton nutrients and the influence of different processes (e.g. mixing, upwelling and biological processes) on these distributions, **(2)** characterize the detailed vertical structure of chlorophyll-*a* with respect to irradiance, nutrient supply and physical structure, **(3)** experimentally assess causal relationships between phytoplankton productivity and the availability of light **(4)** determine the utilisation of different sources of inorganic and organic nitrogen by phytoplankton, and **(5)** experimentally assess the relationships between nitrogen concentration, temperature, photosynthesis and the kinetics of nitrogen uptake. Ancillary objectives were to calibrate the *SeaPoint* fluorometer and *ISUS* nitrate probe attached to the Rosette.

Methods

Samples for inorganic nutrients (ammonium, nitrite, nitrate, orthophosphate and orthosilicic acid) were taken at all rosette stations (see Table 1) to establish detailed vertical profiles (see Fig. 1 for vertical sampling resolution). Additional samples for dissolved organic nitrogen (DON) and urea were taken at stations where incubations were performed. Ammonium was determined immediately after collection using modifications of the manual fluorometric method (e.g. Holmes et al. 1999). Urea samples were stored frozen and DON samples were preserved with acid and stored in the dark at 4°C for post-cruise determination. The concentrations of nitrate, nitrite, orthophosphate and orthosilicic acid were determined on fresh samples using an Autoanalyzer 3 (Bran+Luebbe) with colorimetric methods adapted from Grasshof (1999).

Samples for the natural abundance of ^{15}N and ^{13}C in particulate organic matter were taken at 5 m and in the chlorophyll maximum at stations where incubations were performed (Table 1). Volumes ranging from 12 to 20 liters were filtered onto 47 mm pre-combusted GF/F filters with a peristaltic pump and the filters were desiccated at 60°C in a drying oven. These data will be used for nitrogen uptake calculations and to assess the nitrogen status of phytoplankton communities.

SetCol protocol (Bienfang 1981) was carried with water from the chlorophyll maximum at the stations where incubations were performed to measure the sinking rate of the micro algae cells. Fractions from the top, the middle and the bottom part of the column were filtered on GF/F filter and extracted with acetone to determine the chlorophyll concentrations. Samples for the taxa composition were taken in the top, the middle and the bottom fraction in a second column and were stored with acid lugol for a post-cruise analysis.

The relationship between light and the uptake of C and N by phytoplankton (light-gradient incubation in Table 1) from the chlorophyll maximum was assessed using dual labelling with stable isotopes of C and N in four light-gradient modules (10 light intensities). Temperature was maintained at *in situ* levels with a chilling circulator. Samples from all modules were spiked with ^{13}C-bicarbonate; two modules received saturating additions of ^{15}N-nitrate, ^{15}N-ammonium (or ^{15}N-urea, or ^{15}N-nitrite), and the other two trace additions. Incubations were terminated by filtration onto 24-mm GF/F filters. All filters were desiccated at 60°C and stored dry for post-cruise determination of isotopic enrichment and particulate organic carbon and nitrogen.

The effect of temperature on photosynthesis and the kinetics of nitrate, ammonium or nitrite uptake were determined in two laboratory incubators maintained at 0 and 6°C with high-capacity chilling circulators. Illumination was provided by sun-simulating fluorescent tubes. For each incubator, bottles were spiked at 6 different concentrations with the target ^{15}N-labelled nitrogen source. The nitrate bottles were also spiked with ^{13}C-bicarbonate.

The effects of incubation treatments (variable nutrient additions, temperature and light conditions) on the photosynthetic characteristics of phytoplankton were assessed by Pulse Amplitude Modulated fluorometry (PAM; Heinz-Walz). Nitrate data were used to calibrate the ISUS nitrate probe. Calibration of the Rosette fluorometer was achieved by comparing the instrument's output with

extracted chlorophyll *a* and PAM data. The Phytoflash system was powered by a CTD (SBE-19) and deployed in self-contained mode from the front deck (nighttime).

Table 1. List of sampling stations and measurements during leg 3 of ArcticNet 2007&CFL.

Station	Cast	Date	UTC	Nuts	PAM	Kinetics	Light gradient	Phytoflash
101	003	29/09/2007	20:29	X	X	X	X	X
103	005	30/09/2007	09:11	X				
105	007	30/09/2007	16:47	X	X			
115	009	01/10/2007	14:53	X	X		X	X
113	012	02/10/2007	07:04	X				
111	014	02/10/2007	12:41	X	X			
108	017	03/10/2007	10:07	X	X	X	X	X
134	020	04/10/2007	07:23	X	X			
301	022	07/10/2007	10:37	X				
302	024	07/10/2007	20:34	X	X	X	X	
305	026	08/10/2007	23:52	X				
308	028	09/10/2007	17:41	X	X			
309	030	10/10/2007	11:43	X	X			X
310	033	11/10/2007	21:09	X	X			
434	037	15/10/2007	19:14	X	X			
432	039	15/10/2007	23:24	X				
430	041	16/10/2007	01:12	X				
428	043	16/10/2007	03:24	X				
426	045	16/10/2007	07:33	X				
435	048	17/10/2007	21:03	X	X		X	
1806	050	19/10/2007	18:14	X	X	X	X	
1800	054	20/10/2007	9:59	X				
437	057	21/10/2007	1:31	X	X			
412	060	21/10/2007	11:24	X				
414	063	21/10/2007	19:00	X				
408	069	22/10/2007	15:15	X	X	X	X	
420	072	23/10/2007	7:02	X	X			
407	076	24/10/2007	3:48	X	X	X	X	
1016	080	25/10/2007	1:48	X				
1012	082	25/10/2007	5:58	X				
405	085	25/10/2007	21:17	X	X	X	X	
1004	089	26/10/2007	10:43	X				
1000	092	26/10/2007	22:28	X	X			
1100	094	27/10/2007	10:12	X	X			
1104	096	27/10/2007	13:52	X				
1108	098	27/10/2007	18:13	X				
1110	100	28/10/2007	00:06	X	X			
1114	102	28/10/2007	6:18	X				
1116	103	28/10/2007	14:22	X	X	X	X	
1120	106	29/10/2007	1:03	X				
1216	109	30/10/2007	00:34	X				

1212	111	30/10/2007	12:56	X				
1208	114	31/10/2007	5:59	X				
1204	116	31/10/2007	9:45	X				
1200	119	31/10/2007	23:03	X				
1508	122	01/11/2007	14:00	X				
1600	127	02/11/2007	3:00	X				
1604	129	02/11/2007	12:15	X				
1606	130	02/11/2007	18:41	X				
1610	133	03/11/2007	00:47	X				
1902	135	03/11/2007	15:55	X				
1908	140	05/11/2007	15:17	X				

Preliminary Results

Figure 1 shows chlorophyll fluorescence and the concentrations of nitrate, nitrite, silicate and phosphate along the section of the North Water Polynya in the Baffin Bay. Nutrient concentrations were typically low in the upper mixed layer, reflecting prior utilization by diatoms. The nutrient deficit extended deeper in the west, just east of the sill, presumably reflecting biological consumption upstream in the southbound Arctic outflow. This scenario is consistent with the relatively deep extent of chlorophyll fluorescence in the region. Isopleths were widely spaced on the vertical, which is indicative of relatively weak density stratification at the onset of wind-driven mixing in autumn. By contrast, isopleths were closely spaced in the east, where the vertical stratification remained strong due to reduced wind exposure.

The chlorophyll maxima on the section seem sited on the nitracline in the western part of the bay. This result tends to prove that the growth of the phytoplankton is limited by the contribution in new nitrogen form (nitrate). This kind of relationship suggests that the phytoplankton lowers progressively the nitracline during the ice-free season until it reaches the depth (ca. 70 metres) where the light is inefficient to support a gross growth which seems happen in the eastern part of the bay.

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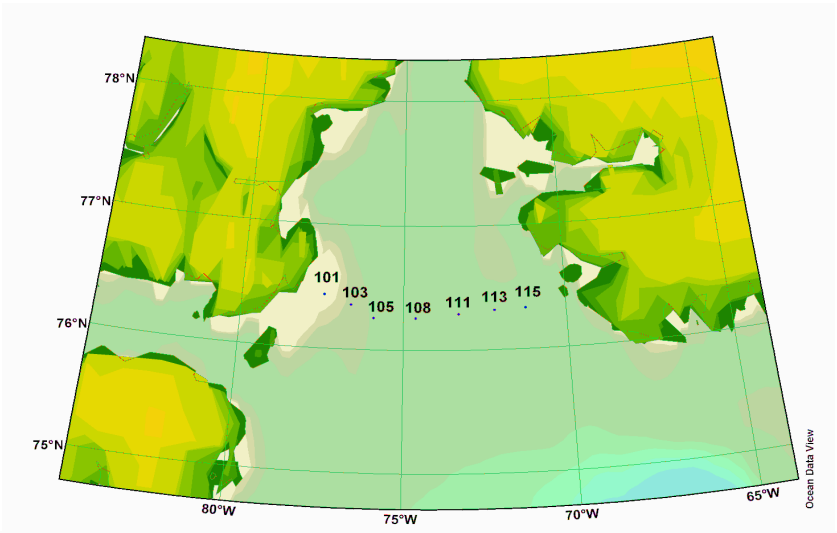
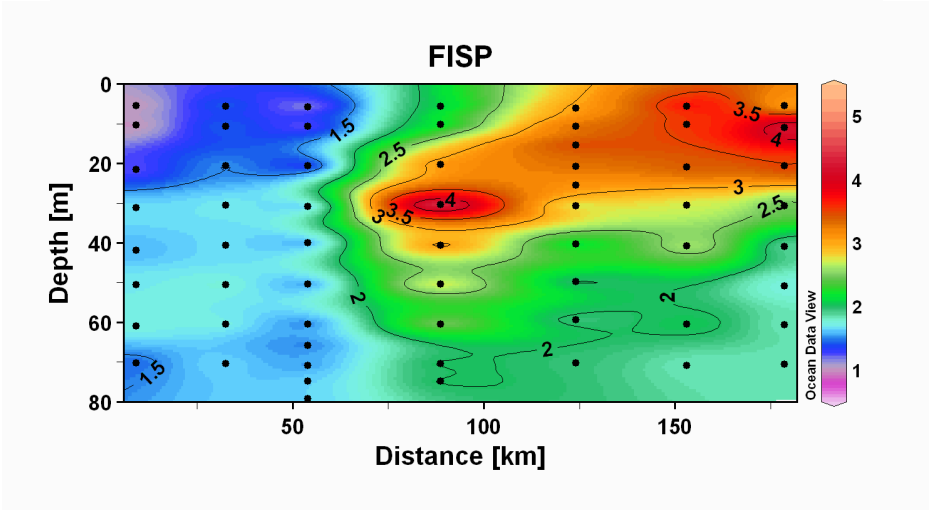
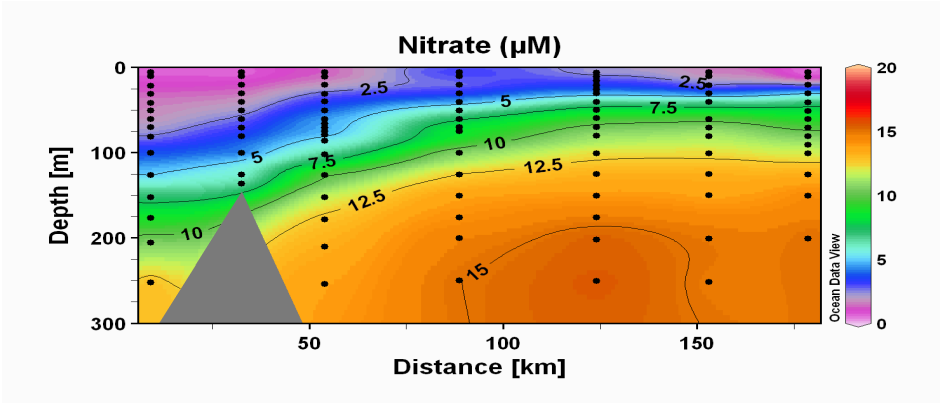
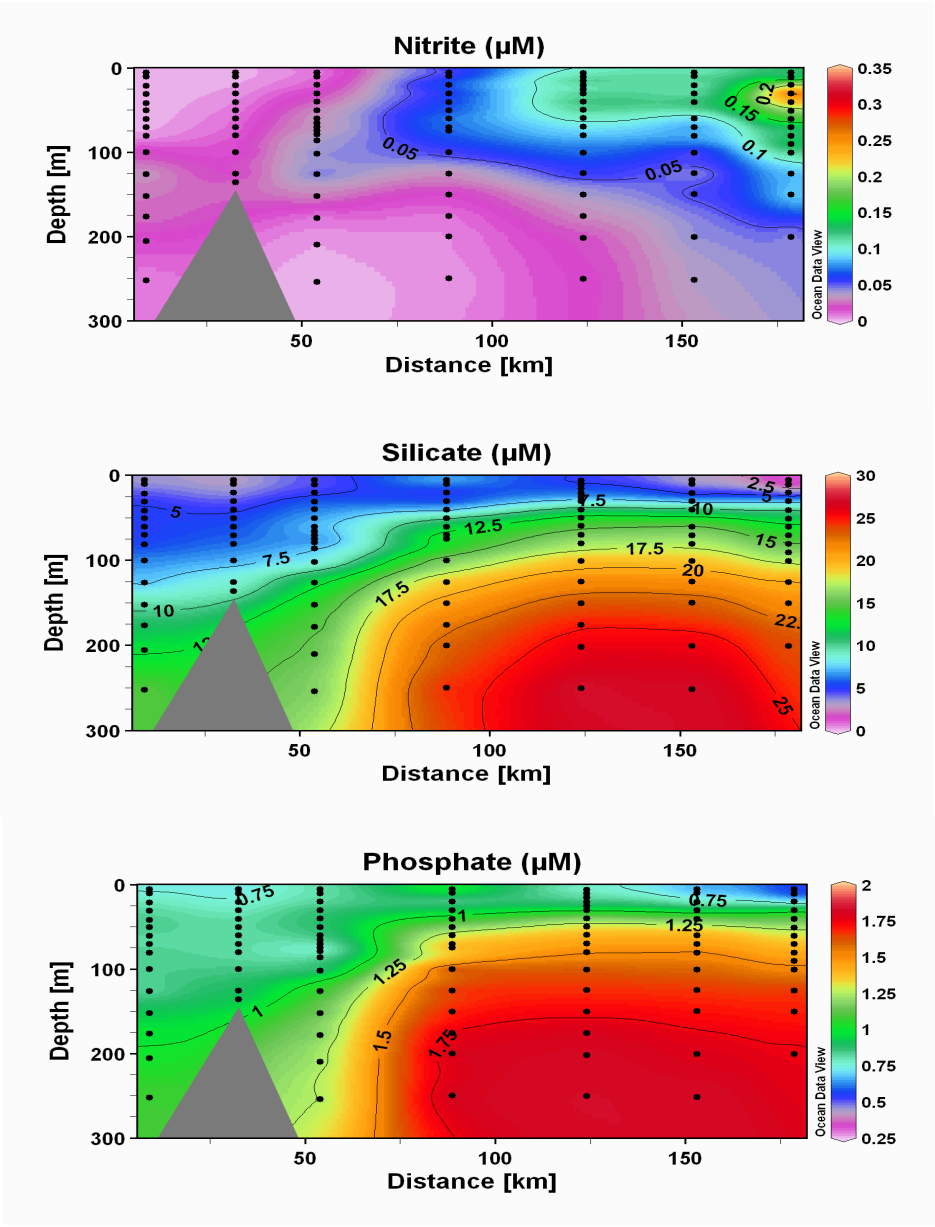
Figure 1. Longitudinal sections of chlorophyll fluorescence (FISP, arbitrary unit), nitrate, nitrite, silicate and phosphate (µM) in the upper 300 m of Baffin Bay. Note the change of vertical scale for the fluorescence panel (100 m). Black dots mark sampling depths and numbers on the map identify the sampling stations.









2.7.4. Phytoplankton & primary production

PIs: Michel Gosselin, Michel Poulin.
Participants: Michel Poulin (CMN) and Lindsay Vare (Plymouth), with part-time assistance from Geneviève Tremblay (ISMER)

This ArcticNet component of this project (Leg 3A) focused on understanding the development of the summer-fall phytoplanktonic communities along an east to west environmental gradient in the Canadian High Arctic, whereas the CFL component (Leg 3B) looked specifically at how the atmospheric, oceanic and hydrologic forcing of sea ice will dictate the overall seasonal production of phytoplankton in the flaw lead and adjacent fast ice.

The main objective is to determine the environmental variables that govern the abundance, composition and production of the summer-fall phytoplanktonic communities in the Canadian High Arctic from the North Water in Baffin Bay to the Mackenzie shelf in the Beaufort Sea, including the North-West passage. This second ArcticNet cruise (Leg 3) brought us to Baffin Bay, the Northwest Passage and the Beaufort Sea, including a suite of stations as part of the Circumpolar Flaw Lead

(CFL) system study in the Beaufort Sea southwest of Banks Island. The main goal of ArcticNet was to compare the phytoplanktonic communities between the eastern and the western Arctic in terms of algal species composition and abundance and to establish the relationships between the environmental variables and the changes occurring in the abundance, the species composition and the primary production of the arctic planktonic microflora. The following hypotheses will be tested (1) a nutrients gradient from the eastern to the western Arctic will influence the species composition of the phytoplankton, (2) a temperature and salinity gradient from the eastern to the western Arctic will affect the species composition of the phytoplankton, and (3) the summer-fall phytoplanktonic communities of the eastern Arctic are more productive than the ones of the western Arctic. The CFL project will focus on the western Arctic region, south-west of Banks Island, tempting to solve the following questions: 1) How do the landfast and flaw lead regions differ in the timing and rates of primary production? 2) Is the phytoplankton community composition and structure different between these two regions? and 3) Is biological production in these regions light and/or nutrient limited?

Water sampling was conducted with a CTD-rosette system collecting water at optical depths corresponding to 100%, 50%, 30%, 15%, 5%, 1% and 0.2% surface irradiance, at the deep maximum chlorophyll (Chl max), and at 75 m and 100 m. Six stations were visited in the Baffin Bay region (101, 105, 108, 111, 115, 134), six stations in the Northwest Passage (301, 302, 308, 309, 310, 314), and 20 stations in the Amundsen Gulf – Beaufort Sea region (405, 407, 408, 420, 434, 435, 437, 1000, 1100, 1110, 1116, 1200, 1216, 1600, 1606, 1800, 1806, 1902, 1908, 1916). Total and fractionated chlorophyll (Chl) and chlorophyll > 20 µm were measured at each corresponding optical depth, the Chl max, at 75 m and 100 m at each sampling site whenever feasible. Routine analyses performed on seawater are indicated in Table 1. Particulate organic carbon (POC) and nitrogen (PON) were done at 50% and 15% surface irradiance, the Chl max and at 100 m. Pico/nanoplankton and bacteria (Pico/Bact) were done at 50%, 30%, 5% and 1% surface irradiance, and at Chl max and 100 m. Planktonic cells were collected at 50% and 15% surface irradiance and at Chl max for species composition and abundance. Dissolved (DOC) and total organic carbon (TOC) were done at 50% and 15% surface irradiance, and at Chl max and 100 m. Samples for pigment analysis by high pressure liquid chromatography (HPLC) were collected at the Chl max only for ArcticNet stations plus at 50% surface irradiance for CFL stations. Protists < 20 µm and > 20 µm for epifluorescence microscopy and FISH were collected at 50% surface irradiance and at Chl max for CFL stations only. Stations 301, 420, 1100 and 1800 were sampled at night time with no Secchi deployment, therefore, fixed water depths were used, while stations 1908 and 1916 were sampled from the moon pool at fixed water depths.

Primary production experiments were conducted at only five sampling sites in the Canadian High Arctic during September-November 2007 (101, 108, 115, 302, 309), due to bad sea conditions which contributed to the destruction of the front deck incubator; primary production experiments were stopped after station 309. Water samples were collected at seven optical depths (100%, 50%, 30%, 15%, 5%, 1% and 0.2% surface irradiance), inoculated with ^{14}C and incubated on the front deck of the ship for 24 h. Water samples at Chl max were incubated to the nearest optical depth. After the incubation, filtrations were performed in the Radvan and scintillation vials were counted aboard the ship in the scintillation counter.

We also recorded continuously the incident light with a PAR sensor (Li-Cor) located on a flat surface on top of a container in front of the ship. At almost all stations sampled, we performed underwater light profiles with a PNF.

Acknowledgements
This project was supported by a Network of Centers of Excellence Grant (ArcticNet), Discovery grants from the Natural Sciences and Engineering Research Council (NSERC) of Canada, IPY-CFL to Michel Gosselin and Michel Poulin, and by a research grant from the Canadian Museum of Nature to Michel Poulin. We are grateful to the Canadian Coast Guard captain, Lise Marchand, officers and crew of the *CCGS Amundsen* for their skillful support during the joint ArcticNet-CFL 2007 leg 3 campaign. We acknowledge the invaluable support of the chief scientist, Jean-Éric Tremblay, during

the expedition as well as several of the scientific staff who provided some assistance in the conduct of our sampling program, and in particular Geneviève Tremblay.

Recommendations
In order to avoid further destruction of the front deck incubator, a movable steel structure should be built to cover the incubator when bad sea conditions prevail, or think of a better protected location on the ship.

The PAR Li-Cor sensor should perhaps be relocated somewhere else than the top surface of the front deck container on starboard because of night ship illumination for sailing and/or front deck operations.

We should think of a proper way to transport water sample bottles (heavy) from the rosette shack to lower deck laboratories.

2.7.5. Short-term vertical fluxes

PI: Christine Michel (Freshwater Institute Winnipeg, DFO)
Participant: Geneviève Tremblay (ISMER, UQAR)

Introduction
Sediment traps have been used to estimate the sinking flux of organic material in the ocean and to assess the composition of that flux. There are two pathways to describe organic carbon in the water column. 1) Phytoplankton carbon can be transferred to the higher trophic level by zooplankton grazing. Part of this carbon can be used by other organisms including fish, mammals and bird, while another part may be exported at deeper depth in the form of fecal pellets (feces). This pathway favors transfer to the pelagic ecosystem. 2) On the other hand, phytoplankton carbon that is not used can be directly exported through sedimentation of intact cells. This pathway leads to food input to the benthic (sea floor) community.

Objectives
This study investigates the biogeochemical cycling of carbon and other organic constituents through the use of short-term particle interceptor traps. The general objective of this study is to characterize the sinking export of carbon and organic material from the euphotic zone (magnitude and composition of the sinking fluxes and material), and the transformation of material during its sinking to depth. This research aims at understanding how climate-related changes in the distribution, timing, magnitude and type of primary production may affect the fluxes of material to the benthic and pelagic food webs.

Methods
During the ArcticNet (27th of September to 17th of October 2007) and CFL program (18th of October to 8th of November 2007), we deployed the traps at six stations throughout the Canadian High Arctic. Of the 12 full stations (full and mooring stations) originally scheduled, only 6 deployments could be performed. Heavy ice condition at stations 101, 1116, 1216, and 1200 did not permit FST deployment. Because of a tight schedule and strong winds, station 437 was transformed into basic station, giving no time for FST deployment. Station 1806 was too shallow for deployment.

The traps were PVC cylinders with an internal diameter of 10 cm and a height/diameter ratio of 7. Before each deployment, seawater collected at 200m deep at a previous station was filtered through 0.22 µm filter membranes. The traps were filled with the filtered seawater to create a dense layer. A series of five PVC cylinders were installed on a line at each sampling depth (50m, 100m, and 150m) in order to collect enough material to perform subsequent analyses. At the surface, the trap line was attached to a positioning system (ARGOS and radio beacon) and a series of small floats (Viny floats) to minimize vertical motion. The traps were deployed for a period of 12-24 hours. Upon recovery, the traps were placed in a dark cold room for 8 h. After allowing the sediment to settle, the supernatant was removed and the bottom volume (ca. 1000ml) of the traps was kept for analysis. Samples were

analyzed for particulate organic carbon and nitrogen (POC/PON), dissolved organic carbon (DOC) and nitrogen (DON), stable isotopes (Isotopes), biogenic silica (BioSi), total chlorophyll *a* and phaeopigments (total chl*a*), exopolymeric substances (EPS) phytoplankton composition and abundance (Cells), fecal pellet abundance (FP), and DAPI.

Another aspect of this project is to evaluate the spatial and vertical distribution of dissolved organic carbon and nitrogen in Arctic marine waters, as these constituents play important roles in the cycling of organic material on the shelves. Water column samples were taken at all basic and full stations throughout the Canadian High Arctic for a total of 30 stations.

2.7.6. Bacterial processes

PI: Roxane Maranger
Participant: Roxane Maranger

Scientific Objectives CFL: As part of team 7, the goals of my team are to measure bacterial C production, community respiration (directly and via ETS activity) and bacterial biomass, in order to elucidate the role of bacterial in ecosystem C processing. Another objective for CFL will be to measure N2O concentrations in the water column to understand whether this by-product of nitrification and denitrification accumulates a

Objectives Leg 3B: My main goal for this leg was to set up our stations, assure we had all the necessary materials we needed for legs 4-10, do some preliminary tests of new methods and see the sampling site for the first time. I am familiar at working in temperate lakes and need to adjust methods accordingly.

Bacterial production rates are low but measurable.
Respiration using the Fibox and sensor is difficult to detect. We will continue testing, but put more effort in ETS as back-up. Also had difficulties with chamber temperature stability and set up where the Fi-Box incubations were taking place.
I experimented with different types of filtration to try to streamline ETS filtration.

October 18-25: lab and instrument set up and calibration.

Acronyms:
BP: Bacterial production
BR: bacterial/community respiration
ETS: Electron Transport Systems Activity
BA: Bacterial Abundance
N2O: Nitrous oxide, headspace gas exchange

Oct 25
STN: 1200, Cast 119
BP: 80, 60, 50, 30, 10, 0 m depth
BA: 80, 60, 50, 30, 10, 0 m depth

Oct 26
STN: 1000
BR and BP in surface water and ice

Oct 27
STN: 1000
N2O: 30, 0 m and air

Oct 28
STN: 1116 Cast 103
BP: 80, 60, 50, 30, 10, 0 m depth
N2O: 40, 0 m and air

Oct 29
STN 1216
Cast 109
N2O: 50, 0 m and air

Oct 31
STN: 1200, Cast 119
BP: 80, 60, 50, 30, 10, 0 m depth
BA: 80, 60, 50, 30, 10, 0 m depth
ETS: 50 and 0 m

Nov 1
STN: 1200, Cast 119
BP: 100, 70, 50, 30, 10, 5 m depth
BA: 80, 60, 50, 30, 10, 5 m depth
ETS: 50 and 0 m
BR: 50, 10 and 5 m

Nov 2
STN: 1606
CAST: 131
N2O: 50, 0 m and air (verify bottle 11-12)

Nov 3
STN: 1902
Cast: 135
N2O: 30, 5 m and air

STN: 1902
Cast: 136
N2O: 200, 47, 5 m and air

Nov 4-8 Inventory, protocol write up, organisation.

2.8. Team 8

General objective
The question this project hopes to answer is how climate variability in physical forcing and the biogeochemical response to this primary forcing will affect organic contaminants and mercury (Hg)/methyl mercury (MeHg) cycling. Ultimately, we propose to relate changes in delivery and biogeochemical cycling of these contaminants to their levels in fish, marine mammals and the people who consume these tissues as part of their traditional diets.

An additional sampling campaign of PFOA (perfluorooctanoic acid) and PFOS (perfluorooctane sulfonic acid) was undertaken during ArcticNet and CFL 2007-2008. The program is designed to obtain a detailed picture of PFOA and PFOS concentrations in near shore and open ocean sites in the Canadian arctic.

2.8.1. Organic contaminants

PI: Gary Stern (DFO, Freshwater Institute)
Participants: Allison MacHutchon & Joanne DeLaronde (DFO, Freshwater Institute)
Monika Pucko (PhD candidate, University of Manitoba)

Hexachlorocyclohexane (HCH)

Technical HCH is a mixture of several isomers, the most abundant being α-HCH (60-70%), γ-HCH (5-12%) and β-HCH (10-15%). Technical HCH and pure γ-HCH (lindane, pesticide active isomer) have been used for over 50 years and are now ubiquitous in water throughout the northern hemisphere with the highest levels found in the surface water layers near pack ice in the Arctic Ocean.

Technical HCH was banned or heavily restricted by China, the former Soviet Union and India between the mid-1980s and 1990. Concentrations of α-HCH in arctic air responded quickly to these large-scale usage changes and declined by an order of magnitude from the early 1980s to mid-1990s in steps that closely matched global usage and emission estimates. As a consequence, the direction of net gas exchange in arctic waters reversed from deposition in the 1980s to air-water equilibrium or volatilization in the mid-1990s.

The α-isomer is the prominent in Arctic air, water, biota and soil, and moves northward via cold-condensation, a process whereby the contaminant evades into the atmosphere, drifts with atmospheric currents, and condenses in colder climates where at colder temperatures increasingly favours the water and extensive ice cover inhibit further evasion. Hence the contaminant accumulates disproportionately in the Arctic.

Water sampling
Water (4L) was collected from the rosette at all full and basic stations. At the surface, a plastic bucket was used to collect the water. Where feasible, transects across water bodies were collected. In the lab, water was pumped through a glass-fiber filter followed by an ENV+ solid-phase extraction (SPE) cartridge using peristaltic pumps. On ArcticNet leg 3/CFL leg 1, we collected 29 profiles, usually consisting of 9 depths, with the emphasis on the upper water column. Filters and cartridges are frozen and brought back the Freshwater Institute for analysis. $^{18}\delta O$ and salinity samples were also collected at each site and depth where HCH samples were taken.

HCH water filtration (Aft chemistry lab)

Air Sampling
The air sampler was set up on the bow of the ship on the starboard side for all full stations, most basic stations, and several transects. Samples are collected on a glass fiber filter and polyurethane foam (PUF) for analysis of organic contaminants. Air samples collection time ranged between 4 and 23 hours. A total of 32 samples were collected. Filters and PUFs were frozen at -20°C and shipped frozen back to the FWI for HCH contaminant analysis.

Air sampler / Ptarmigan perch

Ice sampling
Ice samples for HCHs concentration and enantiomeric composition were collected at each basic and full station where the newly formed ice was present (Table 1). The samples for oxygen isotope composition ($\delta^{18}O$) and salinity were taken along with all ice samples. The ice samples were collected in collaboration with team 2 and the ice microstructure analysis was made on most of them (except from stn. 1000 and stn. 1600) (see team 2 cruise report). In cases where more than one type of ice was present, 2 ice samples were collected. The total of 12 samples of newly formed sea ice for HCHs, $\delta^{18}O$ and microstructure analysis was collected.

Table 1 Ice sampling locations for HCHs during leg 3B

Date	Station	Type of ice	HCH sample #	$\delta^{18}O$ sample #
26 Oct 07	1000	slushy pancake ice	AN07-LV-268	284
27 Oct 07	1110	nilas	AN07-LV-285	301
28 Oct 07	1116	nilas	AN07-LV-294	310
29 Oct 07	1216	nilas	AN07-LV-301	312
31 Oct 07	1200	consolidated pancake ice	AN07-LV-310	321
01 Nov 07	1600	consolidated pancake ice (slushy pieces collected)	AN07-LV-320	331
02 Nov 07	1606	consolidated pancake ice (slushy pieces collected)	AN07-LV-327	338
03 Nov 07	1902	nilas (smooth with nidle-like frost flowers and no slushy layer)	AN07-LV-337	348
03 Nov 07	1902	grey ice with 0.5-1 cm of snow on top	AN07-LV-338	349
05 Nov 07	1908	big pancake floes with a 1 - 1.5 cm layer of snow on top	AN07-LV-347	359
05 Nov 07	1908	nilas from between big	AN07-LV-346	358

		pancakes with nidle-like frost flowers and a thin (a few mm) slushy layer on top		
06 Nov 07	1916	grey ice with a thin slushy layer (a few mm) and a lot of big shining conical-like frost flowers on top	AN07-LV-349	361

Ice samples were collected from the ice cage. When the ice was thin enough, the ice chipper was used. In case of thicker ice (>15 cm) the ice cores were taken. The total of 4-8 L of melted ice was pumped through a glass-fiber filter followed by an ENV+ solid-phase extraction (SPE) cartridge using peristaltic pumps. The cartridges and GFFs were stored in -80 °C and brought to the DFO (Winnipeg) for further chemical analysis.

Ice cage/ice corer (Pascale Collin and Phil Hwang)

Perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS)

PFOA and PFOS are the two major perfluoros present in North Atlantic waters. They range in concentrations from <10 to 500 pg/L. Previous work has shown that they are present in somewhat higher concentrations in near shore waters sampled around Nain (June and September 2006) and Resolute Bay (June 2006). In this sampling program we hope to obtain a detailed picture of PFOA and PFOS concentrations in near shore and open ocean sites to test our hypothesis that concentrations follow a declining gradient away from land.

Flourinated materials are found in a wide range of applications because of their unique stability toward redox agents as well as for their inert and nonadhering surface properties. They are used in many commercial products such as paints, polishes, packaging, lubricants, firefighting foams, cookware, and stain repellents. During the past six years, scientists and consumers became more aware of these materials when 3M, a longtime major manufacturer of these compounds, declared that it was stopping

production of some perfluorinated compounds, including PFOS and PFOA. The primary reason for withdrawing PFOS from the marketplace was the discovery that it is persistent, bioaccumulative, and toxic in animal studies. The U.S. Environmental Protection Agency subsequently requested more information on PFOA to ascertain the sources of human exposure and to determine the environmental effects.

PFOA and PFOS are likely present as residuals in polymers used on the ship because of past use as stain repellents, floor polishes, lubricants in Teflon (PFOA only) and therefore could be sources of contamination, especially in ship and lab air. Water was collected off the rosette through norprene and tygon tubing directly into polyethylene containers to limit contact with ship air as much as possible. Other possible sources of contamination to be avoided are Teflon tubing and bottles, Gortex or other stain repellent coated clothing, possibly KimWipes and waterproof paper.

Collection of water from the rosette for PFOS and PFOA analyses.

Between 1 and 2 L of water was pumped through 6 ml (150 mg) WAX solid phase extraction cartridges at a flow rate of 10 ml / minute using peristaltic pumps. The cartridges were preconditioned (July 18) and shipped dry in 50 ml polypropylene vials, sealed with parafilm wax. Prior to filtration, the cartridges are spiked with 50 µl of an internal standard made up of 11 PFC's. In order to avoid air contamination during filtration, an additional WAX cartridge packed with polyurethane foam was used as an air filter. After filtration, cartridges are returned to the polypropylene vials, resealed with parafilm and refrigerated at 4 C.

Filtration of water through WAX cartridge with additional cartridge acting as an air filter.

Water blanks and cartridge recovery checks were performed to identify contamination sources. As an additional check of on-board collections and extractions, duplicate water samples were collected at a number of stations. These duplicate water samples will be sent back for extraction in a clean room setting for comparison to ship extraction.

Water was collected in depth profiles using a plastic bucket for surface water and the rosette for 5, 10, 25, 50, 100 and 200 meters at 2 stations (111, 435). A spatial study was also conducted with water from 5 m (rosette collection) at 9 stations (134, 301, 302, 305, 308, 309, 310, 314, and 434).

2.8.2. Biotic Sampling (mercury, stable isotopes)

The main purpose of this study is to link physical and biological processes to mercury levels in the food web and to target the pelagic food web biomagnification and bioaccumulation of mercury with stable isotopes and fatty acids. Thus, all biological samples collected will be measured for total mercury and MeHg along with stable isotopes to place organisms into their associated trophic levels.

Biological samples were collected at every basic and full stations along the cruise transect. Various zooplankton families and fish samples were collected using the vertically towed Monster net (200 and 500 µm), an oblique Tucker net (2x500 µm) and the RMT (rectangular midwater trawl, 1600 µm). Zooplankton and fish were sorted into families, placed into plastic vials and Whirlpak bags and frozen until they can be analyzed for THg, MeHg, stable isotopes and fatty acids. Zooplankton was collected at 32 stations. Many thanks to the University of Laval zooplankton team for hard work out on the foredeck!

Additionally, total body length (the distance from the front of the head to the tip of the longest uropod) of the individuals of the hyperiid specie *Themisto sp.*, an amphipod highly distributed throughout the High Arctic was measured to the nearest 0.5 mm. Animals greater than 18 mm are considered adult and smaller than that free living juvenile. The individuals were divided into size classes; 0-10 (newly hatched individuals/Juvenile 1), 11- 15 (Juvenile 2), 16-20 (1 year old immatures), 21-30 (individuals of over 2 years old), >30 and whenever possible, separated into different vials as described above.

2.8.3. Mercury

PI: Vincent L. St. Louis (University of Alberta)
Participant: Igor Lehnherr (University of Alberta)

Introduction
Concentrations of the neurotoxin mono-methylmercury (MMHg) are increasing in many marine mammals of the Canadian Arctic to levels that may be toxic to Northern peoples consuming these animals as part of a traditional diet. The objective of our team within ArcticNet is to determine the source of this MMHg to arctic marine foodwebs and we are currently building on work completed during the previous two ArcticNet cruises (2005 and 2006). One of the key processes resulting in the contamination of biota with mercury (Hg) is the formation of methylated Hg species, such as MMHg, from inorganic Hg(II) species which themselves are not as readily bioaccumulated. The methylation of Hg(II) in marine sediments has been shown to take place in various temperate locations, and in freshwater systems it has also recently been demonstrated that Hg can be methylated to MMHg in certain regions of the water column (i.e. the hypolimnion). However, most of the research conducted thus far on Hg biogeochemical cycling in the Arctic has focused on atmospheric processes which result in the deposition of Hg(II) in marine and coastal systems; but the link from the deposition of Hg(II) to the formation of MMHg is still a missing link. Our understanding of the methylation-demethylation processes resulting in the formation and removal of MMHg in Arctic marine systems is very limited as is our knowledge of the rates of the major redox transformations that constitute the biogeochemical cycle of Hg in arctic seawater, despite the obvious importance of such information in constructing regional or global Hg models. Since a high proportion of the total Hg (THg, all forms of

Hg in a sample) measured in the lower parts of the water column during ArcticNet 2005 and 2006 existed in methylated forms such as MMHg and dimethylmercury (DMHg, a volatile, toxic form of Hg that can be photolyzed to MMHg), we hypothesize that Hg(II) can be methylated directly in the water column. In other words, we are proposing that the production of methylated Hg species in bottom sediments alone is not enough to result in the concentrations measured in the overlying water column. By adding different Hg stable-isotope tracers to seawater samples in incubation experiments, we are attempting to measure water column Hg methylation rates to determine if this process is a potential source of Hg contamination to marine organisms in the Canadian Arctic. Using the same techniques, we are also quantifying the rates of some of the other major biogeochemical processes, such as reduction and demethylation reactions, implicated in the cycling of Hg in arctic marine waters. In addition, we are also measuring background concentrations of a broad range of Hg species in the water column: THg, MMHg, DMHg and DGEM (dissolved gaseous elemental mercury) to continue building a baseline against which potential future changes in the distribution of dissolved Hg species can be compared. This work will result in the measurement of the first rate constants of some of the major biogeochemical pathways in the cycle of Hg in arctic marine waters, which will in turn provide valuable information towards building a regional Hg model. Our overall understanding of Hg cycling in the Arctic will be enhanced allowing us to better predict changes in this cycle as climate change continues to impact the Arctic.

Methods

Sample Collection and Processing:

At each station, we sampled the water column at two different depths, namely the sub-surface chlorophyll maximum and the bottom of the oxycline, using Teflon-lined Niskin bottles mounted on the ship's rosette. From each depth we collected water in separate acid-washed Teflon bottles for THg and MMHg analysis using standard ultra-clean procedures such as the "clean hands, dirty hands" protocol. THg and MMHg samples were preserved by acidification within 12 hours of collection. For the purpose of the isotope-addition methylation experiments, water was collected in certified ultra-clean amber boston-round glass bottles and 1L glass jugs by twice overfilling each bottle from the bottom – using c-flex tubing – to preserve *in situ* redox conditions. Water was also collected and filtered for sulfate and DOC analysis.

Experimental Concept and Procedure

The basic design of the methylation experiments was to add Hg(II) of a specific isotope and measure the concentration of MMHg and DMHg containing that particular isotope of Hg after various incubation times to obtain a time-series of data from which methylation rates could be calculated.

$^{198}Hg(II) \longrightarrow MM^{198}Hg + DM^{198}Hg$; methylation rate = % of ^{198}Hg added that is converted to MMHg or DMHg per day per L of water

Samples also received a spike of isotopically-labelled MMHg to monitor the decrease in that species over time from both demethylation reactions and the production of DMHg from MMHg.

$MM^{199}Hg \longrightarrow {}^{199}Hg(II)$; demethylation rate = % of $MM^{199}Hg$ lost per day $MM^{199}Hg$

$\longrightarrow DM^{199}Hg$; methylation rate = % of $MM^{199}Hg$ added that is converted to DMHg per day per L of water

Incubation samples were split into three different series for each depth. Two of these series received a received a high-level addition of $^{198}Hg(II)$ stable-isotope tracer and a low-level addition of $MM^{199}Hg$. Samples from these series were incubated in the dark at 4 °C for 0, 12 and 24 hours, after which times samples were either acidified (series 1) or frozen (series 2) to stop all biotic activity and preserve the sample. The acidification versus freezing comparison was done to ensure that acidifying samples, which is currently the protocol most often used to preserve Hg water samples, does not induce artifact methylation of the inorganic Hg(II) tracer. These samples will be analysed for $MM^{198}Hg$ and $MM^{199}Hg$ back at the University of Alberta to quantify methylation and demethylation reaction rates, respectively. The third incubation series was conducted in 1L glass jugs amended with high-level

additions of both ^{198}Hg(II) and MM^{199}Hg, and incubated for 0, 12 and 24 hours at 4 °C, in the dark. At the end of the predetermined incubation period, samples were purged with a flow of UHP nitrogen and volatile Hg species were captured by adsorption on carbo-traps (for DMHg) and gold-traps (for DGEM). This experiment will allow us to determine the rate at which DMHg is produced in the water column and if it is predominantly formed from Hg(II) or from MMHg. At the same time, we are also able to quantify the reduction of both Hg(II) and MMHg, as measured from the production of DGEM, which is the reduction end-product. At station 115, this experiment was also replicated in the presence of light to qualitatively determine whether light enhances or inhibits any of the processes resulting in the formation of volatile Hg species (DMHg and DGEM). By measuring a third isotope of Hg (i.e. one that is neither ^{198}Hg nor ^{199}Hg) during the analysis of the carbo- and gold-traps, we will also be able to measure the background ambient levels of both DMHg and DGEM in the water column.

Preliminary Results

Due to the complex analytical nature of our work, we are not able to analyze any of the samples while on board of the CCGS Amundsen. Therefore, we will not obtain any data or results until samples are returned to the *Biogeochemistry Lab* at the University of Alberta for low-level Hg analysis using various mass-spectroscopy techniques.

Stations Sampled

Station ID	Cast Number	Depths Sampled /m	Work Conducted
Station 101	004	60, 216	Full suite of samples and experiments
Station 115	011	20, 211	Full suite of samples and experiments
Station 302	025	34, 327	Full suite of samples and experiments
Station 308	029	26, 190	Full suite of samples and experiments
Station 309	031	26, 151	Ambient THg and MMHg sampling only
Station 314	034	20, 80	Ambient THg and MMHg sampling only
Station 434	036	9, 35	Ambient THg and MMHg sampling only
Station 435	046	33,125	Full suite of samples and experiments

2.9. Remotely operated vehicle (ROV) operations

Participants: Vincent Auger (ROPOS), Luc Michaud & Pascal Massot (Université Laval)

Introduction

From September 27th to October 8th, 2007 the Canadian Scientific Submersible Facility sent me, Vincent Auger, to help the University of Laval's team prepare and deploy their Sub-Atlantic Super Mohawk for its first dives as well as provide in-the-field training. Originally it was hoped that the Remotely Operated Vehicle (ROV) could be promptly setup and used to recover lost moorings. Due to time and schedule restrictions, these complex operations were however postponed to be replaced by 3 short sea-trials dives of the ROV which allowed both the ROV team and ship's crew to get familiar with the steps and considerations of operating an ROV from the CCGS Amundsen.

In retrospection, the approach taken during this expedition was essential to establish the procedures and operational familiarities required for the safe deployment and use of the ROV onboard the Amundsen. Both the Amundsen and ROV team now have a foundation to continue using their ROV and develop its potential.

Initial Preparations

On our arrival on the ship it was clear that the overall system would require 2 or 3 days of work before a dive could be attempted. The moonpool area was filled with larges boxes which would have to be moved, and the control room and ROV control equipment was partially setup. Furthermore the ROV and TMS would require extensive inspection and testing for its first dive.

The main tasks performed for preparation were:

- Emptied moonpool area of boxes and cleaned control room to allow for the setup of equipment.
- Vehicle Inspection.
- Leak found on the TMS drum shaft. The top hose clamp was slightly tightened until the leak stopped. The compensator was then filled and the leak cleaned. There is still sweating occurring at the base of the drive shaft gearbox. The base-seal should be cleaned or replaced. We did not have enough oil onboard to perform this task.
- Both TMS' compensators (2700cc each) were nearly empty. This was due to the oil slowly making its way into the tether over the course of the past months, a common occurrence in oil-compensated systems. The ROV's termination box also emptied due to the same effect. In order to avoid the unnecessary loss of oil, these compensator valves could be close when the system is not used for extended periods of time.
- Complete inspection and cleaning of the vehicle and TMS in order to verify every connection and fitting on the system.
- Test of all vehicle's functions and support systems.
- Complete setup the control room.
- Installation and test of navigation systems.
- Melting of 2-3 feet of ice which formed in the moonpool.
- By the evening of September 30th, after approximately 40 hours of work, the vehicle was fit to dive and all support systems were operational. At this point our main concern was an intermittent communication problem with the vehicle's telemetry which we were unable to pin-point.

Dives

A total of 3 dives took place during my visit. All parties involved were in agreement that if the winds exceeded 25 knots, any dive would be aborted before the sea build-up could lead to unsafe operation and recovery. Furthermore, the captain or ROV supervisor could abort a dive at any time if he/she believed the operation was unsafe. For each dive the following teams, see table 1 and 2, were established for safe launch, operation, and recovery of the vehicle.

Table 1 : Launch and recovery Team

Position	Main Tasks
ROV Supervisor	Directs the operations in the moonpool room and communicates with both the bridge and ROV control room.
Crew Supervisor	Ensures the overall safety of the operations taking place in the moonpool room.
Winch Operator	Operates the main umbilical winch under the direction of the ROV supervisor.
Crane/Cable Guide Operator	Operates the crane and then the cable guide under the direction of the ROV supervisor.
ROV Pilot	Sits at the consoles and pilots the ROV under the direction of the ROV supervisor via a hands-free telephone headset system. The pilot also reports any fault or concern to the ROV supervisor.
2 Crew	Hook and Unhook the TMS. Stabilize the vehicle and TMS while it is free hanging. Assist as directed.

Table 2: Basic Operation's Team

Position	Main Tasks
ROV Supervisor	Supervises the technical aspects of the dive
ROV Pilot	Operates the ROV under the direction of the ROV supervisor
Investigator	Guides the ROV team to achieve the scientific objectives of the dive. The investigator is often the person that has planned the dive and its objectives with the ROV team.
Winch Operator	Operates the main umbilical winch under the direction of the ROV supervisor.

Dive 1 – October 1st

This dive was designed to familiarize all involved personnel and develop operational procedures on the use of the ROV system onboard the Amundsen. As preparation for this first dive, all involved parties took part in a meeting which outlined the dive's goals, explained what was expected of each group, and also addressed any concerns on this initial operation. An important point that was raised during this meeting is that the ship does not have a bow thruster, a fact that limits the ship's ability to keep station.

Goals

- Validate all systems underwater.
- Familiarize the ROV team and ship's crew on the deployment and recovery of the system through the moonpool.
- Familiarize the ROV team with important vehicle maneuvers
- Exit the TMS
- Fly the vehicle around the TMS
- Usage of the navigation system and sonar
- Enter the TMS

Dive Log

12:30	Dive starts
	Original lifting system is unsafe - going with a strap.
	TMS lifting point is too far forward causing an unacceptable pitch.
	There is a turn in the cable leading the TMS to turn to port.
	Fit some tag lines to help control the TMS while lowering it into the water.
	At this point - decision is taken that we will not venture outside of the moon-pool due to the TMS' pitch.
	Testing that the ROV can control TMS rotations went okay. Vehicle can turn TMS with approximately 80% thrust.
	All systems are working well - no faults detected.
	Problems with Navigation system - cannot track - decision to look at this once vehicle is back on deck.
	Test with the winch to ensure that it pays in and out smoothly.
	Vehicle Recovery
14:30	Vehicle back on deck and moon-pool closed

defects

1. TMS' pitch is excessive
2. A safe TMS lifting apparatus must be built.
3. Loss of vehicle telemetry continues after 30 minutes without problems at start of dive.
4. Winch level-wind is backwards.
5. Navigation system did not track.
6. Cable guide requires a new cable – starboard winch's cable is damaged.
7. Navigation screen to the bridge, network problems.

Post-Dive Corrections

1. The umbilical lift point was moved all the way back on the lifting rail in order to reduce the pitch as much as possible.
2. Ship's engineering built an angle bracket that mount on the existing lift rail just forward of the new umbilical lift point. A lifting eye was then bolted through the bracket to allow the moonpool room's overhead crane to safely move the TMS.

3. The actual telemetry problem was found after Dive 2, a dirty fibre connection within the control console.
4. The level-wind screw was manually turned until it matched the cable's position and direction on the drum.
5. The navigation system was tested on deck, no problems were found. The system did not track during the dive as we pressed the wrong software button to "wake-up" the transponders for navigation.
6. The cable guide's starboard side winch wire was replaced and cable guide tested for proper operation. Several brackets were also grinded down to facilitate the cable guide lowering.
7. The network switch below the bridge was defective; it was replaced by the ship's electronic technician.

Dive Summary

Due to an excessive pitch angle on the TMS, the plan to venture outside of the moonpool had to be abandoned. The pitch was caused by the forward location of the umbilical attach point and was severe enough that the upper-back portion of the TMS was resting against the moonpool wall. The TMS may have pitched even further once outside the moonpool making its recovery unnecessarily difficult. Unfortunately, the lift point could not be tested prior to the dive as there is not enough headroom in the moonpool room to lift the TMS using the umbilical.

This dive however remained a good opportunity to validate all systems and identify any defects as both the TMS and ROV were fully submerged for the first time on this cruise. Once the tests done, the vehicle was recovered without problems. It is also important to note that the dive also allowed us to fine-tune our deployment and recovery procedures and manoeuvres.

Dive 2 – October 3rd

We were allotted 4 hours for this dive which picked-up on Dive 1's original goals as well as gave the ship the opportunity to practice station keeping with the TMS in the water column.

Dive Log

8:15	System is ready to dive - ship is doing a CTD
9:00	CTD is completed - ship gives okay to dive and is now drifting.
9:38	We have the TMS on top of the moonpool
10:15	Vehicle is in the water at 40 meters - going out of the TMS for flying exercises
11:15	Going back in the TMS - ship will now try to hold station
11:40	Ship is done it's station keeping test - returning to surface with the TMS
12:00	Dive is over, everything back on deck

Defects

1. Telemetry problem continues.
2. Video capture computer hangs and requires reboot.
3. Tracklink navigation system works well but periodically gives fatal error messages asking to power-cycle the transducer.

Post-Dive Corrections

1. Fibre-optic connections were moved from the -10dB to the 0dB connectors. Cleaned all fibres, including ones inside of console. We can no longer reproduce the telemetry problem.
2. The video capture computer also ran the Tracklink software; we separated the two and did several successful capture tests.
3. We could not reproduce this behaviour, maybe (2) was also causing problems with the Tracklink software.

Dive Summary

All dives objectives were reached. The deck crew was confident and both the deployment and recovery were smooth. Luc and Pascal practiced flying around the TMS and were able to familiarize

themselves on the Super Mohawk's particular flying dynamic. Luc also practiced flying from the TMS's camera and successfully "parked" the vehicle back in the TMS.
Once the ROV was back in the TMS, the ship practiced station keeping for approximately half an hour. Establishing the ship's ability to keep station is essential to successful ROV operations. The captain was able to gain valuable information on the drag behaviour of the TMS during these manoeuvres. As we expected, the TMS essentially remained directly below the moonpool during the entire dive but abrupt ship motion could cause steep cable angles.

Dive 3 – October 6th
This final training dive was designed to mimic a video exploration dive. 4 hours were available for this opportunistic dive which had us sheltered from foul weather in Admiralty Inlet. After our departure from the Nanisivik port, a dive area was specifically selected for its flat muddy bottom (300m depth) which would facilitate bottom exploration as well as minimize the risk of a TMS collision with rising subsea features should the ship have problem holding station.

Goals
- Familiarize the night crew with the deployment and recovery procedures
- Provide more flying practice around the TMS.
- Safely bring the system to the bottom, only if the ship can hold station.
- Explore a small area and do a short transect if time allows.
- Return to the TMS from the bottom and safely enter TMS.

Dive Log

21:00	System is ready to dive – ship is drifting.
	Lowering TMS through moonpool and stopping TMS at 30m depth – ship is free to manoeuvre.
	Vehicle exits the TMS – fair currents make it difficult to keep TMS in sight.
	Lost sight of TMS for approximately 10 minutes
	Found TMS again, several turns in the tether from the search. Found out that the trim buttons were both pressed causing the vehicle to behave abnormally hence making the search for the TMS harder than it had to be.
	Took out the turns (~8) in the tether.
	Lowering TMS at 20m/min while Pascal is flying around it.
	TMS near bottom ~ 40m according to ship's echo sounders.
	Luc flies the vehicle to the bottom, slowly going away from the TMS' mouth.
	Vehicle is on bottom at 311 meters – exploring and practicing landings and transects in soft mud.
	Compass cannot be used – navigation system is reliable enough to work.
	Vehicle returns to the TMS.
	Pascal practices flying in the TMS camera and parks the vehicle.
	Beginning recovery at 25m/min
23:45	Vehicle is back on deck

DEFECTS
1. Video capture computer crashed during the dives – computer completely hangs and requires reboot.
2. Tracklink software still hangs and gives an error message asking for a transducer power-cycle.

Post-Dive Corrections
1. The captured video was corrupted during the computer crash. Considerable effort was put into piecing together the corrupted file in order to extract some of the video. While we were able to recover some of the video, the capture software had other problems and the original data was

corrupted. Some video snippets and images were however recovered. It may be possible to recover more of the video and images but is likely not worth the effort. Pascal will look into the capture card problem, the last hints pointed towards an IRQ conflict.

2. The Tracklink software "crashed" several times. While it was easy and relatively quick to get going again the problem was an annoyance. This matter should be discussed with LinkQuest Inc.

Dive Summary
All of the dive's objectives were reached and the vehicle explored a bottom crawling with life. The night's crew first deployment was smooth and without incident, the ship held station beautifully never venturing outside of the watch circle, and both Pascal and Luc were able to widen their piloting skill sets.
The main hick-up during the dive was the lost-of-sight of the TMS shortly after the vehicle's exit. While there was a considerable current, I believe the accidental enabling of the *trim* buttons was the main cause of this problem. The *trim* buttons are used to apply a constant vehicle attitude to offset surrounding currents, a useful feature when you've enabled it on purpose. The excessive *trim* easily simulated a stronger current and greatly reduced the vehicle's maneuverability leading to the loss-of-sight of the TMS. The TMS was however in-sight after approximately 10 minutes and while there was some turns in the tether they were all taken out and offered a improvised tutorial on a situation both Luc and Pascal will face again.

With approximately 30 minutes of bottom time, both Luc and Pascal were able to pilot the vehicle on the bottom and practice soft landings and travels. The ability to travel without suspending sediments is an important skill as good video and exploration depend on it. It is also important to note that the vehicle's compass does not work well enough to rely on. The turn counter, a useful tool which tells you how many turns you've put into the tether, uses the compass and can therefore not be trusted. During our bottom exploration we were careful to offset each right turn with a left turn, a good habit in any case.

On our return to the cage, we were especially careful when paying-in as if there was a turn in the tether it could have easily got caught in the TMS and caused damage leading to loss of vehicle telemetry, etc. The tether did not have any turns and we were able to return the vehicle in the TMS without problem to begin recovery.

Observations and Recommendations
During the preparations it became evident that the University of Laval's technicians have a wide range of responsibility and tasks to perform on the vessel. While they were able to offer some help during the system preparation their many responsibility made it difficult to dedicate as much time to the ROV as they would want or would be required if the system was used frequently.

The Super Mohawk system is a good vehicle with great potential but it is important to remember that the Amundsen operation is just beginning and will require some supplies and tools. During my visit I compiled a list of concerns and things to do in order to make the vehicle a reliable tool to the users of the Amundsen. The "must" points that are to follow are things and items the vehicle and team require.

Must do

- Starboard vertical propeller blade needs to be resurfaced. It is damaged and likely unbalanced. This unbalance will cause unnecessary strain on the propellers shaft and possibly reduce its lifespan.
- The TMS slip-ring torque arrester is secured to the TMS drive motor electrical cable and connector and not a fixed bracket as shown in the slip-ring's user manual. While this came from the factory this way, a proper torque arrester bracket should be built and installed to remove the unnecessary strain on both the oil-filled hose and drive motor electoral connection.
- Leak in the port arm's wrist cylinder. This problem was known but we had too little hydraulic oil (Tellus 22) to perform this task without risking our ability to dive the vehicle.

- Contact Sub-Atlantic concerning the radio interference problems on the pilot's console. They have likely seen and fixed this problem before.
- Contact LinkQuest concerning the constant power-cycle that must be performed on the transducer during operation.
- Organize spare and establish any missing critical spares.
- Establish any missing tools or instruments required for the proper offshore maintenance of the vehicle.
- Refit the TMS drive gear housing. It is slowly leaking oil from the base-seal.

Must Buy

- Fibre-optic kit which will allow the team to perform vehicle re-termination.
- Fibre-optic light meters to troubleshoot communication problems.
- Fibre-optic spare connectors and patch cables.
- Vehicle oil-supply of all 3 necessary oil. Tellus 22, Castrol Hyspin, and Transformer oil.
- Hydraulic fittings, valves, hoses, etc…
- Compensation bottles and nozzles, at least 2 more.
- Spare set of FOCAL multiplexer board (top and bottom).

ROV Suggestions

- Install altimeter on the TMS. This is almost "must" items as it will help keep the TMS at a safe distance from the bottom. Dragging the TMS on the bottom can have catastrophic consequences.
- Install a radio and strobe beacon on the vehicle. Should the vehicle be separated from the TMS for any reason, these beacons will be invaluable in finding the vehicle again.
- Install a camera on the cable guide. This isn't necessary but would be a great addition as it would allow the ROV pilot to guide the vehicle in the moonpool more efficiently than with only the supervisor's commands.
- Flush all vehicle oils. This is a good thing to do for oil that has been sitting for over 3 years.
- Switch both cameras internal with NTSC cameras. The FOCAL multiplexer boards will handle NTSC and this would remove a layer or complexity to the system. Keeping the housing and changing only the electronics will also be much cheaper than changing the entire camera.
- Look at important non-critical spares for vehicle's support systems. Navigation and video are currently the vehicle's only deliverable for scientific mission, if these missions are to be successful spares for these support systems should be available.
- Build a sturdier pole for the Tracklink system to reduce vibration.
- Add spare fibres from the winch to the control room - having these fibres in protective coating would also be beneficial against abrasion.

General Suggestions

- Investigate usage of ship's Dynamic Positioning system for ROV operations.
- Prepare future moorings with an ROV in mind. Insert a weak leak the ROV will be able to manipulate or cut free.
- Consider a user-pay usage or other revenue system for ROV missions.
- Consider marketing of the ROV's capabilities to other science groups.
- Think of ways to extend vehicles capability while considering the moonpool limitations.

Conclusion

The University of Laval Super Mohawk is a system with great potential. It is however important to keep in mind that it is in its infancy and that both the ROV team and the Amundsen crew need to continually develop and practice their skills in order to competently handle problematic situations and successfully complete complex missions such as mooring salvage and scientific sampling.

For the ROV team, it would be beneficial to continue a partnership with CSSF which can help with advice and mission planning as well as provide further training and assistance during offshore missions. The University of Laval's ROV team is often very busy with other responsibility and the helping hand of an experienced ROV pilot has already proven valuable.

The CGSS Amundsen did very well during my visit. The ship was able to hold station without the use of a dynamic positioning (DP) or bow thruster. While the ship does have DP, mechanical problems did not allow us to use it. Dynamic positioning or a bow thruster would be extremely beneficial to ROV operations under less-than-perfect weather conditions.

The future uses of the ROV are unclear at the moment. It is certain to eventually serve as a tool in mooring salvage as well as seafloor exploration. There has also been some interest in its use to inspect the ship's hull and propellers for damage, a task performed by ROVs on other icebreakers to plan dry dock repairs. Regardless of the short-term work plans, I believe it is important for both the ROV team and the Amundsen crew to continue using the ROV on a periodic basis. Not only will this improve the team's performance and skill, it will ensure that the vehicle and team are ready to dive when called upon

Leg 4

8 November – 20 December 2007

edited and compiled by Gary Stern and David Barber
(Chief Scientists)

1. General overview

1.1. Science personnel

		Embark		Disembark	
Leg	**Participant**	**Place**	**Date**	**Place**	**Date**
4A	Dave Barber	Paulatuk	08-Nov	Sachs	26-Nov
4A-B	Daniel Bourgault	Paulatuk	08-Nov	Amundsen	20-Dec
4A-B	Hugo Drouin	Paulatuk	08-Nov	Amundsen	20-Dec
4A-B	Marie-Emmanuelle Rail	Paulatuk	08-Nov	Amundsen	20-Dec
4A-B	Dustin Isliefson	Paulatuk	08-Nov	Amundsen	20-Dec
4A-B	Matthew Asplin	Paulatuk	08-Nov	Amundsen	20-Dec
4A-B	Jinping Zhao	Paulatuk	08-Nov	Amundsen	20-Dec
4A-B	Tao Li	Paulatuk	08-Nov	Amundsen	31-Jan
3B-4A	Phil Hwang	Sachs	18-Oct	Sachs	26-Nov
4A-B	Mukesh Gupta	Sachs	18-Oct	Sachs	26-Nov
4A-B	Pierre Galand	Paulatuk	08-Nov	Amundsen	20-Dec
4A-B	Cèlia Marrasé,	Paulatuk	08-Nov	Amundsen	20-Dec
4A-B	Helen Cloutier	Paulatuk	08-Nov	Amundsen	20-Dec
4A-B	Louis Letourneau	Paulatuk	08-Nov	Amundsen	20-Dec
4A-B	Brent Else	Paulatuk	08-Nov	Amundsen	20-Dec
4A-B	Nes Southerland	Paulatuk	08-Nov	Amundsen	20-Dec
4A-B	Kyle Simpson	Paulatuk	08-Nov	Amundsen	20-Dec
4A-B	Gabriel Maltais-Landry	Paulatuk	08-Nov	Amundsen	20-Dec
4A-B	Eric Collins	Paulatuk	08-Nov	Amundsen	20-Dec
3B-4A	Monika Pucko	Sachs	18-Oct	Sachs	26-Nov
4B	Bruno Rosenberg	Paulatuk	08-Nov	Sachs	26-Nov
4A-B	Sylvain Blondeau	Paulatuk	08-Nov	Amundsen	20-Dec
4A-B	Maxime Dumais	Paulatuk	08-Nov	Amundsen	20-Dec
4A	Brian Payton	Paulatuk	08-Nov	Sachs	26-Nov
4A	Amos Vernon	Paulatuk	08-Nov	Sachs	26-Nov
4B	Gary Stern	Sachs	26-Nov	Amundsen	20-Dec
4B	Jesse Carrie	Sachs	26-Nov	Amundsen	20-Dec
4B	Gauthier Carnat	Sachs	26-Nov	Amundsen	20-Dec
4B	Anthony Christopher	Sachs	26-Nov	Amundsen	20-Dec
4B	Patrick Ellison	Sachs	26-Nov	Amundsen	20-Dec
4B	Elizabeth Grossman	Sachs	26-Nov	Amundsen	20-Dec
4B	Trevor Lucas	Sachs	26-Nov	Amundsen	20-Dec
4B	Martina Buttler	Sachs	26-Nov	Sachs	01-Dec

4B	Lot Shafai	Sachs	26-Nov	Amundsen	20-Dec
4B	Leah Janzen	Amundsen	14-Dec	Amundsen	17-Dec
4B	Carmen Merrifield	Amundsen	14-Dec	Amundsen	17-Dec
4B	Dave Rae	Amundsen	14-Dec	Amundsen	17-Dec
4B	Jonathan Whitten	Amundsen	14-Dec	Amundsen	17-Dec
4B	Peter Mansbridge	Amundsen	14-Dec	Amundsen	17-Dec

1.2. Cruise Track

Figure 1. Amundsen cruise track for Leg 4A

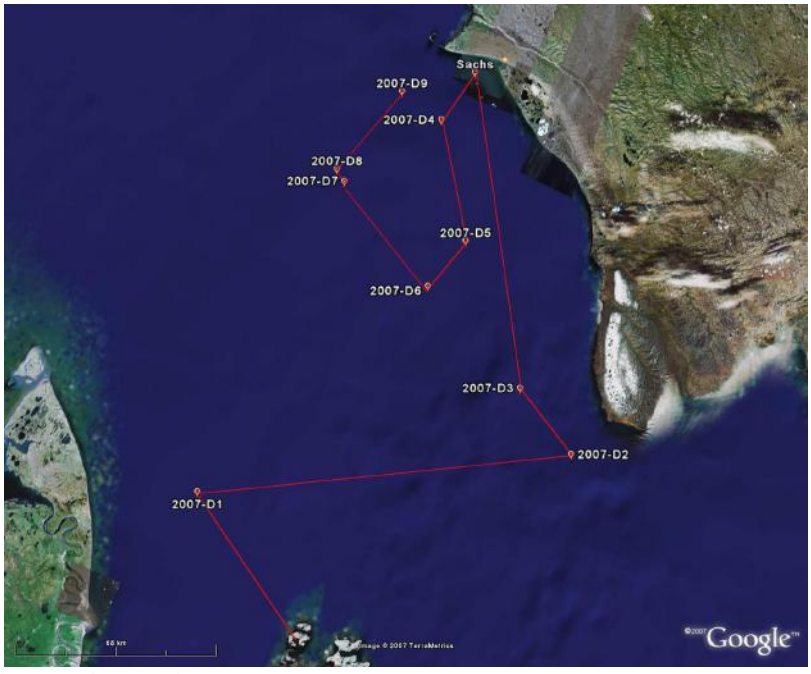


Figure 2. Amundsen cruise track Leg 4B

1.3. Ship Log of Science Activities

Station	Date	Hour	Latitude		Longitude		Cap	Activities	Depth (m)	Winds		Ice
										Dir	Speed (kts)	
Paulatuk	10/Nov/2007	11:40	69 29.9113	°N	123 55.8044	° W	231	Rosette ↓	44	130	25	10/10
Paulatuk		12:00	69 29.9115	°N	123 55.8051	° W	231	Rosette	44	130	20	10/10
1117	15/Nov/2007	19:00	69 51.9263	°N	126 29.1289	° W	294	EM Transect 1st Stan	175	80	28	10/10
1117		19:25	69 51.9560	°N	126 29.3079	° W	296	EM Transect 2nd Stan	175	80	27	9+/10
1117		19:50	69 52.0563	°N	126 29.8244	° W	299	EM Transect 3rd	170	80	26	9+/10
1117		20:01	69 52.111	°N	126 30.056	° W	305	EM Transect 4th	171	77	26	9+/10
1117		20:35	69 52.111	°N	126 30.056	° W	305	Ice cage (sea ice physics) ↓	171	80	26	9+/10
1117		21:32	69 52.111	°N	126 30.056	° W	305	Cage (physics) - Cage (cont) ↓	171	77	29	9+/10
1117		22:35	69 52.111	°N	126 30.056	° W	305	Cage (cont) - Cage (light syst) ↓	171	73	27	9+/10
1117	16/Nov/2007	1:32	69 52.111	°N	126 30.056	° W	305	Rosette ↓	171	76	26	9+/10
1117		1:47	69 52.111	°N	126 30.056	° W	305	Rosette	171	78	25	9+/10
1117		1:52	69 52.111	°N	126 30.056	° W	305	Rosette ↓	171	75	23	9+/10
1117		2:17	69 52.111	°N	126 30.056	° W	305	Rosette	171	77	23	9+/10
1117		2:53	69 52.111	°N	126 30.056	° W	305	Tucker ↓	171	81	27	9+/10
1117		3:12	69 52.111	°N	126 30.056	° W	305	Tucker	171	80	29	9+/10
1117		3:52	69 52.111	°N	126 30.056	° W	305	VMP ↓	171	80	31	9+/10
1117		5:59	69 52.110	°N	126 30.058	° W	305	VMP	171	80	33	9+/10
1117		7:27	69 52.110	°N	126 30.058	° W	305	Rosette ↓	171	80	28	9+/10
1117		7:44	69 52.110	°N	126 30.058	° W	305	Rosette	171	80	34	9+/10
1117		8:30	69 52.110	°N	126 30.058	° W	305	EM Transect 1st Stan	171	83	34	9+/10
1117		8:57	69 52.17	°N	126 30.28	° W	310	EM Transect 2nd Stan	171	86	36	9+/10
1117		9:25	69 52.24	°N	126 30.48	° W	316	EM Transect 3rd	171	86	35	9+/10
1117		9:48	69 52.314	°N	126 30.653	° W	321	EM Transect 4th	170	88	34	9+/10
1117		10:45	69 52.308	°N	126 32.538	° W	184	Ice Cage (cont) ↓ – skippy boat ↓	164	89	33	9+/10
1117		12:40	69 52.300	°N	126 32.541	° W	184	Ice Cage (light system) ↓	164	90	30	9+/10
1117		12:50	69 52.300	°N	126 32.541	° W	184	Ice Cage (contaminants)	164	92	32	9+/10
1117		14:40	69 52.300	°N	126 32.541	° W	184	Ice Cage (light system)	164	92	34	9+/10
1117		17:15	69 52.301	°N	126 32.543	° W	184	Rosette ↓	164	90	34	9+/10

1117		18:05	69 52.301	°N	126 32.541	° W	184	Rosette	164	90	38	9+/10
405	18/Nov/2007	14:20	70 38.416	°N	122 53.125	° W	139	EM Transect 1st Stan	460	69	17	9+/10
405		15:06	70 38.08	°N	122 53.12	° W	138	EM Transect 2nd Stan	450	74	21	9+/10
405		15:45	70 38.090	°N	122 54.175	° W	139	Ice cage (sea ice physics) ↓	467	70	15	8/10
405		16:30	70 38.089	°N	122 53.479	° W	139	Ice Cage (light system) ↓	456	70	13	8/10
405		17:00	70 38.126	°N	122 53.93	° W	140	Ice cage (sea ice physics)	587	67	18	9/10
405		18:53	70 38.208	°N	122 56.454	° W	141	Tucker ↓	574	60	17	8/10
405		19:31	70 38.238	°N	122 56.867	° W	141	Tucker	597	70	14	8/10
405		19:40	70 38.254	°N	122 56.947	° W	141	Tucker ↓	603	70	15	8/10
405		20:20	70 38.264	°N	122 57.326	° W	141	Tucker surface	608	60	15	8/10
405		20:50	70 38.297	°N	122 57.367	° W	143	Tucker	611	70	15	8/10
405		22:06	70 38.226	°N	122 57.711	° W	145	Rosette ↓	613	70	16	8/10
405		23:19	70 38.200	°N	122 57.805	° W	149	Rosette	614	72	17	8/10
405		23:32	70 38.198	°N	122 57.835	° W	150	VMP ↓	614	74	16	8/10
405	19/Nov/2007	0:37	70 38.197	°N	122 57.969	° W	156	VMP	621	75	15	8/10
405		1:09	70 37.715	°N	122 57.136	° W	134	EM Transect 1st Stan	622	72	13	9/10
405		1:50	70 37.47	°N	122 56.96	° W	150	EM Transect 2nd Stan		74	10	9/10
405		2:38	70 37.29	°N	122 57.09	° W	155	Ice cage (sea ice physics) ↓	605	78	18	9/10
405		3:26	70 37.73	°N	122 57.72	° W	159	Ice cage (sea ice physics)	620	80	16	9/10
405		4:05	70 37.238	°N	122 58.364	° W	162	Ice Cage (Contaminants) ↓	636	80	15	9/10
405		5:10	70 37.281	°N	122 59.145	° W	166	Ice cage (Contaminants)	640	81	13	9/10
405		5:58	70 37.291	°N	122 59.850	° W	168	Rosette ↓	640	85	15	9/10
405		6:58	70 37.348	°N	123 00.714	° W	171	Rosette	645	80	13	9/10
405		8:07	70 37.472	°N	123 01.572	° W	178	Hydrobios ↓	638	85	15	9/10
405		8:46	70 37.452	°N	123 02.170	° W	200	Hydrobios	614	87	17	8/10
405		9:10	70 37.300	°N	123 02.814	° W	167	VMP ↓	637	79	14	8/10
405		9:52	70 37.274	°N	123 03.262	° W	192	VMP	637	78	19	8/10
405		10:45	70 37.767	°N	123 02.263	° W	63	Ice Cage (light system) ↓	634	88	16	9/10
405		12:20	70 37.893	°N	122 59.951	° W	66	Ice cage (light system)	623	87	12	9/10
1100		17:56	71 02.123	°N	123 14.079	° W	24	EM Transect 1st Stan		94	27	8/10
1100		18:20	71 02.123	°N	123 14.079	° W	32	EM Transect 2nd Stan	287	100	26	8/10
1100		18:40	71 02.123	°N	123 14.079	° W	35	EM Transect 3rd	286	90	29	8/10

1100		19:25	71 02.123	°N	123 14.079	° W	35	Ice cage (sea ice physics) ↓	285	90	30	8/10
1100		20:24	71 02.123	°N	123 14.079	° W	36	Ice cage (sea ice physics)	282	97	28	8/10
1100		20:52	71 02.123	°N	123 14.079	° W	35	Rosette ↓	274	97	29	8/10
1100		21:35	71 02.123	°N	123 14.079	° W	33	Rosette	283	93	25	8/10
1100		21:56	71 02.201	°N	123 15.441	° W	34	Ice Cage (light system) ↓	286	98	27	8/10
1100		23:30	71 02.075	°N	123 15.905	° W	46	Ice cage (light system)	284	99	31	8/10
1100	20/Nov/2007	0:06	71 02.015	°N	123 16.208	° W	52	Tucker ↓	285	98	33	8/10
1100		0:10	71 02.005	°N	123 16.289	° W	53	Tucker	285	98	33	8/10
1100		0:33	71 01.996	°N	123 16.449	° W	55	Tucker ↓	284	98	32	8/10
1100		1:02	71 01.996	°N	123 16.790	° W	60	Tucker	283	94	33	8/10
1100		3:10	71 02.099	°N	123 18.593	° W	82	VMP ↓	271	89	24	8/10
1100		3:58	71 02.179	°N	123 19.440	° W	89	VMP	256	100	26	8/10
1100		4:13	71 02.217	°N	123 19.778	° W	92	Rosette ↓	256	100	26	7/10
1100		5:00	71 02.439	°N	123 21.109	° W	105	Rosette	254	100	24	7/10
1100		5:12	71 02.450	°N	123 21.161	° W	108	VMP ↓	254	100	23	7/10
1100		5:51	71 02.599	°N	123 21.840	° W	117	VMP	256	100	25	7/10
1100		6:50	71 02.910	°N	123 23.322	° W	130	Hydrobios ↓	253	100	24	7/10
1100		7:16	71 03.069	°N	123 23.917	° W	135	Hydrobios	246	100	24	7/10
1100		8:47	71 03.725	°N	123 24.310	° W	26	EM Transect 1st Stan	242	109	26	7/10
1100		10:00	71 04.150	°N	123 25.754	° W	43	Ice cage (sea ice physics) ↓	250	109	25	7/10
1100		10:30	71 04.366	°N	123 26.141	° W	50	Ice cage (sea ice physics)	250	110	25	8/10
1100		11:00	71 04.534	°N	123 26.293	° W	51	Ice Cage (Contaminants) ↓	248	115	26	8/10
1100		11:12	71 04.583	°N	123 26.353	° W	51	Ice cage (Contaminants)	247	115	24	8/10
1100		11:30	71 04.682	°N	123 26.452	° W	54	Ice Cage (Contaminants) ↓	247	115	27	8/10
1100		12:08	71 04.951	°N	123 26.721	° W	63	Ice cage (Contaminants)	246	122	23	8/10
1100		13:19	71 06.005	°N	123 25.066	° W	357	Ice Cage (light system) ↓	258	120	24	8/10
1100		15:03	71 06.363	°N	123 24.788	° W	21	Ice cage (light system)	261	135	21	8/10
1910		19:35	71 13.522	°N	123 55.703	° W	284	EM Transect 1st Stan	221	45	5	9/10
1910		20:08	71 13.622	°N	123 56.119	° W	293	EM Transect 2nd Stan	219	316	6	9/10
1910		20:47	71 13.755	°N	123 56.570	° W	295	EM Transect 3rd	221	300	10	9/10
1910		21:41	71 13.830	°N	123 56.518	° W	295	Ice cage (sea ice physics) ↓	221	254	6	9/10
1910		22:47	71 13.895	°N	123 56.433	° W	294	Ice cage (sea ice physics)	221	213	7	9/10

1910		23:56	71 13.977	°N	123 56.279	° W	294	VMP ↓	218	159	5	9/10
1910	21/Nov/2007	1:02	71 14.037	°N	123 56.168	° W	293	VMP	214	quiet		9/10
1910		1:43	71 14.087	°N	123 56.148	° W	293	Rosette ↓	213	quiet		9/10
1910		2:00	71 14.097	°N	123 56.148	° W	294	Rosette	214	quiet		9/10
1910		2:14	71 14.117	°N	123 56.138	° W	294	VMP ↓	213	quiet		9/10
1910		2:56	71 14.167	°N	123 56.158	° W	294	Rosette ↓	213	2	7	9/10
1910		3:12	71 14.197	°N	123 56.168	° W	294	Rosette	212	355	7	9/10
1910		3:18	71 14.204	°N	123 56.173	° W	294	VMP ↓	212	355	7	9/10
1910		5:05	71 14.384	°N	123 56.347	° W	294	VMP	215	330	7	9+/10
1910		5:12	71 14.397	°N	123 56.364	° W	294	Rosette ↓	215	335	7	9+/10
1910		5:33	71 14.432	°N	123 56.394	° W	294	Rosette	211	345	7	9+/10
1910		5:41	71 14.445	°N	123 56.411	° W	293	VMP ↓	211	340	7	9+/10
1910		7:06	71 14.594	°N	123 56.612	° W	293	VMP	214	270	2	9+/10
1910		7:14	71 14.605	°N	123 56.641	° W	293	Rosette ↓	214	270	2	9+/10
1910		7:35	71 14.644	°N	123 56.697	° W	293	Rosette	211	quiet		9+/10
1910		8:10	71 14.684	°N	123 56.746	° W	293	VMP ↓	212	quiet		9+/10
1910		8:50	71 14.733	°N	123 56.812	° W	292	VMP	214	quiet		9+/10
1910		8:55	71 14.742	°N	123 56.825	° W	293	Rosette ↓	214	quiet		9+/10
1910		9:08	71 14.755	°N	123 56.841	° W	293	Rosette	215	quiet		9+/10
1910		9:30	71 14.776	°N	123 56.867	° W	293	VMP ↓	214	quiet		9+/10
1910		10:06	71 14.805	°N	123 56.898	° W	293	VMP	215	quiet		9+/10
1910		10:38	71 14.818	°N	123 56.912	° W	293	VMP ↓	212	quiet		9+/10
1910		10:55	71 14.832	°N	123 56.918	° W	293	VMP	212	quiet		9+/10
1910		11:03	71 14.833	°N	123 56.732	° W	293	Rosette ↓	212	quiet		9+/10
1910		11:43	71 14.848	°N	123 56.876	° W	292	Rosette	211	quiet		9+/10
1910		11:49	71 14.849	°N	123 56.874	° W	292	VMP ↓	211	quiet		9+/10
1910		12:10	71 14.855	°N	123 56.851	° W	292	VMP	212	250	7	9+/10
1910		12:17	71 14.858	°N	123 56.861	° W	292	Rosette ↓	212	250	7	9+/10
1910		12:30	71 14.860	°N	123 56.841	° W	292	Rosette	212	243	6	9+/10
437		22:03	71 45.700	°N	126 26.950	° W		EM Transect 1st Stan	340	88	10	9+/10
437		22:22	71 45.818	°N	126 27.274	° W		EM Transect 2nd Stan	338	86	9	9+/10
437		23:03	71 45.950	°N	126 27.495	° W	335	EM Transect 3rd	338	89	8	9+/10

437		23:45	71 45.912	°N	126 27.408	° W	336	Ice cage (sea ice physics) ↓	338	70	4	9+/10
437	22/Nov/2007	0:27	71 45.853	°N	126 27.290	° W	336	Ice cage (sea ice physics)	338	50	10	9+/10
437		5:17	71 45.013	°N	126 28.290	° W	333	Ice Cage (light system) ↓	354	40	12	9/10
437		6:17	71 44.906	°N	126 29.151	° W	334	Ice cage (light system)	361	40	14	9/10
437		7:13	71 44.943	°N	126 30.446	° W	331	EM Transect 1st Stan	n.d.	50	18	9/10
437		7:38	71 44.958	°N	126 31.117	° W	329	EM Transect 2nd Stan	n.d.	50	21	9/10
437		8:15	71 44.931	°N	126 32.097	° W	333	EM Transect 3rd	n.d.	50	20	9/10
437		9:00	71 45.009	°N	126 33.573	° W	328	EM Transect 4	391	54	20	9/10
437		9:30	71 44.963	°N	126 34.546	° W	328	Ice cage (physics & cont) ↓	398	46	14	9/10
437		11:25	71 44.837	°N	126 36.685	° W	328	Ice cage (physics & cont)	414	41	14	9/10
437		12:08	71 44.766	°N	126 37.294	° W	327	Ice Cage (light system) ↓	421	35	14	9/10
437		13:04	71 45.279	°N	126 36.567	° W	327	Ice cage (light system)	429	43	18	9/10
437		14:34	71 44.364	°N	126 38.886	° W	325	Rosette ↓	435	42	18	9/10
437		15:30	71 44.120	°N	126 39.669	° W	324	Rosette	446	40	19	9/10
437		15:35	71 44.100	°N	126 39.740	° W	324	VMP ↓	446	40	20	9/10
437		16:27	71 43.909	°N	126 40.654	° W	325	VMP	448	45	18	9/10
437		16:30	71 43.904	°N	126 40.687	° W	325	Ice team deploy Argo	48	45	18	9/10
437		17:02	71 43.806	°N	126 41.373	° W	325	Hydrobios ↓	447	50	17	9/10
437		17:49	71 43.686	°N	126 42.411	° W	326	Hydrobios	449	37	15	9/10
437		18:23	71 43.622	°N	126 43.187	° W	326	Rosette ↓	450	40	17	9/10
437		18:52	71 43.555	°N	126 44.135	° W	326	Rosette	451	40	19	9/10
1825	24/Nov/2007	14:00	73 50.157	°N	127 26.222	° W	319	Em scan	210	62	7	9+/10
1825		14:44	73 49.479	°N	127 26.536	° W	319	Ice cage ↓	210	53	6	9+/10
1825		16:55	73 59.3	°N	127 27.1	° W	319	Ice cage	210	45	5	9+/10
1820		19:07	73 47.264	°N	126 47.458	° W	282	EM Transect 1st Stan	109	60	5	9+/10
1820		19:42	73 47.123	°N	126 47.885	° W	282	EM Transect 2nd Stan	111	60	8	9/10
1820		20:24	73 46.99	°N	126 48.92	° W	284	EM Transect 3rd	107	95	9	9/10
1820		21:30	73 46.665	°N	126 49.159	° W	284	Ice cage (physics & cont) ↓	108	140	7	9/10
1820		22:45	73 46.343	°N	126 49.437	° W	284	Ice cage (physics & cont)	112	156	6	9/10
1820		22:49	73 46.323	°N	126 49.456	° W	284	Ice Cage (light system) ↓	112	156	5	9/10
1820	25/Nov/2007	0:00	73 46.012	°N	126 49.756	° W	284	Ice cage (light system)	113	173	5	9/10
1820		7:27	73 44.071	°N	127 18.230	° W	232	Tucker ↓	141	200	9	9+/10

1820		7:54	73 43.956	°N	127 18.204	° W	230	Tucker	150	200	12	9+/10
1820		8:06	73 43.926	°N	127 18.214	° W	232	Tucker ↓	151	188	13	9+/10
1820		8:28	73 43.8	°N	127 18.2	° W	232	Tucker	144	181	12	9+/10
1820		8:48	73 43.721	°N	127 18.187	° W	232	Rosette ↓	141	181	12	9+/10
1820		9:20	73 43.588	°N	127 18.166	° W	232	Rosette	145	188	13	9+/10
1820		9:30	73 43.535	°N	127 18.161	° W	232	VMP ↓	152	188	12	9+/10
1820		9:43	73 43.493	°N	127 18.153	° W	232	VMP	150	189	12	9+/10
1812		15:55	73 04.454	°N	127 25.521	° W	88	EM Transect 1st Stan	181	180	7	9+/10
1812		16:30	73 04.335	°N	127 24.750	° W	85	EM Transect 2nd Stan	180	180	7	9/10
1812		17:06	73 04.205	°N	127 24.325	° W	81	EM Transect 3rd	176	195	7	9/10
1812		18:05	73 03.911	°N	127 24.154	° W	81	Ice cage (physics) ↓	179	196	7	9/10
1812		18:35	73 03.820	°N	127 24.119	° W	81	Ice cage (cont) ↓	178	191	6	9/10
1812		19:05	73 03.695	°N	127 24.086	° W	81	Ice cage (physics)	177	191	7	9/10
1812		19:39	73 03.531	°N	127 24.074	° W	81	Ice cage (cont)	177	200	7	9/10
1812		19:55	73 03.466	°N	127 24.077	° W	81	Ice Cage (light system) ↓	179	201	7	9/10
1812		20:50	73 03.2	°N	127 24.123	° W	81	Ice cage (light system)	176	199	6	9/10
1812		21:32	73 02.996	°N	127 24.204	° W	81	Tucker ↓	177	202	6	9/10
1812		22:00	73 02.875	°N	127 24.274	° W	81	Tucker	177	202	6	9/10
1812		22:22	73 02.779	°N	127 24.34	° W	81	Hydrobios ↓	180	207	5	9/10
1812		22:52	73 02.672	°N	127 24.423	° W	81	Hydrobios	181	207	6	9/10
1812		23:12	73 02.547	°N	127 24.535	° W	81	Rosette ↓	183	208	5	9/10
1812		23:53	73 02.373	°N	127 24.723	° W	81	Rosette	183	215	5	9/10
1812	26/Nov/2007	0:02	73 02.330	°N	127 24.772	° W	81	VMP ↓	184	213	4	9/10
1812		1:29	73 01.972	°N	127 25.236	° W	81	VMP	186	0	0	9/10
1800		8:28	72 06.515	°N	127 38.022	° W	209	EM Transect 1st Stan	384	145	8	8/10
1800		9:03	72 06.364	°N	127 38.298	° W	204	EM Transect 2nd Stan	384	156	6	8/10
1800		9:33	72 06.218	°N	127 38.413	° W	165	EM Transect 3rd	387	144	4	8/10
1800		10:09	72 06.108	°N	127 38.673	° W	165	Ice cage (physics) ↓	389	112	5	8/10
1800		10:40	72 06.006	°N	127 38.924	° W	165	Ice cage (physics)	386	149	8	8/10
1800		11:48	72 05.289	°N	127 35.546	° W	252	Ice cage (cont) ↓	386	80	5	8/10
1800		12:50	72 05.158	°N	127 36.060	° W	217	EM Transect 1st Stan	373	82	7	8/10
1800		13:30	72 05.023	°N	127 36.419	° W	209	EM Transect 2nd Stan	373	88	6	8/10

1800		14:07	72 04.934	°N	127 36.664	° W	210	Ice cage (physics) ↓	375	86	6	8/10
1800		14:32	72 04.859	°N	127 36.805	° W	210	Ice cage (physics)	383	88	7	8/10
2007-D1	28/Nov/2007	7:07	70 24.585	°N	126 20.158	° W	297	EM Transect 1st Stan	280	200	13	9+/10
2007-D1		7:37	70 24.676	°N	126 20.894	° W	299	EM Transect 2nd Stan	281	195	16	9+/10
2007-D1		8:10	70 24.796	°N	126 21.688	° W	297	EM Transect 3rd	283	210	16	9+/10
2007-D1		9:20	70 25.037	°N	126 23.029	° W	296	Ice cage ↓	285	212	18	9+/10
2007-D1		11:45	70 25.645	°N	126 25.729	° W	291	Ice cage	290	215	20	9+/10
2007-D1		13:36	70 25.859	°N	126 27.495	° W	288	Rosette ↓	285	225	20	9+/10
2007-D1		14:01	70 24.318	°N	126 31.377	° W	287	Ice cage (physics) ↓	285	230	25	9+/10
2007-D1		14:15	70 25.911	°N	126 28.069	° W	286	Rosette	290	225	30	9+/10
2007-D1		14:26	70 25.938	°N	126 28.205	° W	285	Ice cage (physics)	290	227	30	9+/10
2007-D1		14:27	70 25.938	°N	126 28.205	° W	285	VMP ↓	290	227	30	9+/10
2007-D1		15:30	70 26.017	°N	126 28.835	° W	283	VMP	292	241	20	9+/10
2007-D1		15:35	70 26.017	°N	126 28.872	° W	283	Rosette ↓	289	248	24	9+/10
2007-D1		16:21	70 26.000	°N	126 29.249	° W	281	Rosette	294	235	22	9+/10
2007-D1		16:23	70 25.999	°N	126 29.265	° W	280	Ice Cage (light system) ↓	294	235	22	9+/10
2007-D1		16:59	70 25.975	°N	126 29.519	° W	279	Tucker ↓	290	230	20	9+/10
2007-D1		17:12	70 25.968	°N	126 29.622	° W	278	Ice cage (light system)	291	230	27	9+/10
2007-D1		17:48	70 25.938	°N	126 29.814	° W	276	Tucker ↓	289	250	18	9+/10
2007-D1		18:18	70 25.862	°N	126 30.040	° W	275	Tucker	293	255	20	9+/10
2007-D1		21:22	70 25.132	°N	126 32.670	° W	267	Rosette ↓	289	266	16	9/10
2007-D1		22:13	70 24.968	°N	126 33.942	° W	267	Rosette	290	274	17	9/10
2007-D2	29/Nov/2007	16:45	70 55.320	°N	123 19.044	° W	283	Ice cage (cont) ↓	415	340	30	8/10
2007-D2		17:30	70 54.764	°N	123 18.922	° W	253	Ice cage (cont)	427	340	32	8/10
2007-D2		18:25	70 53.984	°N	123 21.086	° W	70	EM Transect 1st Stan	426	335	24	8/10
2007-D2		18:50	70 53.760	°N	123 20.885	° W	69	Ice cage ↓	448	310	23	8/10
2007-D2		19:12	70 53.523	°N	123 53.682	° W	70	Ice cage	443	310	20	8/10
2007-D3		22:00	71 08.877	°N	123 55.631	° W	43	Ice Cage (light system) ↓	242	330	17	8/10
2007-D3		23:10	71 08.222	°N	123 55.364	° W	43	Ice cage (light system)	393	340	22	8/10
2007-D3	30/Nov/2007	6:09	71 03.490	°N	123 58.156	° W	46	Rosette ↓	339	330	27	8/10
2007-D3		6:28	71 03.253	°N	123 58.295	° W	46	Rosette	334	325	18	8/10
2007-D3		6:58	71 02.935	°N	123 58.457	° W	47	VMP ↓	330	320	25	8/10

2007-D3		8:20	71 02.130	°N	123 58.469	° W	47	VMP	327	314	18	8/10
2007-D3		8:34	71 02.039	°N	123 58.437	° W	47	Tucker ↓	326	310	15	8/10
2007-D3		9:01	71 01.768	°N	123 58.344	° W	47	Tucker	325	325	25	8/10
2007-D3		9:17	71 01.711	°N	123 58.322	° W	47	Tucker ↓	327	314	23	8/10
2007-D3		9:36	71 01.429	°N	123 58.201	° W	47	Tucker	329	315	17	8/10
2007-D3		9:46	71 01.332	°N	123 58.152	° W	47	Tucker ↓	329	320	16	8/10
2007-D3		10:08	71 01.072	°N	123 58.022	° W	47	Tucker	331	320	16	8/10
2007-D3		10:36	71 00.867	°N	123 57.930	° W	47	Hydrobios ↓	337	326	30	8/10
2007-D3		12:15	70 59.669	°N	123 57.769	° W	48	Hydrobios	345	320	20	8/10
2007-D3		12:58	70 59.189	°N	123 57.899	° W	48	Ice cage ↓	350	327	31	8/10
2007-D3		13:45	70 58.627	°N	123 58.074	° W	49	Weather Balloon	353	322	27	9/10
2007-D3		14:00	70 58.482	°N	123 58.139	° W	49	Ice cage	352	326	31	9/10
2007-D3		19:25	70 54.999	°N	124 01.705	° W	50	Ice cage (light+phys) ↓	414	330	26	9/10
2007-D3		21:30	70 54.215	°N	124 02.467	° W	49	Ice cage (light+phys)	562	325	19	9/10
Sachs	1/Dec/2007	9:45	71 54.072	°N	125 26.460	° W	0	Ice cage (light+phys) ↓	49	14	16	9+/10
Harbour		10:20	71 54.072	°N	125 26.460	° W	0	Ice cage (light)	49	40	12	9+/10
			71 54.072	°N	125 26.460	° W	0	Ice cage (phys)	44	35	14	9+/10
		16:45	71 54.079	°N	125 26.462	° W	0	Weather Balloon	44	50	10	9+/10
2007-D4		22:55	71 42.879	°N	125 37.172	° W	11	Ice cage (light) ↓	256	55	10	8/10
2007-D4		23:59	71 42.873	°N	125 37.092	° W	11	Ice cage (light)	253	60	10	8/10
2007-D4	2/Dec/2007	11:10	71 43.792	°N	125 34.207	° W	13	Ice cage (cont + phys) ↓	247	35	8	8/10
2007-D4		12:38	71 43.817	°N	125 33.869	° W	13	Ice cage (cont)	248	40	7	8/10
2007-D4		12:50	71 43.826	°N	125 33.846	° W	13	Ice cage (phys)	248	55	5	8/10
2007-D4		13:34	71 43.864	°N	125 33.785	° W	13	Rosette ↓	248	25	6	8/10
2007-D4		14:15	71 43.913	°N	125 33.755	° W	14	Rosette	247	37	6	8/10
2007-D4		14:36	71 43.947	°N	125 33.750	° W	14	VMP ↓	248	23	5	8/10
2007-D4		15:41	71 44.0496	°N	125 33.717	° W	14	VMP	247	35	5	8/10
2007-D4		16:30	71 44.132	°N	125 33.685	° W	14	Weather Balloon	245	30	4	8/10
2007-D4		18:18	71 44.410	°N	125 33.583	° W	14	Rosette ↓	245	130	7	8/10
2007-D4		19:00	71 44.531	°N	125 33.469	° W	14	Rosette	246	175	7	8/10
2007-D4		19:10	71 44.557	°N	125 33.440	° W	14	VMP ↓	246	150	8	8/10
2007-D4		20:28	71 44.778	°N	125 33.123	° W	14	VMP	244	145	8	8/10

2007-D4		20:50	71 44.835	°N	125 33.047	° W	14	Hydrobios ↓	242	160	10	8/10
2007-D4		21:30	71 44.922	°N	125 32.910	° W	14	Hydrobios	243	155	12	8/10
2007-D4		22:42	71 45.150	°N	125 32.439	° W	14	Ice cage ↓	241	187	10	8/10
2007-D4		23:30	71 45.277	°N	125 32.172	° W	15	Ice cage	238	165	15	8/10
2007-D4	3/Dec/2007	6:28	71 46.628	°N	125 31.346	° W	15	Rosette ↓	239	160	15	8/10
2007-D4		6:44	71 46.699	°N	125 31.344	° W	15	Rosette	238	155	15	8/10
2007-D4		6:59	71 46.743	°N	125 31.338	° W	15	VMP ↓	237	145	15	8/10
2007-D4		8:10	71 46.979	°N	125 31.296	° W	15	VMP	236	164	12	8/10
2007-D4		8:53	71 47.087	°N	125 31.254	° W	15	Tucker ↓	234	160	12	8/10
2007-D4		9:21	71 47.157	°N	125 31.230	° W	15	Tucker	234	160	13	8/10
2007-D4		9:45	71 47.234	°N	125 31.327	° W	16	Tucker ↓	233	155	15	8/10
2007-D4		10:12	71 47.323	°N	125 31.174	° W	16	Tucker	232	156	10	8/10
2007-D4		10:15	71 47.323	°N	125 31.174	° W	16	Tucker ↓	232	156	10	8/10
2007-D4		10:40	71 47.391	°N	125 31.126	° W	15	Tucker	232	160	12	8/10
2007-D4		10:53	71 47.437	°N	125 31.115	° W	15	Tucker ↓	231	157	14	8/10
2007-D4		11:20	71 47.492	°N	125 31.075	° W	14	Tucker	232	160	15	8/10
2007-D4		15:50	71 48.083	°N	125 30.335	° W	12	Skippy Boat ↓	222	185	12	8/10
2007-D4		16:07	71 48.107	°N	125 30.276	° W	12	Ice cage (phys) ↓	224	180	10	8/10
2007-D4		16:25	71 48.145	°N	125 30.187	° W	12	Skippy Boat	218	180	14	8/10
2007-D4		18:00	71 48.370	°N	125 29.542	° W	12	Ice cage	215	175	10	8/10
2007-D4		18:25	71 48.426	°N	125 29.405	° W	12	Rosette ↓	216	177	11	8/10
2007-D4		18:44	71 48.464	°N	125 29.303	° W	12	Rosette	214	190	10	8/10
2007-D4		18:48	71 48.473	°N	125 29.277	° W	12	VMP ↓	214	180	11	8/10
2007-D4		19:55	71 48.535	°N	125 29.088	° W	13	VMP	215	185	12	8/10
2007-D4		20:50	71 48.539	°N	125 29.075	° W	13	Ice cage (light) ↓	213	190	9	8/10
2007-D4		21:35	71 48.550	°N	125 29.063	° W	14	Ice cage (light)	213	195	8	8/10
2007-D4	4/Dec/2007	9:20	71 32.879	°N	124 20.990	° W	118	EM Transect 1st Stan	213	198	6	9/10
2007-D4		9:50	71 32.872	°N	124 20.870	° W	116	EM Transect 2nd Stan	213	230	8	9/10
2007-D4		10:35	71 32.858	°N	124 20.520	° W	110	EM Transect 3rd	213	215	10	9/10
2007-D5		13:35	71 24.958	°N	124 55.947	° W	242	EM Transect 1st Stan	221	190	6	9/10
2007-D5		14:10	71 24.967	°N	124 55.849	° W	241	Ice cage (phys + cont) ↓	217	210	7	9/10
2007-D5		15:16	71 24.996	°N	124 55.636	° W	241	Ice cage (phys + cont)	217	200	5	9/10

2007-D5		16:03	71 25.015	°N	124 55.516	° W	241	Ice cage (light) ↓	215	205	11	9/10
2007-D5		17:03	71 25.025	°N	124 55.435	° W	241	Ice cage (light)	214	205	9	9/10
2007-D5		17:50	71 25.026	°N	124 55.431	° W	241	Rosette ↓	214	205	8	9/10
2007-D5		18:25	71 25.027	°N	124 55.430	° W	241	Rosette	214	210	7	9/10
2007-D5		18:36	71 25.027	°N	124 55.430	° W	241	VMP ↓	213	214	7	9/10
2007-D5		19:58	71 25.050	°N	124 55.371	° W	241	VMP	219	205	7	9/10
2007-D5		20:10	71 25.059	°N	124 55.339	° W	241	Tucker ↓	218	205	6	9/10
2007-D5		20:42	71 25.071	°N	124 55.266	° W	241	Tucker	216	215	9	9/10
2007-D5		20:50	71 25.075	°N	124 55.232	° W	241	Tucker ↓	216	210	8	9/10
2007-D5		21:11	71 25.087	°N	124 55.118	° W	241	Tucker	218	215	10	9/10
2007-D5		21:15	71 25.089	°N	124 55.099	° W	241	Tucker ↓	218	220	10	9/10
2007-D5		21:35	71 25.100	°N	124 54.974	° W	241	Tucker	216	230	7	9/10
2007-D5		22:00	71 25.110	°N	124 54.795	° W	241	Rosette ↓	215	250	12	9/10
2007-D5		22:15	71 25.115	°N	124 54.639	° W	241	Rosette	216	240	9	9/10
2007-D5	5/Dec/2007	6:16	71 24.623	°N	124 50.968	° W	241	Rosette ↓	224	240	10	9/10
2007-D5		6:37	71 24.611	°N	124 50.886	° W	241	Rosette	223	255	10	9/10
2007-D5		6:56	71 24.596	°N	124 50.794	° W	241	VMP ↓	216	245	11	9/10
2007-D5		8:00	71 24.540	°N	124 50.419	° W	241	VMP	225	245	11	9/10
2007-D5		9:10	71 24.496	°N	124 50.090	° W	240	Hydrobios ↓	224	250	10	9/10
2007-D5		9:40	71 24.451	°N	124 49.868	° W	240	Hydrobios	226	295	11	9/10
2007-D5		14:00	71 22.851	°N	124 51.507	° W	222	Skippy Boat ↓	230	295	11	9/10
2007-D5		15:15	71 22.521	°N	124 50.724	° W	222	Skippy Boat	230	310	11	9/10
2007-D5		16:30	71 22.326	°N	124 50.238	° W	223	Ice cage (light) ↓	232	330	12	9/10
2007-D5		16:40	71 22.302	°N	124 50.194	° W	223	Ice cage (phys) ↓	231	320	12	9/10
2007-D5		17:18	71 22.192	°N	124 50.034	° W	223	Ice cage (phys)	230	315	10	9/10
2007-D5		17:42	71 22.134	°N	124 49.955	° W	222	Ice cage (light)	237	327	10	9/10
2007-D5		18:30	71 22.010	°N	124 49.900	° W	223	Rosette ↓	229	320	10	9/10
2007-D5		18:50	71 21.965	°N	124 49.880	° W	223	Rosette	231	325	10	9/10
2007-D5		19:07	71 21.930	°N	124 49.872	° W	223	Rosette ↓	232	340	10	9/10
2007-D5		19:21	71 21.910	°N	124 49.865	° W	223	Rosette	233	330	10	9/10
2007-D5		19:33	71 21.900	°N	124 49.871	° W	223	Rosette ↓	231	315	9	8/10
2007-D5		19:41	71 21.885	°N	124 49.882	° W	223	Rosette	230	336	15	8/10

2007-D5		20:00	71 21.863	°N	124 49.894	° W	222	Rosette ↓	230	325	7	8/10
2007-D5		20:13	71 21.855	°N	124 49.888	° W	222	Rosette	229	338	13	8/10
2007-D5		20:29	71 21.831	°N	124 49.883	° W	223	Rosette ↓	228	325	11	8/10
2007-D5		20:41	71 21.809	°N	124 49.878	° W	223	Rosette	229	320	11	8/10
2007-D5		21:46	71 21.731	°N	124 49.781	° W	225	Rosette ↓	227	313	11	8/10
2007-D5		21:54	71 21.712	°N	124 49.718	° W	225	Rosette	228	305	10	8/10
2007-D5		22:26	71 21.658	°N	124 49.582	° W	225	Rosette ↓	230	325	8	8/10
2007-D5		22:40	71 21.632	°N	124 49.488	° W	225	Rosette	228	325	9	8/10
2007-D5		23:30	71 21.536	°N	124 49.193	° W	225	Rosette ↓	229	325	14	8/10
2007-D5		23:47	71 21.478	°N	124 49.023	° W	225	Rosette	229	330	8	8/10
2007-D5	6/Dec/2007	0:24	71 21.354	°N	124 48.668	° W	225	Rosette ↓	229	334	17	9/10
2007-D5		0:42	71 21.289	°N	124 48.479	° W	225	Rosette	227	330	13	9/10
2007-D5		1:25	71 21.101	°N	124 47.997	° W	225	Rosette ↓	225	310	10	9/10
2007-D5		1:38	71 21.042	°N	124 47.846	° W	225	Rosette	228	330	13	9/10
2007-D5		2:30	71 20.799	°N	124 47.283	° W	225	Rosette ↓	230	340	15/20	9/10
2007-D5		2:48	71 20.712	°N	124 47.123	° W	225	Rosette	228	335	15/20	9/10
2007-D5		3:23	71 20.551	°N	124 46.831	° W	225	Rosette ↓	228	330	15	9/10
2007-D5		3:39	71 20.474	°N	124 46.730	° W	225	Rosette	231	337	18	9/10
2007-D5		4:21	71 20.284	°N	124 46.470	° W	225	Rosette ↓	229	335	13	9/10
2007-D5		4:36	71 20.227	°N	124 46.397	° W	225	Rosette	229	335	14	9/10
2007-D5		5:26	71 20.023	°N	124 46.207	° W	225	Rosette ↓	229	310	12	9/10
2007-D5		5:45	71 19.964	°N	124 46.179	° W	225	Rosette	235	330	17	9/10
2007-D5		6:24	71 19.798	°N	124 46.133	° W	225	Rosette ↓	235	332	15	9/10
2007-D5		6:45	71 19.739	°N	124 46.140	° W	225	Rosette	233	335	14	9/10
2007-D5		7:26	71 19.618	°N	124 46.171	° W	225	Rosette ↓	235	330	16	9/10
2007-D5		7:43	71 19.569	°N	124 46.196	° W	225	Rosette	234	325	12	9/10
2007-D5		10:25	71 19.107	°N	124 47.250	° W	225	Ice cage ↓	240	340	15	9/10
2007-D5		12:28	71 18.872	°N	124 47.666	° W	225	Ice cage	247	340	14	9/10
2007-D5		12:40	71 18.861	°N	124 47.665	° W	225	Rosette ↓	247	337	16	9/10
2007-D5		13:03	71 18.838	°N	124 47.649	° W	225	Rosette	245	340	15	9/10
2007-D5		13:19	71 18.823	°N	124 47.611	° W	225	VMP ↓	246	335	14	9/10
2007-D5		14:26	71 18.790	°N	124 47.328	° W	225	VMP	245	345	12	9/10

2007-D5		16:30	71 18.698	°N	124 46.617	° W	226	Ice cage (light) ↓	246	340	12	9/10
2007-D5		16:38	71 18.692	°N	124 46.581	° W	226	Ice cage (phys) ↓	246	332	12	9/10
2007-D5		17:45	71 18.680	°N	124 46.462	° W	225	Ice cage	248	335	9	9/10
2007-D5		18:12	71 18.680	°N	124 46.468	° W	225	Rosette ↓	247	345	10	9/10
2007-D5		18:44	71 18.682	°N	124 46.502	° W	226	Rosette	247	350	10	9/10
2007-D5		19:02	71 18.685	°N	124 46.533	° W	226	VMP ↓	247	15	9	9/10
2007-D5		20:00	71 18.692	°N	124 46.638	° W	225	VMP	246	346	5	9/10
2007-D5	7/Dec/2007	6:15	71 18.820	°N	124 47.279	° W	225	Rosette ↓	246	2	6	9/10
2007-D5		6:53	71 18.856	°N	124 47.446	° W	225	Rosette	248	357	4	9/10
2007-D5		7:22	71 18.884	°N	124 47.594	° W	225	VMP ↓	245	33	4	9/10
2007-D5		8:30	71 18.952	°N	124 47.973	° W	225	VMP	245	0	0	9/10
2007-D5		8:50	71 18.974	°N	124 48.106	° W	225	Tucker ↓	243	0	0	9/10
2007-D5		9:12	71 18.994	°N	124 48.239	° W	225	Tucker	243	0	0	9/10
2007-D5		9:19	71 19.001	°N	124 48.289	° W	225	Tucker ↓	243	0	0	9/10
2007-D5		9:46	71 19.026	°N	124 48.470	° W	225	Tucker	241	0	0	9/10
2007-D5		13:20	71 19.107	°N	124 49.543	° W	225	Skippy Boat ↓	242	0	0	9/10
2007-D5		14:45	71 19.104	°N	124 49.611	° W	225	Skippy Boat	247	40	6	9/10
2007-D5		15:57	71 19.100	°N	124 49.651	° W	225	Ice cage (light) ↓	241	60	6	9/10
2007-D5		16:39	71 19.099	°N	124 49.664	° W	225	Ice cage (phys) ↓	241	59	6	9/10
2007-D5		17:14	71 19.099	°N	124 49.662	° W	225	Ice cage (light)	241	65	7	9/10
2007-D5		17:55	71 19.106	°N	124 49.691	° W	225	Ice cage (phys)	241	87	7	9/10
2007-D5		18:07	71 19.108	°N	124 49.704	° W	225	VMP ↓	241	80	7	9/10
2007-D5		20:00	71 19.161	°N	124 50.051	° W	225	VMP (continuité)	242	80	5	9/10
2007-D5	8/Dec/2007	7:05	71 19.826	°N	124 53.795	° W	226	VMP	240	0	0	9/10
2007-D5		9:20	71 20.065	°N	124 55.041	° W	227	Ice cage (cont) ↓	237	10	5	9/10
2007-D5		10:10	71 20.176	°N	124 55.665	° W	227	Ice cage (cont)	239	30	7	9/10
2007-D6	9/Dec/2007	6:26	71 15.305	°N	125 10.912	° W	94	Rosette ↓	327	quiet	0	9+/10
2007-D6		6:43	71 15.307	°N	125 10.996	° W	94	Rosette	326	quiet	0	9+/10
2007-D6		6:55	71 15.308	°N	125 11.064	° W	94	VMP ↓	327	quiet	0	9+/10
2007-D6		8:00	71 15.319	°N	125 11.457	° W	94	VMP	326	quiet	0	9+/10
2007-D6		8:28	71 15.326	°N	125 11.634	° W	94	Tucker ↓	322	quiet	0	9+/10
2007-D6		9:00	71 15.336	°N	125 11.857	° W	94	Tucker	322	quiet	0	9/10

2007-D6		9:10	71 15.340	°N	125 11.927	° W	94	Tucker ↓	321	quiet	0	9/10
2007-D6		9:40	71 15.35	°N	125 12.139	° W	94	Tucker	318	quiet	0	9/10
2007-D6		9:43	71 15.351	°N	125 12.170	° W	94	Tucker ↓	318	quiet	0	9/10
2007-D6		10:12	71 15.352	°N	125 12.346	° W	94	Tucker	314	quiet	0	9/10
2007-D6		10:30	71 15.348	°N	125 12.486	° W	93	EM Transect 1st Stan	317	330	6	9/10
2007-D6		13:02	71 15.217	°N	125 13.297	° W	93	EM Transect 2nd	307	340	6	9/10
2007-D6		13:20	71 20.109	°N	125 11.908	° W	93	Ice cage (phys) ↓	308	340	6	9/10
2007-D6		13:40	71 15.139	°N	125 13.442	° W	93	Ice cage (cont) ↓	305	345	5	9/10
2007-D6		14:45	71 15.002	°N	125 13.538	° W	93	Ice cage (phys + cont)	307	335	6	9/10
2007-D6		15:20	71 14.927	°N	125 13.538	° W	93	EM Transect finish	309	3457	7	9/10
2007-D7		19:20	71 16.211	°N	125 13.737	° W	106	Rosette ↓	330	5	11	9/10
2007-D7		19:51	71 16.171	°N	125 13.835	° W	106	Rosette	325	0	11	9/10
2007-D7	10/Dec/2007	7:08	71 15.972	°N	125 15.296	° W	103	Rosette ↓	334	0	10	9+/10
2007-D7		7:44	71 15.962	°N	125 15.4	° W	103	Rosette	337	0	10	9+/10
2007-D7		8:00	71 15.956	°N	125 15.445	° W	103	VMP ↓	331	10	8	9+/10
2007-D7		8:25	71 15.952	°N	125 15.543	° W	103	Ice cage (LIGHT) ↓	330	5	8	9+/10
2007-D7		9:05	71 15.935	°N	125 15.718	° W	103	VMP	329	10	7	9+/10
2007-D7		9:40	71 15.924	°N	125 15.908	° W	103	Tucker ↓	329	14	8	9+/10
2007-D7		10:10	71 15.913	°N	125 16.096	° W	103	Tucker	333	5	9	9+/10
2007-D7		10:18	71 15.911	°N	125 16.137	° W	103	Tucker ↓	336	0	9	9+/10
2007-D7		10:48	71 15.903	°N	125 16.335	° W	103	Tucker ↓	335	10	8	9+/10
2007-D7		11:19	71 15.874	°N	125 16.542	° W	103	Tucker	331	10	8	9+/10
2007-D7		13:15	71 15.700	°N	125 17.349	° W	101	EM Transect 1st Stan	335	0	10	9+/10
2007-D7		13:15	71 15.700	°N	125 17.349	° W	101	Ice cage (phys) ↓	335	0	10	9+/10
2007-D7		13:17	71 15.700	°N	125 17.349	° W	101	Ice cage (cont) ↓	335	0	10	9+/10
2007-D7		14:15	71 15.590	°N	125 17.673	° W	101	EM Transect Fin	335	15	7	9/10
2007-D7		15:15	71 15.489	°N	125 17.932	° W	100	Ice cage (cont)	337	355	6	9+/10
2007-D7		16:57	71 15.379	°N	125 18.063	° W	100	Rosette ↓	337	10	6	9+/10
2007-D7		17:50	71 15.329	°N	125 18.136	° W	99	Rosette	337	0	6	9+/10
2007-D7		18:55	71 15.303	°N	125 18.274	° W	99	Ice cage (light) ↓	337	10	5	9+/10
2007-D7		19:30	71 15.298	°N	125 18.325	° W	98	Rosette ↓	337	12	4	9+/10
2007-D7		19:30	71 15.298	°N	125 18.325	° W	98	EM Transect 1st Stan	337	12	4	9+/10

2007-D7		19:35	71 15.294	°N	125 18.354	° W	98	Ice cage (light) ↓	337	12	5	9+/10
2007-D7		19:50	71 15.291	°N	125 18.395	° W	98	Rosette surface	337	N	5	9+/10
2007-D7		20:05	71 15.288	°N	125 18.432	° W	98	Rosette ↓	345	10	5	9+/10
2007-D7		20:13	71 15.284	°N	125 18.467	° W	98	EM Transect Fin	346	20	5	9+/10
2007-D7		20:22	71 15.281	°N	125 18.497	° W	98	Rosette surface	347	20	6	9+/10
2007-D7		20:36	71 15.276	°N	125 18.553	° W	98	Rosette ↓	347	18	7	9+/10
2007-D7		21:07	71 15.263	°N	125 18.681	° W	98	Rosette ↓	351	18	6	9+/10
2007-D7		21:30	71 15.255	°N	125 18.790	° W	97	Rosette ↓	351	355	4	9+/10
2007-D7		22:00	71 15.243	°N	125 18.928	° W	97	Rosette ↓	353	5	4	9+/10
2007-D7		22:56	71 15.201	°N	125 19.224	° W	97	Rosette ↓	352	10	5	9+/10
2007-D7		23:32	71 15.156	°N	125 19.45	° W	96	Rosette ↓	352	15	5	9+/10
2007-D7	11/Dec/2007	0:00	71 15.120	°N	125 19.644	° W	96	Rosette ↓	354	8	5	9+/10
2007-D7		0:37	71 15.071	°N	125 19.924	° W	96	Rosette ↓	354	16	6	9+/10
2007-D7		1:05	71 15.028	°N	125 20.152	° W	95	Rosette ↓	359	29	4	9+/10
2007-D7		1:37	71 14.976	°N	125 20.404	° W	95	Rosette ↓	361	46	6	9+/10
2007-D7		2:03	71 14.934	°N	125 20.605	° W	95	Rosette ↓	361	30	3	9+/10
2007-D7		2:27	71 14.894	°N	125 20.783	° W	94	Rosette ↓	359	35	7	9+/10
2007-D7		2:58	71 14.849	°N	125 20.995	° W	94	Rosette ↓	362	33	4	9+/10
2007-D7		3:26	71 14.812	°N	125 21.189	° W	94	Rosette ↓	364	41	7	9+/10
2007-D7		3:57	71 14.775	°N	125 21.418	° W	93	Rosette ↓	367	50	6	9+/10
2007-D7		4:26	71 14.750	°N	125 21.605	° W	93	Rosette ↓	367	80	5	9+/10
2007-D7		4:57	71 14.731	°N	125 21.778	° W	93	Rosette ↓	364	73	5	9+/10
2007-D7		5:28	71 14.716	°N	125 21.950	° W	93	Rosette ↓	367	80	5	9+/10
2007-D7		5:59	71 14.716	°N	125 22.100	° W	92	Rosette ↓	364	105	5	9+/10
2007-D7		6:26	71 14.721	°N	125 22.190	° W	92	Rosette ↓	368	125	5	9+/10
2007-D7		6:58	71 14.731	°N	125 22.293	° W	92	Rosette ↓	370	125	4	9+/10
2007-D7		7:28	71 14.756	°N	125 22.412	° W	92	Rosette ↓	370	140	4	9+/10
2007-D7		7:47	71 14.780	°N	125 22.502	° W	92	Rosette	374	140	4	9+/10
2007-D7		8:00	71 14.797	°N	125 22.574	° W	92	VMP ↓	367	140	4	9+/10
2007-D7		8:37	71 14.850	°N	125 22.802	° W	92	Ice cage (light + phys) ↓	376 ?	135	5	9+/10
2007-D7		9:20	71 14.959	°N	125 23.227	° W	92	VMP	381 ?	120	5	9+/10
2007-D7		9:44	71 15.003	°N	125 23.398	° W	92	EM Transect 1st Stan	382 ?	110	5	9+/10

2007-D7		10:20	71 15.119	°N	125 23.859	° W	93	Ice cage (light+phys) (cont) ↓	387 ?	120	5	9+/10
2007-D7		10:35	71 15.148	°N	125 23.980	° W	93	EM Transect Fin	387 ?	140	5	9+/10
2007-D7		11:30	71 15.327	°N	125 24.696	° W	93	Ice cage (cont)	382 ?	120	5	9+/10
2007-D7	12/Dec/2007	8:12	71 20.883	°N	125 39.899	° W	99	Rosette ↓	406 ?	135	5-10	9+/10
2007-D7		8:40	71 21.047	°N	125 40.289	° W	99	Rosette	436 ?	120	5-10	9+/10
2007-D7		9:28	71 21.252	°N	125 40.811	° W	99	Tucker ↓	441 ?	135	10	9+/10
2007-D7		10:08	71 21.475	°N	125 41.381	° W	99	Tucker	446 ?	125	10	9+/10
2007-D7	**Probably not good**	13:10	71 22.633	°N	125 44.208	° W	100	Ice cage (phys) ↓	434	140	10	9+/10
2007-D7	**System is frozen**	13:30	71 22.773	°N	125 44.533	° W	100	Ice cage (cont) ↓	434	145	11	9+/10
2007-D7		14:20	71 23.062	°N	125 45.230	° W	100	Ice cage (phys)	421	145	10	9+/10
2007-D7		15:05	71 23.284	°N	125 45.779	° W	100	EM Transect 1st Stan	421	137	12	9+/10
2007-D7		15:50	71 23.510	°N	125 46.294	° W	101	Ice cage (cont)	421	140	12	9+/10
2007-D7		17:05	71 23.841	°N	125 46.930	° W	101	EM Transect Fin	420 ?	140	11	9+/10
2007-D7		18:30	71 24.207	°N	125 47.599	° W	102	Rosette ↓	440 ?	145	10	9+/10
2007-D7		19:24	71 24.430	°N	125 48.032	° W	102	Rosette		155	8	9+/10
2007-D7		19:30	71 24.467	°N	125 48.113	° W	102	VMP ↓	435 ?	160	9	9+/10
2007-D7		19:30	71 24.467	°N	125 48.113	° W	102	Ice cage ↓	435 ?	160	9	9+/10
2007-D7		19:50	71 24.530	°N	125 48.254	° W	102	Ice cage	435 ?	152	8	9+/10
2007-D7		20:00	71 24.579	°N	125 48.351	° W	102	Ice cage ↓	441 ?	155	6	9+/10
2007-D7				°N		° W		VMP				
2007-D7		21:15	71 24.863	°N	125 49.125	° W	102	Ice cage	447 ?	145	9	9+/10
2007-D7		23:05	71 25.291	°N	125 50.634	° W	103	Weather Balloon	450 ?	135	8	9+/10
2007-D7	13/Dec/2007	7:22	71 26.765	°N	125 56.466	° W	104	Rosette ↓	440 ?	202	2	9+/10
2007-D7		7:50	71 26.793	°N	125 56.564	° W	104	Rosette	435 ?	196	2	9+/10
2007-D7		8:10	71 26.807	°N	125 56.620	° W	104	VMP ↓	443 ?	quiet		9+/10
2007-D7		9:00	71 26.827	°N	125 56.800	° W	104	EM Transect start and VMP on board	446 ?	quiet		9+/10
2007-D7		9:05	71 26.830	°N	125 56.831	° W	104	Ice cage (phys) ↓	448 ?	quiet		9+/10
2007-D7		9:30	71 26.836	°N	125 56.924	° W	105	Ice cage (cont) ↓	445 ?	quiet		9+/10
2007-D7		9:55	71 26.842	°N	125 57.046	° W	105	Ice cage (phys)	447 ?	230	4	9+/10
2007-D7		10:20	71 26.846	°N	125 57.175	° W	105	EM Transect end	447 ?	230	5	9+/10
2007-D7		10:27	71 26.847	°N	125 57.205	° W	105	EM Transect start	447 ?	230	5	9+/10

2007-D7		11:25	71 26.858	°N	125 57.492	° W	105	Weather Balloon	448 ?	quiet		9+/10
2007-D7		12:10	71 26.869	°N	125 57.696	° W	105	EM Transect end	439	255	4	9+/10
2007-D7		12:15	71 26.869	°N	125 57.704	° W	105	Ice cage (cont)	447	254	5	9+/10
2007-D7		11:20	71 15.6	°N	125 30.6	° W	105	Weather Balloon		240	2	9+/10
2007-D7		13:20	71 26.865	°N	125 58.01	° W	105	Ice cage (phys) ↓	440	238	4	9+/10
2007-D7		15:00	71 26.838	°N	125 58.362	° W	105	Ice cage (phys)	442	205	4	9+/10
2007-D7		17:05	71 26.857	°N	125 58.307	° W	105	Weather Balloon	434	180	5	9+/10
2007-D7		18:30	71 26.897	°N	125 57.975	° W	105	Ice cage (light) ↓	436	190	9	9+/10
2007-D7		19:24	71 26.951	°N	125 57.650	° W	105	Rosette ↓	432	205	7	9+/10
2007-D7		20:05	71 27.000	°N	125 57.360	° W	105	Rosette / VMP ↓		195	11	9+/10
2007-D7		20:35	71 27.053	°N	125 57.151	° W	105	Ice cage (cont) ↓	442	200	15	9+/10
2007-D7		21:05	71 27.127	°N	125 56.919	° W	104	VMP		180	13	9+/10
2007-D7		21:45	71 27.231	°N	125 56.655	° W	104	Ice cage (cont)		190	12	9+/10
2007-D7		23:09	71 27.465	°N	125 56.201	° W	104	Weather Balloon	447	195	13	9+/10
2007-D7	14/Dec/2007	5:00	71 26.847	°N	125 54.011	° W	104	Weather Balloon	~440	243	12	9+/10
2007-D7		7:00	71 26.487	°N	125 53.466	° W	104	Rosette ↓	~440	282	9	9+/10
2007-D7		7:25	71 26.408	°N	125 53.363	° W		Rosette	~445	284	12	9+/10
2007-D7		8:00	71 26.332	°N	125 53.260	° W	104	VMP ↓	~445	275	10	9+/10
2007-D7		9:00	71 26.197	°N	125 53.143	° W	104	EM Transect start	~450	290	10	9+/10
2007-D7		9:10	71 26.167	°N	125 53.129	° W	104	Ice cage (phys) ↓	~449	295	8	9+/10
2007-D7		9:30	71 26.149	°N	125 53.124	° W	104	Hydrobios ↓	~450	308	11	9+/10
2007-D7		9:55	71 26.054	°N	125 53.133	° W	104	Ice cage (phys)	~459	325	14	9+/10
2007-D7		10:00	71 26.041	°N	125 53.137	° W	104	Hydrobios	~455	320	16	9+/10
2007-D7		10:20	71 25.980	°N	125 53.151	° W	104	Ice cage (cont) ↓	~462	320	14	9+/10
2007-D7	*** Failed ***	11:33	71 25.715	°N	125 53.402	° W	104	Ice cage (cont) Weather balloon	~450	325	14	9+/10
2007-D7		17:10	71 24.719	°N	125 55.102	° W	103	Weather Balloon	~443	310	12	9+/10
2007-D7		17:45	71 24.569	°N	125 55.154	° W	103	Ice cage (cont)	445	320	10	9+/10
2007-D7		18:10	71 24.500	°N	125 55.172	° W	103	Rosette ↓	443	315	10	9+/10
2007-D7		18:33	71 24.425	°N	125 55.184	° W	104	Rosette	439	315	10	9+/10
2007-D7		19:30	71 24.233	°N	125 55.190	° W	104	Ice cage (light) ↓	430	350	8	9+/10
2007-D7		19:50	71 24.189	°N	125 55.213	° W	104	EM Transect fin	434	340	6	9+/10
2007-D7		20:25	71 24.108	°N	125 55.215	° W	104	Rosette ↓	435	335	6	9+/10

2007-D7		20:45	71 24.054	°N	125 55.232	° W	104	Rosette surface	437	330	8	9+/10
2007-D7		21:30	71 23.991	°N	125 55.276	° W	104	Rosette ↓ + Ice cage (light)	428	316	6	9+/10
2007-D7		22:30	71 23.935	°N	125 55.375	° W	104	Rosette ↓	432	295	3	9+/10
2007-D7		23:25	71 23.892	°N	125 55.490	° W	104	Weather Balloon	432	310	6	9+/10
2007-D7		23:30	71 23.889	°N	125 55.497	° W	104	Rosette ↓	432	310	6	9+/10
2007-D7	15/Dec/2007	0:25	71 23.840	°N	125 55.624	° W	103	Rosette ↓	427	318	5	9+/10
2007-D7		1:25	71 23.810	°N	125 55.810	° W	103	Rosette ↓	441	303	3	9+/10
2007-D7		2:25	71 23.779	°N	125 56.023	° W	103	Rosette ↓	454	340	5	9+/10
2007-D7		3:25	71 23.750	°N	125 56.313	° W	103	Rosette ↓	451	344	5	9+/10
2007-D7		4:26	71 23.707	°N	125 56.671	° W	103	Rosette ↓	455	346	3	9+/10
2007-D7		5:25	71 23.653	°N	125 56.990	° W	103	Rosette ↓	432	15	2	9+/10
2007-D7		6:29	71 23.586	°N	125 57.346	° W	103	Rosette ↓	435	40	2	9+/10
2007-D7		7:34	71 23.543	°N	125 57.676	° W	103	Rosette ↓	437	90	3	9+/10
2007-D7		8:36	71 23.527	°N	125 57.964	° W	103	Rosette ↓	432	100	2	9+/10
2007-D7		9:30	71 23.532	°N	125 58.201	° W	103	Rosette ↓+ EM Scan start	424	quiet		9+/10
2007-D7		10:15	71 23.553	°N	125 58.408	° W	103	EM Scan finish	424	quiet		9+/10
2007-D7				°N		° W		Ice cage (phys+cont) ↓				
2007-D7		11:05	71 23.598	°N	125 58.719	° W	103	Rosette ↓	428	quiet		9+/10
2007-D7		11:20	71 23.612	°N	125 58.830	° W	103	Ice cage	429	quiet		9+/10
2007-D7		11:30	71 23.617	°N	125 58.805	° W	103	Rosette ↓	432	quiet		9+/10
2007-D7		12:55	71 23.720	°N	125 59.635	° W	103	Tucker ↓	433	quiet		9+/10
2007-D7		13:30	71 23.784	°N	126 00.056	° W	103	Tucker	435	quiet		9+/10
2007-D7		13:40	71 23.803	°N	126 00.163	° W	103	Tucker ↓	434	quiet		9+/10
2007-D7		14:15	71 23.903	°N	126 00.728	° W	103	Tucker	440	quiet		9+/10
2007-D7		14:35	71 23.930	°N	126 00.875	° W	103	VMP ↓	446	quiet		9+/10
2007-D7		15:20	71 24.041	°N	126 01.442	° W	103	Ice cage (phys) ↓	448	quiet		9+/10
2007-D7		15:30	71 24.071	°N	126 01.576	° W	103	VMP	451	quiet		9+/10
2007-D7		16:30	71 24.259	°N	126 02.384	° W	103	Ice cage ↓	458	quiet		9+/10
2007-D7		19:30	71 24.814	°N	126 04.580	° W	103	Ice cage (light) ↓	447	quiet		9+/10
2007-D7		19:40	71 24.834	°N	126 04.640	° W	103	Rosette ↓	447	quiet		9+/10
2007-D7		19:55	71 24.882	°N	126 04.779	° W	103	Ice cage (cont) ↓	447	quiet		9+/10
2007-D7		20:15	71 24.943	°N	126 04.943	° W	103	Rosette	447	quiet		9+/10

2007-D7		20:25	71 24.967	°N	126 05.002	° W	103	VMP ↓	449	quiet		9+/10
2007-D7		21:07	71 25.074	°N	126 05.262	° W	103	Ice cage (cont+light) ↓	451	quiet		9+/10
2007-D7		21:20	71 25.087	°N	126 05.336	° W	103	VMP	454	quiet		9+/10
2007-D7		21:37	71 25.122	°N	126 05.442	° W	103	Weather Balloon	459	quiet		9+/10
2007-D7	16/Dec/2007	7:15	71 26.582	°N	126 11.209	° W	108	Rosette ↓	457	quiet		9+/10
2007-D7		7:35	71 26.645	°N	126 11.343	° W	108	Rosette	464	quiet		9+/10
2007-D7		7:51	71 26.668	°N	126 11.390	° W	109	VMP ↓	463	30	1	9+/10
2007-D7		9:00	71 26.804	°N	126 11.740	° W	109	VMP	465	quiet		9+/10
2007-D7		9:50	71 26.890	°N	126 11.959	° W	109	EM Scan start	~467	quiet		9/10
2007-D7		10:10	71 26.919	°N	126 12.037	° W	109	Ice cage (phys) ↓	467	quiet		9/10
2007-D7		10:25	71 26.940	°N	126 12.101	° W	109	Ice cage (phys) ↓	466	quiet		9/10
2007-D7		10:50	71 26.986	°N	126 12.228	° W	110	EM Scan finish	465	quiet		9/10
2007-D8		15:01	71 28.461	°N	126 18.785	° W	352	Rosette ↓	459	55	4	9/10
2007-D8		15:31	71 28.545	°N	126 19.099	° W	325	Rosette	459	58	5	9/10
2007-D8		15:50	71 28.689	°N	126 19.349	° W	342	Ice cage ↓	460	42	5	9/10
2007-D8		15:50	71 28.691	°N	126 19.403	° W	342	VMP ↓	460	42	5	9/10
2007-D8		16:17	71 28.756	°N	126 19.624	° W	342	VMP	460	40	5	9/10
2007-D8		16:20	71 28.765	°N	126 19.653	° W	343	Rosette ↓	460	40	5	9/10
2007-D8		16:35	71 28.811	°N	126 19.798	° W	343	Ice cage	450	50	5	9/10
2007-D8		16:50	71 28.830	°N	126 19.858	° W	343	Rosette	450	40	6	9/10
2007-D7b		19:50	71 28.169	°N	126 16.470	° W	115	Ice cage (cont) ↓	444	2	8	9/10
2007-D7b		20:54	71 28.276	°N	126 16.848	° W	116	Ice cage (cont)	453	20	6	9/10
2007-D7b	17/Dec/2007	10:50	71 28.904	°N	126 22.611	° W	119	Ice cage (cont) ↓	457	26	5	9/10
2007-D7b		10:55		°N		° W		Tucker ↓				
2007-D7b		11:28	71 28.899	°N	126 22.836	° W	119	Tucker	458	26	6	9/10
2007-D7b		11:50	71 28.899	°N	126 22.976	° W	119	Ice cage (cont)	458	26	6	9/10
2007-D9		18:05	71 48.426	°N	125 51.910	° W	67	EM Scan start	234	8	7	9+/10
2007-D9		18:53	71 48.275	°N	125 52.149	° W	68	Ice cage ↓	235	30	7	9+/10
2007-D9		19:36	71 48.129	°N	125 52.348	° W	68	Ice cage (light) ↓	243	20	6	9+/10
2007-D9		20:50	71 47.886	°N	125 52.623	° W	68	Ice cage (light)	242	30	5	9+/10
2007-D9	18/Dec/2007	7:18	71 46.432	°N	125 57.033	° W	69	Rosette ↓	255	80	11	9+/10
2007-D9		8:00	71 46.386	°N	125 57.277	° W	69	Rosette	255	75	12	9+/10

2007-D9		8:20	71 46.374	°N	125 57.347	° W	69	VMP ↓	255	85	11	9+/10
2007-D9		9:10	71 46.322	°N	125 57.625	° W	69	VMP	256	70	12	9+/10
2007-D9		9:45	71 46.284	°N	125 57.781	° W	69	Ice cage (light) ↓	256	85	12	9+/10
2007-D9		10:50	71 46.218	°N	125 57.943	° W	70	Hydrobios ↓	256	105	11	9+/10
2007-D9		11:10	71 46.199	°N	125 57.984	° W	69	Hydrobios	256	90	11	9+/10
2007-D9		16:23	71 46.009	°N	125 59.301	° W	70	Rosette ↓	253	63	15	9+/10
2007-D9		16:45	71 45.992	°N	125 59.494	° W	70	Rosette	253	80	12	9+/10
2007-D9		18:07	71 45.974	°N	126 00,279	° W	70	VMP ↓	253	75	15-20	9+/10
2007-D9		18:55	71 45.974	°N	126 00.703	° W	71	VMP	253	95	13	9+/10
2007-D9		20:20	71 45.963	°N	126 01.328	° W	71	Ice cage (light) ↓	254	80	12	9+/10
2007-D9		20:45	71 45.952	°N	126 01.443	° W	71	Ice cage (light)	254	60	10	9+/10

2. Team reports

2.1. Team 1

2.1.1. CTD/Rosette

Participants: Hugo Drouin, Marie-Emmanuelle Rail (INRS-ETE, 490, Rue de la Couronne, Québec)

Objectives
Description of water masses and general circulation over a year in Beaufort Sea and Amundsen Gulf.

Materials
Physical parameters were recorded using a ship mounted RDInstruments Ocean Surveyor ADCP (150kHz), and a rosette frame equipped with 24 bottles of 12 L and the following sensors:

Table 1: Sensors used on the Rosette

Photo	Item	Manufacturer	Type & Properties	Serial Number
	CTD	SeaBird	SBE-911 Sampling rate : 24 Hz	
	Temperature	SeaBird	SBE 3plus Range: -5°C to + 35°C Accuracy: 0.001	4204
	Pressure	SeaBird	Accuracy: 0.015% of full range	90584
	Conductivity	SeaBird	SBE 4C Range: 0 to 7 S/m Accuracy: 0.0003	2696
	Oxygen	SeaBird	SBE-43 Range: 120% of saturation Accuracy: 2% of saturation	0427

	pH	SeaBird	SBE-18 Range: 0 to 14 pH Accuracy: 0.01 pH	0444
	Nitrates	Satlantic	MBARI ISUS Range: 0.5 to 200 µM Accuracy: ± 2 µM	134
	PAR	Biospherical		4664
	SPAR	Biospherical		20147
	Fluorometer	Sea Point		2465
	Transmisometer	WetLab	Path length: 25 cm	CST-558DR
	Altimeter	Benthos		1061

Method

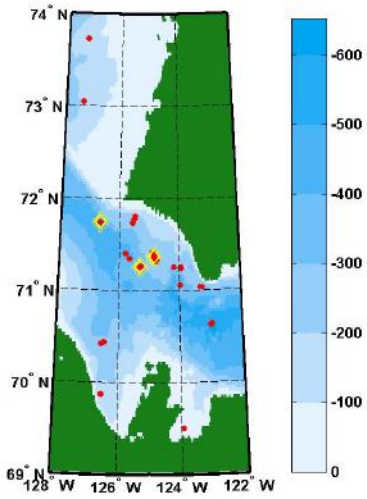
For the whole leg, because of heavy ice conditions, the rosette was deployed from the Moon Pool. CTD or Rosette casts were usually performed twice a day at 6-7 a.m. and 6-7p.m. Three times, we did a 13 hours non-stop CTD sampling. Water was sampled according to each team requests. Here are examples of usual depths collected by them.

- *Nutrients* (Team 7; PI: Jean-Éric Tremblay): salinity of 33.1, 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300 and every 100 m up to the bottom.
- *DIC* (Team 6; PI: Lisa Miller): salinity of 33.1, 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300 and every 100 m up to the bottom.
- *Contaminants* (Team 8; PI: Gary Stern): 10, 25, 50, 100, 200 m and bottom.
- *DNA* (Team 7; PI: Connie Lovejoy)
- *Microbes* (Team 7; PIs: Carlos Pedros and Roxanne Maranger)

Sampling field

We focus on the Amundsen Gulf and on western part on Banks Island. Because of some problems, the hull ADCP recorded only the first two weeks and the last five days.

Figure 1: Positions of Rosette casts are shown as red dots and stations of 13 hours sampling are yellow diamonds



Probes calibration

Salinity: Samples were taken on many casts with small bottles of 200 mL. They were analysed with an autosal GuildLine, model 8400B. Its range goes from 0.005 to 42 and its accuracy is <0.002. The results were satisfying. The difference in between the salinity probe recordings and the samples was around 0.025.

Oxygen: Oxygen sensor calibration was performed using Winkler's method and a Mettler Toledo titration machine.

pH: Tests were done three times using two buffers. The sensor is quit stable. Results are as follow:
Buffer 4.01 gave 4.02
Buffer 7.00 gave 7.41
Sea water is usually around pH=8, we can expect pH data to be a little over estimated.

Reagent Blanks were performed once, results show that chemicals are still good (m<4). We sampled oxygen on six casts.
Each time, we choose five depths of different oxygen concentration and sampled it three times. Results were really goods, the probe recordings and the samples were always quite similar.

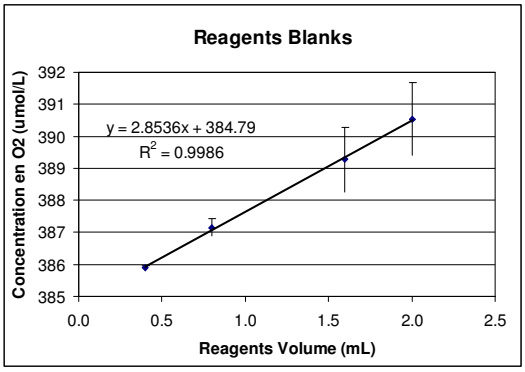


Figure 2: Reagents Blanks (m=2.85).

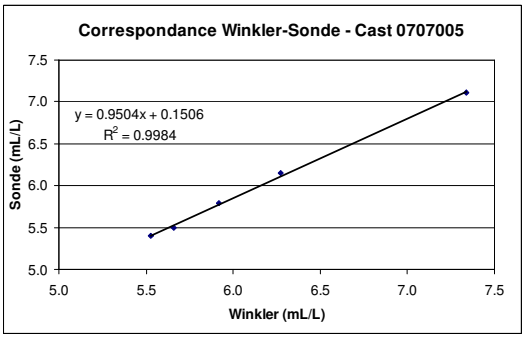


Figure 3: Relation between samples and probe recordings during cast #005 (m=0.95).

Problems

- **Sensors**
  Water got into electronic cables a few time sending an error signal to the computer. Very few data are lost, mainly on casts 084 and 101. Every sensor works well except the nitrate one. The nitrate profiles always looks the same, but the data range change often.
- **Bottles**
  We got no problem with the bottles on this cruise, except when they leak a little. We changed the bungee ropes and the O rings on most of them but they keep leaking.
- **Deck material (winch, A-frame, etc.)**
  The cable guides broke often. The winch got no problem.
- **ADCP:** we lost the GPS data for a week or two. We lost the hard drive after three weeks. We couldn't sample on the fifth week because of heavy ice under the ship hull affecting signal.

Available data

All information concerning the Rosette casts are summarized in the CTD Logbook. It includes cast and station numbers, date and time of sampling in UTC, latitude and longitude, bottom and cast depth, comments concerning the cast and its name. A Rosette sheet was also created for every single cast. It includes the same information than the CTD Logbook plus the bottle distribution among every sampling team. The weather information is written in every Rosette Log as well as in a meteorological logbook. For every cast, data recorded at the moment of bottle closure were averaged and recorded in the so-called 'bottle files'. Averaged data are those recorded between 3 seconds before bottle closure and 7 seconds after it. It includes the bottle position, time and date, pressure, temperature, salinity, transmissivity, chlorophyll, oxygen, irradiance and pH measurements. All those files are available on the 'Shares'.

- Rosette sheets and the CTD logbook : Shares\Leg4\Rosette\logs
- Bottles files : Shares\Leg4\Rosette\bottles
- Plots of every cast including salinity, temperature, oxygen, transmissometer, nutrients, fluorometer and irradiance : Shares\Leg4\Rosette\plots

Between November 8th and December 20th 2007, 105 casts were performed.

Preliminary Results

The 13 hours marathons were performed on two locations. The first was done on station 2007-D5 and the two others on station 2007-D7.

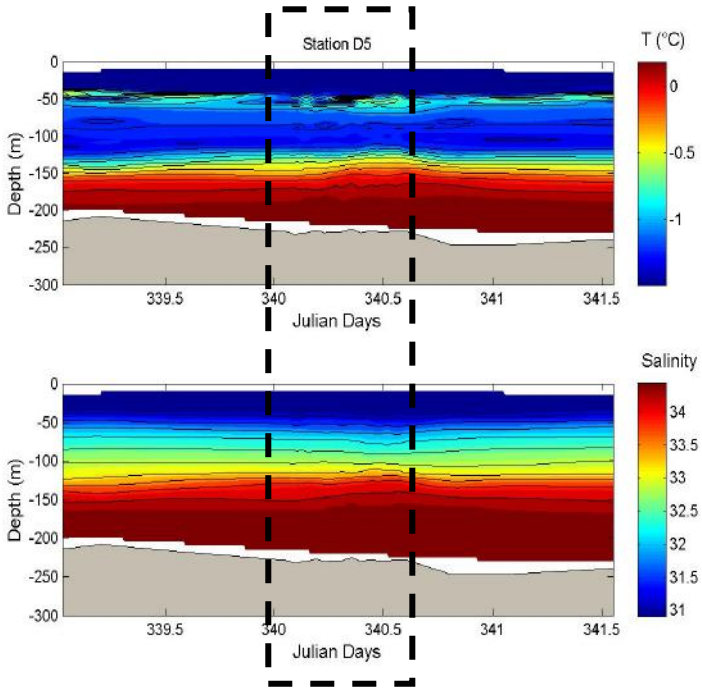


Figure 4 show temperature and salinity data recorded on station 2007-D5.

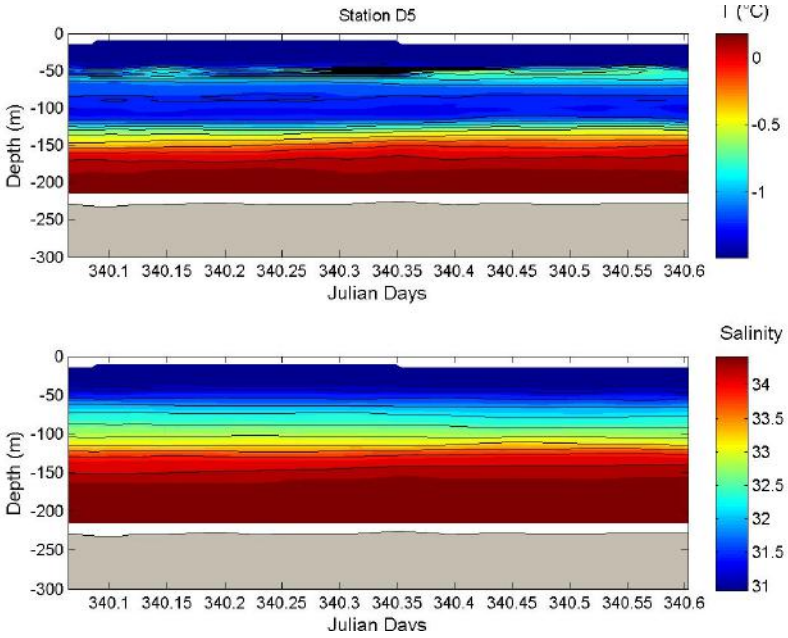


Figure 5 is a zoom on the 13 hours sampling on this same station (2007-D5).

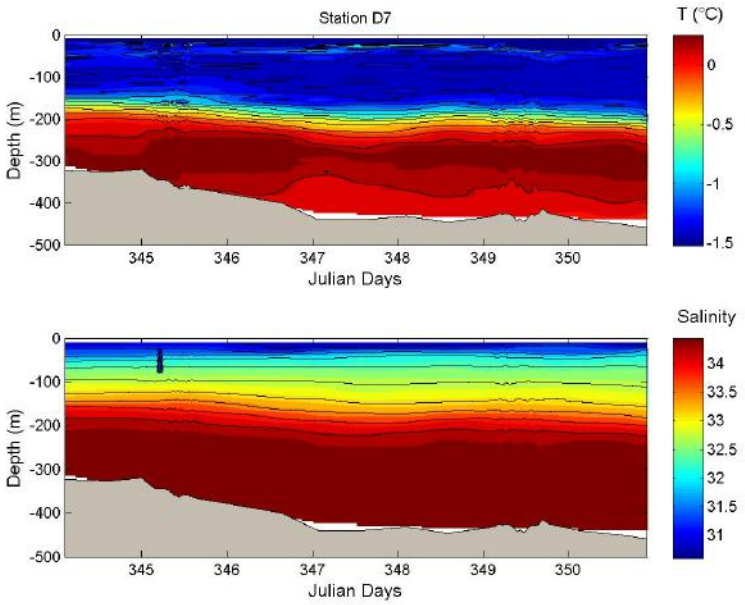
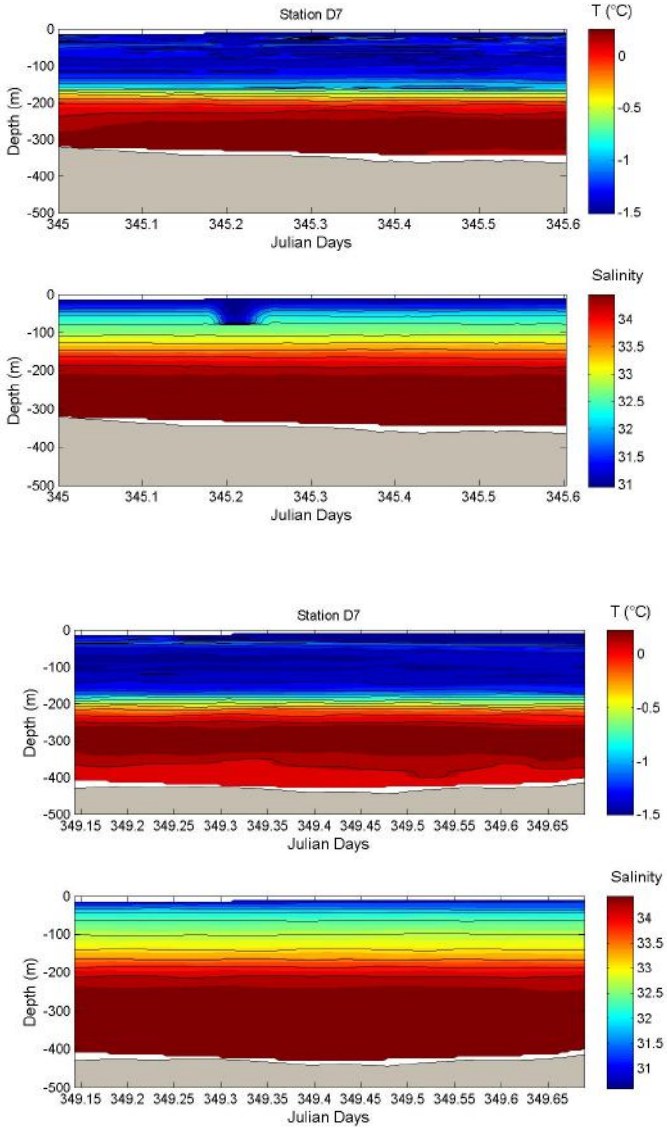


Figure 6 show temperature and salinity data recorded on station 2007-D7.

Figure 7 and **figure 8** are zooms of the two 13 hours sampling of this station (2007-D7).



2.1.2. Turbulence

Participant: Daniel Bourgault, *Memorial University*

Introduction and objectives
Ocean turbulence act to mix water properties, such as heat, salt, nutrients, pollutants etc. In order to understand and predict the evolution of ocean properties at all time-scales, from weather to climate time-scale, we need to understand how these constituents get mixed given the background (e.g. stratification) and forcing conditions (winds, tides).

The objective is to collect *in situ* measurements to quantify ocean mixing in the Beaufort Sea and Amundsen Gulf.

Instrument and installation
The Vertical Microstructure Profiler (VMP) is a loosely-tethered free-fall profiler. It is equipped with a suite of microstructure sensors that can measure mm-scale water properties from which the

turbulence intensity can be inferred. These sensors are: 2 shear probes, 2 microstructure thermistors and 1 microstructure conductivity sensor. The VMP is also equipped with standard SeaBird temperature and un-pumped conductivity sensors.

The VMP was deployed from the moonpool. A dedicated space and a table was made in the moopool area, on the other side of the rosette, for the VMP deck unit and winch (see photo below).

Figure 1: VMP installation in the moonpool area.

Sampling Protocol
The sampling protocol established for the VMP can be divided into two categories:

Monitoring mode: The long-term monitoring mode of the VMP operations consists in sampling continuously for one hour twice a day, once in the morning, generally at around 0700 or 0800, and once in the evening, at around 1900 or 2000. Around 3-5 profiles can generally be collected per sampling period, depending on the depth. We hope this sampling strategy will be continued in the following legs in order to obtain a long time-series over the winter season of the water properties and turbulence characteristics within the CFL drift site.

Experiment mode: The experiment mode of sampling is carried out on an opportunistic basis. The type of experiment carried out depended on the person in charge of the VMP and should be pre-arranged with the Chief Scientist. Examples of experiments that could be carried are: Sampling before, during and after a strong wind event or sampling through a newly formed flaw lead. Another example of experiment, as done twice during Leg 4, is to look at the semi-diurnal variability by continuously sampling for a period of 13 hours.

Sampling stations and data management
Around 250 VMP profiles were collected during Leg 4. All the information relative to each profile, such as position, depth, number of profiles collected, atmospheric conditions, etc., is logged into the Excel file: **LogBook_CFL_Leg4.xls**

All data are stored on the VMP laptop and a backup copy is stored on D. Bourgault's personal laptop.

The table below summarizes the sampling carried out during Leg 4:

Date (2007), Time	Lat	Lon
16 NOV, 1107	69 52.111	-126 30.056
19 NOV, 0632	70 38.198	-122 57.839
19 NOV, 1610	70 37.300	-123 02.814
20 NOV,1017	71 02.099	-123 18.593

21 NOV, 0702	71 13.977	-123 56.279
22 NOV, 2241	71 44.100	-126 39.740
25 NOV, 1629	73 43.535	-127 18.161
26 NOV, 0705	73 02.330	-127 24.772
28 NOV, 2133	70 25.938	-126 28.205
30 NOV, 1405	71 02.935	-123 58.457
02 DEC, 2139	71 43.947	-125 33.750
03 DEC, 0213	71 44.557	-125 33.440
03 DEC, 1404	71 46.743	-125 31.338
04 DEC, 0152	71 48.473	-125 29.277
05 DEC, 0140	71 25.027	-124 55.430
05 DEC, 1401	71 24.596	-124 50.794
06 DEC, 2024	71 18.823	-124 47.611
07 DEC, 0205	71 18.685	-124 46.533
07 DEC, 1425	71 18.884	-124 47.594
08 DEC, 0112	71 19.108	-124 49.704
09 DEC, 1400	71 15.305	-125 10.912
10 DEC, 1457	71 15.956	-125 15.445
11 DEC, 1501	71 14.797	-125 22.574
13 DEC, 0235	71 24.467	-125 48.113
13 DEC, 1511	71 26.807	-125 56.620
14 DEC, 0314	71 27.000	-125 57.360
14 DEC, 1507	71 26.332	-125 53.260
15 DEC, 2137	71 23.930	-126 00.875
16 DEC, 0327	71 24.967	-126 05.002
16 DEC, 1454	71 26.668	-126 11.390
16 DEC, 2254	71 28.691	-126 19.403
18 DEC,1517	71 46.374	-125 57.347

Observations

Figure 1 shows typical profiles of temperature, salinity and microstructure shear obtained with the VMP. In general, the top 50-m is characterized with finescale temperature and salinity structures. The measured shear is often quite uniform from surface to bottom. More detailed analysis are required to infer turbulent quantities from these measurements.

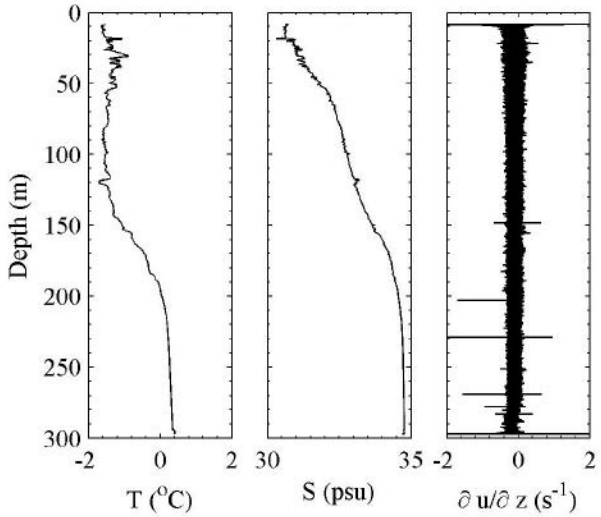


Figure 2: Example of raw temperature, salinity and micro-shear profiles obtained with the VMP on the 10 December 2007.

Figure 2 shows an example of measurements collected during one experiment where continuous VMP profiles were collected for 13 hours. 56 profiles were collected. The figure shows the temperature variability observed during the sampling period. There is no clear evidence that tides induced important change, although inspection of the ADCP data will be necessary to confirm this. Large variabilities in temperature, ±0.5 °C, were observed for the layer located between 40 m and 80 m.

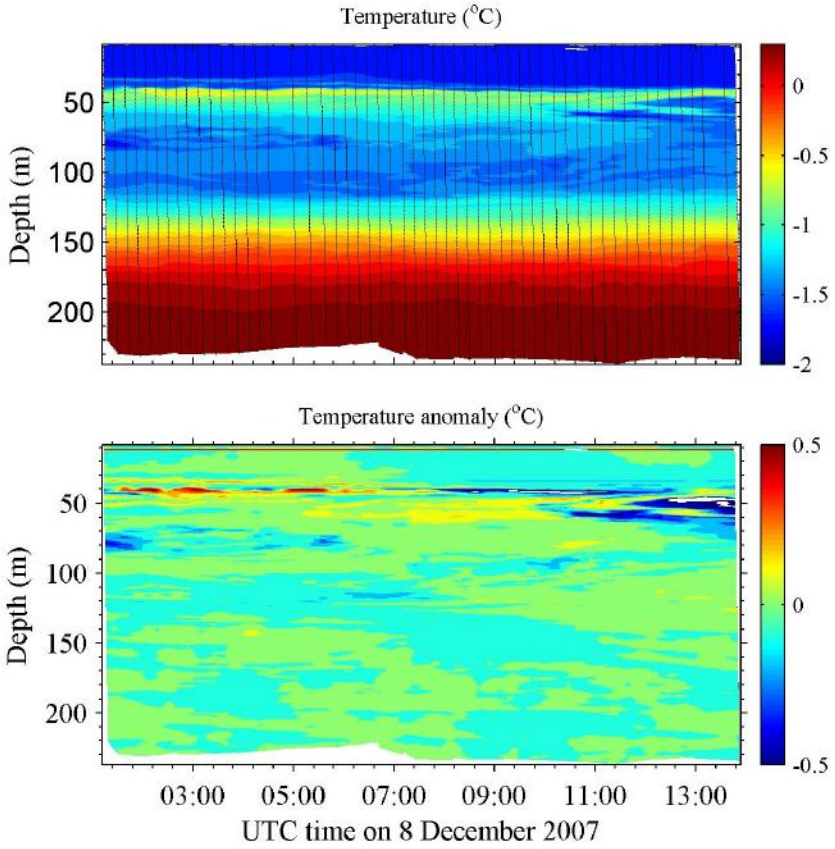


Figure 3: Example of measurements obtained during one of the VMP tidal-variability experiment. (top) temperature field and (bottom) temperature anomaly highlighting the variation over the course of the sampling period. The oblique vertical lines in the top panel represent the VMP casts.

Problems

One of the shear probe channel (channel S2) does not work. The problem is likely due to the small white cable (called SMC cable) that connects the sensor to the inside electronics. D. Bourgault ordered new shear probes and new cables. These will be brought on the ship by G. Sutherland on Leg 5. The SMC cable for shear probe 2 should be replaced as soon as possible.

Since the SeaBird conductivity sensor is not pumped this sometime caused spurious, unrealistic spikes in conductivity when the probe goes through strong temperature gradients. This is a well-known problem for conductivity cell and relates to the thermal lag of the cell. These measurements will have to be taken with care. Methods exist to remove this problem (papers from R. Lueck. Ask D. Bourgault).

Otherwise the instrument seems to work fine. It is important to regularly clean the probe connectors with contact cleaner.

2.2. Team 2

2.2.1. Ice dynamics

PI: David Barber
Cruise Participants: Monika Pucko, Phil B. J. Hwang, Mukesh Gupta, Dustin Isleifson, Matthew Asplin, Jinping Zhao, Tao Li

General Ice Conditions
During Leg 4A we encountered many different forms of ice, including nilas, thin first year ice, and multiyear ice. The most common type of ice encountered was first year ice around 40 cm thick with frost flower coverage. In Leg 4B we began to visit thicker first year ice, up to a thickness of about 80 cm at most. Snow cover was generally not present, with the exception of the multiyear ice case and a few others.

Physical Sampling
The ice raid program that was started in Leg 3B was maintained throughout Leg 4A. The goal is to obtain physical and microstructure measurements of the snow and sea ice. We generally used the ice cage on the port side of the ship, but several times we visited the ice by skippyboat in order to visit several sites of interest or to simply get away from the ship influence. In Leg 4B we reached the drift mode of the CFL project and therefore we were able to visit the site regularly via the gangplank on the ship. At this point in time it was critical to set up a fence around the EM measurement location such that it would not be accidentally disturbed.

The ice surface condition was recorded and site photos were taken. Our standard procedure was to take photos with a metre-stick present in order to obtain information on the surface conditions, and when appropriate the percentage distribution of frost flowers and their type. When snow was present we performed a snow pit measurement according to our standard procedure. This includes temperature profiles, salinity profiles, capacitance plate measurements, and snow grain photos. Two ice cores were taken at each site – one for temperature, one for salinity and microstructure. Microstructure analysis was performed on at least the top 20 cm of the ice core, and in most cases, the entire core was analyzed. For salinity we cut the cores into 5 cm segments and allowed the segments to melt in a plastic bag or container. The conductivity, temperature, and salinity were recorded using a conductivity meter.

The cold lab temperature was regularly maintained throughout Leg 4. We found that it was useful to have a day every ~10 days during which the cold lab was heated in order to defrost the condenser on the cooling unit. Otherwise, the temperature eventually will not be consistent and will slowly rise, as in Leg 3.

21 different sites were visited throughout the project. Once we were in the drift station we visited the ice each day to observe the diurnal variability. The ice raids are summarized in Table 1.

Table 1: Ice raid summary.

DATE	STATION	TIME	ICE TYPE	ICE MICRO
15-Nov-07	1117	20h00	First year ice (33 cm)	No
16-Nov-07	1117	11h00	First year ice (35 cm)	Yes
18-Nov-07	405	16h00	FYI with frost flowers (43 cm)	Yes
19-Nov-07	405	03h00	FYI with frost flowers, finger rafting of ice (46 cm)	Yes

19-Nov-07	1100	19h00	Rubble ice, FYI (46 cm)	No
20-Nov-07	1200	10h00	Consolidated pancake ice (6 cm)	Yes
20-Nov-07	1910	19h30	FYI with frost flowers (37 cm)	No
21-Nov-07 & 22-Nov-07	437	21h30 & 11h30	FYI with frost flowers (56 cm)	Yes
24-Nov-07	1825	16h00	MYI with snow (>3.2 m)	Yes
24-Nov-07	1820	21h00	FYI with frost flowers (26 cm)	Yes
25-Nov-07	1812	18h00	FYI with frost flowers (31 cm)	Yes
26-Nov-07	1800	10h00	FYI with frost flowers (24 cm)	No
26-Nov-07	1800	12h00	Nilas (9 cm)	No
26-Nov-07	1800	14h00	Nilas (5.5 cm)	Yes
28-Nov-07	2007D1	09h00	FYI (52 cm)	Yes
29-Nov-07	2007D3	18h00	Nilas (4 cm)	Yes
2-Dec-07	2007D4	11h00 & 23h00	FYI with frost flowers (33 cm)	Yes
4-Dec-07	2007D5	14h00	FYI, old consolidated pancake (26 cm)	Yes
9-Dec-07	2007D6	10h30 & 13h30	FYI with thin snow (69 cm)	Yes
10-Dec-07	2007D7	13h00	FYI with thin snow (78 cm)	Yes
17-Dec-07	2007D8	18h45	FYI with thin snow (48 cm)	Yes

Ship Based EM Measurements

EM measurements were conducted throughout Leg 4 in order to observe the interaction of electromagnetic radiation with various ice conditions. The collected data will be used in electromagnetic modeling studies and for calibration of satellite remote sensing data. The results of this study will allow for us to improve our knowledge of the temporal evolution of sea ice physical, thermodynamic, and electrical properties during the fall freeze-up period.

Scatterometer

A fully polarimetric scatterometer system was operated at each station stop. Initially the height was recorded at 7.56 m above the surface, but later this value changed due to loading in the ship and adjustments of the instrument to a height of 8.2 m. Measurements from the ship were conducted with a sweep from -30° to 30° in the azimuth, requiring the 0° reference at a perpendicular line to the ship side. The variation in elevation was measured with sweeps in the elevation at 5° increments on the range 20° to 60°. An infrared transducer (Everest, 4000L) was mounted on a rail near the scatterometer. The ice thickness camera was moved from the main deck on the port side to the scatterometer shed, one deck higher. This was due to issues with location and heating of the controlling laptop.

Ship-Based Radiometer (SBR)

Dual polarized radiometers operating at 37 GHz and 89 GHz with a 6° were mounted about 12 m above the sea surface on the port side of the ship. During transect operation the radiometers were kept at an incident angle of 55°. At station stops the system was operated in a scan mode, changing the incident angle from 30° to 150° using 5° steps. A network camera was used to monitor the surface conditions at a sampling rate of 10 s. The settings have not been changed otherwise. In addition, a

hand-held camera is used at each site to provide more information on the surface conditions.

Laser Profiler
A laser profiler was used to investigate the surface roughness during EM transects, but saw little use during Leg 4B due to temperature restrictions and breakage of the beam mount.

Ground Penetrating Radar
A ground penetrating radar system (GPR) was used to investigate snow and sea ice thickness and structure on an opportunistic basis. Three separate units were operated with frequencies of 250 MHz, 500 MHz, 1 GHz. Operation of these units at this time of year is new for our group, so everything was very experimental. We found that we were unable to obtain useful results until the ice was at least 60 cm thick. Unfortunately, due to corrosion and sensitivity the connectors on two of the units were damaged (500 MHz and 1 GHz units) and must be replaced. As well, the odometer began to malfunction for no apparent reason. These replacements are expected to be on the ship for Leg 5B or 6B at worst. One of the useful results we had from this experiment was the measurement of the runway thickness using the 1 GHz units. We found that we were able to validate the thickness of each runway and used several auger holes to acquire the correct thickness of approximately 78 cm at each end of the GPR transect.

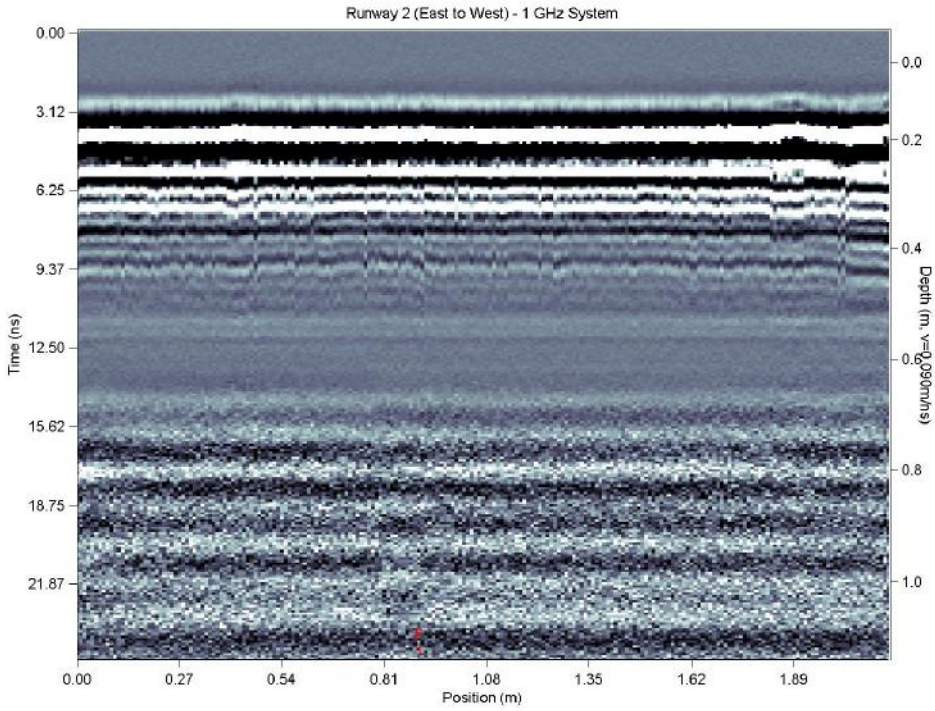


Figure 1: Successful GPR profile of the runway at Station 2007D7

Skippyboat
The purpose of the skippyboat is to allow us to investigate several sites using the ship based EM equipment, and still return to the sites to perform physical sampling. The skippyboat was deployed several times over the course of Leg 4. There were no significant issues that arose during operation. Currently the skippyboat has been winterized until a later date when it is more appropriate to use it.

Atmospheric Sampling Program
The purpose of the atmospheric sampling program is to monitor cloud cover and cloud properties, upper level and boundary layer winds, temperature, and humidity.

All-Sky Camera
The all-sky camera system is used to take pictures of sky in order that percentage and type of cloud cover may be determined throughout the cruise. The all-sky camera was non-functional upon our

arrival onboard the ship. We discovered that the webcam required a laptop with a USB 2.0 port in order to obtain high-resolution pictures, and so, a new laptop was obtained. There were ongoing issues heating the webcam itself; it would cease operating at temperatures below -5 C. The ship's electrician was able to construct a small, custom heater out of electrical "heating wire." The all-sky camera is now fully functional, and requires daily maintenance to ensure the dome is not frosty.

Ceilometer

The ceilometer is used to measure the height of the cloud layers above the ship. The ceilometer was fully functional throughout all of Leg 4. Routine maintenance and backup was performed at regular intervals.

Profiling Radiometer

The profiling radiometer is used to measure the temperature, relative humidity, and pressure within the atmosphere. It was activated fully on November 22, and has been running for all of Leg 4B. A liquid nitrogen calibration was conducted on November 26, and will be performed again during Leg 6. The instrument has collected data on the standard high pressure inversions that are characteristic of this region, as well as boundary layer temperature and humidity profiles. The passage of a significant low pressure system was profiled Dec 13/14.

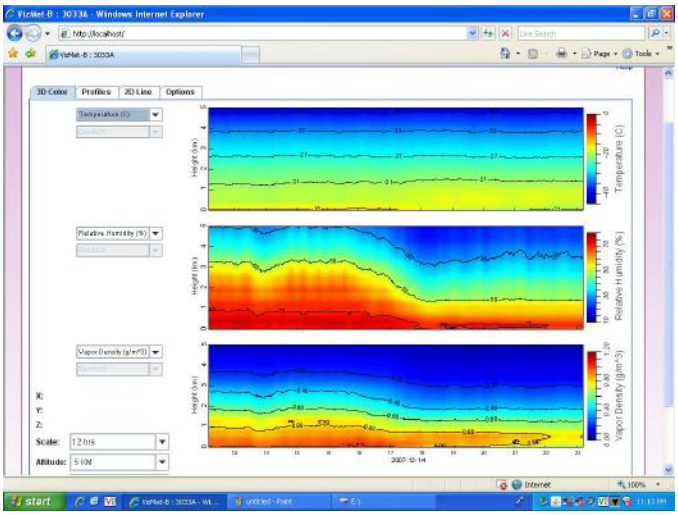


Figure 2: Profiling radiometer graph showing changes in temperature, relative humidity, and water vapour density throughout the atmospheric column associated with the passage of a cold front on December 14th.

Radiosondes (weather balloons)

The radiosonde system setup was delayed by bad weather; balloon launches were very difficult to conduct during Leg 4A. There were 14 balloon launches during Leg 4B, including a coordinated 7-balloon launch over 36-hours at a 6-hour interval, which profiled the passage of the Dec 13/14th cyclone (2007D7). Other launches were performed Dec 1st (Sach's Harbour), Dec 2nd - 3rd (2007D4), Dec 12th and Dec 15th (2007D7). Two launches were unsuccessful.

Laser Precipitation Gauge

This instrument was fully functional throughout Leg 4. The instrument continues to run, and all data has been downloaded and archived.

Ice Motion Beacons

We were able to deploy many ice beacons during Leg 4, and future deployments will be at approximately 2 week intervals or as significant opportunities arise (MYI floes).

Table 2: Ice motion beacon deployments.

Beacon ID	Date Deployed	Location Deployed	Status
18300	Nov 19 2007	MYI: De Salis Bay	ACTIVE
17300	Nov 22 2007	FYI: Stn 437	LOST

23330	Nov 24 2007	~74N, 127W	ACTIVE
912920	Nov 24 2007	Stn 1825	ACTIVE
13320	Nov 24 2007	Stn 1825	ACTIVE
24220	Dec 8 2007	Stn 2007D6	ACTIVE
22250	Dec 14 2007	MYI near 2007D7	ACTIVE
918920	Dec 16 2007	MYI near 2007D7	ACTIVE

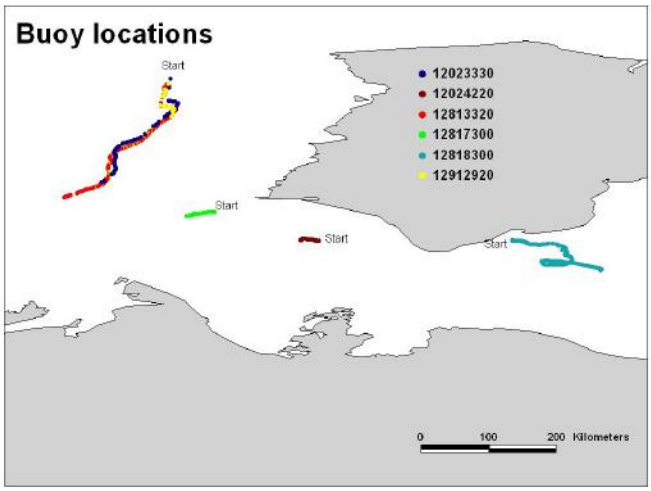


Figure 3: Ice beacon locations as of December 14, 2007.

Met-ocean "MOBS" Buoys
MOBS buoy deployment was limited to testing and buoy locator system testing. The functionality of the buoy's range-finding system appeared to be limited to only 500-700m (contrary to the company's specifications). The solution devised was to use the ship's FM transceiver set to 160.725 MHz, and attach a battery-powered strobe light to the beacon. No data collection occurred due to the lack of opportunities for safe deployment and recovery in open water.

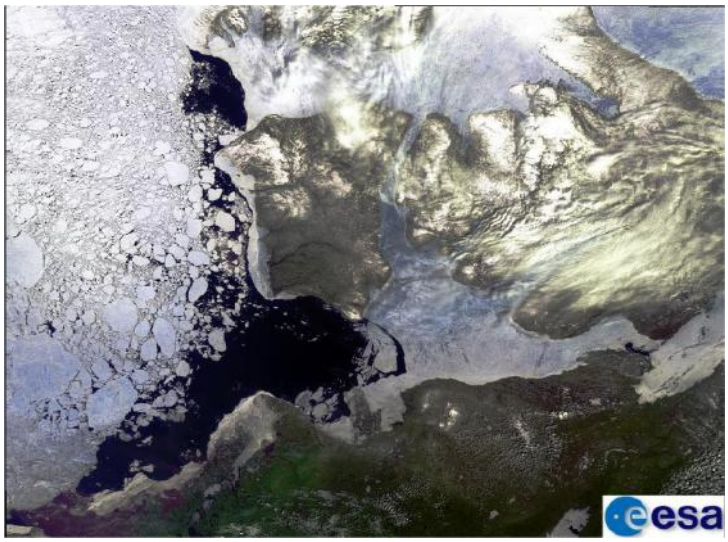
Met-ocean "POPS" Buoy
POPS buoy was not deployed during Leg 4 due to inadequate instrument capabilities. We are returning the profiler fish to met-ocean for a firmware update.

AVOS (Environment Canada MetObs System)
This instrument is not specifically our responsibility; however, we duly report that the instrument froze up on December 12th, was fixed immediately, but the Iridium service remained malfunctional. Matthew and the ship's electronic's officer (Rejean) were able to correct this on December 18th and the system is now functional.

Recommendations
In general, the data collection is proceeding as planned with no major issues that have not been resolved. As time progresses and we enter the winter it is imperative that all exposed instruments must be free of frost buildup and must be maintained at correct operating temperatures.

2.2.2. Optical Observation

Participants: Jinping Zhao and Tao Li



Key Lab for Polar Oceanography and Global Ocean Change

Ocean University of China

2007-12-20

Introduction: Light in dark Arctic Ocean

Solar radiation is the main heat source to the ocean. In ice covered ocean, part of solar energy can penetrate the sea ice to heating water. Light attenuation through sea ice is a main topic of Arctic study. Usually, optical observations are conducted in summer, as there is sun then.

However, the sunlight is declining projected onto the ice surface with the maximum solar height about 30 degree in summer. The sunlight in ice is dispersive and light paths sunlight traveled are more than ice thickness. So the attenuation measured with certain ice thickness is related to the solar height. The attenuation coefficient measured and referred to diffuse attenuation coefficient should be corrected by different solar height. People need to know the attenuation when the light is vertically projected on the ice, as then the light path is equal to the ice thickness. Unluckily, there is no such an opportunity from natural light in the Arctic Ocean.

As a great opportunity, a group from Ocean University of China participate the Leg-4 cruise to conduct an in situ optical experiment using an artificial lamp. The lamp is composed of 10 fluorescent lamps with the similar light spectrum of sun. By putting the lamp on the ice surface and shining downward, an underwater instrument, PRR-800 with 18 channels, records the intensity of the light, which is attenuated by sea ice and snow. The experiment tests both cases with snow and without snow in different ice thicknesses and different locations. The power of the lamp is about 500 W/m^2, little bit brighter than sunlight in summer. In the dark Arctic Ocean, the light must be a marvelous spectacle to the oceanic inhabitant.

It is expected that the experiment result can give the attenuation coefficient with the light path equal to ice thickness, which shows the nature of sea ice attenuation for different wavelength lights. Using this result, we can better estimate the light penetrating through sea ice with different solar heights and different ice thicknesses, which will be benefit to calculate the thermal budget through ice sheet in any season. Detected light under ice can illustrate the attenuation not only by ice thickness, but also by the particles and brine in the ice. The data can be used by ice physics and physical oceanography, and have potential connection with sea ice ecology.

Marched to the ice, the equipments are more than 100 kg, including a lamp, an ice auger, a power generator, two optical instruments, a computer, and a series of cables and connectors. During Leg-4, they have obtained successfully 36 measurements for attenuation measurements and 3 measurements for attenuation of lateral scattering light.

Instruments

Artificial lamp

We tried to make a xenon lamp, but failed to use it as it is too heavy to carry, about 120 kg. Also, the pot of the light is too small, about 30 by 30 cm.

We made a lamp in this cruise using fluorescent lamps. Each fluorescent lamp is 60 W, special for outdoor use. Ten fluorescent lamps are used to be composed of an integrated lamp. The lamps are parallelly aligned every 10 cm. The effective bright space of the lamp is 96 by 120 cm. The intensity of the lamp is about 500 W/m^2, little bit brighter than sunlight in summer this area. All the inner materials are decorated with white color to reflect light. The rectifiers of the fluorescent lamps are mounted on the back of the lamp.

Fig 2.1 Artificial lamp for the experiment

On sea ice, the lamp is powered by an electricity power generator, whose power is 1 kW to supply the system.

Fluorescent lamp as a light source is not very stable, because the fluorescent material will change with time. The other issues can also impact on the light stability. For example, output power from the power generator, the outside air temperature, the oscillation of wind speed, etc. Therefore, we need to test the stability of the lamp in various conditions to find the available period for measuring. The test results will guide the correct usage during the observation.

We used PRR-810 to measure the variation of light intensity in an indoor laboratory in Nov. 14, 2007. The instrument was putted 50 cm from the center of the lamp. The variation of light intensity is as shown in following figure. The horizontal coordinate is the number of record, 5 records per second.

After turn on the light, the intensity increased continuously in first 2.5 minutes. Since then the light intensity went down slowly. It cannot reach its stable in 15 minutes. During 15 minutes period, the intensity changed 10% of it.

After 15 minutes, the lamp became very stable. The change of light intensity was less than 1%. The error caused by the instable is acceptable. However, we still decide to calibrate the lamp in situ, in case the unexpected change in intensity of the lamp because of the weather and power.

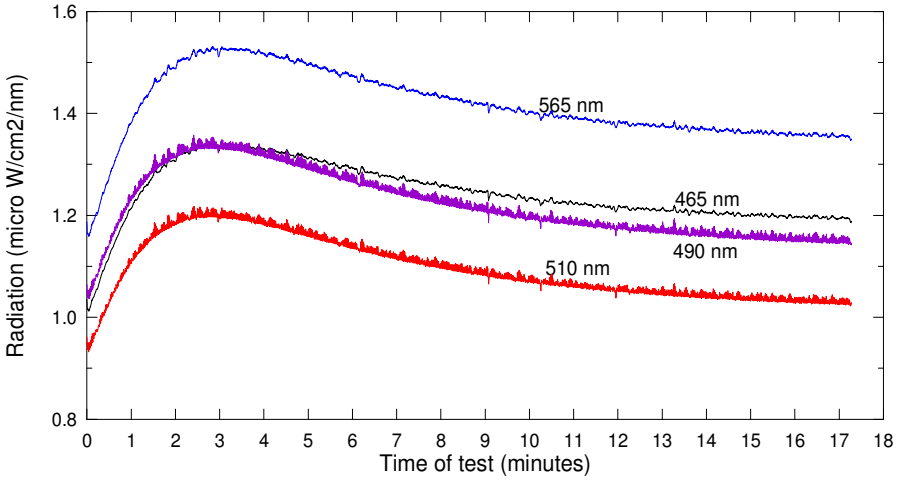


Fig. 2.2 Variation of light intensity with time

Though the spectrum of the lamp covers the solar spectra in violet, visible and infrared, the intensity of the lamp in each wavelength is different with that of solar radiation, because of the feature of the lamp, as shown in Fig 2.3. However, as the purpose of this experiment is to measure the attenuation rates, not the absolute values, the lamp is still satisfied to the purpose

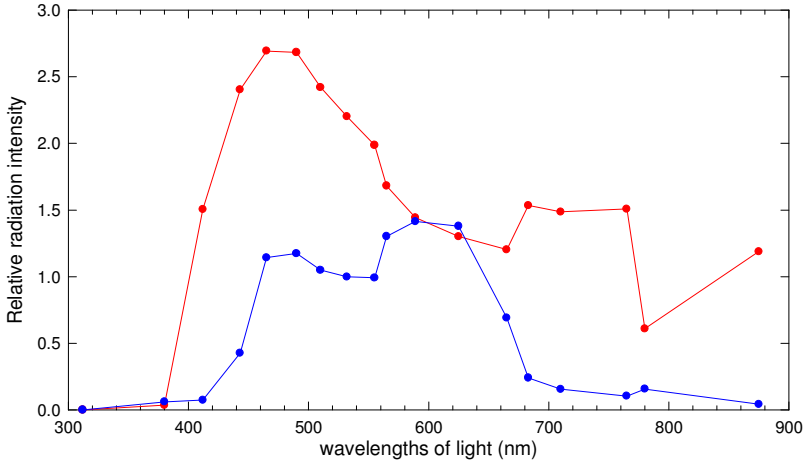


Fig 2.3 spectral distribution of intensity for both sunlight (red) and lamp (blue)

Optical Instruments

The instruments used for optical observation are high resolution Profiling Reflectance and Radiometer (PRR) made by Biospherical Instruments Inc. (BSI, USA). The system includes both an underwater profiler PRR-800 and a surface unit PRR-810, which collect signals simultaneously. Both instruments are all multispectral ones with very high resolution and sensitivity, enough to detect the light in dark condition under sea ice. The parameters for the system are as follows.

PRR-800
Optical features:
Wavelenths:313, 380, 412, 443, 490, 510, 520, 532, 555, 565, 589, 625, 665, 683, 710, 765, 780 and 875nm
Bandwidth: 10nm FWHM
Sensors:
Upwelling radiance, downwelling irradiance, dual axis inclinometer, detector array temperature, PRT water temperature, and pressure /depth
Irradiance array
Typical Saturation: 10^{5} $\mu Wcm^{-2}nm^{-1}$
Noise Equivalent Irradiance: $10^{-5}\mu Wcm^{-2}nm^{-1}$
Radiance array
Typical Saturation: 10^{-3} $Wcm^{-2}nm^{-1}$ sr^{-1}
Noise Equivalent Irradiance: 10^{-12} $Wcm^{-2}nm^{-1}$ sr^{-1}


Fig 2.4 A photo for PRR-800

PRR-810
Optical features:
Wavelenths: 313, 380, 412, 443, 490, 510, 520, 532, 555, 565, 589, 625, 665, 683, 710, 765, 780 and 875nm
Bandwidth: 10nm FWHM
Sensors:
Downwelling irradiance and detector array temperature

PRR-800/810 is a cable linked system to collect data directly by a computer during the deployment. A deck unit links PRR-800, PRR-810 and computer tocontrol the data acquirement.

The wavelengths of the instruments are carefully chosen for multiple scientific purposes.

Ultraviolet: 313 and 380.
Visible: 412, 443, 490, 510, 520, 532, 555, 565, 589, 625, 665, 683, and 710
Infrared: 765,780 and 875nm

These wavelengths cover the most high energy part of solar spectrum, as shown in Fig. 2.6. By this instrument, the spectral distribution of attenuation can be obtained.

The sampling frequency of PRR800/810 is 5Hz, a record per 0.2 second.


Fig 2.5 A photo for PRR-810

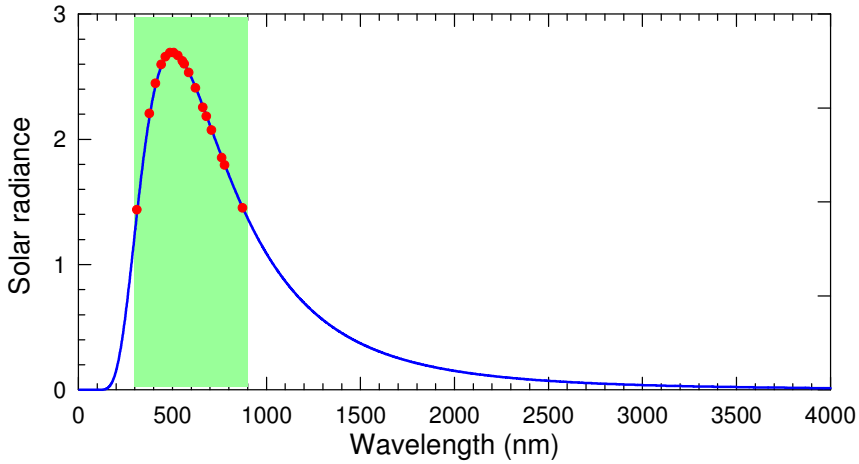


Fig 2.6 Wavelengths of PRR-800/810 in solar radiation spectra
Unit of vertical coordinate is 10^7 W m^{-2} Sr^{-1} μm^{-1}. Red dots express the wavelengths of the instruments. Green shade shows the range of 300-900nmwavelength, whose energy is about 0.628 of total solar radiation.

Deployment for vertical attenuation experiment
Through a hole with diameter of 20 cm, the underwater instrument, PRR-800, is deployed with a cable. Then, rotating the connector, the instrument is turned 90 degree to the bottom of ice.

The lamp is put on the surface of the snow. The consistency of this manner with that of hanging the lamp is demonstrated.

A calibration measurement is conducted by PRR-810 just after the underwater measurements to ensure measuring correct intensity.

The data collection unit and computer were put on a box to real-time monitor the tilt of the underwater instruments and the data quality.

The measurement is for two cases, snow covered and snow removed.

Deployment for lateral attenuation experiment
Lateral attenuation experiment is for measuring the attenuation feature of the lateral scattering light. Lateral scattering is impossible to measure in natural light. The lateral attenuation coefficient includes much information to the structure of sea ice.

Firstly we need to create a basin by auger with the width of 10 cm and length of 50 cm for putting PRR-810 inside horizontally. The depth of the basin depends on the thickness of sea ice, the deeper, and the better. Observation is in different level vertically to measure the change.

The measurement adopts the manner that the instrument is in fixed position, but the light lamp is in moving. The lamp moves from the position just above the instrument to away from the instrument. In total, 1.70 m is enough to leave the domain with scattering light.

The moving of the lamp will be stopped every 5 cm to keep the reliable record of the radiation value.

The data collection unit and computer were put on a box to real-time monitor data quality. The underwater unit is not used in this measurement, but has to be linked to the system.

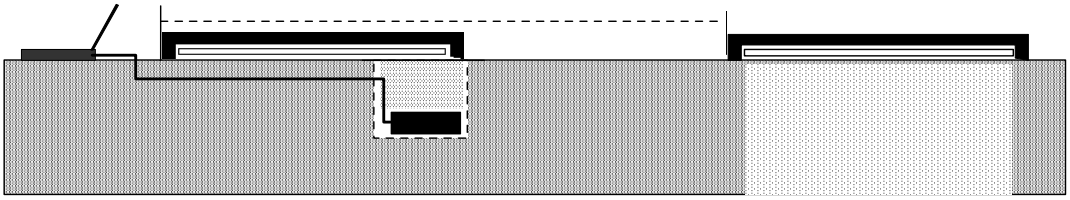


Fig. 3.2 measurement for lateral scatting light

Deployment for CTD

In each station, we conducted a CTD profile down to 50 meters to understand the water condition just below sea ice.

Guide to the experiment for optical attenuation of sea ice and snow

Equipments to the field

Following equipments are needed to carry on the field

No.	Name of equipment	Weight	Carrier
1	Fluorescent lamp	20 kg	1+2
2	Optical instruments	15 kg	1
3	Cables + 250W lamp	15 kg	1
4	Power generator	10 kg	1
5	Jeffy driller	5 kg	2
6	Underwater frame	15 kg	2
7	Computer	2 kg	2
8	Desk box of optical instruments	4 kg	1
9	Tripod, ruler, toolbox, spade	3 kg	2

Pre-experiment for the lamp

A detailed pre-experiment is for measuring the light field of the lamp to be used in calculating the attenuation by snow and ice.

Step	Experiment
1	Put the lamp with the normal parallel to the ground
2	Measure light intensity distribution in each rectangular section at 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0 meters
3	Calculate the scatting rate of the lamp with distance

Operational program for nature light

For nature light, we need to measure the downwelling radiation to the ice, upwelling reflection from ice, and downwelling radiation to the bottom of ice.

Step	Operation	Note
1	Choose proper experiment field	Avoid to step on the field
2	Start ice driller and drill a hole on ice	Measure ice thickness
3	Generate electricity	Use a connector with 3 plugs
4	Link and deploy PRR-800	Put on accurate position
5	Put PRR-810 on tripod	
6	Start instruments system	Keep computer warm before using
7	Measure with snow	
8	Remove snow and measure	Measure snow thickness
9	Finish	

Operational program for artificial light
For artificial light, we do not need to measure the incidence and reflection.

Step	Operation	Note
1	Choose proper experiment field	Avoid to step on the field
2	Start ice driller and drill a hole on ice	Measure ice thickness
3	Generate electricity	Use a connector with 3 plugs
4	Switch on the lamp	Preheating bout 15 minutes
5	Link and deploy PRR-800	Put on accurate position
6	Put PRR-810 on tripod	
7	Start instruments system	Keep computer warm before using
8	Measure downwellings with snow	
9	calibration with snow	
10	Remove snow and measure	Measure snow thickness
11	calibration without snow	
12	Finish	

Data report during Leg-4

During Leg-4, we worked on two kinds of measurements, light attenuation through sea ice and lateral light attenuation.

Light attenuation through sea ice
During Leg-4, about 36 measurements are conducted in 15 stations. The following list (Table 5.1) is the simple description for these measurements.

Table 5.1 Information for vertical attenuation measurements

№	Stn	Ice	Snow	Latitude	Longitude	File name
1	1117			69°51.9560'N	126°29.3079 'W	2007_11_15_2147.mdb , 2007_11_15_2235.mdb
2	1117	37cm	2cm	69°51.9560'N	126°29.3079 'W	2007_11_15_0012.mdb
3	1117	36cm	3cm	69°52.111'N	126°30.056'W	2007_11_16_0633.mdb
4	1117	34cm	1cm	69°52. 301'N	126°32.541'W	2007_11_16_2106.mdb
5	405	42cm	0cm	70°38.089'N	122°53.479'W	2007_11_19_0006.mdb
6	405	43cm	1cm	70°37.767'N	123°02.263'W	2007_11_19_1813.mdb
7	1100	65cm	1cm	71°01.994'N	123°16.757'W	2007_11_20_0534.mdb
8	1100A	110cm	3cm	71°06.473'N	123°24.693'W	2007_11_20_2144.mdb
9	437	56cm	1cm	71°44.841'N	126°29.758'W	2007_11_22_1241.mdb
10	437	56cm	1cm	71°44.232'N	126°39.297'W	2007_11_22_1933.mdb
11	1820	27cm	1cm	73°45.744'N	126°50.004'W	2007_11_25_0615.mdb
12	1812	32cm	1cm	73°02.995'N	127°24.224'W	2007_11_26_0312.mdb
13	2007D1	52cm	5cm	70°25.925'N	126°28.127'W	2007_11_28_2346.mdb
14	2007D3	55cm	4cm	71°08.877'N	123°55.631'W	2007_11_30_0531.mdb
15	2007D3	69cm	4cm	71°08.877'N	123°55.631'W	2007_11_30_0544.mdb
16	2007D3	66cm	3cm	71°54.999'N	124° 01.705'W	2007_12_01_0256.mdb
17	2007D3	52cm	3cm	71°54.999'N	124° 01.705'W	2007_12_01_0316.mdb
18	2007D3	49cm	3cm	71°54.999'N	124° 01.705'W	2007_12_01_0335.mdb
19	2007D4	34cm	4cm	71°42.917'N	125°37.042'W	2007_12_02_0633.mdb
20	2007D4	36cm	4cm	71°42.917'N	125°37.042'W	2007_12_04_0418.mdb
21	2007D5	27cm	2cm	71°25.030'N	124°55.419'W	2007_12_04_2332.mdb
22	2007D5	42cm	2cm	71°18.690'N	124°46.580'W	2007_12_05_2357.mdb
23	2007D5	39cm	2cm	71°18.690'N	124°46.580'W	2007_12_06_0008.mdb
24	2007D5	44cm	2cm	71°18.690'N	124°46.580'W	2007_12_06_0017.mdb
25	1200	47cm	2cm	71°18.690'N	124°46.580'W	2007_12_07_0011.mdb
26	1200	59cm	2cm	71°18.690'N	124°46.580'W	2007_12_07_2335.mdb
27	1200	77cm	1cm	71°18.690'N	124°46.580'W	2007_12_07_2353.mdb
28	2007D6	70cm	4cm	71°15.275'N	125°13.138'W	2007_12_09_1712.mdb
29	2007D7	77cm	2cm	71°15.952'N	125°15.543'W	2007_12_10_1549.mdb
30	2007D7	75cm	2cm	71°15.952'N	125°15.543'W	2007_12_10_1609.mdb
31	2007D7	78cm	5cm	71^0 25.715N	125^0 53.402W	2007_12_15_0326.mdb

32	2007D7	80cm	2.5cm	71^0 25.715N	125^0 53.402W	2007_12_15_0340.mdb
33	2007D7	82cm	4cm	71^0 25.715N	125^0 53.402W	2007_12_15_0405.mdb
34	2007D7	84cm	3.5cm	71^0 25.715N	125^0 53.402W	2007_12_16_0308.mdb
35	2007D9	53cm	6cm	71^0 47.689N	125^0 52.848W	2007_12_18_0331.mdb
36	2007D9	58cm	6cm	71^0 47.689N	125^0 52.848W	2007_12_18_0319.mdb

Attenuation for lateral scattering light

The measurement for lateral scattering light attenuation is an experiment. During Leg-4, we worked on two stations with fourteen measurements. The all measurements are listed in Table 5.2.

Table 5.2 Information for lateral attenuation measurements

No	Stn	Date	Level	Lamp width	File name
1	D5	Dec 7	12	96 cm	2007_12_07_0011
2	D7	Dec 10	32	96 cm	2007_12_11_0242
3	D7	Dec 10	22	96 cm	2007_12_11_0250
4	D7	Dec 10	12	96 cm	2007_12_11_0300
5	D7	Dec 10	5	96 cm	2007_12_11_0310
6	D7	Dec 13	5	10 cm	2007_12_14_0201
7	D7	Dec 13	12	10 cm	2007_12_14_0210
8	D7	Dec 13	22	10 cm	2007_12_14_0217
9	D7	Dec 13	32	10 cm	2007_12_14_0222
10	D7	Dec 13	32	50 cm	2007_12_14_0227
11	D7	Dec 13	22	50 cm	2007_12_14_0232
12	D7	Dec 13	12	50 cm	2007_12_14_0238
13	D7	Dec 13	5	50 cm	2007_12_14_0242
14	D7	Dec 13	5	96 cm	2007_12_14_0246

CTD measurements

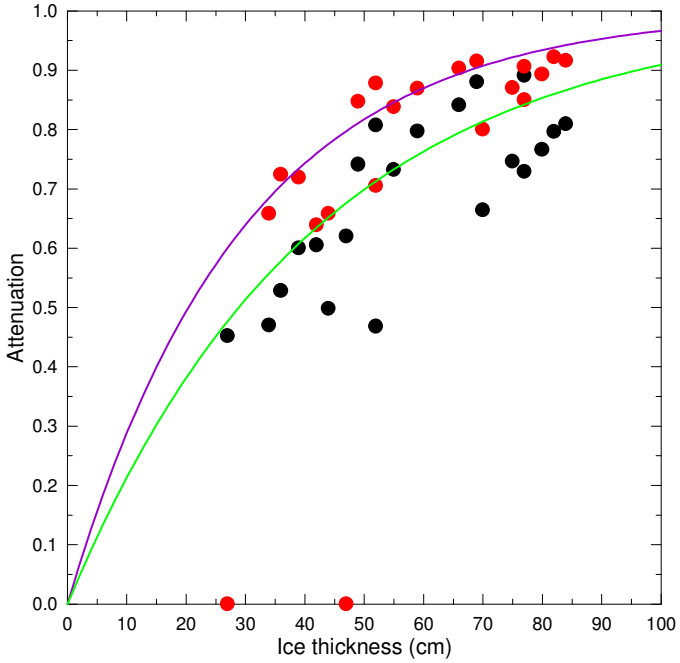
Twelve CTD profiles are measured in total. The data has been corrected by its software. The information for these data is as follows (Table 5.3).

Table 5.3 Station information for CTD

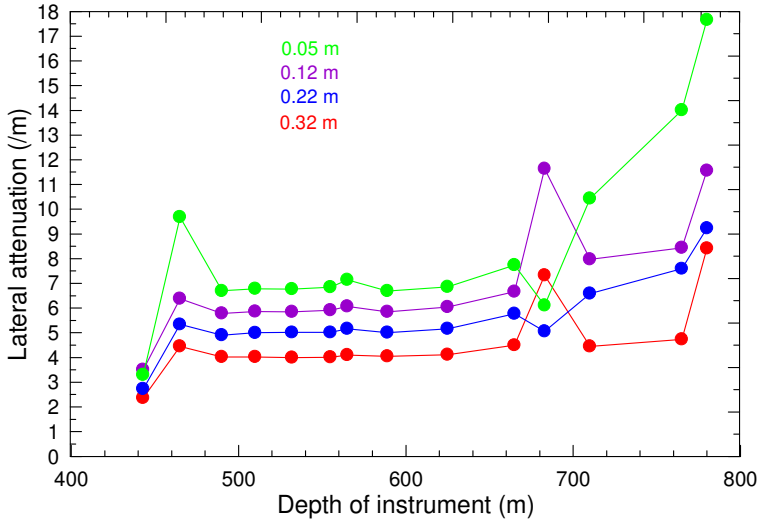
No.	No. PRR	Stn.	Deploy Dep.	Latitude	Longitude	File name
1	002	1117	5m	69°51.956'N	126°29.3079 'W	200711140001.txt
2	002	1117	5m	69°51.956'N	126°29.3079 'W	200711140002.txt
3	004	1117	47m	69°52.111'N	126°30.056'W	200711170001.txt
4	009	437	65m	71°44.841'N	126°29.758'W	200711220001.txt

5	010	437	62m	71°44.232'N	126°39.297'W	200711220002.txt
6	012	1812	61m	70°37.767'N	123°02.263'W	200711250001.txt
7	012	1812	64m	73°02.995'N	127°24.224'W	200711250002.txt
8	013	2007D1	60m	70°25.925'N	126°28.127'W	200711280001.txt
9	019	2007D4	62m	71°42.917'N	125°37.042'W	200712010001.txt
10	021	2007D5	64m	71°25.030'N	124°55.419'W	200712040001.txt
11	021	2007D5	62m	71°25.030'N	124°55.419'W	200712050002.txt
12	**035**	**2007D9**	**63m**	**71^0 47.689N**	**125^0 52.848W**	200712180001.txt

Research initiatives



Transmissions measured in different locations and with different ice thickness

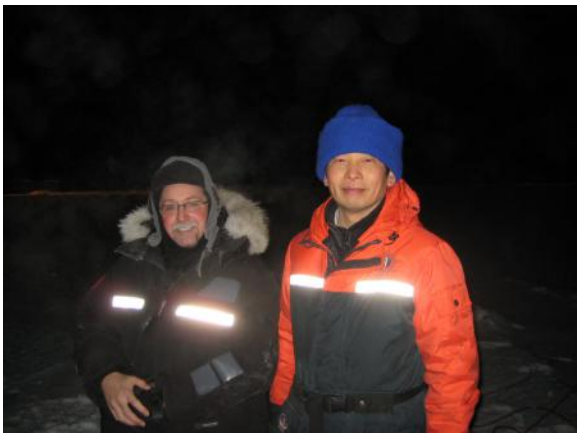


Spectral attenuation coefficient of lateral scattering light in different levels

We greatly appreciate the chief scientists of CFL, Dr. **David Barber**, to provide us the opportunity to participate the cruise. During the cruise, he gave us much help and suggestions to our work, and he created lots of opportunities and convenience to us for in situ measurements. We also appreciate **Gary Stern**, the cruise chief scientist, who supported us as much as possible for our field observation and scientific research.
We greatly appreciate the Captain of Amundsen, **Jolien Stephane**, and his crew to provide in the maximum extent help to us. Specially, we appreciate crew members, **Rock Poulin**, **Steeve Quirion**, **Daniel Cloutier**, ect, who always provide necessary help to us in need during the cruise.
Before and during this cruise, **Phil Hwang** provides us many helps in preparing equipments, instruments, cloths and materials for field work. His help is the key to our successful observation. We got lots help from **Sylvain Blondeau** in producing and improving our equipments. Here we hope to express our earnest appreciations to him.
We appreciate **Vernon Amos** and **Trevoe Lueas**, who are responsible to guard our safety in so many times down to the ice.
We appreciate the **China IPY Office**, who offers us support to participate the cruise. We also appreciate the **Nature Science Foundation of China** for their support in the key project with No. 40631006.

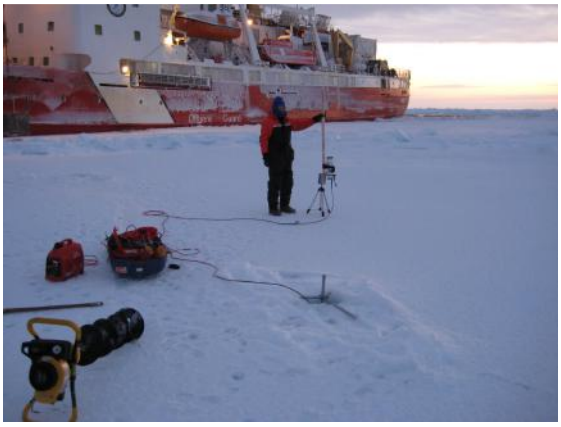
Appendix 1: Photos in working

With chief scientist David Barber



With chief scientist Gary Stern

We are coming

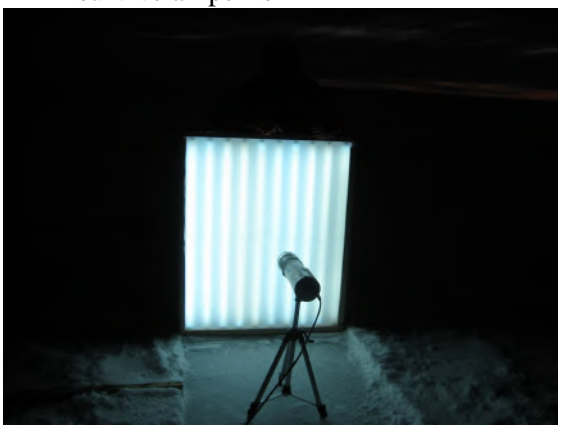


Measure the last sunlight

It is not too thick

survive all perils

A light in the dark



Take a photo for the light

Hidden in ice

Learn the ropes

Illuminate the world

Walking light

Our sun

Who can see me?

Appendix 2: Log of CFL Leg-4 cruise

Amundsen CFL cruise

LOG for PRR800/810 and CTD

Station Name.	1117	Station no.	001(testing)	Date	11-15
Start time		Latitude	69°51.9560'N	Ice thickness	
Finish time		Longitude	126°29.3079 'W	Snow thickness	
File name	2007_11_15_2147.mdb, 2007_11_15_2235.mdb				
Start time		End time		Working Area	Ice
Air temp. (°C)		Wind speed(kts)		Wind direct.(°)	
Light					
Sun light	(1) Bright (2)shaded by cloud (3) shade by fog (4) night				
Light used	(1) natural light (2) artificial light (3) both				
CTD					
File name	None		Deploy depth	0.0 m	
Description This experiment, Station no.001, is done after Station no.002, just for testing the equipments. (1) To measure the light change with time. Faced to the center of the light. (2) To measure the light change across the lamp with the step every 5 cm.					
Recorder	Zhao(calibrated by Tao)		**Ocean University of China**		

Amundsen CFL cruise

LOG for PRR800/810 and CTD

Station Name.	1117	Station no.	002	Date	11-14
Start time	15:30	Latitude	69°51.9560'N	Ice thickness	37cm
Finish time	18:30	Longitude	126°29.3079 'W	Snow thickness	2cm
File name	2007_11_15_0012.mdb				
Start time		End time		Working Area	Ice
Air temp. (°C)		Wind speed(kts)		Wind direct.(°)	
Light					
Sun light	(1) Bright (2)shaded by cloud (3) shade by fog **(4) night**				
Light used	(1) natural light **(2) artificial light** (3) both				
CTD					
File name	200711140001.txt, 200711140002.txt		Deploy depth	5 m	
Description This station is just beside the dock. Following stages are recorded. (1) preparation (2) measured with snow (3) cleaned the snow (4) measured without snow (5) turn off light At the last stage, strong wind with snow was coming. A fox appeared surround us.					
Recorder	Zhao(calibrated by Tao)		**Ocean University of China**		

Amundsen CFL cruise

LOG for PRR800/810 and CTD

Station Name.	1117	Station no.	003	Date	11-15
Start time	23:30	Latitude	69°52.111'N	Ice thickness	36cm
Finish time	02:00	Longitude	126°30.056'W	Snow thickness	3cm
File name	2007_11_16_0633.mdb				
Start time		End time		Working Area	Ice
Air temp. (°C)	-16.7	Wind speed(kts)	27	Wind direct. (°)	73
Light					
Sun light	(1) Bright (2)shaded by cloud (3) shade by fog **(4) night**				
Light used	(1) natural light **(2) artificial light** (3) both				
CTD					
File name	Failed by the problem of CTD-2			Deploy depth	55.0 m
Description Using artificial light for observation. Following stages in the record: (1) preparation (2) measured with snow (3) calibrated in situ (4) measured without snow (5) calibrated in situ It is the first time to calibrate in situ. It is windy. We spend about 30 minutes to unfasten the rope. After this measurement, we improved the roll of the rope.					
Recorder	Zhao(calibrated by Tao)		**Ocean University of China**		

Amundsen CFL cruise

LOG for PRR800/810 and CTD

Station Name.	1117	Station no.	004	Date	11-16
Start time	12:30	Latitude	69°52. 301'N	Ice thickness	34cm
Finish time	14:40	Longitude	126°32.541'W	Snow thickness	1cm
File name	2007_11_16_2106.mdb				
Start time		End time		Working Area	Ice
Air temp(°C)	-14.2	Wind speed(kts)	30	Wind direct.	90
Light					
Sun light	**(1) Bright** (2)shaded by cloud (3) shade by fog (4) night				
Light used	**(1) natural light** (2) artificial light (3) both				
CTD					
File name	200711170001.txt			Deploy depth	47.0 m
Description Observed in natural light. Solar height is about 10 degree. The light penetrate to the water is very weak looked from the data. Following stages we take: (1) preparation (2) measured the albedo (3) measured the downwelled irradiance (4) measure the underwater light. The measurement is carried on the snow covered ice. Snow thickness is about 1 cm. We wasted much time in the auger. It did not work. Finally, we dill the hole by an ice					

auger with the help from Phil.		
Recorder	Zhao(calibrated by Tao)	**Ocean University of China**

Amundsen CFL cruise

LOG for PRR800/810 and CTD

Station Name.	405	Station no.	005	Date	11-18
Start time	16:00	Latitude	70°38.089'N	Ice thickness	42cm
Finish time	17:40	Longitude	122°53.479'W	Snow thickness	0cm
File name	2007_11_19_0006.mdb				
Start time		End time		Working Area	Ice
Air temp(°C)	-19.7	Wind speed(kts)	13	Wind direct.	70
Light					
Sun light	(1) Bright (2)shaded by cloud (3) shade by fog **(4) night**				
Light used	(1) natural light **(2) artificial light** (3) both				
CTD					
File name	Does not work by unknown reason			Deploy depth	47.0 m

Description

Good weather, wind is weak, and temperature is not too low. Nearly now snow at all, but there is some snow pot on it. We observed two times for both with and without snow pot.

(1) Measure with snow pot
(2) Tried to calibrate, but the electricity broke down.
(3) Measure with snow pot again
(4) Calibrate
(5) Clean the snow pot
(6) Measure without snow pot
(7) Move across 10 cm to test the change of light intensity.
(8) Calibrate again

Recorder	Zhao(calibrated by Tao)	**Ocean University of China**

Amundsen CFL cruise

LOG for PRR800/810 and CTD

Station Name.	405	Station no.	006	Date	11-19
Start time	10:50	Latitude	70°37.767'N	Ice thickness	43cm
Finish time	12:30	Longitude	123°02.263'W	Snow thickness	1cm
File name	2007_11_19_1813.mdb				
Start time		End time		Working Area	Ice
Air temp(°C)	-17.6	Wind speed(kts)	16	Wind direct.	88
Light					
Sun light	**(1) Bright** (2)shaded by cloud (3) shade by fog (4) night				
Light used	**(1) natural light** (2) artificial light (3) both				
CTD					
File name	Does not work by unknown reason			Deploy depth	0.0 m

Description

Good weather. During sunrise period.

(1) Measure underwater light with no stop.
(2) Measure downwelling radiation with snow
(3) Measure reflection with snow

(4) Clean snow (5) Measure downwelling radiation without snow (6) Measure reflection without snow (7) Repeat the process two times (8) Automatically stopped by unknown reason In this period, the sun is rising with solar height less than 5 degree. The radiation continuously increases.

Recorder	Zhao(calibrated by Tao)	**Ocean University of China**

Amundsen CFL cruise

LOG for PRR800/810 and CTD

Station Name.	1100	Station no.	007	Date	11-19
Start time	21:50	Latitude	71°01.994'N	Ice thickness	65cm
Finish time	23:40	Longitude	123°16.757'W	Snow thickness	1cm
File name	2007_11_20_0534.mdb				
Start time		End time		Working Area	Ice
Air temp(°C)	-15.4	Wind speed(kts)	27	Wind direct.	98
Light					
Sun light	(1) Bright (2)shaded by cloud (3) shade by fog **(4) night**				
Light used	(1) natural light **(2) artificial light** (3) both				
CTD					
File name	Does not work by non-power			Deploy depth	0.0 m

Description

Ice is rough. Besides ship there is a ridge. Across the ridge, ice smoother, but still very rough. It is impossible to find a ice flat enough. Where we observed is a relative flat and small area. As there are some small ice blocks frozen on ice sheet, the lamp cannot cover the ice without gap. Anyway, the last arrange for the lamp is good.

(1) Lamp is lightened during the preparation.
(2) Measure with now.
(3) Calibration.
(4) We took too long time to calibrate, so we measured again, but the intensity changed much.
(5) Clean snow, but ice surface is still white.
(6) Measure without snow
(7) Calibration

It is windy. 35 knot/sec. Very cold.

Recorder	Zhao(calibrated by Tao)	**Ocean University of China**

Amundsen CFL cruise

LOG for PRR800/810 and CTD

Station Name.	1100A	Station no.	008	Date	11-20
Start time	13:30	Latitude	71°06.473'N	Ice thickness	110cm
Finish time	14:50	Longitude	123°24.693'W	Snow thickness	3cm
File name	2007_11_20_2144.mdb				
Start time		End time		Working Area	Ice
Air temp(°C)	-13.3	Wind speed(kts)	24	Wind direct.	120
Light					

Sun light	(1) Bright **(2)shaded by cloud** (3) shade by fog (4) night		
Light used	**(1) natural light** (2) artificial light (3) both		
CTD			
File name	None	Deploy depth	0.0 m
Description Warm and weak wind. We drilled 3 holes. The first one is interrupted by order to return to ship. The second one is drilled successfully, but there is another ice under the drilled ice and the PRR cannot get through the water. The third hole is drilled and used for measurement. It is 110 cm. (1) deploy instrument (2) measure with snow (3) measure albedo (4) measure irradiance (5) clean snow (6) measure irradiance (7) measure albedo			
Recorder	Zhao(calibrated by Tao)	**Ocean University of China**	

Amundsen CFL cruise

LOG for PRR800/810 and CTD

Station Name.	437	Station no.	009	Date	11-22
Start time	05:15	Latitude	71°44.841'N	Ice thickness	56cm
Finish time	06:15	Longitude	126°29.758'W	Snow thickness	1cm
File name	2007_11_22_1241.mdb				
Start time		End time		Working Area	Ice
Air temp(°C)	-19.4	Wind speed(kts)	12	Wind direct.	40
Light					
Sun light	(1) Bright (2)shaded by cloud (3) shade by fog **(4) night**				
Light used	(1) natural light **(2) artificial light** (3) both				
CTD					
File name	200711220001.txt			Deploy depth	65m
Description Warm and weak wind. Work is favoring. Finished within one hour including deployment of CTD. (1) measure the light with snow (2) prepare calibration, but the power is disconnected. (3) Measure again (4) Calibration (5) Clean snow (6) Measure without snow (7) calibration					
Recorder	Zhao(calibrated by Tao)		**Ocean University of China**		

Amundsen CFL cruise

LOG for PRR800/810 and CTD

Station Name.	437	Station no.	010	Date	11-22
Start time	12:00	Latitude	71°44.232'N	Ice thickness	56cm
Finish time	13:15	Longitude	126°39.297'W	Snow thickness	1cm

File name	2007_11_22_1933.mdb				
Start time		End time		Working Area	Ice
Air temp(°C)	-21.3	Wind speed(kts)	14	Wind direct.	35
Light					
Sun light	(1) Bright **(2)shaded by cloud** (3) shade by fog (4) night				
Light used	**(1) natural light** (2) artificial light (3) both				
CTD					
File name	200711220002.txt			Deploy depth	62 m
Description -21 C. Cold, but no wind. Finished within one hour including deployment of CTD. (1) Keep measurement of underwater unit (2) Measure reflection from snow surface. (3) Measure downwell radiation (4) Clean snow (5) Measure downwell radiation (6) Measure reflection from snow surface					
Recorder	Zhao(calibrated by Tao)		**Ocean University of China**		

Amundsen CFL cruise

LOG for PRR800/810 and CTD

Station Name.	1820	Station no.	011	Date	11-24
Start time	22:50	Latitude	73°45.744'N	Ice thickness	27cm
Finish time	00:10	Longitude	126°50.004'W	Snow thickness	1cm
File name	2007_11_25_0615.mdb				
Start time		End time		Working Area	Ice
Air temp. (°C)	-19.2	Wind speed(kts)	5	Wind direct.	156
Light					
Sun light	(1) Bright (2)shaded by cloud (3) shade by fog **(4) night**				
Light used	(1) natural light **(2) artificial light** (3) both				
CTD					
File name	None			Deploy depth	0.0 m
Description Warm and no wind. A layer with snow is not snow. It is a flower of brine from ice. (1) measure with snow (2) calibration (3) clean snow (4) measure without snow (5) calibration					
Recorder	Zhao(calibrated by Tao)		**Ocean University of China**		

Amundsen CFL cruise

LOG for PRR800/810 and CTD

Station Name.	1812	Station no.	012	Date	11-25
Start time	19:50	Latitude	73°02.995'N	Ice thickness	32 cm
Finish time	21:00	Longitude	127°24.224' W	Snow thickness	1 cm
File name	2007_11_26_0312.mdb				

Start time		End time		Working Area	Ice
Air temp. (°C)	-16.3	Wind speed(kts)	7	Wind direct.(°)	201
Light					
Sun light	(1) Bright (2)shaded by cloud (3) shade by fog **(4) night**				
Light used	(1) natural light **(2) artificial light** (3) both				
CTD					
File name	200711250001.txt, 200711250002.txt			Deploy depth	61, 64m
Description Warm and no wind. A layer with snow is not snow. It is a flower of brine from ice. (1) measure with snow (2) calibration (3) clean snow (4) measure without snow (5) calibration					
Recorder	Zhao	**Ocean University of China**			

Amundsen CFL cruise

LOG for PRR800/810 and CTD

Station Name.	2007-D1	Station no.	013	Date	11-28
Start time	16:50	Latitude	70°25.925'N	Ice thickness	52 cm
Finish time	18:10	Longitude	126°28.127' W	Snow thickness	5 cm
File name	2007_11_28_2346.mdb				
Start time		End time		Working Area	Ice
Air temp. (°C)	-15.9	Wind speed(kts)	22	Wind direct.(°)	235
Light					
Sun light	(1) Bright (2)shaded by cloud (3) shade by fog **(4) night**				
Light used	(1) natural light **(2) artificial light** (3) both				
CTD					
File name	200711280001.txt			Deploy depth	60 m
Description It is the second measurement. The first one lost surface data. Warmest day without wind. A real snow layer exists. (1) measure with snow (2) calibration (3) clean snow (4) measure without snow (5) calibration					
Recorder	Zhao	**Ocean University of China**			

Amundsen CFL cruise

LOG for PRR800/810 and CTD

Station Name.	2007D3	Station no.	014、015	Date	11-29
Start time	22:00	Latitude	71°08.877'N	Ice thickness	55、69 cm
Finish time	23:10	Longitude	123°55.631' W	Snow thickness	4 cm

File name	2007_11_30_0531.mdb、2007_11_30_0544.mdb				
Start time		End time		Working Area	Ice
Air temp. (°C)	-17.6	Wind speed(kts)	17	Wind direct. (°)	330
Light					
Sun light	(1) Bright (2)shaded by cloud (3) shade by fog **(4) night**				
Light used	(1) natural light **(2) artificial light** (3) both				
CTD					
File name	None			Deploy depth	0.0 m
Description Warm and windy, but not very strong. Drifting station. Ice with different thickness. Two measurements are conducted. (1) measure with snow (2) calibration (3) clean snow (4) measure without snow (5) calibration					
Recorder	Zhao		**Ocean University of China**		

Amundsen CFL cruise

LOG for PRR800/810 and CTD

Station Name.	2007D3	Station no.	016、017、018	Date	11-30
Start time	19:30	Latitude	71°54.999'N	Ice thickness	66、52、49 cm
Finish time	21:10	Longitude	124° 01.705'W	Snow thickness	3 cm
File name	2007_12_01_0256.mdb、2007_12_01_0316.mdb、2007_12_01_0335.mdb				
Start time		End time		Working Area	Ice
Air temp. (°C)	-15.2	Wind speed(kts)	26	Wind direct. (°)	330
Light					
Sun light	(1) Bright (2)shaded by cloud (3) shade by fog **(4) night**				
Light used	(1) natural light **(2) artificial light** (3) both				
CTD					
File name	200711300001 with the wrong power			Deploy depth	0.0 m
Description Warm and windy. Drifting station. Ice with different thickness. Three measurements are conducted. (1) measure with snow (2) calibration (3) clean snow (4) measure without snow (5) calibration					
Recorder	Zhao		**Ocean University of China**		

Amundsen CFL cruise

LOG for PRR800/810 and CTD

Station Name.	2007D4	Station no.	019	Date	12-1

Start time	23:00	Latitude	71°42.917'N	Ice thickness	34 cm
Finish time	24:00	Longitude	125°37.042' W	Snow thickness	4 cm
File name	2007_12_02_0633.mdb				
Start time		End time		Working Area	Ice
Air temp. (°C)	-17.7	Wind speed(kts)	10	Wind direct. (°)	55
Light					
Sun light	(1) Bright (2)shaded by cloud (3) shade by fog **(4) night**				
Light used	(1) natural light **(2) artificial light** (3) both				
CTD					
File name	200712010001.txt			Deploy depth	62m
Description Warm, no strong wind. Drifting station. Ice with uniform thickness. Forgot recording and re-measured. (1) measure with snow (2) calibration (3) clean snow (4) measure without snow (5) calibration					
Recorder	Zhao	**Ocean University of China**			

Amundsen CFL cruise

LOG for PRR800/810 and CTD

Station Name.	2007D4	Station no.	020	Date	12-3
Start time	21:00	Latitude	71°42.917'N	Ice thickness	36 cm
Finish time	22:00	Longitude	125°37.042' W	Snow thickness	4 cm
File name	2007_12_04_0418.mdb				
Start time		End time		Working Area	Ice
Air temp. (°C)	-19	Wind speed(kts)	9	Wind direct. (°)	190
Light					
Sun light	(1) Bright (2)shaded by cloud (3) shade by fog **(4) night**				
Light used	(1) natural light **(2) artificial light** (3) both				
CTD					
File name	None			Deploy depth	0.0 m
Description Warm, no strong wind. Drifting station. Ice with uniform thickness. Forgot recording and re-measured. (1) measure with snow (2) calibration (3) clean snow (4) measure without snow (5) calibration					
Recorder	Zhao	**Ocean University of China**			

Amundsen CFL cruise

LOG for PRR800/810 and CTD

Station Name.	2007D5	Station no.	021	Date	12-4
Start time	16:00	Latitude	71°25.030'N	Ice thickness	27 cm
Finish time	17:00	Longitude	124°55.419' W	Snow thickness	0 cm
File name	2007_12_04_2332.mdb				
Start time		End time		Working Area	Ice
Air temp. (°C)	-20.6	Wind speed(kts)	11	Wind direct. (°)	205
Light					
Sun light	(1) Bright (2)shaded by cloud (3) shade by fog **(4) night**				
Light used	(1) natural light **(2) artificial light** (3) both				
CTD					
File name	200712040001.txt			Deploy depth	64m
Description Little bit cold and windy. Uniform thickness of ice. Snow is melt into ice. It is special for light, as it is less reflected. Snow cannot be cleaned. (1) measure (2) calibration					
Recorder	Zhao	**Ocean University of China**			

Amundsen CFL cruise

LOG for PRR800/810 and CTD

Station Name.	2007D5	Station no.	022、023、024	Date	12-5
Start time	16:30	Latitude	71°18.690'N	Ice thickness	42、39、44 cm
Finish time	17:40	Longitude	124°46.580' W	Snow thickness	1-2 cm
File name	2007_12_05_2357.mdb、2007_12_06_0008.mdb、2007_12_06_0017.mdb				
Start time		End time		Working Area	Ice
Air temp. (°C)	-16.5	Wind speed(kts)	12	Wind direct. (°)	330
Light					
Sun light	(1) Bright (2)shaded by cloud (3) shade by fog **(4) night**				
Light used	(1) natural light **(2) artificial light** (3) both				
CTD					
File name	200712050002.txt			Deploy depth	62 m
Description Warm and windy, but not very strong. Drifting station. Ice with different thickness. Three measurements are conducted. (1) measure with snow (2) calibration (3) clean snow (4) measure without snow (5) calibration Repeated for three holes. No. 022 is new frozen ice.					

Recorder	Zhao	**Ocean University of China**

Amundsen CFL cruise

LOG for PRR800/810 and CTD

Station Name.	1200	Station no.	025	Date	12-6
Start time	16:30	Latitude	71°18.690'N	Ice thickness	47 cm
Finish time	17:40	Longitude	124°46.580' W	Snow thickness	1-2 cm
File name	2007_12_07_0011.mdb				
Start time		End time		Working Area	Ice
Air temp. (°C)	-16.7	Wind speed(kts)	12	Wind direct. (°)	340
Light					
Sun light	(1) Bright (2)shaded by cloud (3) shade by fog **(4) night**				
Light used	(1) natural light **(2) artificial light** (3) both				
CTD					
File name	None			Deploy depth	0.0 m
Description Warm. Drifting station. In the same station with yesterday. We conduct two things. The first is to measure the lateral scatting. The second is to measure in the hole for only no snow one. The results are written in the same file. The ice is completely consistent with the one of 024 yesterday. (1) measure without snow (2) calibration For the test, the PRR-810 is put in the 13 cm of snow to measure the scattering light. The start position is beside the edge of lamp, then move the light to opposite side with the step length of 5 cm till 170 cm in total.					
Recorder	Zhao	**Ocean University of China**			

Amundsen CFL cruise

LOG for PRR800/810 and CTD

Station Name.	1200	Station no.	026、027	Date	12-7
Start time	16:00	Latitude	71°18.690'N	Ice thickness	59、77 cm
Finish time	17:10	Longitude	124°46.580' W	Snow thickness	2、1cm
File name	2007_12_07_2335.mdb、2007_12_07_2353.mdb				
Start time		End time		Working Area	Ice
Air temp. (°C)	-16.4	Wind speed(kts)	6	Wind direct. (°)	60
Light					
Sun light	(1) Bright (2)shaded by cloud (3) shade by fog **(4) night**				
Light used	(1) natural light **(2) artificial light** (3) both				
CTD					
File name	None			Deploy depth	0.0 m
Description Warm. Drifting station. In the same station with yesterday.. (1) measure with snow					

(2) calibration (3) clean snow (4) measure without snow (5) calibration		
Recorder	Zhao	**Ocean University of China**

Amundsen CFL cruise

LOG for PRR800/810 and CTD

Station Name.	2007D6	Station no.	028	Date	12-9
Start time	08:30	Latitude	71°15.275'N	Ice thickness	70 cm
Finish time	10:30	Longitude	125°13.138' W	Snow thickness	4cm
File name	2007_12_09_1712.mdb				
Start time		End time		Working Area	Ice
Air temp. (°C)	-18.3	Wind speed(kts)	6	Wind direct. (°)	330
Light					
Sun light	(1) Bright (2)shaded by cloud (3) shade by fog **(4) night**				
Light used	(1) natural light **(2) artificial light** (3) both				
CTD					
File name	None			Deploy depth	0.0 m
Description Warm. Drifting station. In the same station with yesterday.. (1) measure with snow (2) calibration (3) clean snow (4) measure without snow (5) calibration					
Recorder	Zhao	**Ocean University of China**			

Amundsen CFL cruise

LOG for PRR800/810 and CTD

Station Name.	D7	Station no.	029、030	Date	12-10
Start time	08:30	Latitude	71°15.952'N	Ice thickness	77、75 cm
Finish time	10:00	Longitude	125°15.543' W	Snow thickness	2 cm
File name	2007_12_10_1549.mdb、2007_12_10_1609.mdb				
Start time		End time		Working Area	Ice
Air temp. (°C)	-21.7	Wind speed(kts)	8	Wind direct. (°)	5
Light					
Sun light	(1) Bright (2)shaded by cloud (3) shade by fog **(4) night**				
Light used	(1) natural light **(2) artificial light** (3) both				
CTD					
File name	None			Deploy depth	0.0 m
Description Warm and windy, but not very strong. Drifting station. Ice with different thickness. Two measurements are conducted.					

(1)measure with snow (2)calibration (3)clean snow (4)measure without snow (5)calibration		
Recorder	Tao	**Ocean University of China**

Amundsen CFL cruise

LOG for PRR800/810 and CTD

Station Name.	D7	Station no.	031、032、033	Date	12-14
Start time	19:30	Latitude	71^0 25.715N	Ice thickness	78\80\82cm
Finish time	21:30	Longitude	125^0 53.402W	Snow thickness	5\2.5\4 cm
File name	2007_12_15_0326.mdb、2007_12_15_0340.mdb、2007_12_15_0405				
Start time		End time		Working Area	Ice
Air temp. (^{o}C)	-18.9	Wind speed(kts)	14	Wind direct. (^{o})	325
Light					
Sun light	(1) Bright (2)shaded by cloud (3) shade by fog **(4) night**				
Light used	(1) natural light **(2) artificial light** (3) both				
CTD					
File name	None			Deploy depth	0.0 m
Description Warm and windy, but not very strong. Drifting station. Ice with different thickness. Two measurements are conducted. (1)measure with snow (2)calibration (3)clean snow (4)measure without snow (5)calibration note: the first measurement was done by the PRR810 with the diameter of the 1cm, while the rest of the survey is with the diameter of the 10cm. CBC people are working with us and take the video of us.					
Recorder	Tao		**Ocean University of China**		

Amundsen CFL cruise

LOG for PRR800/810 and CTD

Station Name.	D7	Station no.	034	Date	12-15
Start time	19:30	Latitude	71^0 25.715N	Ice thickness	84cm
Finish time	21:30	Longitude	125^0 53.402W	Snow thickness	3.5 cm
File name	2007_12_16_0308.mdb				
Start time		End time		Working Area	Ice
Air temp. (^{o}C)	-21.7	Wind speed(kts)		Wind direct. (^{o})	
Light					

Sun light	(1) Bright (2)shaded by cloud (3) shade by fog **(4) night**		
Light used	(1) natural light **(2) artificial light** (3) both		
CTD			
File name	None	Deploy depth	0.0 m
Description Warm and windy, but not very strong. Drifting station. Ice with different thickness. Two measurements are conducted. (1)measure with snow (2)calibration (3)clean snow (4)measure without snow (5)calibration note: CBC people are working with us and take our video of us again, and we have got two ice core of the thickness of 78cm.			
Recorder	Tao	**Ocean University of China**	

Amundsen CFL cruise

LOG for PRR800/810 and CTD

Station Name.	D9	Station no.	035,036	Date	12-17
Start time	19:30	Latitude	71^0 47.689N	Ice thickness	53/58cm
Finish time	21:30	Longitude	125^0 52.848W	Snow thickness	6 cm
File name	2007_12_18_0331.mdb, 2007_12_18_0319.mdb				
Start time		End time		Working Area	Ice
Air temp. (^{o}C)		Wind speed(kts)		Wind direct. (^{o})	
Light					
Sun light	(1) Bright (2)shaded by cloud (3) shade by fog **(4) night**				
Light used	(1) natural light **(2) artificial light** (3) both				
CTD					
File name	None			Deploy depth	0.0 m
Description Warm and windy, but not very strong. Drifting station. Ice with different thickness. Two measurements are conducted. (1)measure with snow (2)calibration (3)clean snow (4)measure without snow (5)calibration					
Recorder	Tao		**Ocean University of China**		

2.3. Team 4

2.3.1. Zooplankton & Fish/ Acoustic

Participants: Hélen Cloutier (U.Laval), Louis Létourneau (U.Laval), Sylvain Blondeau, Maxime Dumais (electronician technician from U Laval)

General objective and field program

The general objective of our team is marine productivity and sustained exploitation of emerging fisheries which is to assess the impact of sea-ice cover reduction and increasing sea temperatures on biological productivity, fisheries resources and marine Mammal populations of the coastal Canadian arctic. Aboard the CCGS Amundsen, we collect indices of the ecosystem maturity late in autumn and at the beginning of the winter (November and December).

However, the 2007 cruise differed from the previous missions, being a component of the Canada's contribution to the International Polar Year, the ship CCGS Amundsen left Québec in August for a mission of 15 months. Since October 18th date we were begin-Ning the Circumpolar Flaw Lead Study (CFL) which will examine on an annual cycle how the physical processes moderate biogeochemical processes within the changing northern flaw lead ecosystem nearby Banks Island (Beaufort Sea). Therefore, the sampling during this period can be seen as a pre-winter survey of the flaw lead area to get an indication of the status of the marine ecosystem at the end of the growth season and associated physical forcing. Our multidisciplinary ArcticNet team is thus strongly linked with Team 4 (Pelagic and Benthic Foodwebs – Fortier) and Team 7 (Carbon Fluxes – Tremblay) of the CFL program

Operations during the ArcticNet-CFL leg 4 were spread on the East-West gradient of the Canadian Arctic. This represented a large spectrum of sampling conditions and three oceanographic regions were visited the south-eastern Beaufort Sea (Western Arctic) comprised of the Franklin Bay and Banks Shelves, and of the Amundsen Gulf area (the CFL study region).

The main field objectives of our multitask ArcticNet Theme 1.4 sub-team were:

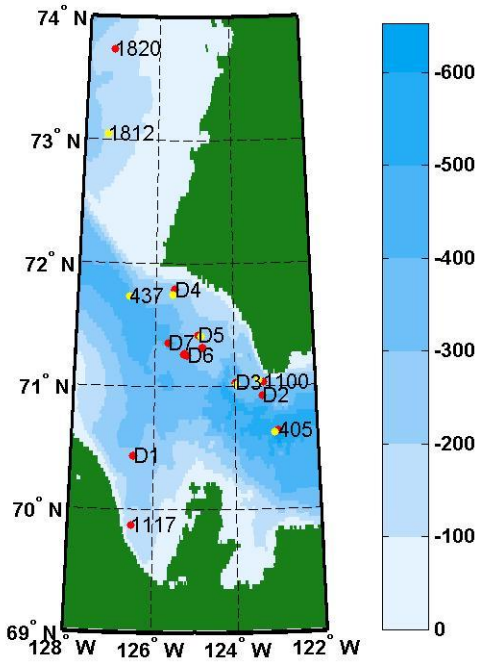
1) To assess zooplankton / fish abundance and diversity by using various plankton nets.

2) To track zooplankton / fish biomass and distribution with the EK60 Echosounder.

In addition, zooplankton samples collected during leg 4 are also used in other ArcticNet-CFL subprojects such as the cycling of contaminants (G. Stern). As well, part of the samples collected will be used in a study to identify the sources and pathways of omega-3 in the arctic marine food chain (J. Michaud, E. Dewaily and L. Fortier) and is linked to the ArcticNet theme 1.5 that is focussing on the importance of omega-3 fatty acid in the traditional diet of Inuit communities. Also as part of the CFL Team 4 on the pelagic food web, the assessment of the respiration rates of the zooplankton community by the Electron Transfer Sysem (ETS) activity method was performed at chosen stations (G. Darnis and L. Fortier). At some stations, zooplankton samples were also collected for genetic studies at UQAR (France Dufresne and Adriana Radulovici).

In total, 13 stations were visited for zooplankton. However, the ice conditions (multiyear ice floes or fast-growing sea ice) severely constrained the sampling at many stations during leg 4. Acoustics EK60 monitoring was done continuously during the whole cruise.). The Table 1 (p. 4) summarizes the sampling activities at each of the 12 stations. And the details of the operations are fully described in the following sections: 1- Zooplankton.

Figure 1: Leg 4 stations



Graphic by Marie-Emmanuelle Rail (INRS)

Vertical tows (1m^2- Net, Hydrobios)

1-m^2 Square (Frame rigged with 1 square m^2 opening nets (1 x 200, µm mesh), out-rigged with a 10 cm diameter net (50 µm) and equipped with flowmeter (1 TSKs). This net is used for integrated water column sampling. When deploying, winch speed down was <20 m/min to avoid mixing of the nets, and winch speed up was 40m/min. The content of one 200 µm (TSK-QT) and the 50 µm mesh-net were preserved in formaldehyde for taxonomy (Fortier). The content of the others casts nets were sorted for contaminants, lipids and genetics studies. At some stations, ETS assays were performed using one of the integrated tows (see Table 2 for details). This gear was systematically deployed at all full stations.(photo a)

Hydrobios: Multi plankton sampler (photo b) equipped with nine 200 µm-mesh nets (opening 0.5 m^2). This was allowing for depth specific sampling of the water column. The *Hydrobios* is also equipped with a CTD to record water column properties while collecting biological samples. When deploying, winch speeds down and up were both 40m/min. The *Hydrobios* was deployed at full stations in every region when conditions were favourable. At some stations, the content of each net was divided between preservations (4% buffered formaldehyde) and ETS assays were performed for. Please note that the recurrent problem with the *Hydrobios*'s flowmeters has not been resolved yet (they do not work in the water, while they work on deck).

Photo (a)

Photo (b)

Table 1: 1m2 tucker net stations

Date	Stations				Sampling gear		Use sample					
	number	type	depth	1m2	Hydro	taxonomy	contamin	lipids	Dna	ets	incub	swim
						Fortier L	Stern G	Michaud J	UQAR	Darnis G	Darnis	Sampei
2007-11-16	1117	F	171	x		x						
2007-11-19	405	F	562	x		x 50%		x 25%				x 25%
2007-11-19	405	F	605	x			x					
2007-11-20	1100	F	284	x		x						
2007-11-25	1820	F	135	x		x						
2007-11-25	1820	F	139	x				x				
2007-11-26	1812	F	171	x		x						
2007-11-29	2007d1	F	289	x		x		x	x			
2007-11-29	2007d1	F	290	x			x					
2007-11-30	2007d3	F	310	x		x			x			
2007-11-30	2007d3	F	310	x			x					
2007-11-30	2007d3	F	310	x				x				
2007-12-03	2007d4	F	226	x			x					
2007-12-03	2007d4	F	226	x		x						
2007-12-03	2007d4	F	226	x						x		
2007-12-05	2007d5	F	211	x			x					
2007-12-05	2007d5	F	209	x		x						
2007-12-05	2007d5	F	211	x				x	x			
2007-12-09	2007d6	F	316	x		x						
2007-12-09	2007d6	F	314	x			x					
2007-12-09	2007d6	F	311	x				x	x		x	
2007-12-10	2007d7	F	322	x		x			x			
2007-12-10	2007d7	F	330	x			x					
2007-12-10	2007d7	F	328	x				x		x		
2007-12-15	2007d7	F	420	x						x	x	
2007-12-15	2007d7	F	420	x		x						
2007-12-17	2007d7	F	435	x				x		x		

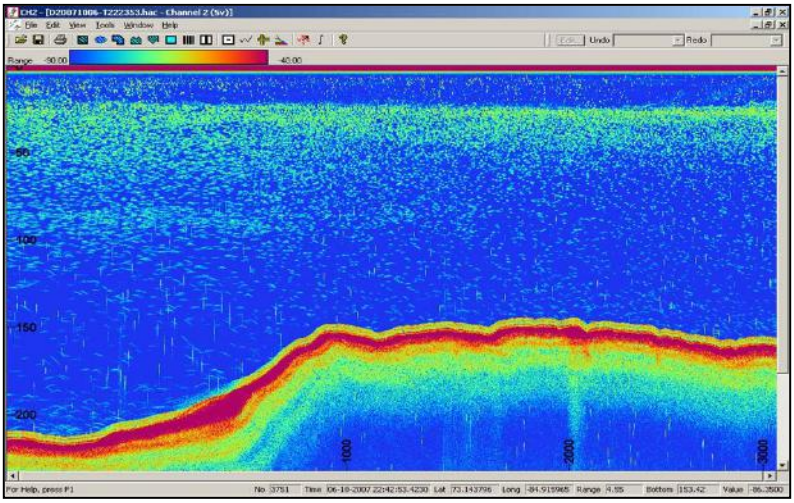
Table 2: Hydrobios casts

Date	Stations			Sampling gear		Use sample				
	number	type	depth	1m2	Hydro taxonomy	contamin	lipids	Dna	ets	incub
					Fortier L	Stern G	Michaud J	UQAR	Darnis G	Darnis
2007-11-19	405	F	631	X	X					
2007-11-20	1100	F	242	X	X					
2007-11-23	437	F	440	X	X					
2007-11-26	1812	F	171	X	X					
2007-11-30	2007d3	F	329	X	x					
2007-12-03	2007d4	F	236	X	x					
2007-12-05	2007d5	F	217	X	x				X	
2007-12-14	2007d7	F	410	X	x				X	
2007-12-18	2007d9	F	230	X	x				X	

Acoustic monitoring

The Amundsen is equipped with a scientific echosounder, the EK-60, to continuously monitor the distribution of zooplankton and fish. A particular attention is devoted to Arctic cod, *Boreogadus saida*, which plays a key role in the Arctic marine ecosystem. During the first part of leg 3, an acoustic layer was detected between 20 and 100 m below the surface (Figure 3) everywhere along the route of the vessel from Resolute to the Greenland coast. Based on the analysis of the split-beam information, it seemed to contain mostly small fish and large zooplankton. When comparing the vertical distribution of the echoes to that of the water column characteristics obtained from Rosette casts, the acoustic layer appears to be associated with an intrusion of warmer waters below the surface. Another acoustic layer likely resulting from the presence of larger fish and associated with different water mass was present between 250 and 500 m. This layer, which according to its multifrequency acoustic signature also contains zooplankton, was more concentrated in the western part of Lancaster Sound. It settled on the bottom of the NOW polynya around the 350 m depth contour, especially on the Canadian side.

Figure 2: Typical EK-60 feature in Eastern Arctic



2.4. Team 6

PIs: Tim Papakyriakou (U of M), Lisa Miller (IOS), Jean-Louis Tison (U.L.B.)
Participants: Brent Else (U of M), Nes Sutherland (IOS), Gauthier Carnat (U of M)

2.4.1. Surface Meteorology and Flux Project

Brent Else

Introduction
The surface meteorology and flux program (CFL Team 6) is designed to record basic meteorological conditions and to study exchanges of momentum, heat and mass across the atmosphere-sea ice-ocean interface. The main value of this program to the overarching objectives of Team 6 is the direct measurement of CO_2 fluxes.

Fluxes of CO_2 are measured by the eddy covariance technique, which is dependent only on atmospheric measurements. Although measurement of these fluxes is extremely useful information, it is essentially meaningless without an understanding of the processes (physical, biological and chemical) that drive gas exchange. In an open-ocean situation this context is largely provided by measurement of sea-surface pCO_2, but the situation becomes much more complex when a sea ice cover is included in the equation.

This section of the CFL Team 6 cruise report reviews the atmospheric and sea surface pCO_2 measurements that were made during Leg 6. Other sections of the report will deal with the sea ice measurements that were made in support of the CO_2 flux measurements.

Micrometeorology and Eddy Covariance Flux Tower

Methods
The micrometeorological tower located on the front deck of the Amundsen (Figure 1.1) provided continuous monitoring of meteorological variables and eddy covariance parameters. The tower consists of slow response sensors that record bulk meteorological conditions (air temperature, humidity, wind speed/direction, surface temperature) and fast response sensors that record the eddy covariance parameters (CO_2/H_2O concentration, 3D wind velocity, 3D ship motion, air temperature) (Table 1.1). In addition, radiation sensors (Figure 1.1, Table 1.1) were installed on the roof of the wheelhouse to provide information on incoming longwave, shortwave and photosynethetically active radiation. All data was logged to Campbell Scientific dataloggers; a model CR5000 logger was used for the eddy covariance data, a CR1000 logger for the slow response met data, and a CR23X for the radiation data. All loggers were synchronized to UTC time using the ship's GPS system as a reference.

The eddy covariance system on the tower makes use of two separate gas analyzers and a single 3D sonic anemometer. The dual gas analyzers system allows us to make use of both closed path and open path eddy covariance systems. The open path gas analyzer has the benefit of making measurements concurrently with the sonic anemometer, but the closed path gas analyzer is not as easily disturbed by adverse weather conditions.

In order to make sure that the two systems are comparable, careful calibrations were performed on both instruments. The closed path system is based on a LI-7000 gas analyzer which employs two optical cells, one of which was used to monitor the drift of the instrument by constantly passing a stream of ultra-high purity N_2. In addition, the sample cell of the instrument was calibrated daily using the ultra-high purity N_2 to zero the CO_2 and H_2O measurements, and a reference gas of known CO_2 to span the instrument. Occasionally, a span calibration of the H_2O sensor was performed using

a dew point generator (model LI-610). The open path gas analyzer (LI-7500) could not be calibrated as conveniently, and so it was calibrated approximately every three weeks. In general, we find that this is effective for this particular instrument, which does not drift significantly over time.

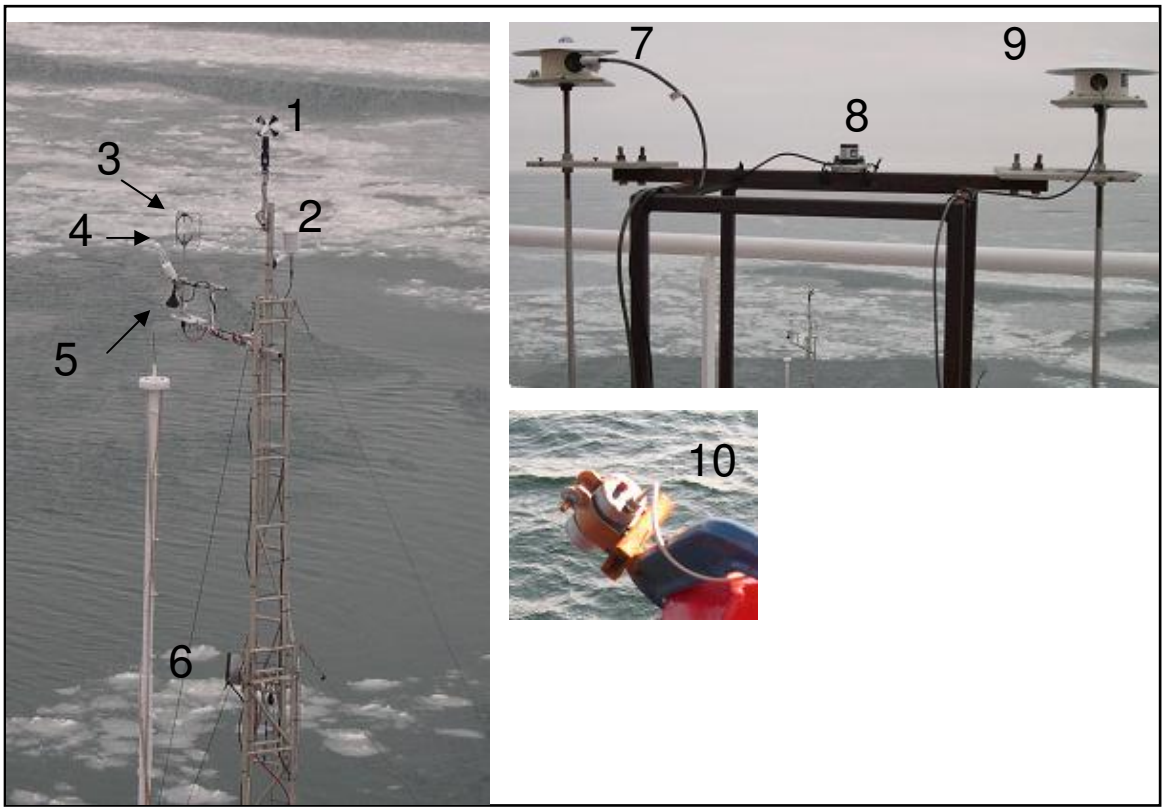


Figure 1.1: Meteorology and flux program instrument setup. See Table 1 for description of instruments based on the numbers. Note that on Nov. 18 the Motion Pak (6) was moved to the rear face of the tower to facilitate easier motion correction.

Table 1.1: Description of instruments shown in Fig. 1.1.

Fig 1	Sensor	Variables	Units	Ht from deck (m)	Scan (s) /Ave (min)	Specs
1	wind monitor (RMYoung 05103)	wind speed/directio	m/s; º	8.45	2/1	±0.6 m/s ±3º deg
2	temperature/relative humidity probe (Vasailla HMP45C212)	T and RH	ºC; %	7.53	2/1	Humidity ±2% 0-90% @ 20ºC ±3% 90-100% @ 20º 0.05% RH/ºC Temperature ± 0.1 ºC
3	3D wind velocity (Gill R3 ultra-sonic anemometer)	u,v,w, speed o sound (SOS)	m/s	7.1	10 Hz	RMS noise <1% offset <0.01 m/s SOS < 0.5% accuracy
4	LI7500 open path ga analyzer	CO_2/H_2O	µmol/m^3 mmol/m^3	7.1	10 Hz	RMS noise ±0.1 µmol/mol zero drift 0.1 µmol/mol/ºC gain drift 0.1%/ºC
5 (inlet, analyzer not shown)	LI7000 closed path g analyzer	CO_2/H_2O	µmol/m^3 mmol/m	inlet at 7.1	10 Hz	RMS noise ±0.1 µmol/mol zero drift 0.3 µmol/mol/ºC gain drift 0.2%/ºC
6	multi-axis inertial sensor (MotionPak, Systron Donner)	rate x,y,z accel x,y,z	º/s; g	6.48	10 Hz	rate <0.004º/s acc <10 µg
7	pyranometer (Eppley, model PSP)	SW_in	W/m^2	7.0	2/1	~±5%
8	quantum sensor (Kipp & Zonen, PARLite)	PAR	µmol/m^2/	7.6	2/1	~±5%
9	pyrgeometer (Eppley, model PIR)	LW_in	W/m^2	7.0	2/1	~±10%
10	surface temperature (Everest infrared transducer, model 4000.44ZL)	Tsrfc	ºC	1.6 m	3/1	±0.5 ºC accuracy
not shown	pressure transducer (RM Young, 61205V	Patm	kPa		2/1	

Sample data

As an example of the slow response meteorological data, Figure 1.2 shows the evolution of air temperature and wind speed over one day at Station D7 (a first year sea ice floe, ~70cm depth). An example of the rapid response flux data is shown in Figure 1.3, which shows 10 minutes of vertical wind speed and CO_2 concentration. A great deal of processing will be required to calculate actual fluxes of CO_2, and to filter out erroneous data.

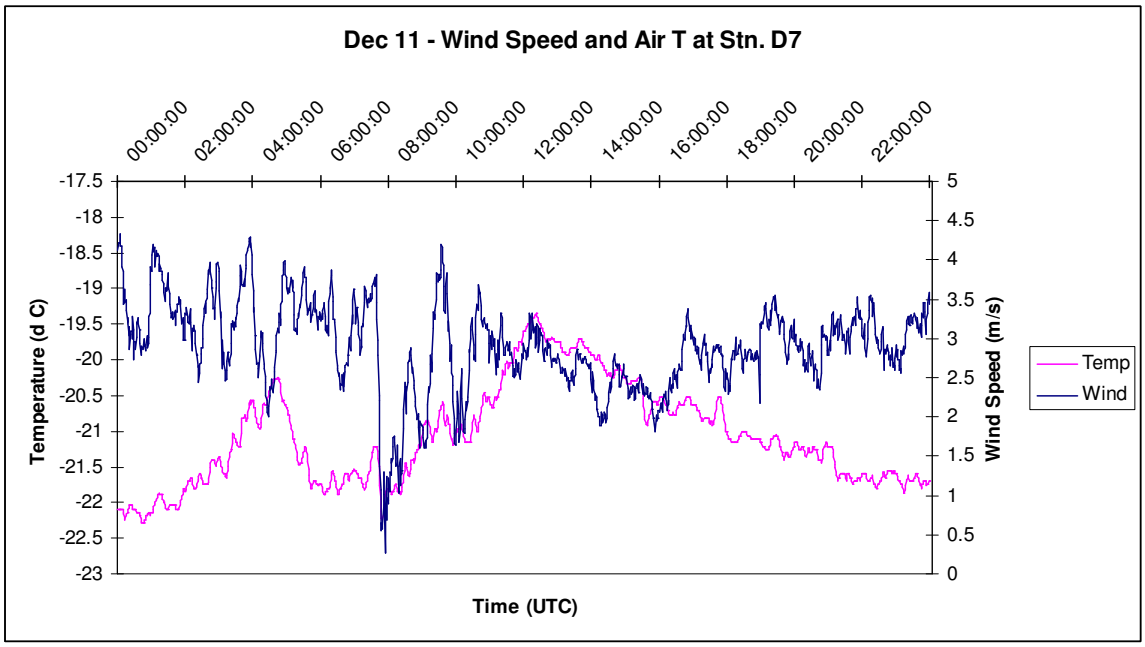


Figure 1.2: Slow response meteorological data example; wind speed and air temperature (24 hrs)..

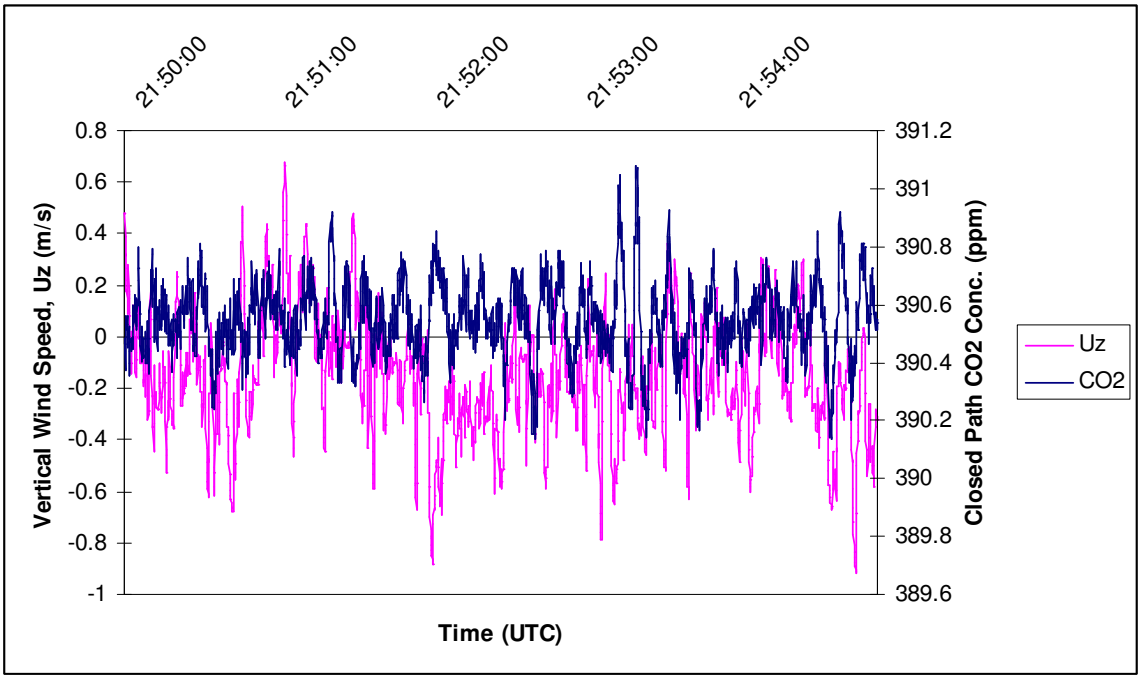


Figure 1.3: Fast response flux data example; vertical wind speed and closed path $_{CO2}$ concentration (10 min).

Notes

The meteorological tower ran consistently for the duration of the leg (Nov. 8-Dec. 20) with the exception of a brief period when the tower was taken down for maintenance (Nov 18). However, for significant periods of time during the leg certain sensors were inoperable due to atmospheric conditions. The most common problem encountered during this leg was riming due to the cold, moist conditions. This problem most seriously affected the LI-7500, which was very difficult to keep clean. The problem also affected the sonic anemometer, but to a much lesser degree. The extent of data lost due to atmospheric conditions cannot be estimated at this time, and will only be known once post processing is complete.

A second key note for this leg is that a problem with the calibration routine for the LI-7000 gas analyzer was identified. Due to the high flow rate required for the closed path sample line, the sample cell of the LI-7000 operates at a low pressure (~50 kPa). On previous legs the LI-7000 was calibrated at a pressure of ~100 kPa, which apparently caused a systematically high reading of CO_2 concentration. This problem was rectified on Dec. 6 by making some minor adjustments to the piping systems. All data collected prior to Dec. 6 will need to be corrected for this error.

Finally, a minor change was made to the tower on Nov. 18 by changing the motion sensor to the back face of the tower. This change will allow for easier motion correction, because it aligns the axes of the sensor with the sonic anemometer. All data prior to this date will have to take into consideration the offset of the motion pak relative to the axes of the anemometer.

On-track pCO_2 System

Methods

A custom-built pCO_2 system was utilized on this leg to measure dissolved $_{CO2}$ at the sea surface in near real time. The system (Figure 1.4) is located in the engine room of the Amundsen, and draws sample water from the ship's clean water intake. The water is passed into a sealed container through a shower head, maintaining a constant headspace. This set up allows the air in the headspace to come into equilibrium with the CO_2 concentration of the seawater, and the air is then cycled from the container into the LI-7000 gas analyzer in a closed loop. Thermocouples are used to measure water temperature immediately before entering the equilibration chamber, and to measure the temperature of the air in the chamber. All data is logged to a Campbell Scientific CR1000 datalogger.

The LI-7000 gas analyzer was calibrated daily using ultra-high purity N_2 as a zero gas, and a gas with known CO_2 concentration as a span gas. Spanning of the H_2O sensor was not necessary because a desiccant column removes H_2O from the air stream before passing into the sample cell. As with the closed path system, a stream of N_2 is constantly cycled through the reference cell of the LI-7000 to monitor and correct for drift of the instrument.

Figure 1.4: The on-track pCO_2 system located in the engine room of the Amundsen. The equilibration chamber is the clear cylinder (left bottom) and the gas analyzer is the box with the digital display.

Sample Data
Figure 5 shows an example of a single day of CO_2 data recorded by the on-track system, along with water temperature. Further processing must still be undertaken to correct the values for changes in temperature that occur due to the length of the sample line, and to properly calculate pCO_2.

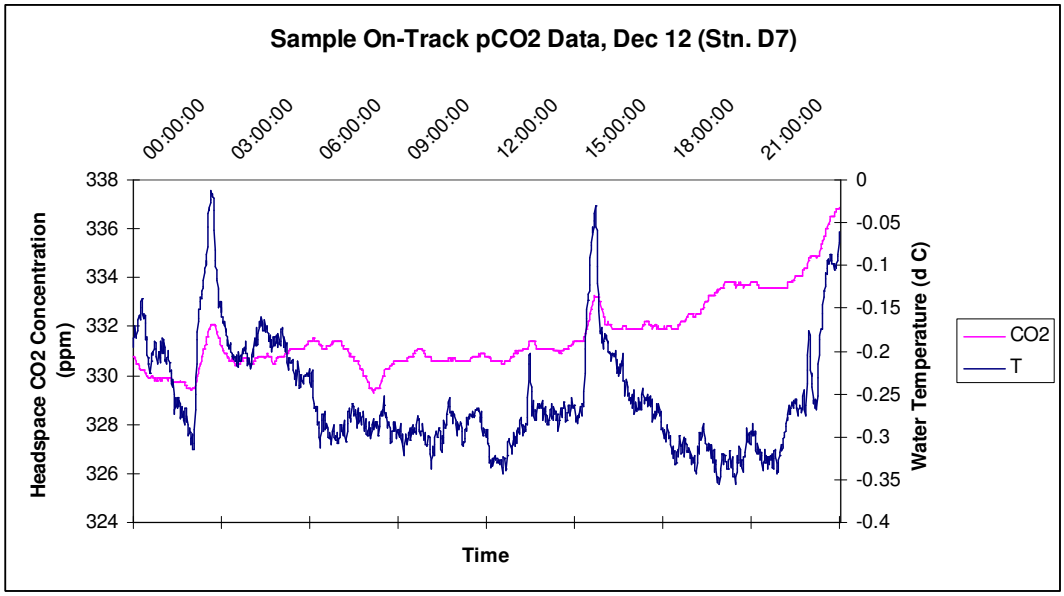


Figure 1.5: Sample on-track pCO_2 data (CO_2 and water temperature)

Notes
The on-track pCO_2 system was active for the duration of the leg, with some minor interruptions for maintenance. Major interruptions in data collection were experienced when the ship was breaking ice, which either reduced the flow of water into the equilibration tank, or completely blocked it. In the case of blocked flow, the data is lost, but tests will have to be conducted to determine if data obtained with low water flow is useful. No changes were made to the system during this leg.

2.4.2. CO_2 in Sea Ice Project

Brent Else

Introduction
The primary focus of Team 6 is to gain a better understanding of the cycling of climatologically important gases in Arctic seas. A large base of knowledge already exists regarding air-sea gas exchange, but considerably less is known about the exchange of gases in an ice covered ocean. During CFL Leg 4, a sampling program was carried out to examine CO_2 in sea ice with the goal of creating a context against which measurements made by the eddy covariance flux system (section 1) can be interpreted.

To gather this contextual information, several different methods were used to understand the distribution of CO_2 in sea ice. Silicon "peepers" were deployed to measure profiles of CO_2 within the ice matrix and "sackholes" were drilled to collect brines for analysis of dissolved CO_2 content. To determine fluxes of CO2 directly associated with the sea ice, a flux chamber was used. This sampling provides a very unique dataset that will allow us to understand the state of sea ice with respect to CO2 early in the ice growth season.

Peepers

Methods

Silicon chambers (approximately 15cm in length, 5cm in diameter) were deployed in the ice, either in sackholes or in auger holes drilled completely through the ice (Figure 2.1). The silicone membrane is permeable to gas exchange, and if the peeper is left in the ice for a long period of time (at least 24hrs) the ambient gas in the peeper should come into equilibrium with gas that exists in brines and air pockets in the sea ice. Stainless steel tubing was used to sample the gas in the peepers with a gas analyzer (Licor model LI-820). The setup was designed to cycle air from the peepers through the gas analyzer in a closed loop. Data from the LI-820 was logged to a Campbell Scientific CR10X data logger at a frequency of 1 Hz. This allowed for the observation of a peak in CO_2 concentration as the gas in the peeper cycles through the gas analyzer. Although this eventually results in mixing of ambient atmosphere into the peeper chamber, we believe that the initial peak is representative of the CO_2 concentration in the ice.

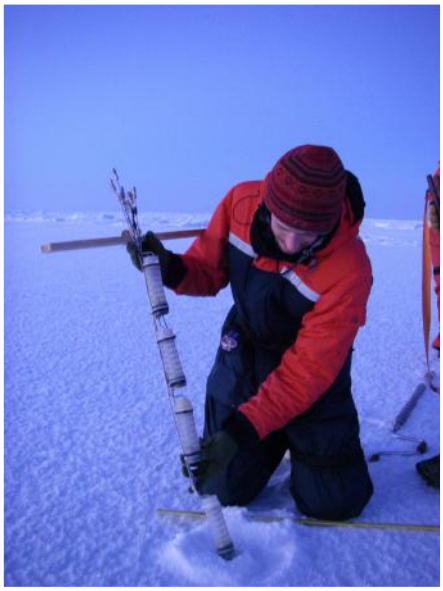


Figure 2.1: Deployment of a peeper array into an auger hole drilled through the ice to the ocean.

Deployment dates/locations

Table 2.1: Deployment date/location for peeper sampling. All times/dates UTC.

Site	Deployment Date	Removal Date	Sample Dates/Time	Notes
D5	Dec. 6, 0000	Dec. 8, 1700	Dec. 7, 0000 Dec. 8, 0000 Dec. 8, 1630	-Deployed 5 peepers; 3 in 20 cm sackholes, 2 in a 40cm sackhole array (1 at 20cm, 1 at 40cm)
D7	Dec. 11, 1800 (array) Dec. 12, 1800 (sackholes) Dec. 13, 1800 (50cm sackhole)	Dec. 17, 1730	Dec. 13, 0300 (array only) Dec. 14, 0400 (except 50cm sackhole) Dec. 15, 0000 Dec. 16, 0300 Dec. 17, 0300	-Deployed an array of peepers through an auger hole to the ocean (Fig. 1); depths of 20cm, 40cm, 60cm and 85 cm (i.e. in the water below the interface) -Deployed 4 peepers in 20cm sackholes, 1 in a 40cm sackhole, 1 in 50cm sackhole.

Sample data

Figure 2.2 shows the sample output from the LI-820 gas analyzer for one peeper run. A clear peak is observed at 725 ppm, which is indicative of the CO_2 concentration in the ice. Figure 2.3 shows the observations of the peeper array deployed at station D7 during one sampling period, showing significant vertical variation.

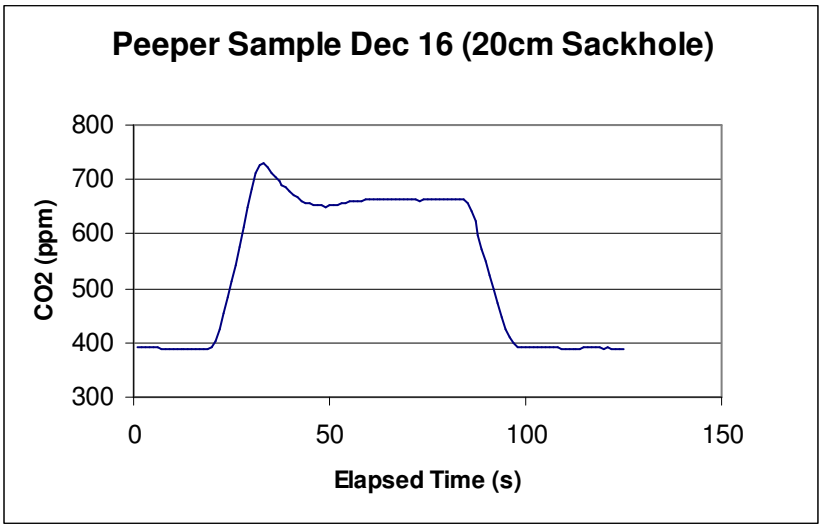


Figure 2.2: Raw peeper sampling data from a 20cm peeper at Stn. D7

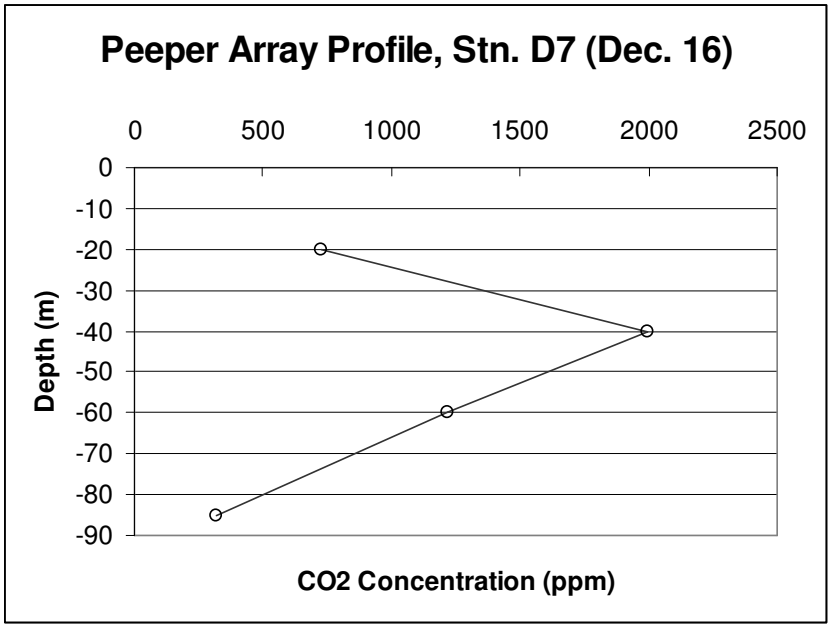


Figure 2.3: Sample profile from the peeper array shown in Fig. 1.

Peeper notes

In some peepers at station D7 the CO_2 concentration exceeded the limit of the gas analyzer (2000 ppm). However, it seems likely that the peak can be estimated by graphing the data (e.g. Fig. 2). In the future, the LI-820 should be set to a larger range by modifying the optical bench of the analyzer cell. During this leg we lacked the materials to make this modification.

Brine Sampling

Methods

In order to sample dissolved CO_2 in brine, sackholes were drilled by coring down to a desired depth without breaking through to the ocean interface. These holes were capped with an insulating barrier to prevent gas exchange, and left at least 6 hours to accumulate brine. Initially, we attempted to sample the brines in situ, using a portable pCO_2 system. Unfortunately, we had problems with the sample lines freezing, and as a solution we were forced to collect the brine in glass jars. The sampling was done with a syringe and surgical tubing, being careful to avoid injection of bubbles. The jars were sealed with greased glass stoppers to prevent gas exchange. The jars were returned to the ship where they were sampled immediately using the portable pCO_2 system (Figure 2.4).

The portable pCO_2 system cycles water through a membrane contractor (LiquiCel ® minimodule) and subsequently passes the equilibrated gas through a LI-820 gas analyzer in a closed loop. In order to allow the system time to equilibrate, the water was cycled through the glass jar, and left to run for at least 30 minutes. Although this certainly allows some gas exchange, it is a desirable method because the amount of gas exchange can be quantified to a certain degree. The pCO_2 system also measures water temperature as it passes through the equilibrator, but as a check on this system a temperature probe was inserted into the bottle and temperature in the bottle was measured at regular intervals. These temperature measurements will be important when analyzing the data, since perturbations in temperature from the in situ state likely have an effect on the carbonate equilibrium.

Figure 2.4: Sampling set up for brine pCO_2. In later instances the bottle was kept at a lower temperature by working in an ice bath, or a cool room. The bottle top was capped with parafilm to limit gas exchange.

Sample Dates/Locations

Table 2.2: Deployment date/location for brine sampling. All times/dates UTC.

Station	Sample Date	Notes
D4	Dec. 7	-2 samples at 20cm
D4	Dec. 8	-2 samples at 20cm
D7	Dec. 13	-1 sample at 20cm, 1 sample at 40cm
D7	Dec. 16	-1 sample at 20cm, 1 sample at 40cm

Sample Data
Figure 2.5 shows raw data from one pCO_2 brine sample. There is a clear period of time when CO_2 is increasing as the gas stream equilibrates with the water sample. After this, the sample appears to degass. From this information, we can probably make a reasonable estimate of dissolved CO_2 in brine.

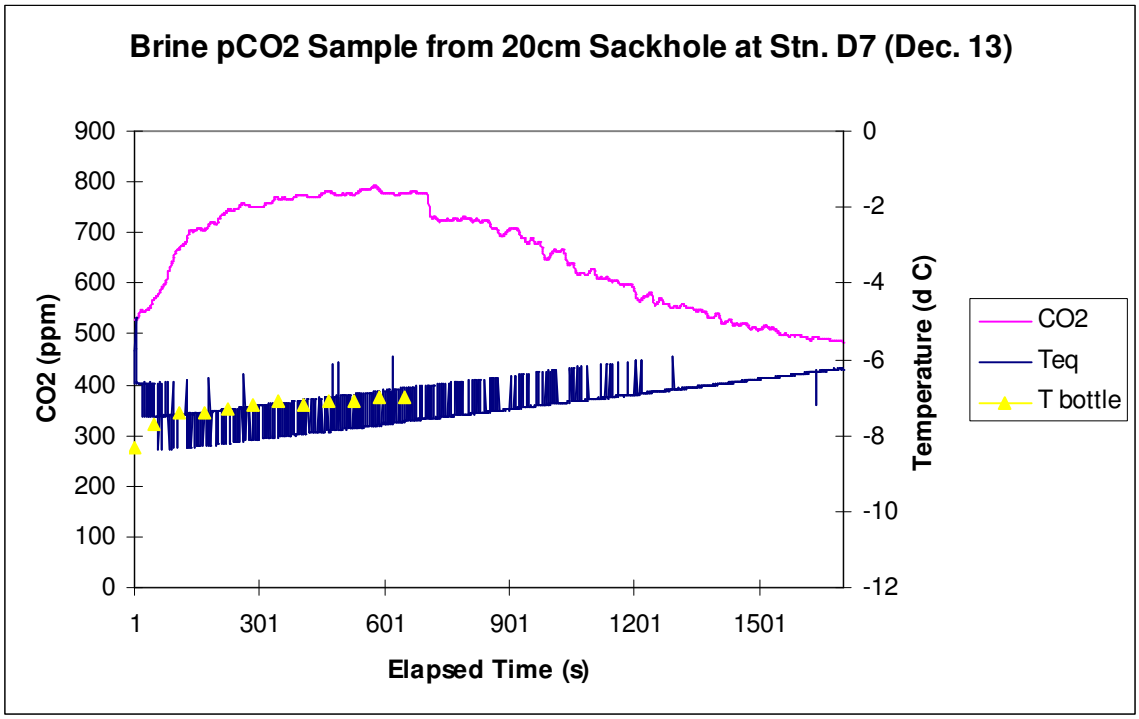


Figure 2.5: Raw data from one brine sampling experiment. Teq is the water temperature recorded by the pCO_2 system, and T bottle is the temperature manually recorded using the temperature probe.

Notes
It is unclear at this time exactly how to interpret the data obtained using this collection method (see Figure 2.5). In situ sampling would generally be more desireable, however the method of cycling the brine through the gas analyzer and back into a sackhole would likely be just as problematic with respect to changes in temperature and gas exchange. In fact, the volume of water collected in a single shallow brine hole can be considerably less than the jars, in which case gas exchange could be an even bigger problem. Further refinements of this method are probably necessary in future legs to ensure reliable data is collected.

Flux Chamber

Methods
When measuring fluxes of CO_2 with the eddy covariance system, there is always some ambiguity regarding the "footprint" of the measurement. This is a problem when dealing with a highly spatially variable icescape such as the one encountered in Leg 4. To resolve some of this ambiguity, a flux chamber was deployed over certain ice types to directly measure the flux of CO_2.

The flux chamber is a sealed cylinder connected the LI-820 gas analyzer used in the peeper and brine experiments (Figure 2.6). Gas is continually cycled through the chamber and the analyzer in a closed loop, and measurements are recorded every 20 seconds on the CR10X datalogger. A small fan in the top of the flux chamber homogenizes the air to ensure that a gradient of CO_2 does not build up in the chamber. The theory of operation is quite simple – if the concentration of CO_2 in the chamber changes, a flux of CO_2 must be occurring related to the sea ice.

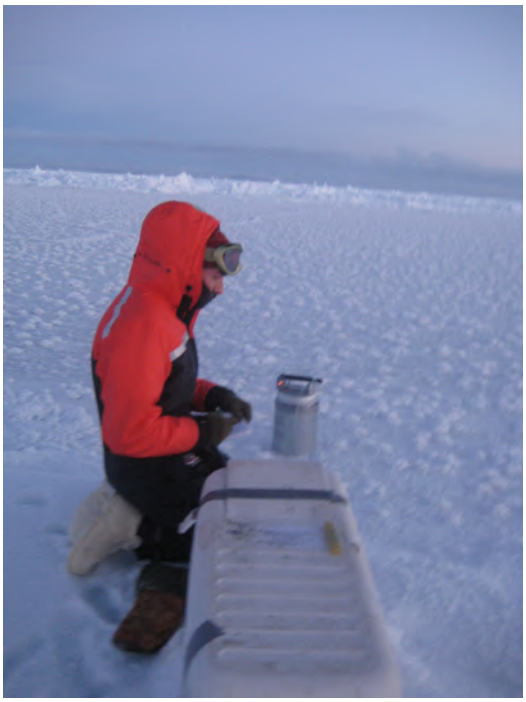


Figure 2.6: Deployment of the flux chamber. Gas analyzer is located in the white cooler.

Sample Dates and Locations

Table 2.3: Deployment dates and locations of flux chamber. All times UTC.

Station	Date/Time	Notes
D2	Nov. 30, 2000	-2 runs on frost flowers
D4	Dec. 2, 1800	-2 runs over frost flowers
D4	Dec. 3, 2300	-3 runs
D5	Dec. 7, 1745	-1 run, poor data results (contaminated?)
D7	Dec. 13, 1656	-3 runs over 55cm FYI

Sample Data

Figure 2.7 shows sample data from a run at station D7 over one hour. There does not appear to be any trend in the data, with CO_2 concentrations varying within 1ppm. This indicates no exchange of CO_2 with the ice. Although all of the data has not been processed, it appears that no fluxes were recorded with this method during the Leg 4 cruise.

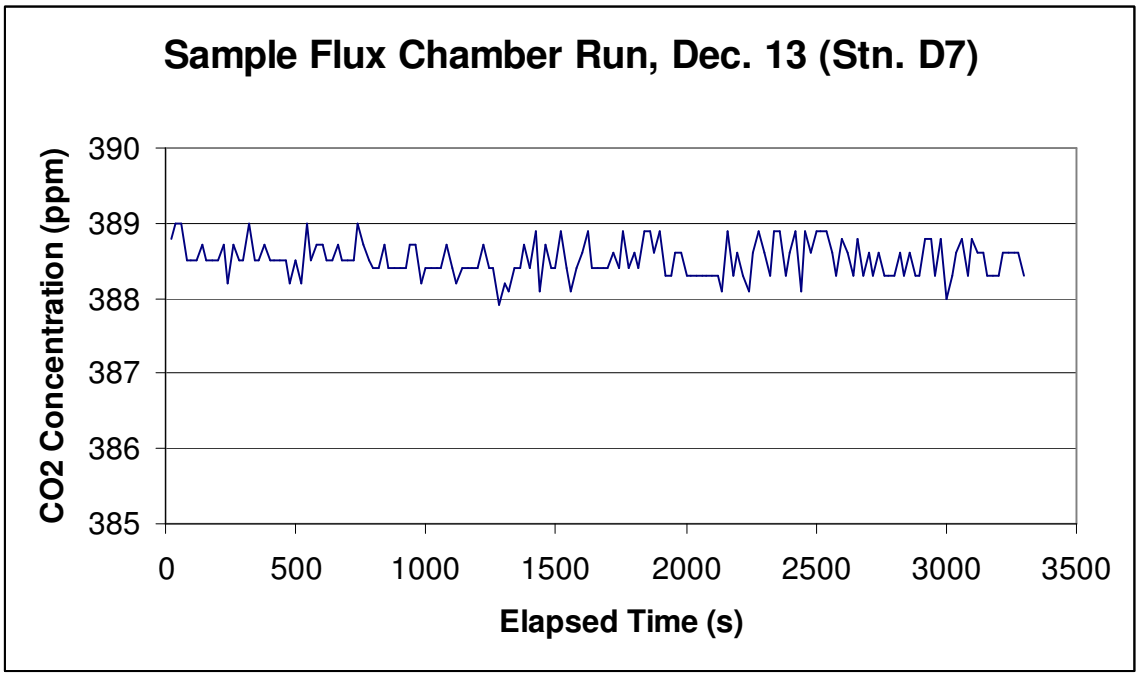


Figure 2.7: Sample flux chamber data over new first year sea ice (approx. 55cm thick).

Flux Chamber Notes
The flux chamber was a fairly reliable piece of equipment during this cruise. In the future, attempts should be made to take measurements over very thin (5-10cm ice) to assess whether fluxes of CO_2 occur over newly growing ice.

2.4.3. Dimethyl Sulphur (DMS) Project

Gauthier Carnat

Introduction
The fieldtrip was conducted during the three weeks of leg CFL 4B as member of Team 6 (gas fluxes). I was the representative of the Belgian team leaded by Dr. Jean-Louis Tison (U.L.B. university, Brussels) and Dr. Bruno Delille (U.L.G. university, Liège) for this leg, the first one we were on. Some other scientists will continue the same work during the next legs until leg 8B.

This fieldtrip was done for a PhD research purpose in University of Manitoba with Dr. Tim Papakyriakou as advisor.

Aim of the study
As a sea ice biogeochemistry team, our main goal is to conduct a study of a various set of biogeochemical variables during the whole CFL experiment (Fig. 3.1.).

Fig. 3.1 List of Variables

List of Variables
Temperature
Salinity
DO18
Thin Sections
DMS,P,O
Total gas content
O2, N2, CH4, Ar, CO2

Nutrients
Chla
Iron and TM

The interest of doing this is double. Firstly, it will give us a good idea of the evolution of these variables through one complete cycle of sea ice growth and melting in a very specific area. Secondly, we will have at the end of the experiment a background of understanding for gases dynamics inside sea ice (minor and major driving factors) with modelling perspectives.

For my own personal project, I was focusing on two climatic effect gases and their dynamics in the sea ice system.

The first one is the carbon dioxide, in close collaboration with Brent Else and Nes Sutherland.

The second one is Dimethylsulfur and related compounds (Dimethylsulphoniopropionate and Dimethylsulfoxyde).

This involves concentration profiles in ice, water and brines and some fluxes measurements as well.

Material and methods

Field measurements

During this early stage of ice formation, our objective was to sample different types of ice at different spots, giving us a spatial and ice type variability. On the other hand, the separation of the measurements inside the three weeks gave us an idea of temporal variability. This one will be reinforced by the next leg's experiments.

We separated our work in main stations (complete set of variables) and punctual sporadic stations (specific set of variables). The next figure gives a description of the stations done.

Fig. 3.2 List of stations

Date	**Type of station**	**Comments**
11/28/2007	Complete	
11/29/2007	Punctual	Pancake Ice (DMS,P,O measurements)
11/30/2007	Punctual	40 cm new ice with frost flowers (Bell measurements)
12/02/2007	Punctual	30 cm new ice with frost flowers (Brines uptake)
12/03/2007	Complete	
12/06/2007	Complete	

On each station we delimitated a clean working area and organized our sampling around three main activities:

1) Ice sampling: we took 11 ice cores for each complete station, using a 7.5 cm diameter corer. The cores have the size of the ice thickness of the considered spot they were taken in. Each core is dedicated to 1 variable or group of variables. A short description of each core (cracks in the core) was made on the field. Most of these 55 cores will be sent back to Winnipeg or Belgium for further analysis.

   Using a temperature probe and a drill, we measured the temperature of the ice on the first core taken on each site every 5 cm starting from 2.5 cm of the surface. In order to have a spatial

coherence, this 5 cm resolution will be used for all the variables measurements. The same first core was then cut in 5 cm pieces and put in Tupperware's to measure salinity back on the ship.

In addition, 15 cores were directly cut on the ship for direct analysis. This concerns the most sensitive variables, subject to quick changes in time.

2) Brine sampling: depending on the ice thickness, we drilled several brine holes as close as possible to the coring site, using a 20 cm spatial resolution. The brine holes were usually drilled in the morning and sampled in the afternoon to give time to the brines to fill the hole. To avoid any gas exchange with the atmosphere, we covered the holes with Styrofoam insulation. Using a small pump or syringes, the brine was pumped out and put in vials for analysis.

3) Water sampling: the water at the sea/ice interface (called 0 m water) was sampled by the use of a pump and weights.

In addition, general observations were made on the field including temperature measurements, freeboard measurements and snow thickness. The next figure shows an example of those observations for one station.

Fig. 3.3. General observations on the field for one station

Variable	Value
Snow Cover (cm)	1.5, new snow
Average Ice Thickness (cm)	60
Freeboard (cm)	5, no flooding
Air Temperature (°C)	-15.5
Snow Temperature (°C)	-14.5
Snow/Ice Interface Temperature (°C)	-14
Water Temperature (°C)	-1.5
Brine Temperature at 20 cm depth (°C)	-10.5
Brine Temperature at 40 cm depth (°C)	-7.8

Post-field analysis

Here below is a list of the variables measured on the ship.

Salinity and DO18

Using a calibrated salinity probe and Tupperware containers filled with ice cut in the field and melted on the ship, we measured the salinity of approximately 50 samples, which represents a spatial resolution of 5 cm for each station. The same water was then used to fill in small DO18 vials for further analysis.

Nutrients and Chl_a

With the help of Kyle Simpson, we did approximately 200 nutrients samples. This represents measurements of NO_2, NO_3, Si and PO_4 at a spatial resolution of 5 cm.

With the help of Dr. Célia Marrasé, the Chl_a level was measured for each station. Considering the low Chl_a levels usually observed in the ice during this time of year (very low light input), we decided to filter melted ice for every 15 cm instead of the usual 5 cm spatial resolution. This represents a total amount of 15 measurements.

DMS, DMSP, DMSO

Using an ice crusher, Dr. Maurice Levasseur's "purge and trap system" and a gas chromatographer, we extracted the DMS from the ice and measured the total amount of DMS at a spatial resolution of 5 cm, for a total of 50 samples. The system was calibrated three times during the whole experiment by using a permeation oven which sends a specific concentration of DMS to the gas chromatographer. Here below is a picture of the ice crusher and of the "purge and trap system" used. In addition, Fig. 3.4. shows the three calibration curves obtained.

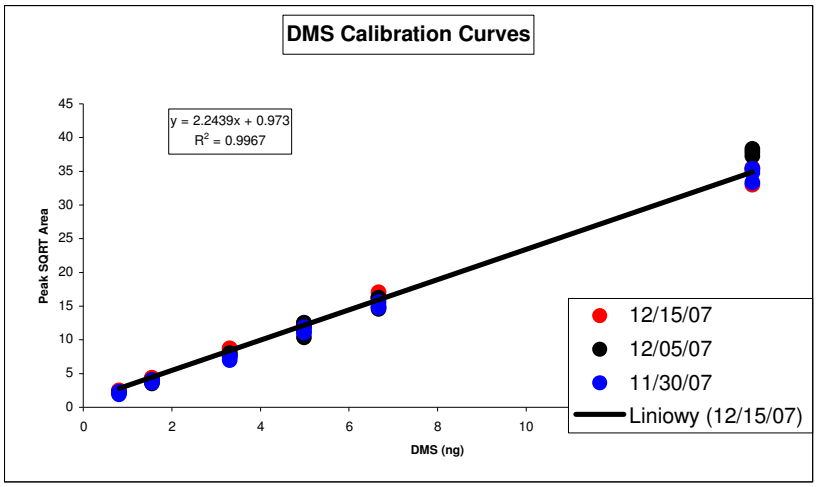


Fig. 3.4. DMS Calibration Curves

By addition of NaOH pellets to the crushed ice, we turned DMSP into DMS and measured 50 concentrations of DMSP. Some ice was also stored in 20 ml vials for DMSO measurements in Belgium.

We measured also DMS and DMSP concentration in brines and 0 m seawater. We've tried to measure levels of DMS in the air just under frost flowers with syringe uptake as well.

Finally, DMS and DMSP levels were measured in two pancakes.

In total, more than 200 samples of ice, water and brines were analyzed.

Other Variables

Additional studies will be undertaken in Brussels or Winnipeg later this year, when the cores come back from the Arctic.

Sample Data

As an example, we show some results and profiles obtained during the cruise.

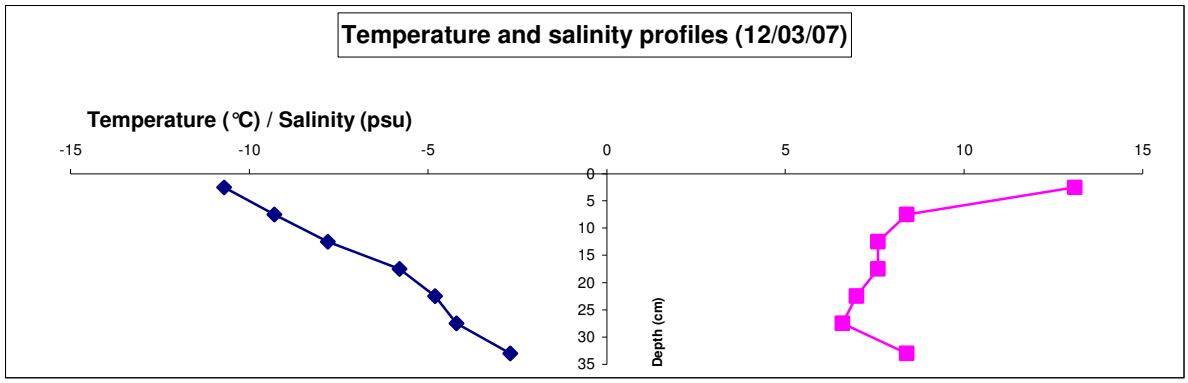


Fig. 4.5. Temperature and salinity profiles for station 12/03/07

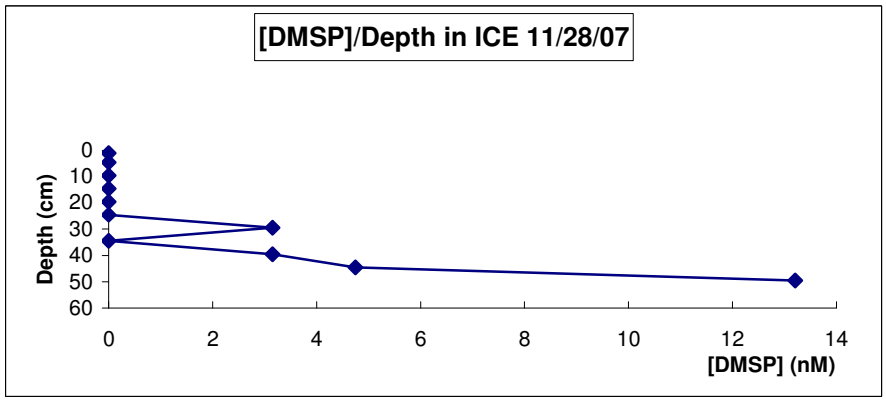


Fig. 4.6. DMSP profile for station 11/28/07

4.6.4 Dissolved Inorganic Carbon (DIC)/Alkalinity Project

Nes Sutherland

Ice Cores and Surface Water Sampling

The study of transfer of carbon through seawater ice is a relatively new field, unfolding over the past five years or so, when it was discovered that seawater ice could actually be permeable to gas exchange, unlike freshwater ice. One tool for studying gas flux is to look at the cores themselves, measuring Dissolved Inorganic Carbon (DIC) and alkalinity in sections throughout the core depth, as well as salinity and temperature for each section. The dynamics of gas flux in the water immediately under the surface is also of interest, as here brines drain out as new ice forms.

This leg was the first one where ice was studied for carbon flux on the Amundsen CFL-IPY cruise, and it was a most interesting period of time to do so, as it was possible to sample ice at almost every stage of development. Some problems were however encountered in attempting to sample young ice, as it was difficult to hold the ship positioned in windy conditions resulting in it drifting over and pushing up layers of ice in the sampling area. As well, work from the cage allowed for minimal manoeuvrability, with it or its door having a tendency to swing. Then there was the risk of the cage dipping into the water! The ideal boat would be the skippy boat, but it was not always available, also due to weather, darkness, the ship being underway, or engine problems…

For roughly the first four weeks of this leg the ship was transiting the area of Franklin Bay, through Amundsen Gulf and up the west side of Banks Island, and back again to the drift site, where the latter two weeks were spent. This resulted in constant sampling of ice cores during the first part, where the many ice types were encountered. Due to the short time at each station it was not possible to sample

for the other carbon flux parameters – brines and peepers, and flux chambers. When finally settled into drift sites, these other parameters could be measured as well, and will eventually be compiled with core data to study the relationship between the different methods.

At each station a team of scientists would be on the ice, sampling various parameters from temperature to microstructure, salinity, biology, and light transmission, as well as carbon. Some of these measurements were intended to be shared amongst the groups, in order to save time and effort in the field. For carbon coring, a minimum of two cores of ~4" diameter were cut at each site, sectioned and bagged in the field to minimize brine loss. In order to focus on the more carbon-active sites, the upper parts of the cores were cut into 0-5, 5-10, and 10-15cm sections, followed by 10cm lengths, with the bottom 5 cm as its own section. Unfortunately it is necessary to have a minimum of 8cm, preferably 10cm, of core length to obtain enough water for filling a DIC/alkalinity bottle, with some remaining for salinity analysis by a handheld conductivity meter. Therefore, the 5 cm lengths were combined in one bag, but the 10 cm sections were individually bagged, and provide a set of duplicates. At some stations snow and frost flowers were also scraped off the surface and into bags. The bags used were Tedlar bags, gas impermeable, with a clamp type seal and small spigot for withdrawing air or water. These bags, although a bit difficult to close when very cold, were very convenient for removing air for melting the core in a relatively air free enclosure – a very small amount of air was always present.

After the cores were processed, surface water samples were taken for DIC/alkalinity, pH and salinity, using a small pond pump. Where possible, water was sampled from just under the surface of water in the core hole, at approximately the bottom of the ice hole, and in the water column, ~1m and ~2m. Not all of these depths were regularly sampled, as sometimes the tubing would freeze. A handheld temperature probe was used for surface temperature, but a portable CTD would have been useful for the other depths.

Back at the lab, the core sections were laid out to thaw, then transferred to DIC bottles, and the remainder saved for the conductivity measurements. For the water samples, the pH's were analysed at 25C using a phenol red and m-cresol purple dye method on a HP8543 spectrophotometer. The DIC bottles were pickled with HgCl and clipped or taped shut. Ideally this would be done in the field, but the HgCl would quickly freeze.

When enough samples were collected, a batch of DIC would be run on the VINDTA 3C – in all about 9 analysis days and 300 samples, running from 12-20 hours at a time. Alkalinities would follow on the TIM 865 Radiometer , with samples sorted by salinity. Two programs were used – one geared for normal seawater, and the other for ice. Further modifications were made to cover very low salinity from multiyear ice, and very high saline brine samples. Unfortunately samples with salinities of less than 2ppth still could not be read. Andrew Dixon Certified Reference Material, Batch 81, was used to calibrate both the VINDTA and the TIM 865, preparing dilutions with Milli-Q water where required for ice samples.

The following table provides a list of stations and cores.

Station	Date	Ice Type	Core Depths (cm) #1	#2	Water	Comments
SH	141107	Core	36	36	3 depths, DIC,pH,sal	SH= Summer Harbour, sampled as a warm up run Bad weather preventing travel to real stations

In open water from ship passage:						
		Slush	0-5		2xpH, 1xDIC	Slush water collected by skippy boat
		Chunk	10			New ice at edge of hole
						Spur of the moment collection, make do gear
1117-N	151107	Snow				N=Night core
		Core	34	35		
1117-D	161107	Snow				D=Day Core
		Core	34	34	3 depths, DIC,pH,sal	
405	191107	FrostFlower				
		Core	45	45	4 depths, DIC,pH,sal	
1100	201107	Pancakes	3-5		4 depths, DIC,pH,sal	sampling from ice cage
		Slush			separate slush/brine	slush from broken pancakes?
437	221107	Frost/snow				
		Core	55	56	1 depth, DIC,pH,sal	
1825	241107	Snow - 2depths				Multiyear Ice Hummock
						Did not core to water - one hummock was 3.3m deep
		Core	100	10		
		Core	66			Multiyear Ice Meltpond
1820	241107	FrostFlower				
		Core	26	26	6 depths, DIC,pH,sal	

1812	251107	FrostFlower				
		Core	31	31	5 depths, DIC,pH,sal	
420N	261107					Only random frost flowers, not collected
		Chunks	9		3 depths, DIC,pH,sal	Ice cage sampling-**N**es
420D	261107	Chunks	6		separate slush/brine	Further along EM transect **D**ustin collected
D1	281107	Snow				
		Core	53	53	4 depths, DIC,pH,sal	
?	291107	Pancakes	4-5		4 depths, DIC,pH,sal	
?	291107	Pancakes	4-5		2 depths, DIC,pH,sal separate slush/brine	**D**ustin/Nes Dunk Cage
D4	021207	FrostFlower				
		Core	34	34	4 depths, DIC,pH,sal	
?	041207	Pancakes (consolidated)	26	26	4 depths, DIC,pH,sal	Core 1 centered in pancake, 2nd one along edge
D5	051207	Chunk	15cm			Sampled from Skippy away from ship, beside natural hole in ice
	061207	Core 1	62			Near crack in ice, not sampled
		Core 2	37	37	3 depths, DIC,pH,sal	~5m from above
	071207	Chunk Chunk	15 8		2 depths, DIC,pH,sal	Edge of Seal Hole
	071207	Core	10			Used cores from sac

						holes for reps
D6						Not sampled
D7	121207	Snow Core	57	57		
	131207				4 depths, DIC,pH,sal	
	141207	Core	63	63		
D8	161207	Chunk Core Surface skim	~11 5 layers of ~10.5cm ~2cm		1 depth, DIC,sal	Ice cage in polynia - at edge of ice layers were naturally overlapping

Rosette Water Sampling

To complete the carbon picture, tying in surface processes with biogeochemical cycling of deep water, DIC, alkalinity and pH samples were also drawn from the rosette at each station, see Table 2. Bottle integrity was first checked by undoing upper vent to test lower seal, then with it closed again, the spigot was opened to see if it leaked. Sampling followed, using established protocols. In general, unless oxygen samples were also drawn, DIC sampling, followed by pH, was done first, to avoid contamination from air. Samples were spiked with 200uL HgCl, and stored in the cold room. Because of the heavy load from ice coring, the water samples were unfortunately not analysed. pH was sampled as described in surface water sampling above.

The following table provides a list of stations and rosette samples.

Station	Date	Cast ID	Samples taken	Comments
1117	151107	005	DIC & Alk, pH	
405	191107	006	DIC & Alk, pH	Bottle 11:poor lower seal
1100	201107	009	DIC & Alk, pH	Bottle 9:poor lower seal
437	221107	017	DIC & Alk, pH	Bottles 6,16, 19:poor lower seal, leaking
1825			No Rosette	Multiyear Ice
1820	251107	019	DIC & Alk, pH	Bottles 11,14:poor lower seal
1812	251107	020	DIC & Alk, pH	Bottles 5,9,11:poor lower seal; Bottle 14 almost empty Oxygen sampled first
420				No Rosette, moonpool clogged with ice, no time to thaw

D1	281107	023 (labelled as 022)	DIC & Alk, pH	Bottle 9:poor lower seal Cast 22 rejected for nutrients due to high welding smoke levels
D4	021207	026	DIC & Alk, pH	Bottles 5,9,14:poor lower seal
D5	041207	029	DIC & Alk, pH	Bottle 22:poor lower seal; bottle 18, spigot leaked
D6				No Rosette
D7	101207	054	DIC & Alk, pH	
D8				Bottles not properly closed due to time constraints Ship returned to Stn D7, but suddenly sent on its way to Sachs Hrbr, without time for a water property cast

2.5. Team 7

2.5.1. Carbon & nutrients fluxes

PI: Jean-Éric Tremblay (Laval University)
Participant: Kyle Simpson (McGill / Laval University)

Rationale
The Arctic climate displays high inter-annual variability and decadal oscillations that modulate growth conditions for marine primary producers. Much deeper perturbations recently became evident in conjunction with globally rising CO2 levels and temperatures (ACIA 2004; Comiso 2003). The thickness and extent of Arctic sea-ice decrease rapidly (Johannessen et al. 1999; Rothrock et al. 1999) and the ice-free season is extending both in the Arctic (Laxon et al. 2003) and subarctic (Stabeno & Overland 2001). Models predict further reductions in ice cover (ACIA 2004). These changes entail a greater penetration of light into surface waters, which is expected to bolster phytoplankton production (Rysgaard et al. 1999), food web productivity and CO2 drawdown by the ocean. At present, phytoplankton production varies by two orders of magnitude across the Canadian Arctic, but the forcing mechanisms are poorly understood and quantified. In the Canadian Archipelago, the productivity of phytoplankton is likely to be limited by light or the supply of allochtonous nitrogen, depending on ice conditions. The supply of allochtonous nitrogen is influenced by climate-driven processes, mainly the large-scale circulation, river discharge, upwelling and regional mixing processes. Over most of the western Arctic, and especially the Beaufort Sea, the concentrations of inorganic nitrogen (i.e. nitrate, nitrite and ammonia) at surface remain low throughout the year and the phytoplankton possibly depend on local recycling and the dissolved organic nitrogen (DON; e.g. urea, amino acids and primary amines) supplied by rivers. A large portion of the phytoplankton biomass is typically located within subsurface chlorophyll maxima (SCM). SCM productivity is possibly in balance with the episodic supply of nitrate across the halocline and/or the supply of ammonium and nitrate by local recycling and nitrification, respectively. Despite the importance of SCM for the food web and CO2 fluxes, little is known about their structure, turnover and susceptibility to environmental variability and change.

Objectives
The main goals of team 7 (nutrients) for CFL were to:
(1) Establish the horizontal and vertical distributions of phytoplankton nutrients and the influence of different processes (e.g. mixing, upwelling and biological processes) on these distributions, with emphasis on the CFL over-wintering "drift area"
(2) Process and analyze the backlog of samples acquired during the final legs of ArcticNET and the previous legs of CFL
(3) Experimentally assess the production of nitrite (nitrification) by bacteria

Methods
Samples for inorganic nutrients (ammonium, nitrite, nitrate, orthophosphate and orthosilicic acid) were taken at all rosette stations (see Table 1) to establish detailed vertical profiles. Additional samples for dissolved organic nitrogen (DON), dissolved organic carbon (DOC) and urea were taken at the same stations. Ammonium was determined immediately after collection using modifications of the manual fluorometric method (e.g. Holmes et al. 1999). Urea samples were analyzed immediately and DON/DOC samples were preserved with acid and stored in the dark at 4°C for post-cruise determination. The concentrations of nitrate, nitrite, orthophosphate and orthosilicic acid were determined on fresh samples using an Autoanalyzer-3 (Bran+Luebbe) with colorimetric methods adapted from Grasshof (1999).

Incubation temperature (nitrification experiment) was maintained at *in situ* levels with a chilling circulator. Samples from all modules were spiked with 13C-bicarbonate; modules received saturating additions of, ^{15}N-ammonium, one of two inhibitors and were incubated in either dark or light conditions. Samples for nitrite concentration were collected at 6hr intervals for the determination of utilization/production kinetics. Incubations were terminated by filtration onto 24-mm 0.2µm silver filters. All filters were desiccated at 55°C and stored dry for post-cruise determination of isotopic enrichment and particulate organic carbon and nitrogen.

Samples taken
All Stations were sampled for nutrients in the water column. (see rosette log)
Surface water, and water under the surface of the ice was sampled when available.
Ice samples were also processed.

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2.5.2. Molecular Microbial Biodiversity

Participant: Pierre Galand (Connie Lovejoy's group), Québec Océan, Département de Biologie, Université Laval, Québec

Introduction and cruise objectives
Microorganisms, including bacteria, archaea, viruses and micro-algae, were until recently very difficult to describe. Their distribution and role in the sea was unknown due to their small size and the

difficulty in isolating and culturing them. With the development of molecular tools targeting the DNA of those organisms, we are now able to uncover functionally diverse microbial communities within the Oceans.

Our first objective was to collect microbial DNA and ancillary data from the Amundsen Golf and Beaufort Sea to detect possible interannual variability at stations sampled earlier and to compare the microbial diversity between those different regions.

Our Second objective was to obtain RNA samples from the same sites to investigate expression of key genes during the winter and under different oceanographic conditions. Our initial work in this area will be to compare diversity, relative abundance and expression of bacteria and archaea AmoA genes. This gene is expressed during nitrification of (ammonia towards nitrate) and codes for a key nitrogen cycling enzyme in the world ocean.

Our third objective was to conduct short term experiments aboard the vessel to enlarge our understanding of the active microbial processes taking place during the winter season. In particular we used a technique known as Stable Isotope Probing (SIP), where flow of carbon through active microbial communities can be studied with the incorporation of stable isotopically labeled substrates into biomass and subsequent identification of the microorganisms actively incorporating the label.

Sampling

We sampled on an opportunity basis throughout the Amundsen Golf and the Beaufort Sea (coast of Banks Island). The comparison of samples gathered during the different wintering legs will allow a better understanding of the seasonal dynamic and the comparison of the different geographical areas will provide valuable information on the diversity and depth distributions of microbes.

In total we sampled 12 stations (Table 1), where a total of 10 variables were collected (Table 2). Our sampling strategy was to obtain microbial DNA and other biological data from specific water masses through the water column with a special focus on the nitricline, the upper mixed layer, the Chlorophyll maximum and deep temperature maxima and minima. Those biologically significant features were identified during the downcast of the CTD. In addition to temperature and salinity, our sampling choices were based on readouts from the oxygen, nitrate, fluorescence, transmissometer and ph probes.

Table 1. Stations sampled for our DNA group.

MMBOAS Stn	Cast nb	Station Name	Date	nb depths	Latitude (north)	Longitude (west)
Franklin Bay	4	1117	16/11/2007	2	69º 52.104	-126º30.031
Amundsen Golf	7	405	19/11/2007	4	70º 137.302	-123º 0.085
Amundsen Golf	8	1100	19/11/2007	4	071º 2.232	-123º 15.112
Beaufort Sea	18	437	22/11/07	4	071º 43.618	-126º 43.108
Beaufort Sea	19	1820	25/11/07	4	073º 43.745	-127º 18.16
Beaufort Sea	20	1812	26/11/07	4	073º 2.555	-127º 24.566
Amundsen Golf	21	2007-1D	28/11/07	4	070º 25.854	-126º 27.444
Amundsen Golf	25	2007-4D	2/12/2007	4	71º43.931	-125º 33.796
Amundsen Golf	50	2007-5D	7/12/2007	4	071º 18.83	-124º 47.263
Amundsen Golf	53	2007-7D	10/12/2007	4	71º15.973	-125º15.328
Amundsen Golf	81	2007-7D	13/12/2007	1	71º26.678	-125º56.482
Amundsen Golf	102	2007-8D	16/12/2007	4	71º28.45	-126º18.87

Sampling was aimed at obtaining microbial DNA and RNA along with biomass and taxonomic information. All variables were sampled using standard techniques.

Table 2. Variables and number of samples taken.

Type of Sample	number of samples
DNA (<3um)	43
DNA (>3um)	43
RNA (<3um)	42
RNA (>3um)	42
Chl a T	43
Chl a (<3um)	43
HPLC Total	19
HPLC (<3um)	19
FISH B & A	4
FISH Eukaryotes	4

Abbreviations and explanations follow: Chlorphyll *a* (Chl a), pigment analysis by high pressure liquid chromatography (HPLC). Fluorescence in situ hybridization (FISH) will be applied to Bacteria, Archaea and eukaryotes (FISH B & A and FISH Eukaryotes, respectively).

Experimental program

SIP (Stable Isotope Probing)

SIP is an elegant tool to resolve the linkage between the structure of populations and their function in an ecosystem. The principal rely on the addition of labelled substrate highly enriched in stable isotopes, such as ^{13}C, to an environmental sample. The denser isotopes are incorporated in the nucleic acids deoxyribose backbone of the organisms utilising the labelled substrate as growth substrate. The denser DNA or RNA is then separated from the light one (non labelled) by caesium chloride (CsCl) density-gradient centrifugation. Finally, once ^{13}C -DNA has been isolated, it can be analysed by various molecular methods allowing the phylogenetic identification of the organisms which assimilated the labelled substrate.

On board, incubations with ^{13}C – bicarbonate were carried out to study the flow of carbon during winter time. Surface water was incubated with the presence ^{13}C – bicarbonate. And incubations were placed in the dark to simulate winter darkness. Over a five weeks period duplicate bottles were periodically filtered for DNA and microscope analysis. The results should provide information on species specific interactions in the flow of carbon through the microbial community.

Results

Since it is currently not feasible to analyse DNA or RNA on board the ship, results of the DNA and RNA surveys will be known only after extensive laboratory work on shore.

Acknowledgements

The cruise was a success and we are grateful to the Chief Scientist, Captain and crew of the Amundsen. We would like to thank M-É Rail and H. Drouin for CTD Rosette operations, S. Blondeau for technical assistance and K. Simpson for nutrient analysis.

2.5.3. Marine Molecular Microbiology Group

Participant: Cèlia Marrasé (Carlos Pedros-Alio's group), Institut de Ciències del Mar (CSIC) – Barcelona, Spain

Our objective is to find empirical relationships between the physical and chemical variables and the diversity and function of the microbes. We are also carrying out this type of study in areas of the Mediterranean and Antarctic seas, and Atlantic Ocean.

Here in the Arctic, the distinctive factors are: the lack of light during part of the year, the low temperatures and the ice cover. Comparing the species composition and activities of microbial communities in systems with diverse chemical and physical regimes is a good way to learn more about the importance of the different forces that determine how microbes use organic and inorganic matter and how this influences other components of the food web. This knowledge is needed to better predict the consequences of natural or anthropogenic changes on these trophic dynamics – or in other words, on the biological production of the system. This will also help us to evaluate the system's ability to buffer these changes at short and long time scales.

During Leg 4 water samples for different biological and chemical analyses were taken: dissolved organic carbon, amino acids, carbohydrates, f-DOM, chlorophyll, FISH Eukaryotes, nanoflagellates, virus, and ciliates. We also performed incubations to quantify bacterivory, and virus diversity and production. I summarized the number of samples and stations in Table1.

Finally I want to thank the Chief Scientists and the Capitan for facilitating our sampling wishes, and to all the crew for being so nice and helpful. They made possible an excellent atmosphere.

Table 1

Stations and Samples taken by ICM Leg 4, X followed by number of depths sampled. ST No=Station number, Chl a, total and<3µm Chlorophyll.

The the complete cast number is 0707 - followed by 3 diget cast number (0707 XXX), from this information the UTC, Lat and Long of all samples can be traced.

Leg	Date	STNo	Cast	Chl a	Citometry, virus	EpiFluor HNF	Ciliates	FISH eucario	Bactivory	virus diversity	viral burst size	viral production	AA, CH, FDOM	DOC	Total phophorus	Investigador
4	16-Nov-07	1117	707004	2	2	2		2								C. Marrase
	19-Nov-07	405	707007	6	6	6	6	5	GR-1						6	
	19-Nov-07	1100	707008	6	6	6		5								
	22-Nov-07	437	707017	6	6	6		5								
	25-Nov-07	1820	707019	6	6	6		5								
	25-Nov-07	1812	707020	6	6	6		5								
	28-Nov-07	D1	707021	6	6	6		5								
	02-Dec-07	D4	707025	6	6	6	6	5	GR-2							
	07-Dec-07	D5	707050	6	6	6	6	5	GR-3	V1	1	1				
	10-Dec-07	D7	707053	7	7	7		6					7	7		
	13-Dec-07	D7	707081	1	1	1		1								
	13-Dec-07	D8	707102	7	7	7		6						7		

2.5.4. Bacterial Processes

PI: Roxane Maranger
Participant: Gabriel Maltais-Landry

Scientific Objectives CFL: As part of team 7, the goals of this team are to measure bacterial C production, community respiration (directly and via ETS activity) and bacterial biomass, in order to elucidate the role of bacteria in ecosystem C processing. Another objective for CFL will be to measure N_2O concentrations in the water column to understand whether this by-product of nitrification and denitrification accumulates at a measurable rate in this system.

Objectives Leg 4: The main objectives were to start sampling on a regular basis and adjust method if need be. Priority was given to the future drift site, but measurements were carried out at several stations outside of this area. Supplementary measurements (bacterial production in melted ice and in water used in grazing experiments) were also carried out.

Bacterial production

- Bacterial production rates were measured using the leucine incorporation method (^{3}H labelled leucine) with 4 hours of incubation at 2°C. Rates of incorporation of radio labelled leucine were then converted into rates of C production.
- Bacterial production rates in the water are low but measurable.

- Bacterial production in the ice seems negligible, at least in the cores we sampled on this leg. Future measurements should be carried out in spring.
- Bacterial production doesn't seem to be significantly impacted by 48 hours of incubation at 2°C.
- Bacterial production rates seem higher near Sachs Harbour (stations 437, D4) and lower at the northwest of Banks island (stations 1812, 1820) than at the other sites (1117, 405, D1, D7, D8).

Bacterial respiration

- Bacterial/community respiration rates were measured using the FIBOX, which measures O_2 depletion in time using sensors glued to the bottom of 500ml Erlenmeyers. The consumption of O_2 in time can be converted in CO_2 production to compare C respiration rate to bacterial C production rate.
- Respiration using the Fibox is difficult when the ship is moving because of sensor alignment problems. However, during the second part of the leg, when the ship was more stable, measurements were carried out with relative success.
- Incubations are pretty long (> 14 days) and instability in cold room temperature can have adverse impacts on measurements. However, chamber temperature stability problems and set up of incubating coolers seem to be okay for now.
- Respiration rates are higher in the surface (10m) than deeper in the water column. In deeper depths, rates are sometimes not measurable. We have too little data on spatial variability for now to state on differences between stations.

ETS

- Due to really low respiration rates in Arctic waters, a back-up method was also employed to obtain respiration rate surrogates via ETS (Electron transport system activity). This is achieved by filtering a large quantity (8L-10L) of water on GF/F filters to collect live cells and freeze them (-80°C) as quick as possible. Back at the lab, we will defreeze these filters and subject the living cells to various enzymatic tests to measure activity.
- Due to the difficulties we have obtaining respiration rates at deeper depths, more efforts were given to ETS filtration as a back-up for respiration.
- Filtrations for ETS were carried out and the fine tuning of the filtration procedure was accomplished. Samples were put in cryovials in the -80C freezer for analysis back in Montreal when the ship gets back to Quebec City.

Bacterial abundance

- Bacterial abundance can be estimated by filtering a small volume of water (20ml) fixed with formaldehyde that has been stained with DAPI (bounds DNA). Slides are then frozen (-20°C) and counted for abundance using 20 random fields.
- Bacterial abundance filtration and slide making has started and the slides were made for all the stations monitored during the leg.
- Counting could not start because no grid was found onboard for the microscope. The slides are still inside the -20°C freezer in the aft labs.

N_2O

- Dissolved N_2O measurements were carried out using the headspace equilibration method with 1.1 L of seawater. 3 samples were taken from each bottle (depth) and will be analyzed at the lab for N_2O on an electron capture detector (GC).
- N_2O measurements were carried out more often than originally planned and the sampling method was refined to get 3 depths rather than 2 depths.
- The plan to do one intensive profile (6 depths) was abandoned due to the need to get out of the drift site quickly at the end of the leg.
- Samples were taken at the end of the leg for analysis (GC) in Montreal.

Sampling activities

Acronyms:
BP: Bacterial production
BR: bacterial/community respiration
ETS: Electron Transport System Activity
BA: Bacterial Abundance
N2O: Nitrous oxide, headspace gas exchange

2007/11/16
STN: 1117, Cast 5
BP, BA: 100, 50, 19.5, 17, 15, 10 m depth
ETS: 19.5, 0 m depth

2007/11/19
STN: 405, Cast 7
BP, BA: 500, 240, 120, 80, 40, 10 m depth
BR: 120, 80, 10 m depth
ETS: 120, 10 m depth
N_2O: 240, 80, 10 m depth

BP: water from 3 grazing experiments for Celia Marasse

2007/11/19
STN: 1100, Cast 8
BP, BA: 267, 100, 80, 60, 30, 10 m depth

2007/11/22
STN: 437, Cast 17
BP, BA: 415, 200, 100, 50, 30, 10 m depth

BP: 2 layers of ice cores from the team of Jody Deming

2007/11/25
STN 1820, Cast 19
BP, BA: 129, 100, 80, 60, 30, 10 m depth
N_2O: 100, 80, 30 m depth

2007/11/25
STN 1812, Cast 20
BP, BA: 167, 100, 70, 50, 40, 10 m depth

2007/11/28
STN D1, Cast 21
BP, BA: 277, 160, 100, 40, 20, 10 m depth
N_2O: 40, 20, 10 m depth

2007/12/02
STN D4, Cast 25
BP, BA: 233, 160, 90, 60, 40, 10 m depth
BR: 90, 60, 10 m depth
ETS: 90, 10 m depth
N_2O: 160, 60, 10 m depth

BP: water from 4 grazing experiments for Celia Marasse

2007/12/07
STN D5, Cast 50
BP, BA: 232, 170, 110, 70, 50, 10 m depth
N_2O: 170, 70, 10 m depth

2007/12/09
BP: water from 4 grazing experiments for Celia Marasse

2007/12/10
STN D7, Cast 53
BP, BA: 315, 190, 120, 80, 40, 10 m depth
BR: 120, 80, 10 m depth
ETS: 120, 10 m depth
N_2O: 120, 80, 10 m depth

Comparison for BP/BA with unfiltered vs. filtered (50 microns) water at 120 and 10 m depths.

2007/12/16
STN D8, Cast 102
BP, BA: 441, 200, 150, 100, 30, 10, 0 m depth
BR: 100, 10 m depth
ETS: 100, 10 m depth
N_2O: 200, 100, 10 m depth

0 m water was taken by K. Simpson outside. Volume was too small to carry out other measurements.

Other activities

2007/11/08 – 2007/11/15: inventory, lab setting up, waiting for ship to finish refuelling and board cargo.

2007/11/15 – 2007/12/18: help given to different teams for ice work, balloon launches and nutrient sampling at the rosette in addition to regular sampling activities.

2007/12/18 – 2007/12/20: lab (s) clean up, final wipe test, inventory of materials used, and filmmaking of protocols for future members of team 7.

2.6. Team 8

2.6.1. Organic contaminants

PI: Gary Stern (DFO, Freshwater Institute)
Participants: Bruno Rosenberg (DFO, Freshwater Institute)
Monika Pucko (PhD student, University of Manitoba)

Hexachlorocyclohexane (HCH)

Water sampling
Water (4L) was collected from the rosette at all full and basic stations. At the surface, a plastic bucket was used to collect the water. Where feasible, transects across water bodies were collected. In the lab, water was pumped through a glass-fiber filter followed by an ENV+ solid-phase extraction (SPE) cartridge using peristaltic pumps. On ArcticNet leg 3/CFL leg 1, we collected 29 profiles, usually

consisting of 9 depths, with the emphasis on the upper water column. Filters and cartridges are frozen and brought back the Freshwater Institute for analysis. $^{18}\delta O$ and salinity samples were also collected at each site and depth where HCH samples were taken.

Air Sampling

The air sampler was set up on the bow of the ship on the starboard side for all full stations, most basic stations, and several transects. Samples are collected on a glass fiber filter and polyurethane foam (PUF) for analysis of organic contaminants. Air samples collection time ranged between 4 and 23 hours. A total of 32 samples were collected. Filters and PUFs were frozen at -20°C and shipped frozen back to the FWI for HCH contaminant analysis.

Ice sampling

Ice samples for HCHs concentration and enantiomeric composition were collected at each basic and full station where the newly formed ice was present (Table 1). The samples for oxygen isotope composition ($\delta^{18}O$) and salinity were taken along with all ice samples. The ice samples were collected in collaboration with team 2 and the ice microstructure and physical analysis was made on all of them (see team 2 cruise report). The total of 7 samples of newly formed sea ice and 1 sample of 1m top layer of multiyear sea ice (MYI) for HCHs, $\delta^{18}O$, physical data and microstructure analysis was collected.

Table 1 Ice sampling locations for HCHs during leg 4A

Date	Station	Type of ice	HCH sample #	$\delta^{18}O$ sample #
12 Nov 07	REF	FYI, fastland homogenous ice taken very close (500 m) to the shore during refuelling in Sommer's Harbor; 2-3 cm of snow on top and a thin slushy layer	AN07-LV-351	364
15 Nov 07	1117	Landfast FYI, 2-3 cm snow on top, hard surface	Ice 1	372
16 Nov 07	1117	Landfast FYI, 2-3 cm snow on top, hard surface	Ice 2	373
19 Nov 07	405	FYI with huge conical frost flowers and no snow on top	Ice	391
20 Nov 07	1100	Consolidated pancake ~5cm with slushy layer (white) on top	Ice	392
20 Nov 07	STU	FYI (~45 cm) with huge conical frost flowers covered by white (snow?) layer	Ice	402
22 Nov 07	437	FYI (~58-67 cm) with huge conical frost flowers covered with 1 cm of snow	Ice	404
24 Nov 07	1825 (MYI)	MYI (~3.3m in the refrozen melt pond), mixture of refrozen melt pond cores and hummocks taken; covered with snow – 10-15 cm; only top 1m cores taken	Ice	414

Ice samples were collected from the ice cage. When the ice was thin enough, the ice chipper was used. In case of thicker ice (>15 cm) the ice cores were taken. The total of 4-8 L of melted ice was pumped through a glass-fiber filter followed by an ENV+ solid-phase extraction (SPE) cartridge using

peristaltic pumps. The cartridges and GFFs were stored in -80 °C and brought to the DFO (Winipeg) for further chemical analysis.

Perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS)

PFOA and PFOS are the two major perfluoros present in North Atlantic waters. They range in concentrations from <10 to 500 pg/L. Previous work has shown that they are present in somewhat higher concentrations in near shore waters sampled around Nain (June and September 2006) and Resolute Bay (June 2006). In this sampling program we hope to obtain a detailed picture of PFOA and PFOS concentrations in near shore and open ocean sites to test our hypothesis that concentrations follow a declining gradient away from land.

Flourinated materials are found in a wide range of applications because of their unique stability toward redox agents as well as for their inert and nonadhering surface properties. They are used in many commercial products such as paints, polishes, packaging, lubricants, firefighting foams, cookware, and stain repellents. During the past six years, scientists and consumers became more aware of these materials when 3M, a longtime major manufacturer of these compounds, declared that it was stopping production of some perfluorinated compounds, including PFOS and PFOA. The primary reason for withdrawing PFOS from the marketplace was the discovery that it is persistent, bioaccumulative, and toxic in animal studies. The U.S. Environmental Protection Agency subsequently requested more information on PFOA to ascertain the sources of human exposure and to determine the environmental effects.

PFOA and PFOS are likely present as residuals in polymers used on the ship because of past use as stain repellents, floor polishes, lubricants in Teflon (PFOA only) and therefore could be sources of contamination, especially in ship and lab air. Water was collected off the rosette through norprene and tygon tubing directly into polyethylene containers to limit contact with ship air as much as possible. Other possible sources of contamination to be avoided are Teflon tubing and bottles, Gortex or other stain repellent coated clothing, possibly KimWipes and waterproof paper.

Between 1 and 2 L of water was pumped through 6 ml (150 mg) WAX solid phase extraction cartridges at a flow rate of 10 ml / minute using peristaltic pumps. The cartridges were preconditioned (July 18) and shipped dry in 50 ml polypropylene vials, sealed with parafilm wax. Prior to filtration, the cartridges are spiked with 50 µl of an internal standard made up of 11 PFC's. In order to avoid air contamination during filtration, an additional WAX cartridge packed with polyurethane foam was used as an air filter. After filtration, cartridges are returned to the polypropylene vials, resealed with parafilm and refrigerated at 4 C.

Water blanks and cartridge recovery checks were performed to identify contamination sources. As an additional check of on-board collections and extractions, duplicate water samples were collected at a number of stations. These duplicate water samples will be sent back for extraction in a clean room setting for comparison to ship extraction.

Water was collected in depth profiles using a plastic bucket for surface water and the rosette for 5, 10, 25, 50, 100 and 200 meters at 2 stations (111, 435). A spatial study was also conducted with water from 5 m (rosette collection) at 9 stations (134, 301, 302, 305, 308, 309, 310, 314, and 434).

2.6.2. Biotic Sampling (mercury, stable isotopes)

The main purpose of this study is to link physical and biological processes to mercury levels in the food web and to target the pelagic food web biomagnification and bioaccumulation of mercury with stable isotopes and fatty acids. Thus, all biological samples collected will be measured for total mercury and MeHg along with stable isotopes to place organisms into their associated trophic levels.

Biological samples were collected at every basic and full stations along the cruise transect. Various zooplankton families and fish samples were collected using the vertically towed Monster net Monster net (200 and 500 µm), an oblique Tucker net (2x500 µm) and the RMT (rectangular midwater trawl, 1600 µm). Zooplankton and fish were sorted into families, placed into plastic vials and Whirlpak bags and frozen until they can be analyzed for THg, MeHg, stable isotopes and fatty acids. Zooplankton was collected at 32 stations. Many thanks to the University of Laval zooplankton team for hard work out on the foredeck.

Additionally, total body length (the distance from the front of the head to the tip of the longest uropod) of the individuals of the hyperiid specie *Themisto sp.*, an amphipod highly distributed throughout the High Arctic was measured to the nearest 0.5 mm. Animals greater than 18 mm are considered adult and smaller than that free living juvenile. The individuals were divided into size classes; 0-10 (newly hatched individuals/Juvenile 1), 11- 15 (Juvenile 2), 16-20 (1 year old immatures), 21-30 (individuals of over 2 years old), >30 and whenever possible, separated into different vials as described above.

Leg 5

21 December 2007 – 31 January 2008

edited and compiled by Tim Papakyriakou and Jody Deming (Chief Scientists)

1. General overview

1.1. Introduction

Leg 5 began with a successful crew change from Inuvik on 20 December 2007 (Table 1) and soon included celebration of the Christmas holiday and the arrival of the New Year (and later the arrival of the Sun!), bringing all participants, from a wide range of countries and cultures, together in a unique way. Logistically, Leg 5 saw the continuation (from Leg 4B) of the 'drift-mode' component of the CFL experiment. In this mode, our requirements were to use as little fuel as possible, while still maintaining some presence in and around the Amundsen Gulf polynya. We learned early in the leg that the weekly fuel allotment was readily exceeded when conditions required sustained ice-breaking through thick ice. Fortunately, we were able to "recover" such over-expenditures of fuel by drifting with an ice floe for more than a week; a drift time of 9 days on a floe initially at >60 cm ice thickness proved optimal for science and for fuel conservation. At the end of the leg, we were pleased to leave the project "in the black," having used less than our overall allotment of fuel (by 22 m^3).

Regarding maintaining a presence in Amundsen Gulf, initial attempts to establish a sampling circuit that included periodic access to the polynya and prolonged station stops in zones of 'slow' drift, usually close to shore in the lee of Banks Island, were not successful in terms of fuel conservation. The prevailing winds and currents within and around the polynya were easterly during Leg 5A, resulting in a strong westward flow of ice in Amundsen Gulf. We learned that in high winds the drift rate west could be fast enough to pose both a fuel problem and a hazard to science operations. The necessarily short residence time on a rapidly drifting floe did not justify the fuel consumed trying to maintain a presence in the Amundsen Gulf, nor could the moon pool be opened when ice was actively rafting. The ice can be pushed under the ship's bow, floating up into the opening (as experienced on New Year's Eve) or can be so large as to block descent of the rosette even though the moonpool appears entirely free of ice by visible inspection (as experienced during Leg 5B). We also could not safely establish on-ice sampling (with equipment left in place) when conditions were so dynamic. Our initial compromise was to tuck the ship up to the lee of Banks Island, where the drift rate was slower, allow drift north and west, then re-establish position to the southeast. This approach worked as long as the prevailing winds drove us to the northwest. Partway through Leg 5B, the prevailing winds shifted after a notable storm bringing 40-knot winds and our drift became southeasterly, easing the situation from several perspectives.

Accumulated experience from this leg yielded the following criteria for selecting a suitable floe: an initial ice thickness > 60 cm, measured by augur during a reconnaissance flight (90-100 cm worked well, < 60 cm did not); areal dimensions adequate for an airstrip (if needed in emergency or for an impending crew change); and surrounding ice conditions that were relatively safe (no immediate multi-year ice or else buffering first-year ice around the floe). Ultimately, we completed this leg with

a slow drift station (D19) in the southeasterly direction, on which the crew change for Leg 6 successfully took place, accomplishing the Leg 5 science program with near-100% success, as evidenced by the team cruise reports that follow.

1.2. Science Personnel

Table 1. Leg 5 Science Personnel.

Leg	Participant (CFL team)	Embark		Disembark	
		Place	Date	Place	Date
5A	Tim Papakyriakou (Chief Sci)	Inuvik	20-Dec	Amundsen	10-Jan
5B	Jody Deming (Chief Sci)	Inuvik	10-Jan	Amundsen	31-Jan
5A-B	Veronique Lago (1)	Inuvik	20-Dec	Amundsen	31-Jan
5A-B	Loic DeGroot (1)	Inuvik	20-Dec	Amundsen	31-Jan
5A-B	Graig Sutherland (1)	Inuvik	20-Dec	Amundsen	31-Dec
5A-B	Xiang Li (2)	Inuvik	20-Dec	Amundsen	31-Jan
5A-B	Shujiang Li (2)	Inuvik	20-Dec	Amundsen	20-Dec
5A-B	Jinping Zhao (2)	Inuvik	20-Dec	Amundsen	20-Dec
5A-B	Tao Li (2)	Inuvik	20-Dec	Amundsen	31-Jan
5A-B	Bruce Johnson (2)	Inuvik	20-Dec	Amundsen	On board
5B	Charles Hannah (2)	Inuvik	10-Jan	Amundsen	30-Jan*
5B	André April (2)	Inuvik	10-Jan	Amundsen	31-Jan
5A	Dustin Isleifson (2)	Inuvik	10-Jan	Amundsen	31-Jan
5A	Mukesh Gupta (2)	Inuvik	20-Dec	Amundsen	10-Jan
5A-B	Natalia Goryunova (2)	Inuvik	20-Dec	Amundsen	31-Jan
5A-B	Vladimir Shevchenko (2)	Inuvik	20-Dec	Amundsen	31-Jan
5A-B	Petr Bogorodsky (2)	Inuvik	20-Dec	Amundsen	31-Jan
5B	Mikhail Makhotin (2)	Inuvik	10-Jan	Amundsen	31-Jan
5A-B	Sergey Shutilin (2)	Inuvik	20-Dec	Amundsen	31-Jan
5A-B	Stéphane Thanassekos (4)	Inuvik	20-Dec	Amundsen	31-Jan
5A-B	Josée Michaud (4)	Inuvik	20-Dec	Amundsen	31-Jan
5A-B	Marc Ringuette (4)	Inuvik	20-Dec	Amundsen	31-Jan
5A-B	Stelly LeFort (6)	Inuvik	20-Dec	Amundsen	31-Jan
5A-B	Elizabeth Shadwick (6,7)	Inuvik	20-Dec	Amundsen	31-Jan
5A	Laura Sims (2)	Inuvik	20-Dec	Amundsen	10-Jan
5A	Jason Pavlich	Inuvik	20-Dec	Amundsen	10-Jan
5A-B	Ramon Terrado (7)	Inuvik	20-Dec	Amundsen	31-Jan
5A-B	Montserrat Coll Llado (7)	Inuvik	20-Dec	Amundsen	31-Jan
5A-B	Raquel Rodriguez Martinez (7)	Inuvik	20-Dec	Amundsen	31-Jan
5A-B	Andrea Niemi (7)	Inuvik	20-Dec	Amundsen	31-Jan
5A-B	Greg Niemi (7)	Inuvik	20-Dec	Amundsen	31-Jan
5B	Marcela Ewert Sarmiento (7)	Inuvik	10-Jan	Amundsen	31-Jan
5A	Min-Hui Lin (7)	Inuvik	10-Jan	Amundsen	31-Jan
5A-B	Monika Pucko (2,8)	Inuvik	20-Dec	Amundsen	30-Jan*
5A-B	Debbie Armstrong (8)	Inuvik	20-Dec	Amundsen	31-Jan
5A-B	Amanda Chaulk (8)	Inuvik	20-Dec	Amundsen	on board
5A-B	Wojciech Walkusz (8)	Inuvik	20-Dec	Amundsen	30-Jan*
5B	Jeff Latonas (8)	Inuvik	10-Jan	Amundsen	31-Jan
5A-B	Steeve Gagné	Inuvik	20-Dec	Amundsen	on board

*disembarked one day early (on return flight that had brought Leg 6 OASIS team members to the ship), to look after science cargo sent on same flight.

1.3. General Operational Log and Cruise Track

The Google-Earth cruise map below (Fig. 1) captures both the initial expectations for location of Leg 5 work and the realized outcome. The white rectangle is an ideal sampling location by original project plans (superimposed on the cruise track of an earlier mobile leg), while the red rectangle is the compromise region given fuel limitations and safety issues. The next map (Fig. 2) details, as an example, the floe-track of drift station D17 (Leg 5B). It shows the directional shift to the west, towards a more rapid flow zone, which occurred on day 8 and was part of the rationale to leave this site. Subsequent floe-tracking using satellite imagery, conducted by ice specialist André April on board, revealed that D17 was compressed into ridged ice by encroaching multi-year ice within several days after our departure. Judging the choice and location of floes post-D17 was facilitated in part via the use of ice beacons, originally intended for deployment on multi-year ice floes to track them through their lifetimes (see Team 2 report). Three of these beacons were deployed within the selected drift area at the start of Leg 5B (Fig. 1), two on multi-year floes (which remain deployed) and the third on a first-year ice floe that resembled those often selected for drift stations, in order to monitor the separate movements of these different ice types in the immediate region. The strategy served us well, perhaps especially after we lost contact with the third beacon. Identifying the reason for its loss (a lead opened beneath it; Fig. 3) helped direct us away from inshore floes. Accordingly, our final drift station D19, was offshore from previous selections (Fig. 4).

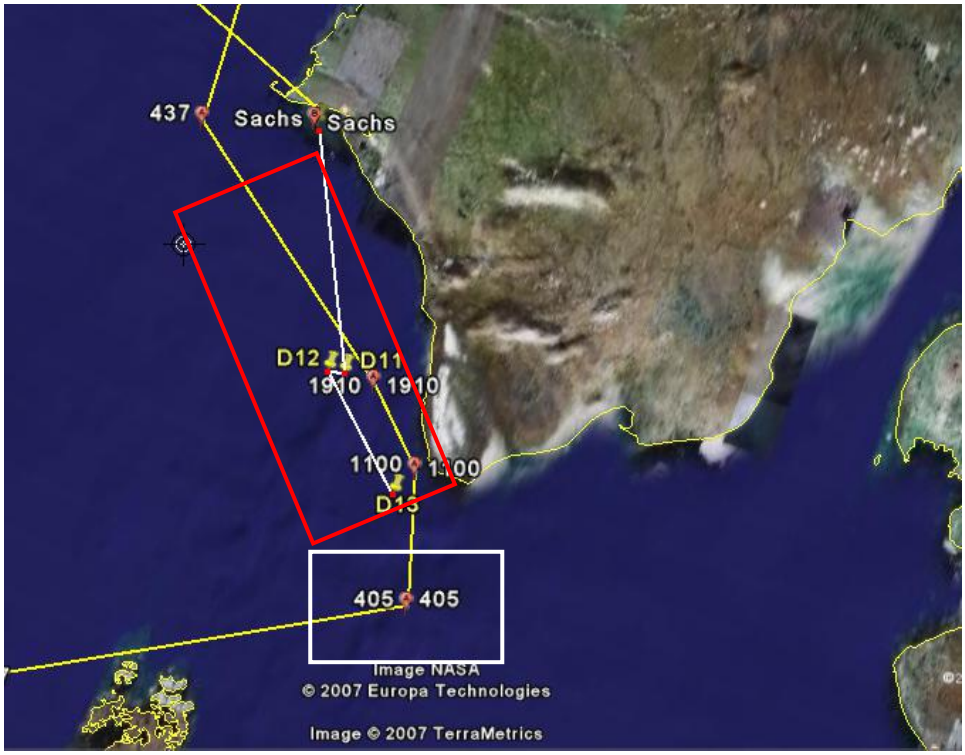


Fig. 1. Google-Earth map showing cruise track during previous mobile Leg 4A and drift-mode Leg 4B (yellow/white lines), the ideal sampling area for drift-mode legs based on original project plans (white box), and the realized area during Leg 5 (red box).

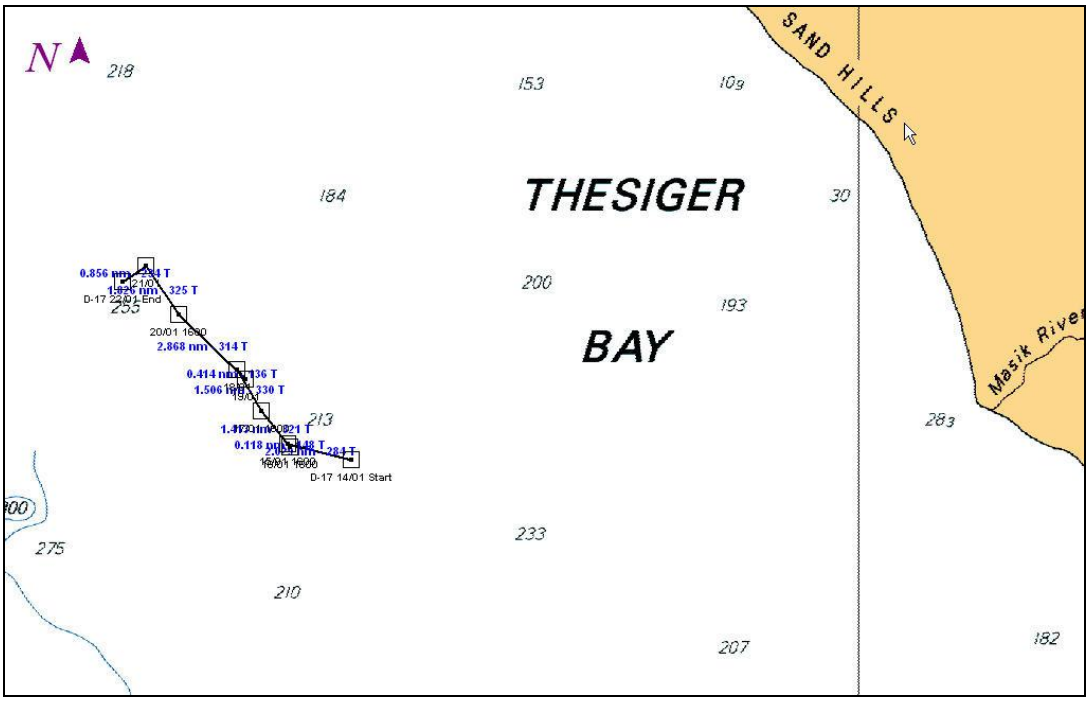


Fig. 2. Daily coordinates (boxed black dots) of drift station D17 (Leg 5B), showing shift on day 8 to the west/southwest, towards a more rapid flow zone, contributing to the decision to leave this floe (map prepared by 2nd lieutenant David Carpentier).

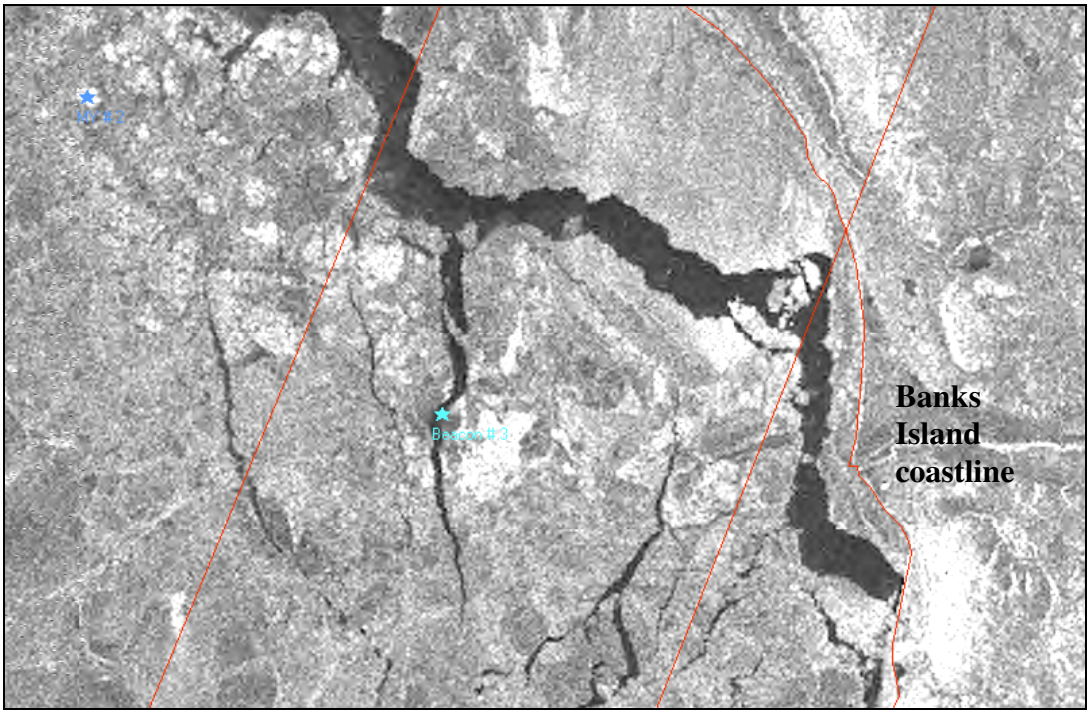


Fig. 3. Radarsat image of the drift-station region (on 21 January) showing two (of three) beacons deployed to facilitate drift-station selection: beacon #2 (blue star, upper left) still on its multi-year floe and the expected location of beacon #3 (aqua star in center) after losing contact with it (map prepared by Chief Officer Michel Dufresne).

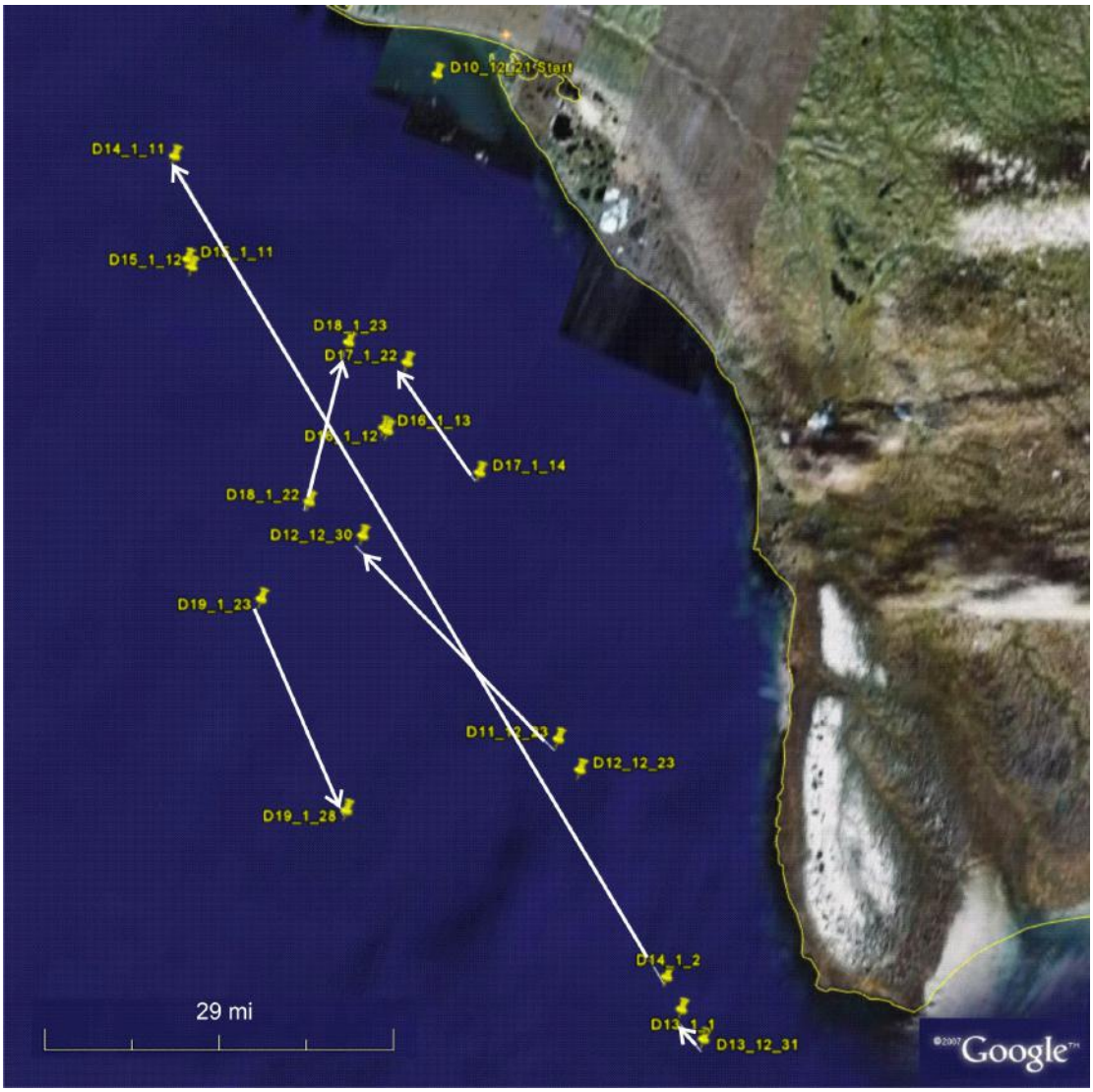


Fig. 4. Google-Earth map showing Leg 5 drift tracks for stations D11–D19.

During Leg 5, we followed the nomenclature for naming drift stations that was established during Leg 4B. For example, 2008D14 was the 14th drift site since the start of the program. The previous site was 2007D13. The main (long residence time) drift stations during Leg 5 were 2008D14, D17 (Fig. 2) and D19, with 5–9 days spent wedged into the floe for full science operations in the moonpool and on the ice. The repositioning effort between drift stations, once we acquired sufficient experience and began to occupy the compromise region (Fig. 1), typically required two days. During transit, we would park overnight at a floe, largely due to the winter darkness of our leg which made moving the ship at night problematic in terms of avoiding heavy ice (and thus conserving fuel). This and other darkness-related challenges were largely relieved once the sun came over the horizon on January 26, near the end of Leg 5. Our "forced" overnight stops enabled science operations from the moonpool and from short-term operations on the ice, so that these floes were also given full station designations. The related transit periods provided for critical (and CFL-unique) sampling of the various stages of freshly forming ice from the cage (see front-page photo). New-ice samples collected during transit were linked to the overnight drift station. A listing of our sampling sites, with location and time on station, is provided (Table 2), along with a Google-Earth map that depicts all of the drift stations of Leg 5 (Fig. 4). The ship's log of science operations as recorded on the bridge is also provided in its entirely (Table 3).

The trade-offs between conserving fuel, keeping the ship in a desired location (for science operations or crew changes), and meeting science goals definitely presented challenges during our leg. We

attribute the overall success of our leg to the conscientious and dedicated work of the men and women of "équipe B." Commanding Officer, Lise Marchand, and Chief Officer, Michel Dufresne, acted with skill, grace and good humor, often under duress, meeting and exceeding the demands placed upon them. Their junior officers brought an important enthusiasm to the effort. Chief Engineer, Richard Bourdeau, and his team ably kept the ship functional in all its capacities as only he could, knowing the ship since its first design-days as a vessel for science. Bosun, Jacques Claveau, proved his worth from day one, as did all members of the crew who worked cheerfully alongside the science participants to accomplish our goals. We especially thank those who served as gun-bearers on the ice (including the Chief Officer), along with scientists Andrea Niemi, Debbie Armstrong, Jeff Latonas, and Dustin Isleifson. Head chef, Jacques Vézina, and his talented team turned the holidays away from home into special memories and continued to feed us creatively even as fresh supplies dwindled. Logistics officer, Lucie Bouchard, and her associates managed an effective stocking of the ship, while our nurse, Marie-Paule Carriére, kept us as healthy as possible in the face of winter colds and such. We stop short of naming everyone only in the interests of space, but speak for the science party in extending our sincere thanks to each and every member of "équipe B" for their essential roles in the success of Leg 5.

Floe D-10-11				
Date	N	W		
	71 54,9	125 26,0		
Floe D-12				
23-Dec	71 13,2	124 09,3	Start	19:50
24-Dec	71 15,3	124 20,4	16:00	
25-Dec	71 14,9	124 24,1	16:00	
26-Dec	71 12,9	124 26,9	16:00	
27-Dec	71 14,2	124 33,0	16:00	
28-Dec	71 20,4	124 52,1	16:00	
29-Dec	71 23,4	125 07,6		
30-Dec	71 23,6	125 08,6	End	8:00
Floe D-13				
Date	N	W		
31-Dec	70 58,3	123 27,6	Start	18:00
1-Jan	70 58,9	123 29,5	16:00	
1-Jan	70 59,8	123 33,8	End	23:50
Floe D-14				
Date	N	W		
2-Jan	71 01,6	123 38,8	Start	4:15
3-Jan	71 14,5	124 29,7	16:00	
4-Jan	71 23,7	124 59,4	16:00	
5-Jan	71 31,4	125 27,4	16:00	
6-Jan	71 32,5	125 31,8	16:00	
7-Jan	71 32,1	125 34,2	16:00	
8-Jan	71 31,6	125 37,8	16:00	
9-Jan	71 31,7	125 46,2	16:00	
10-Jan	71 39,8	126 08,2	16:00	
11-Jan	71 43,7	126 14,0	End	11:30
Floe D-15				
Date	N	W		
11-Jan	71 37,4	126 03,7	Start	20:15
12-Jan	71 37,0	126 02,3	End	11:15
Floe D-16				
Date	N	W		
12-Jan	71 30,9	125 10,8	Start	15:15
13-Jan	71 31,0	125 11,7	End	4:00
Floe D-17				
Date	N	W		
14-Jan	71 30,2	124 49,3	Start	14:35
15-Jan	71 30,7	124 55,5	16:00	
16-Jan	71 30,6	124 55,3	16:00	
17-Jan	71 31,7	124 58,8	16:00	
18-Jan	71 30,0	125 00,5	16:00	
19-Jan	71 32,7	124 59,6	16:00	
20-Jan	71 34,7	125 06,1	16:00	
21-Jan	71 36,2	125 09,4	16:00	
22-Jan	71 35,7	125 11,6	End	11:20
Floe D-18				
Date	N	W		
22-Jan	71 24,6	125 21,7	Start	16:30
23-Jan	71 23,7	125 24,9	End	10:50
Floe D-19				
Date	N	W		
23-Jan	71 17,3	125 24,6	Start	15:25
24-Jan	71 10,3	125 08,7	16:00	
25-Jan	71 11,9	125 03,4	16:00	
26-Jan	71 06,3	124 56,4	16:00	
27-Jan	71 05,6	124 53,7	16:00	
28-Jan	71 05,6	124 53,2	16:00	

Table 2. Daily coordinates (at 1600), plus start and end times and locations, for drift floe stations during Leg 5 (prepared by 2nd Lieutenant David Carpentier).

1.4. Ship Log of Science Activity

Table 3. Science Activity Log for Leg 5 (directly from the Bridge).

Date	Hre	Latitude		Longitude		Cap	Activités	Prof (M)	Vent		T° Air ©	T° Eau (C)
									Dir	Vit		
21 dec 2007	18:15	71 54,88	N	125 25,97	W	32	Eq sur glace	40	160	14	-20.2	-0.32
21 dec 2007	18:15	71 54,8	N	125 25,97	W	32	Eq sur glace	40	150	11	-21	-0.35
22 dec 2007	10:31	71 54,88	N	125 25,97	W	32	Rosette in	35	100	13	-22	-0.24
22 dec 2007	10:42	71 54,88	N	125 25,97	W	32	Rosette out	35	100	12	-22	-0.24
22 dec 2007	11:32	71 54,88	N	125 25,97	W	32	Eq sur glace	35	110	12	-22	-0.2
22 dec 2007	12:30	71 54,88	N	125 25,97	W	32	Eq glace de retour	41	103	13	-22.2	-0.22
22 dec 2007	15:20	71 54,88	N	125 25,97	W	32	Eq glace sortie	35	104	12	-22	-0.25
22 dec 2007	18:45	71 54,88	N	125 25,97	W	32	Tucker in	41	90	14	-21	-0.32
22 dec 2007	19:30	71 54,00	N	125 26,0	W	32	Tucker out	40	85	11	-22	-0.33
22 dec 2007	19:44	71 54,00	N	125 26,0	W	32	Rosette in	41	90	10	-22.3	-0.34
22 dec 2007	20:00	71 54,00	N	125 26,0	W	32	Rosette out	41	70	11	-22.9	-0.32
22 dec 2007	20:18	71 54,00	N	125 26,0	W	32	Vmp in	35	80	11	-22.6	-0.34
22 dec 2007	20:30	71 54,00	N	125 26,0	W	32	Vmp out	35	80	11	-22.1	-0.35
22 dec 2007	22:20	71 54.87	N	125 26,0	W	32	Equipe de glace	38	93	16	-20.8	-0.42
24 dec 2007	8:12	71 14,5	N	124 14,17	W	237	Rosette in	293	125	20	-19	-0.9
24 dec 2007	8:43	71 14,6	N	124 14,8	W	238	Rosette out	291	100	14	-19	-1
25 dec 2007	8:25	71 16,22	N	124 25,29	W	175	Equipe sur glace	254	140	5	-21	-1.07
25 dec 2007	10:00	71 16,22	N	124 25,31	W	175	Eq glace de retour	255	120	5	-21.5	-1
25 dec 2007	18:14	71 15,00	N	124 24,5	W	116	Ctd rosette in	288	240	3	-21.3	-1.01
25 dec 2007	18:44	71 15,00	N	124 24,5	W	116	Ctd rosette out	288	240	4	-21.2	-1.02
25 dec 2007	18:56	71 15,00	N	124 24,5	W	116	Vmp in	288	230	4	-21.2	-1.05
25 dec 2007	19:15	71 14,96	N	124 24,2	W	116	Vmp in	288	Calme		-21.3	-1.05
25 dec 2007	20:15	71 14,96	N	124 24.1	W	116	Vmp out	290	Calme		-21	-1
25 dec 2007	20:30	71 14,96	N	124 24.1	W	116	Hydrobios in	290	Calme		-21	-1
25 dec 2007	21:00	71 14,96	N	124 24,07	W	116	Hydrobios out	290	Calme		-21	-1
25 dec 2007	21:25	71 14,96	N	124 24,08	W	116	Tucker in	290	Calme		-21	-1
25 dec 2007	22:45	71 14,96	N	124 24,08	W	116	Tucker out x 3	284	310	6	-22	-1
26 dec 2007	7:13	71 14	N	124 24,5	W	115	Rosette in	290	355	11	-21.2	-0.94
26 dec 2007	7:29	71 14	N	124 24,6	W	114	Rosette out	287	355	10	-21.2	-0.94
26 dec 2007	7:46	71 13,8	N	124 24,6	W	114	Vmp in	288	350	10	-21.2	-0.94
26 dec 2007	8:03	71 13,8	N	124 24,6	W	114	Vmp out	287	350	10	-21.2	-0.93
26 dec 2007	8:13	71 13,8	N	124 24,6	W	114	Rosette in	285	340	9	-21.2	-0.94
26 dec 2007	8:28	71 13,7	N	124 24,7	W	114	Rosette out	288	340	9	-21.2	-0.94
26 dec 2007	8:38	71 13,7	N	124 24,7	W	114	Vmp in	277	340	9	-21.2	-0.94
26 dec 2007	8:54	71 13,7	N	124 24,7	W	114	Vmp out	284	350	9	-21.7	-1.08
26 dec 2007	9:10	71 13,6	N	124 24,7	W	114	Tucker in	282	340	8	-22	-1.1
26 dec 2007	9:30	71 13,6	N	124 24,8	W	114	Tucker out	278	320	7	-22	-1.1
26 dec 2007	9:55	71 13,5	N	124 24,9	W	114	Rosette in	282	330	8	-22	-1.1
26 dec 2007	10:15	71 13,4	N	124 25,0	W	114	Rosette out	282	330	9	-22	-1.07
26 dec 2007	10:23	71 13,4	N	124 25,0	W	114	Vmp in	277	330	9	-22	-1.07
26 dec 2007	10:53	71 13,3	N	124 25,2	W	114	Vmp out	284	0	12	-22	-1.06
26 dec 2007	11:08	71 13,28	N	124 25,3	W	114	Ctd rosette in	277	350	8	-22	-1.04
26 dec 2007	11:20	71 13,25	N	124 25,4	W	114	Ctd rosette out	283	340	9	-21.8	-1.02
26 dec 2007	11:29	71 13,2	N	124 25,4	W	114	Vmp in	278	350	10	-21.7	-1.03
26 dec 2007	11:56	71 13,19	N	124 25,7	W	114	Vmp out	282	350	9	-21.5	-1.07
26 dec 2007	12:05	71 13,173	N	124 25,801	W	114	Tucker in	285	340	8	-21.4	-1.08
26 dec 2007	12:27	71 13,143	N	124 25,931	W	114	Tucker out	282	350	9	-21.2	-1.11
26 dec 2007	12:57	71 13,103	N	124 26,141	W	114	Ctd rosette in	282	0	10	-21.2	-1.14
26 dec 2007	13:23	71 13,063	N	124 26,311	W	114	Ctd rosette out	274	0	12	-20.8	-1.15
26 dec 2007	13:29	71 13,053	N	124 26,351	W	114	Vmp in	280	0	14	-20.8	-1.15
26 dec 2007	13:47	71 13,023	N	124 26,441	W	114	Vmp out	282	350	13	-20.9	-1.15
26 dec 2007	14:01	71 13,003	N	124 26,511	W	114	Ice team 3xLi	274	350	12	-21	-1.16
26 dec 2007	14:07	71 12,993	N	124 26,541	W	114	Ctd rosette in	275	350	12	-21	-1.16
26 dec 2007	14:32	71 12,953	N	124 26,661	W	114	Ctd rosette out	275	0	11	-20.7	-1.16
26 dec 2007	14:38	71 12,943	N	124 26,671	W	114	Vmp in	275	0	11	-20.7	-1.16
26 dec 2007	15:00	71 12,903	N	124 26,781	W	114	Vmp out	281	0	11	-20.7	-1.16
26 dec 2007	15:13	71 12,883	N	124 26,841	W	114	Ctd rosette in	280	0	10	-20.8	-1.16
26 dec 2007	15:32	71 12,843	N	124 26,901	W	114	Ctd rosette out	274	0	11	-20.8	-1.17
26 dec 2007	15:40	71 12,823	N	124 26,931	W	114	Vmp in	279	0	11	-20.8	-1.17
26 dec 2007	15:55	71 12,803	N	124 26,971	W	114	Vmp out	279	0	11	-20.8	-1.17
26 dec 2007	16:08	71 12,8	N	124 26,97	W	114	Ctd rosette in	284	0	10	-20.8	-1.17
26 dec 2007	16:25	71 12,7	N	124 27,0	W	114	Ctd rosette out	285	10	12	-20.8	-1.15
26 dec 2007	16:35	71 12,7	N	124 27,1	W	114	Vmp in	280	10	11	-20.8	-1.15
26 dec 2007	16:52	71 12,6	N	124 27,1	W	114	Vmp out	280	15	7	-21.1	-1.15
26 dec 2007	16:54	71 12,6	N	124 27,1	W	114	Ctd rosette in	280	15	7	-21.1	-1.15
26 dec 2007	17:15	71 12,6	N	124 27,1	W	114	Ctd rosette out	278	15	7	-21.1	-1.13

A	B	C	D	E	F	G	H	I	J	K	L	M
26 dec 2007	17:24	71 12,6	N	124 27,1	W	114	Vmp in	281	15	8	-21	-1.13
26 dec 2007	17:40	71 12,6	N	124 27,1	W	114	Vmp out	287	15	7	-20.9	-1.1
26 dec 2007	18:14	71 12,5	N	124 27,19	W	114	Ctd rosette in	280	Calme		-21.5	-1.14
26 dec 2007	18:34	71 12,5	N	124 27,2	W	114	Ctd rosette out	280	Calme		-21.5	-1.12
26 dec 2007	18:41	71 12,1	N	124 27,2	W	114	Vmp in	281	100	5	-22.3	-1.14
26 dec 2007	19:00	71 12,1	N	124 27,2	W	114	Vmp out	280	100	5	-22.3	-1.17
26 dec 2007	19:05	71 12,2	N	124 27,1	W	114	Tucker in	280	100	5	-22.3	-1.18
26 dec 2007	19:40	71 12,4	N	124 27,09	W	114	Tucker out	280	100	8	-22.2	-1.18
26 dec 2007	20:04	71 12,4	N	124 27,1	W	114	Ctd rosette in	280	130	8	-20.2	-1.2
26 dec 2007	20:22	71 12,3	N	124 27,1	W	114	Ctd rosette out	280	150	5	-21.4	-1.2
26 dec 2007	20:25	71 12,3	N	124 27,1	W	114	Vmp in	280	150	5	-21.4	-1.2
26 dec 2007	20:45	71 12,3	N	124 27,1	W	114	Vmp out	280	130	6	-22.2	-1.2
26 dec 2007	20:51	71 12,3	N	124 27,1	W	114	Rosette in	279	140	8	-22.2	-1.19
26 dec 2007	21:05	71 12,3	N	124 27,1	W	114	Rosette out	279	140	9	-22.3	-1.18
26 dec 2007	21:12	71 12,3	N	124 27,2	W	114	Vmp in	279	140	9	-22.3	-1.18
26 dec 2007	21:28	71 12,3	N	124 27,2	W	114	Vmp out	280	140	12	-22.6	-1.2
27 dec 2007	6:12	71 12,8	N	124 28,5	W	114	Tucker in	280	115	10	-22.4	-1.08
27 dec 2007	6:32	71 12,8	N	124 28,5	W	114	Tucker out	280	115	8	-22.5	-1.06
27 dec 2007	6:46	71 12,8	N	124 28,5	W	114	Tucker in	280	115	11	-22.6	-1.06
27 dec 2007	7:04	71 12,8	N	124 28,5	W	114	Tucker out	280	110	10	-22.9	-1.06
27 dec 2007	7:15	71 12,9	N	124 28,6	W	114	Rosette in	280	120	11	-22.9	-1.07
27 dec 2007	8:15	71 12,9	N	124 28,6	W	114	Rosette out	280	115	10	-22.9	-1.08
27 dec 2007	8:20	71 12,9	N	124 28,7	W	115	Vmp in	280	130	8	-22.7	-1.05
27 dec 2007	9:10	71 13,0	N	124 28,9	W	116	Vmp out	280	120	12	-23	-1.04
27 dec 2007	10:00	71 13,03	N	124 29,17	W	116	Tucker in	275	130	12	-22	-1.02
27 dec 2007	10:20	71 13,1	N	124 29,3	W	116	Tucker out	278	140	12	-21.8	-1.02
27 dec 2007	11:38	71 13,2	N	124 29,9	W	116	Tucker in	279	130	10	-20.7	-1.06
27 dec 2007	12:00	71 13,3	N	124 30,1	W	116	Tucker out	279	140	12	-20.3	-1.04
27 dec 2007	13:05	71 13,485	N	124 30,691	W	117	Tucker in	302	120	17	-20.6	-1.05
27 dec 2007	13:30	71 13,583	N	124 30,981	W	117	Tucker out	304	130	18	-21	-1.08
27 dec 2007	17:30	71 14,254	N	124 33,011	W	118	Ctd rosette in	303	120	22	-20.5	-1.14
27 dec 2007	17:49	71 14,304	N	124 33,151	W	118	Ctd rosette out	300	120	20	-20.4	-1.14
27 dec 2007	19:10	71 14,5	N	124 33,6	W	119	Tucker in	288	120	25	-20.3	-1.15
27 dec 2007	19:30	71 14,6	N	124 34,1	W	118	Tucker out	288	120	25	-20.5	-1.16
27 dec 2007	19:47	71 14,6	N	124 34,1	W	118	Tucker in	290	120	25	-20.7	-1.18
27 dec 2007	20:12	71 14,7	N	124 34,4	W	118	Tucker out	286	120	23	-20.5	-1.2
27 dec 2007	20:42	71 14,8	N	124 34,8	W	118	Vmp in	280	120	24	-20.7	-1.2
27 dec 2007	21:13	71 14,9	N	124 35,2	W	118	Vmp out	280	130	22	-20.7	-1.2
28 dec 2007	7:05	71 17,2	N	124 43,9	W	119	Rosette in	240	125	34	-23	-1.21
28 dec 2007	7:30	71 17,4	N	124 44,3	W	119	Rosette out	240	125	30	-23.1	-1.2
28 dec 2007	7:32	71 17,4	N	124 44,3	W	119	Vmp in	239	125	30	-23	-1.2
28 dec 2007	8:20	71 17,7	N	124 45	W	119	Vmp out	246	140	36	-23	-1.2
28 dec 2007	13:40	71 19,683	N	124 49,801	W	117	Hydrobios in	222	130	28	-23.1	-1.22
28 dec 2007	14:10	71 19,944	N	124 50,272	W	117	Hydrobios out	227	125	28	-23	-1.2
28 dec 2007	15:25	71 20,197	N	124 51,532	W	118	Tucker in	224	120	25	-23	-1.21
28 dec 2007	15:50	71 20,324	N	124 52,021	W	118	Tucker out	226	130	28	-22.9	-1.19
28 dec 2007	18:46	71 20,8	N	124 54,5	W	117	Rosette in	220	120	30	-21.5	-1.19
28 dec 2007	19:06	71 20,9	N	124 54,9	W	117	Rosette out	218	120	25	-21	-1.19
28 dec 2007	19:18	71 20,9	N	124 55,1	W	117	Vmp in	220	120	25	-21.2	-1.19
28 dec 2007	20:03	71 21,0	N	124 55,7	W	116	Vmp out	223	140	23	-21	-1.17
29 dec 2007	7:09	71 22,6	N	125 03	W	109	Rosette in	255	80	5	-19.2	-1.14
29 dec 2007	7:49	71 22,6	N	125 03,1	W	109	Rosette out	254	80	5	-18.9	-1.13
29 dec 2007	8:00	71 22,7	N	125 03,1	W	109	Vmp in	254	170	3	-18.7	-1.15
29 dec 2007	8:40	71 22,7	N	125 03,3	W	110	Vmp out	248	50	8	-18.5	-1.13
29 dec 2007	10:26	71 22,8	N	125 04,1	W	110	Rosette in	258	110	7	-17.6	-1.12
29 dec 2007	10:44	71 22,8	N	125 04,3	W	109	Rosette out	250	90	7	-17.5	-1.13
29 dec 2007	14:15	71 23,297	N	125 06,835	W	106	Tucker in	270	130	10	-17.7	-1.09
29 dec 2007	14:40	71 23,338	N	125 07,76	W	106	Tucker out	270	90	5	-18.4	-1.11
29 dec 2007	14:50	71 23,357	N	125 07,154	W	105	Tucker in	266	90	5	-18.6	-1.14
29 dec 2007	15:20	71 23,4	N	125 07,4	W	103	Tucker out	264	120	6	-18.4	-1.15
29 dec 2007	18:57	71 23,5	N	125 07,9	W	99	Rosette in	273	125	10	-18.9	-1.17
29 dec 2007	19:08	71 23,5	N	125 07,9	W	99	Rosette out	272	130	9	-18.8	-1.16
29 dec 2007	19:20	71 23,5	N	125 07,9	W	99	Vmp in	272	150	10	-18.8	-1.16
29 dec 2007	20:00	71 23,5	N	125 07,9	W	100	Vmp out	272	170	11	-18.9	-1.15
1-Jan-08	10:50	70 58,7	N	123 28,8	W	94	Rosette in	282	90	9	-25.5	-1.2
1-Jan-08	11:01	70 58,7	N	123 28,8	W	94	Rosette out	282	90	8	-25.5	-1.2
1-Jan-08	13:40	70 58,741	N	123 27,093	W	95	Rosette ctd in	283	90	10	-25	-1.08
1-Jan-08	13:55	70 58,751	N	123 29,143	W	95	Rosette ctd out	285	90	10	-24.9	-1.07

A	B	C	D	E	F	G	H	I	J	K	L	M
1-Jan-08	13:55	70 58,751	N	123 29,143	W	95	Rosette ctd out	285	90	10	-24.9	-1.07
1-Jan-08	14:00	70 58,761	N	123 29,163	W	95	Ctd in	288	90	10	-24.9	-1.07
1-Jan-08	14:20	70 58,771	N	123 29,233	W	95	Ctd out	283	100	10	-24.9	-1.05
1-Jan-08	14:25	70 58,781	N	123 29,243	W	95	Vmp in	284	100	10	-24.9	-1.05
1-Jan-08	15:15	70 58,821	N	123 29,413	W	95	Vmp out	285	100	10	-24.9	-1.04
1-Jan-08	19:05	70 59,1	N	123 30,6	W	96	Rosette in	275	80	12	-25.6	-1.14
1-Jan-08	19:24	70 59,1	N	123 30,6	W	96	Rosette out	275	90	12	-25.8	-1.13
1-Jan-08	19:34	70 59,1	N	123 30,6	W	96	Vmp in	276	90	13	-25.9	-1.13
1-Jan-08	20:30	70 59,2	N	123 31,3	W	98	Vmp out	287	110	17	-26.7	-1.1
1-Jan-08	21:37	70 59,4	N	123 32,3	W	98	Filet tucker in	275	100	19	-27	-1.1
1-Jan-08	22:00	70 59,5	N	123 32,7	W	98	Filet tucker out	275	100	20	-27	-1.1
1-Jan-08	22:10	70 59,5	N	123 32,8	W	98	Filet tucker in	275	90	18	-26.3	-1.1
1-Jan-08	22:31	70 59,5	N	123 33,3	W	98	Filet tucker out	280	90	18	-26	-1.1
2-Jan-08	14:00	71 04,511	N	123 55,033	W	99	Ice cage	295	110	32	-22.6	-1.13
3-Jan-08	13:40	71 13,798	N	124 26,904	W	132	Ice cage	277	120	27	-23.2	-1.03
3-Jan-08	13:40	71 13,815	N	124 26,947	W	132	Rosette in	277	120	27	23.2	1.03
3-Jan-08	14:15	71 14,000	N	124 27,563	W	133	Rosette out	317	120	30	-22.8	-1.01
3-Jan-08	14:25	71 14,025	N	124 27,697	W	133	Vmp in	318	120	32	-22.8	-1
3-Jan-08	15:05	71 14,225	N	124 28,617	W	133	Vmp out	318	120	27	-22.6	-1.03
3-Jan-08	15:25	71 14,310	N	124 29,028	W	133	Hydrobios in	312	120	28	-23	-1.01
3-Jan-08	15:45	71 14,395	N	124 29,437	W	133	Hydrobios out	291	120	27	-23.3	-1.02
3-Jan-08	16:07	71 14,5	N	124 29,97	W	132	Tucker in	283	115	30	-23.2	-1.06
3-Jan-08	16:30	71 14,6	N	124 30,5	W	132	Tucker out	290	115	30	-23.5	-1.1
3-Jan-08	16:40	71 14,68	N	124 30,82	W	132	Tucker in	297	115	30	-23.3	-1.1
3-Jan-08	16:53	71 14,7	N	124 31,16	W	132	Tucker out	297	115	30	-23.2	-1.07
3-Jan-08	17:30	71 14,918	N	124 32,122	W	132	Rosette in	290	110	27	-22.9	-1.02
3-Jan-08	17:56	71 15,0	N	124 32,8	W	132	Rlosette out	291	110	30	-22.9	-1.02
3-Jan-08	19:13	71 15,4	N	124 34,7	W	132	Vmp in	252	110	28	-22	-1.01
3-Jan-08	20:01	71 15,7	N	124 35,8	W	132	Vmp out	234	120	24	-22	-0.99
4-Jan-08	7:00	71 19,9	N	124 49,1	W	128	Rosette in	230	120	30	-22.2	-1.08
4-Jan-08	7:14	71 20,1	N	124 49,4	W	127	Rosette out	230	120	30	-22.2	-1.08
4-Jan-08	7:25	71 20,1	N	124 49,6	W	127	Vmp in	228	120	30	-22.2	-1.08
4-Jan-08	7:55	71 20,4	N	124 50,4	W	127	Vmp out	225	120	30	-22.2	-1.08
4-Jan-08	9:07	71 21,0	N	124 51,7	W	128	Tucker in	221	130	30	-22.8	-0.98
4-Jan-08	9:30	71 21,2	N	124 52,1	W	128	Tucker out	220	130	30	-22.9	-0.99
4-Jan-08	9:45	71 21,3	N	124 52,5	W	128	Ice team	218	130	30	-22.8	-0.99
4-Jan-08	11:10	71 22,0	N	124 54,2	W	128	Ice team de retour	220	120	30	-23.3	-0.98
4-Jan-08	11:05	71 21,9	N	124 54,1	W	128	Rosette in	216	120	30	-23.3	-0.95
4-Jan-08	11:31	71 22,1	N	124 54,7	W	128	Rosette out	219	120	30	-23.2	-1.03
4-Jan-08	14:00	71 23,035	N	124 57,388	W	132	Hydrobios in	220	120	27	-22	-1
4-Jan-08	14:28	71 23,188	N	124 57,821	W	133	Hydrobios out	218	120	25	-22	-1
4-Jan-08	15:10	71 23,471	N	124 58,596	W	134	Rosette in	222	120	28	-22.1	-0.86
4-Jan-08	15:25	71 23,544	N	124 58,801	W	134	Rosette out	222	120	27	-22.2	-0.85
4-Jan-08	15:35	71 23,605	N	124 58,997	W	135	Vmp in	226	120	29	-22	-0.87
4-Jan-08	16:26	71 23,865	N	124 59,917	W	136	Vmp out	232	110	30	-22	-0.9
4-Jan-08	18:58	71 24,8	N	125 03,2	W	137	Rosette in	248	120	30	-22.1	-0.98
4-Jan-08	19:17	71 24,9	N	125 03,7	W	137	Rosette out	248	120	32	-22.1	-0.99
4-Jan-08	20:35	71 25,5	N	125 06,0	W	138	Groupe sur la glace	260	130	35	-22	-1.04
4-Jan-08	21:45	71 25,8	N	125 07,7	W	139	Tao de retour	261	130	27	-22	-1.03
5-Jan-08	6:00	71 28,5	N	125 17,4	W	143	Rosette in	282	135	25	-20.3	-1.06
5-Jan-08	6:31	71 28,6	N	125 17,9	W	143	Rosette out	282	135	22	-20.5	-1.04
5-Jan-08	7:20	71 28,9	N	125 18,9	W	143	Hydrobios in	288	140	21	-20.5	-1.07
5-Jan-08	7:45	71 29,0	N	125 19,5	W	143	Hydrobios out	288	140	22	-20	-1.08
5-Jan-08	8:26	71 29,3	N	125 20,4	W	143	Tucker in	293	140	23	-19.4	-1.07
5-Jan-08	8:44	71 29,4	N	125 20,8	W	144	Tucker out	303	140	25	-19.2	-1.09
5-Jan-08	8:44	71 29,4	N	125 20,8	W	144	Ice team	303	140	25	-19.2	-1.04
5-Jan-08	10:48	71 30,1	N	125 23,2	W	144	Ice team retour	319	140	20	-19	-1.05
5-Jan-08	9:53	71 29,8	N	125 22,1	W	144	Rosette in	312	130	15	-19	-1.06
5-Jan-08	10:35	71 30,0	N	125 22,9	W	144	Rosette out	317	140	20	-18.8	-1.06
5-Jan-08	14:15	71 31,1	N	125 26,3	W	146	Rosette in	323	110	17	-20.1	-0.98
5-Jan-08	14:15	71 31,1	N	125 26,3	W	146	Ice cage	323	110	17	-20.1	-0.98
5-Jan-08	14:35	71 31,2	N	125 26,5	W	146	Rosette out	323	115	18	-20	-0.98
5-Jan-08	14:45	71 31,2	N	125 26,6	W	146	Vmp in	324	120	17	-19.9	-0.98
5-Jan-08	15:20	71 31,3	N	125 27,0	W	146	Vmp out	326	140	16	-19.5	-0.98
5-Jan-08	15:55	71 31,4	N	125 27,4	W	147	Tucker in	328	90	14	-18.6	-0.96
5-Jan-08	16:27	71 31,5	N	125 27,7	W	146	Tucker out	336	90	10	-18.9	-0.94
5-Jan-08	19:00	71 31,8	N	125 28,6	W	147	Rosette in	339	50	7	-18.7	-0.92
5-Jan-08	19:19	71 31,8	N	125 28,8	W	147	Rosette out		50	8	-18.7	-0.91
5-Jan-08	22:03	71 32,1	N	125 30,2	W	148	Rosette in	346	60	6	-18.9	-0.99

A	B	C	D	E	F	G	H	I	J	K	L	M
5-Jan-08	22:20	71 32,2	N	125 30,4	W	148	Rosette out	347	70	5	-18.9	-0.95
6-Jan-08	6:56	71 32,5	N	125 31,5	W	148	Rosette in	348	280	6	-18.6	-1.05
6-Jan-08	7:14	71 32,5	N	125 31,5	W	148	Rosette out	348	280	6	-18.3	-1.01
6-Jan-08	8:05	71 32,5	N	125 31,7	W	148	Tucker in	349	300	3	-18.3	-1.01
6-Jan-08	8:30	71 32,5	N	125 31,7	W	148	Tucker out	350	280	5	-18.7	-1
6-Jan-08	8:40	71 32,5	N	125 31,8	W	148	Ice team	349	270	5	-18.6	-1
6-Jan-08	13:02	71 32,6	N	125 32,2	W	148	Rosette ctd in	342	290	10	-20.9	-1
6-Jan-08	13:16	71 32,6	N	125 32,2	W	148	Rosette ctd out	343	290	10	-20.8	-1
6-Jan-08	14:15	71 32,6	N	125 32,1	W	148	Hydrobios in	343	290	10	-20.4	-1
6-Jan-08	14:40	71 32,6	N	125 32,0	W	148	Hydrobios out	343	290	10	-20.6	-1
6-Jan-08	18:59	71 32,3	N	125 31,4	W	148	Rosette in	349	310	10	-22.6	-0.97
6-Jan-08	19:20	71 32,3	N	125 31,44	W	148	Rosette out	349	310	10	-22.8	-0.97
6-Jan-08	19:24	71 32,3	N	125 31,4	W	148	Vmp in	349	310	10	-23.1	-0.98
6-Jan-08	20:20	71 32,3	N	125 31,5	W	148	Vmp out	350	290	10	-23.7	-0.97
6-Jan-08	20:30	71 32,3	N	125 31,6	W	148	Ice team	350	290	10	-23.8	-0.99
6-Jan-08	21:40	71 32,3	N	125 31,8	W	148	Ice team de retour	350	290	10	-23.8	-0.93
6-Jan-08	21:56	71 32,3	N	125 31,8	W	148	Rosette ctd in	351	290	10	-24.1	-0.94
6-Jan-08	22:16	71 32,3	N	125 31,8	W	148	Rosette ctd out	350	290	10	-23.7	-0.96
7-Jan-08	7:00	71 32,0	N	125 32,1	W	149	Rosette in	352	290	6	-24.8	-1
7-Jan-08	7:18	71 32,0	N	125 32,2	W	149	Rosette out	352	290	7	-24.8	-1
7-Jan-08	8:50	71 32,0	N	125 32,7	W	149	Ice team	351	290	5	-25	-0.96
7-Jan-08	11:37	71 32,1	N	125 33,8	W	149	Ice team de retour	351	Calme		-24.6	-1.01
7-Jan-08	9:02	71 32,0	N	125 32,8	W	149	Tucker in	353	290	5	-25	-0.97
7-Jan-08	9:28	71 32,1	N	125 33,0	W	150	Tucker out	352	290	5	-25	-0.97
7-Jan-08	13:05	71 32,2	N	125 34,2	W	150	Rosette in	344	Calme		-24.2	-1.03
7-Jan-08	13:30	71 32,2	N	125 34,2	W	150	Rosette out	345	255	5	-24.2	-1.04
7-Jan-08	14:00	71 32,2	N	125 34,2	W	150	Ice team	345	264	4	-24	-1.05
7-Jan-08	18:54	71 31,9	N	125 34,1	W	150	Rosette in	354	Calme		-24.2	-1.06
7-Jan-08	19:11	71 31,9	N	125 34,2	W	150	Rosette out	354	Calme		-24.3	-1.05
7-Jan-08	20:10	71 31,9	N	125 34,4	W	150	Hyudrobios in	354	290	5	-24.6	-1.02
7-Jan-08	20:40	71 31,9	N	125 34,5	W	150	Hydrobios out	354	290	5	-24.9	-1.04
7-Jan-08	20:40	71 31,9	N	125 34,5	W	150	Ice team début	354	290	5	-24.9	-1.04
7-Jan-08	22:00	71 31,9	N	125 34,8	W	150	Rosette ctd in	353	Calme		-24.6	-1.03
7-Jan-08	22:15	71 31,9	N	125 34,9	W	150	Rosette ctd out	354	Calme		-24.5	-1.05
7-Jan-08	22:30	71 31,9	N	125 34,9	W	150	Ice team fin	354	Calme		-24.5	-1.07
8-Jan-08	7:04	71 31,5	N	125 35,7	W	151	Rosette in	360	280	5	-23.2	-0.98
8-Jan-08	7:37	71 31,5	N	125 35,8	W	151	Rosette out	359	280	5	-23	-0.95
8-Jan-08	8:05	71 31,6	N	125 35,9	W	151	Vmp in	359	270	5	-22.8	-0.98
8-Jan-08	8:51	71 31,6	N	125 36,1	W	152	Vmp out	358	300	7	-23.2	-0.95
8-Jan-08	8:35	71 31,6	N	125 36,0	W	152	Ice team	358	300	7	-22.8	-0.94
8-Jan-08	9:40	71 31,6	N	125 36,3	W	151	Ice team	360	280	6	-23.4	-0.98
8-Jan-08	11:40	71 31,6	N	125 37,0	W	151	Ice team	358	280	5	-24	-1
8-Jan-08	13:00	71 31,7	N	125 37,4	W	151	Rosette in	352	305	5	-23.8	-1.14
8-Jan-08	13:20	71 31,6	N	125 37,4	W	151	Rosette out	351	305	5	-23.4	-1.14
8-Jan-08	16:15	71 31,6	N	125 37,5	W	151	Tucker in	353	300	8	-24.6	-1.18
8-Jan-08	17:45	71 31,5	N	125 37,9	W	151	Tucker out	354	295	7	-26.5	-1.16
8-Jan-08	19:00	71 31,4	N	125 38,1	W	151	Rosette in	361	290	5	-26.7	-1.19
8-Jan-08	19:25	71 31,4	N	125 38,2	W	151	Rosette out	361	290	5	-26.7	-1.16
8-Jan-08	19:30	71 31,4	N	125 38,2	W	151	Vmp in	361	290	5	-26.6	-1.16
8-Jan-08	19:43	71 31,4	N	125 38,2	W	151	Ice team	361	290	5	-26.6	-1.14
8-Jan-08	19:53	71 31,4	N	125 38,3	W	151	Vmp out	360	290	5	-26.6	-1.13
8-Jan-08	21:00	71 31,4	N	125 38,6	W	151	Ice team	360	300	5	-26.8	-1.06
8-Jan-08	21:30	71 31,4	N	125 38,8	W	151	Ice team	360	310	5	-26.6	-1.08
8-Jan-08	22:05	71 31,4	N	125 38,9	W	151	Rosette ctd in	362	290	6	-27.2	-1.11
8-Jan-08	22:20	71 31,5	N	125 39,1	W	151	Rosette ctd out	362	300	6	-27.3	-1.1
8-Jan-08	23:35	71 31,5	N	125 39,6	W	151	Ice team	361	310	5	-26.6	-1.01
9-Jan-08	6:57	71 31,4	N	125 41,7	W	151	Rosette in	364	300	5	-28.8	-1.09
9-Jan-08	7:17	71 31,4	N	125 41,9	W	151	Rosette out	364	310	5	-28.6	-1.08
9-Jan-08	8:30	71 31,5	N	125 42,3	W	151	Rosette in	365	Calme		-28.5	-1.07
9-Jan-08	9:20	71 31,5	N	125 42,7	W	151	Rosette out	366	Calme		-28.3	-1.06
9-Jan-08	9:35	71 31,5	N	125 42,8	W	151	Ice team Debbie	367	Calme		-28.3	-1.06
9-Jan-08	9:45	71 31,6	N	125 42,9	W	151	Hydrobios in	361	Calme		-28	-1.08
9-Jan-08	10:30	71 31,6	N	125 43,2	W	151	Hydrobios out	367	Calme		-28.8	-1.1
9-Jan-08	11:30	71 31,7	N	125 44,0	W	151	Ice team Tim	367	Calme		-27.9	-1.1
9-Jan-08	13:10	71 31,7	N	125 44,7	W	151	Rosette in	360	Calme		-28.2	-1.07
9-Jan-08	13:25	71 31,7	N	125 44,9	W	151	Rosette out	360	Calme		-27.5	-1.06
9-Jan-08	14:25	71 31,7	N	125 45,5	W	151	Ice team Russe	354	Calme		-28.2	-1.02
9-Jan-08	16:01	71 31,7	N	125 46,3	W	151	Tucker in	368	Calme		-27	-1.02

A	B	C	D	E	F	G	H	I	J	K	L	M
9-Jan-08	17:14	71 31,7	N	125 46,9	W	151	Tucker out	368	Calme		-25.7	-0.96
9-Jan-08	18:56	71 31,7	N	125 47,7	W	151	Rosette in	370	Calme		-25.4	-0.96
9-Jan-08	19:23	71 31,7	N	125 47,9	W	151	Rosette out	370	Calme		-25.1	-0.99
9-Jan-08	19:26	71 31,7	N	125 47,9	W	151	Vmp in	370	Calme		-25	-1.01
9-Jan-08	19:30	71 31,7	N	125 47,9	W	151	Ice team Tao	370	Calme		-25	-1.01
9-Jan-08	19:55	71 31,7	N	125 48,1	W	151	Vmp out	371	Calme		-25	-1.04
9-Jan-08	20:35	71 31,9	N	125 48,5	W	151	Ice team Debbie	372	Calme		-24.5	-1.01
9-Jan-08	21:10	71 32,0	N	125 48,8	W	151	Ice team Tim	372	Calme		-23.8	-1.01
9-Jan-08	21:43	71 32,0	N	125 49,2	W	151	Ice team Debbie	372	Calme		-23.2	-1
9-Jan-08	22:00	71 32,1	N	125 49,4	W	151	Rosette ctd in	373	Calme		-23.2	-0.99
9-Jan-08	22:15	71 32,2	N	125 49,6	W	151	Rosette ctd out	373	110	5	-23.2	-0.97
9-Jan-08	22:40	71 32,3	N	125 49,9	W	151	Ice team Tao	373	110	5	-23.3	-0.95
10-Jan-08	7:00	71 34,4	N	125 56,0	W	156	Rosette in	385	70	12	-23.4	0.92
10-Jan-08	7:20	71 34,4	N	125 56,3	W	156	Rosette out	386	70	11	-23.2	0.94
10-Jan-08	8:03	71 34,7	N	125 57,1	W	156	Rosette in	388	70	10	-22.9	-1.06
10-Jan-08	8:20	71 34,8	N	125 57,3	W	156	Rosette out	391	80	11	-22.4	-1.02
10-Jan-08	8:35	71 34,9	N	125 57,7	W	157	Ice team Debbie	392	80	10	-22.3	-0.93
10-Jan-08	9:00	71 35,0	N	125 58,0	W	157	Rosette in	393	80	10	-22.3	-0.91
10-Jan-08	9:20	71 35,1	N	125 58,4	W	158	Rosette out	396	90	10	-22.2	-0.9
10-Jan-08	9:40	71 35,3	N	125 58,8	W	158	Rosette in	398	90	10	-21.6	-0.91
10-Jan-08	10:00	71 35,4	N	125 59,1	W	158	Rosette out	403	100	12	-21.5	-0.91
10-Jan-08	10:20	71 35,6	N	125 59,6	W	158	Rosette in	407	100	12	-21.4	-0.93
10-Jan-08	11:00	71 35,9	N	126 00,4	W	158	Rosette out	411	100	12	-21.4	-0.9
10-Jan-08	11:20	71 36,1	N	126 00,9	W	158	Rosette in	410	90	12	-21.5	-0.94
10-Jan-08	12:00	71 36,4	N	126 01,7	W	159	Rosette out	398	100	13	-21.5	-1.02
10-Jan-08	12:20	71 36,6	N	126 02,0	W	159	Rosette in	395	90	12	-21.5	-1.02
10-Jan-08	13:00	71 36,9	N	126 02,7	W	159	Rosette out	393	120	19	-21	-1.07
10-Jan-08	13:30	71 37,2	N	126 03,3	W	159	Rosette in	380	125	20	-21.2	-1.03
10-Jan-08	14:05	71 37,5	N	126 03,8	W	160	Rosette out	372	125	21	-21.3	-1.02
10-Jan-08	14:25	71 37,6	N	126 04,1	W	160	Rosette in	368	125	19	-21.3	-1.01
10-Jan-08	15:00	71 37,9	N	126 04,6	W	160	Rosette out	360	110	20	-21.4	-0.99
10-Jan-08	15:20	71 38,0	N	126 04,8	W	160	Rosette in	360	100	15	-21.4	-0.99
10-Jan-08	15:30	71 38,1	N	126 04,9	W	161	Ice team Russe	357	110	18	-21.6	-0.99
10-Jan-08	16:03	71 38,3	N	126 05,2	W	161	Rosette in	356	120	20	-21.8	-0.99
10-Jan-08	16:28	71 38,4	N	126 05,5	W	161	Rosette out	350	120	20	-21.7	-1
10-Jan-08	16:30	71 38,4	N	126 05,6	W	161	Tucker in	350	120	24	-21.7	-1
10-Jan-08	17:07	71 38,6	N	126 05,9	W	161	Tucker out	346	120	25	-21.6	-1
10-Jan-08	17:36	71 38,8	N	126 06,3	W	161	Rosette in	343	120	24	-21.6	-0.99
10-Jan-08	17:55	71 38,9	N	126 06,5	W	161	Rosette out	343	120	23	-21.8	-0.99
10-Jan-08	18:00	71 38,9	N	126 06,6	W	162	Rosette in	340	120	26	-21.8	-0.99
10-Jan-08	18:25	71 38,9	N	126 06,9	W	162	Rosette out	338	120	27	-21.8	-0.99
10-Jan-08	19:00	71 39,3	N	126 07,4	W	162	Rosette in	328	120	24	-21.9	-1
10-Jan-08	19:25	71 39,6	N	126 07,8	W	162	Rosette out	325	120	23	-21.9	-0.99
10-Jan-08	20:01	71 39,8	N	126 08,3	W	162	Rosette in	322	120	25	-21.8	-0.99
10-Jan-08	20:22	71 39,9	N	126 08,5	W	162	Rosette out	321	110	25	-21.8	-1
10-Jan-08	21:05	71 40,2	N	126 09,0	W	163	Rosette in	307	120	22	-21.6	-1.01
10-Jan-08	21:20	71 40,3	N	126 09,3	W	163	Rosette out	307	120	20	-21.5	-1.02
10-Jan-08	21:50	71 40,6	N	126 09,7	W	163	Ice team Debbie	296	120	23	-21.4	-1
11-Jan-08	7:04	71 43,2	N	126 13,1	W	164	Rosette in	235	175	10	-19.7	-0.98
11-Jan-08	7:07	71 43,2	N	126 13,1	W	164	Ice team Dustin	235	180	8	-19.7	-0.99
11-Jan-08	7:37	71 43,3	N	126 13,1	W	164	Rosette out	234	180	11	-19.7	-0.98
11-Jan-08	8:05	71 43,3	N	126 13,2	W	164	Vmp in	235	164	10	-19.7	-1.01
11-Jan-08	8:30	71 43,3	N	126 13,2	W	164	Vmp out	171	175	10	-19.7	-1.01
11-Jan-08	9:05	71 43,4	N	126 13,3	W	164	Hydrobios in	238	175	10	-19.8	-1.02
11-Jan-08	9:25	71 43,4	N	126 13,4	W	164	Hydrobios out	237	175	10	-19.9	-1.02
11-Jan-08	10:30	71 43,5	N	126 13,6	W	164	Rosette ctd in	243	175	10	-19.8	-0.95
11-Jan-08	10:45	71 43,5	N	126 13,7	W	164	Rosette ctd out	243	175	10	-19.8	-0.95
12-Jan-08	7:40	71 37,0	N	126 02,3	W	192	Rosette in	386	240	12	-27.7	-1.07
12-Jan-08	8:10	71 37,0	N	126 02,2	W	192	Rosette out	387	230	12	-27.9	-1.12
12-Jan-08	8:33	71 37,0	N	126 02,2	W	192	Hydrobios in	381	235	13	-28.5	-1.11
12-Jan-08	9:00	71 37,0	N	126 02,2	W	192	Hydrobios out	394	240	11	-28.1	-1.1
12-Jan-08	9:25	71 37,0	N	126 02,2	W	192	Tucker in	388	240	11	-28.1	-1.1
12-Jan-08	9:50	71 37,0	N	126 02,2	W	192	Tucker out	388	250	11	-28	-1.1
12-Jan-08	9:50	71 37,0	N	126 02,2	W	192	Tucker in	388	250	11	-28	-1.1
12-Jan-08	10:30	71 37,0	N	126 02,2	W	192	Tucker out manqué	388	250	10	-28.3	-1.08
12-Jan-08	18:59	71 30,9	N	125 09,7	W	73	Rosette in	260	260	5	-28	-1.09
12-Jan-08	19:16	71 30,9	N	125 09,7	W	74	Rosette out	260	260	6	-28	-1.1
13-Jan-08	7:09	71 27,9	N	124 59,1	W	105	Rosette in	227	15	5	-28.9	-1.2

A	B	C	D	E	F	G	H	I	J	K	L	M
13-Jan-08	7:26	71 27,9	N	124 59,1	W	105	Rosette out	221	20	5	-28.9	-1.2
13-Jan-08	8:15	71 28,0	N	124 59,4	W	105	Hydrobios in	221	45	5	-28.8	-1.1
13-Jan-08	8:35	71 28,0	N	124 59,5	W	105	Hydrobios out	214	25	5	-29	-1.04
13-Jan-08	9:05	71 27,9	N	124 59,7	W	105	Tucker in	221	25	8	-28.7	-1.05
13-Jan-08	9:20	71 27,9	N	124 59,8	W	105	Tucker out	221	35	6	-28.6	-1.04
14-Jan-08	18:54	71 30,9	N	124 51,5	W	90	Rosette in	210	60	18	-25	-1.18
14-Jan-08	19:15	71 30,9	N	124 51,8	W	90	Rosette out	210	60	20	-25.1	-1.19
14-Jan-08	19:20	71 30,9	N	124 51,8	W	90	Vmp in	213	60	17	-25.1	-1.19
14-Jan-08	20:00	71 30,8	N	124 52,4	W	90	Vmp out	212	60	18	-25	-1.16
14-Jan-08	20:03	71 30,8	N	124 53,1	W	90	Tucker in	214	45	20	-25.1	-1.15
14-Jan-08	20:50	71 30,8	N	124 53,4	W	90	Tucker out	219	55	25	-25.2	-1.14
14-Jan-08	21:07	71 30,8	N	124 53,6	W	90	Hydrobios in	216	50	20	-25.3	-1.16
14-Jan-08	21:25	71 30,8	N	124 54,0	W	91	Hydrobios out	217	45	20	-25.2	-1.17
14-Jan-08	21:55	71 30,7	N	124 55,7	W	91	Groupde Tao fin	218	60	10	-24.8	-1.17
15-Jan-08	7:00	71 30,7	N	124 55,7	W	90	Rosette Ctd Dna in	222	35	9	-25.7	-0.99
15-Jan-08	7:25	71 30,7	N	124 55,7	W	90	Rosettwe Ctd out	218	40	8	-25.6	-1.04
15-Jan-08	8:05	71 30,7	N	124 55,7	W	90	Vmp in	217	30	10	-25.7	-1.07
15-Jan-08	8:26	71 30,7	N	124 55,7	W	90	Vmp out	224	30	9	-25.7	-1.07
15-Jan-08	8:50	71 30,7	N	124 55,7	W	90	Ice team	223	30	8	-25.8	-1
15-Jan-08	10:23	71 30,7	N	124 55,7	W	90	EM scan start	223	20	6	-25.6	-1.02
15-Jan-08	11:06	71 30,7	N	124 55,7	W	90	Em scan end	223	15	10	-25.3	-1.03
15-Jan-08	13:15	71 30,7	N	124 55,6	W	90	Rosette in	224	5	7	-24.7	-1
15-Jan-08	13:35	71 30,7	N	124 55,6	W	90	Rosette out	224	5	8	-24.9	-0.98
15-Jan-08	17:45	71 30,6	N	124 55,6	W	90	Emscan start	225	345	7	-25.9	-0.96
15-Jan-08	18:34	71 30,6	N	124 55,3	W	89	EM Scan Stop	224	350	10	-26	-1.03
15-Jan-08	19:00	71 30,6	N	124 55,3	W	90	Rosette in	226	350	9	-26.2	-1.06
15-Jan-08	19:16	71 30,6	N	124 55,3	W	90	Rosette out	226	350	9	-26.3	-1.04
15-Jan-08	19:20	71 30,6	N	124 55,3	W	90	Vmp in	226	350	10	-26.4	-1.04
15-Jan-08	19:46	71 30,5	N	124 55,2	W	90	Vmp out	224	0	9	-26.4	-1.09
15-Jan-08	20:10	71 30,5	N	124 55,3	W	90	Team on ice	226	347	10	-26.1	-1.03
15-Jan-08	21:00	71 30,5	N	124 55,2	W	90	Filet tucker début	226	345	8	-26.5	-1.11
15-Jan-08	21:25	71 30,5	N	124 55,2	W	90	Filet tucker fin	227	355	7	-26.4	-1.13
15-Jan-08	21:45	71 30,5	N	124 55,2	W	90	Retour de Tao	227	340	5	-26.3	-1.15
15-Jan-08	22:05	71 30,5	N	124 55,2	W	90	Ctd in	227	340	9	-26.1	-1.14
15-Jan-08	22:20	71 30,5	N	124 55,2	W	90	Ctd out	227	340	9	-26.3	-1.12
15-Jan-08	22:35	71 30,5	N	124 55,1	W	90	Vmp in	227	350	8	-26.7	-1.08
15-Jan-08	22:50	71 30,5	N	124 55,1	W	90	Vmp out	227	345	8	-26.8	-1.06
16-Jan-08	7:00	71 30,5	N	124 55,1	W	90	Rosette in	227	Calme		-25.6	-1.15
16-Jan-08	7:12	71 30,5	N	124 55,1	W	90	Rosette out	226	Calm e		-25.3	-1.15
16-Jan-08	8:50	71 30,5	N	124 55,1	W	90	Team on ice	226	70	8	-24.8	-1.1
16-Jan-08	9:40	71 30,5	N	124 55,1	W	90	Hydrobios in	225	70	8	-25.3	-1.04
16-Jan-08	10:00	71 30,5	N	124 55,1	W	90	Hydrobios out	225	75	8	-25.2	-1
16-Jan-08	10:15	71 30,5	N	124 55,1	W	90	EM Scan Start	225	80	9	-25.2	-1
16-Jan-08	10:25	71 30,5	N	124 55,1	W	90	Tucker début	225	85	8	-25.2	-1
16-Jan-08	11:00	71 30,5	N	124 55,1	W	90	EM scan end	223	90	9	-25.5	-1.1
16-Jan-08	11:15	71 30,5	N	124 55,1	W	90	Tucker out	225	90	8	-25.5	-1.1
16-Jan-08	13:05	71 30,5	N	124 55,1	W	90	Rosette in	226	98	7	-25.7	-1.1
16-Jan-08	13:25	71 30,5	N	124 55,2	W	90	Rosette out	225	115	6	-25.7	-1.07
16-Jan-08	17:00	71 30,5	N	124 55,4	W	90	EM scan start	226	160	6	-25.2	-0.99
16-Jan-08	18:00	71 30,6	N	124 55,4	W	90	EM scan stop	226	170	5	-25.1	-1.02
16-Jan-08	19:00	71 30,6	N	124 55,4	W	90	Rosette in	226	170	4	-25.2	-1.01
16-Jan-08	19:17	71 30,6	N	124 55,4	W	90	Rosette out	227	170	5	-25.2	-1
16-Jan-08	19:26	71 30,6	N	124 55,5	W	90	Vmp in	226	170	5	-25.5	-1
16-Jan-08	19:38	71 30,6	N	124 55,5	W	90	Vmp out	226	180	3	-25.5	-0.99
16-Jan-08	20:05	71 30,6	N	124 55,5	W	90	Ice team Tao	226	190	3	-25.8	-1.01
16-Jan-08	22:00	71 30,6	N	124 55,4	W	90	Rosette in	226	155	5	-26.2	-0.99
16-Jan-08	22:15	71 30,6	N	124 55,4	W	90	Rosette out	226	165	5	-26.1	-1
17-Jan-08	7:00	71 31,1	N	124 57,1	W	92	Rosette in	220	140	8	-26.2	-0.99
17-Jan-08	7:15	71 31,1	N	124 57,2	W	92	Rosette out	219	140	8	-26.5	-0.97
17-Jan-08	8:10	71 31,2	N	124 57,4	W	92	Hydrobios in	214	140	9	-26.1	-1
17-Jan-08	8:35	71 31,2	N	124 57,4	W	92	Hydrobios out	218	140	8	-25.9	-1.02
17-Jan-08	9:07	71 31,3	N	124 57,5	W	92	Tucker in	214	140	7	-25.9	-1.01
17-Jan-08	9:55	71 31,3	N	124 57,6	W	92	Tucker out (2x)	217	145	7	-26.3	-1.05
17-Jan-08	10:00	71 31,3	N	124 57,6	W	92	EM scan start	217	145	7	-26.3	-1.04
17-Jan-08	11:20	71 31,4	N	124 57,7	W	92	EM Scan end	216	150	10	-26.4	-1.04
17-Jan-08	12:55	71 31,5	N	124 57,9	W	93	Rosette in	215	145	9	-26.2	-1.05
17-Jan-08	13:35	71 31,6	N	124 58,0	W	93	Rosette out	217	150	8	-25.8	-1.02
17-Jan-08	13:40	71 31,6	N	124 58,0	W	93	Vmp in	217	150	8	-25.8	-1.02

A	B	C	D	E	F	G	H	I	J	K	L	M
17-Jan-08	13:55	71 31,6	N	124 58,0	W	93	Vmp out	217	140	7	-25.7	-1.01
17-Jan-08	17:20	71 31,7	N	124 58,3	W	93	Em scan start	215	100	8	-26.3	-1.01
17-Jan-08	18:35	71 31,7	N	124 58,5	W	93	EM scan end	215	100	9	-26.1	-0.98
17-Jan-08	19:02	71 31,7	N	124 58,5	W	93	Rosette in	215	130	7	-25.9	-0.99
17-Jan-08	19:20	71 31,7	N	124 58,5	W	93	Rosette out	215	130	5	-25.8	-0.99
17-Jan-08	20:10	71 31,8	N	124 58,7	W	93	Ice team Tao	215	115	4	-24.7	-0.95
17-Jan-08	22:05	71 31,8	N	124 58,7	W	93	Ice team Tao	216	150	7	-25.1	-0.96
17-Jan-08	22:22	71 31,8	N	124 58,7	W	93	Rosette Ctd out	216	165	8	-25.4	-0.97
18-Jan-08	6:00	71 32,2	N	124 59,7	W	94	Hydrobios in	217	150	11	-25.6	-1.06
18-Jan-08	6:29	71 32,3	N	124 59,9	W	94	Hydrobios out	215	150	11	-25.4	-1.05
18-Jan-08	7:00	71 32,4	N	125 00,0	W	94	Rosette in	215	150	10	-25.2	-1.04
18-Jan-08	7:13	71 32,5	N	125 00,1	W	94	Rosette out	216	150	10	-25.3	-1.04
18-Jan-08	7:30	71 32,5	N	125 00,2	W	95	Tucker in (1)	216	150	10	-25.2	-1.04
18-Jan-08	7:52	71 32,6	N	125 00,4	W	95	Tucker out (1)	214	150	10	-25.9	-1.04
18-Jan-08	8:15	71 32,6	N	125 00,5	W	95	Tucker out (2)	216	165	11	-24.7	-1.04
18-Jan-08	8:37	71 32,7	N	125 00,5	W	95	Rosette in	217	170	12	-24.7	-1.03
18-Jan-08	8:47	71 32,7	N	125 00,6	W	95	Ice team Tao	213	175	12	-24.7	-1.03
18-Jan-08	8:50	71 32,7	N	125 00,6	W	95	Rosette out	213	175	12	-24.7	-1.03
18-Jan-08	9:00	71 32,7	N	125 00,6	W	95	Rosette in	213	170	12	-24.7	-1.02
18-Jan-08	9:18	71 32,8	N	125 00,6	W	95	Rosette out	217	160	15	-24.6	-1.03
18-Jan-08	9:35	71 32,8	N	125 00,7	W	95	Ice team	217	160	15	-24.4	-1.04
18-Jan-08	10:10	71 32,9	N	125 00,7	W	95	EM scan start rosette	217	160	15	-24.1	-1.03
18-Jan-08	10:22	71 32,9	N	125 00,8	W	95	Rosette out	217	170	14	-23.9	-1.02
18-Jan-08	10:50	71 32,9	N	125 00,8	W	95	Team Tao and Andrea	218	170	13	-23.7	-1.01
18-Jan-08	11:02	71 32,9	N	125 00,8	W	95	Rosette in	217	170	13	-23.6	-1.02
18-Jan-08	11:18	71 32,9	N	125 00,8	W	95	EM scan end	215	170	12	-23.6	-1.03
18-Jan-08	11:30	71 33,0	N	125 00,8	W	95	Rosette out	215	175	13	-23.4	-1.03
18-Jan-08	12:10	71 32,9	N	125 00,8	W	95	Rosette in	217	180	9	-23.2	-1.01
18-Jan-08	12:22	71 32,9	N	125 00,7	W	95	Rosette out	217	180	9	-23.2	-1.01
18-Jan-08	13:05	71 33,0	N	125 00,7	W	95	Rosette in	214	180	10	-22.8	-1
18-Jan-08	13:18	71 33,0	N	125 00,7	W	95	Rosette out	215	170	10	-22.8	-1.01
18-Jan-08	14:00	71 33,0	N	125 00,6	W	95	Rosette in	215	180	9	-22.2	-1
18-Jan-08	14:12	71 33,0	N	125 00,6	W	95	Rosette out	215	190	7	-22	-1
18-Jan-08	15:00	71 33,0	N	125 00,5	W	95	Rosette in	215	220	10	-21.4	-0.98
18-Jan-08	15:12	71 33,0	N	125 00,5	W	95	Rosette out	214	215	10	-21.4	-0.97
18-Jan-08	16:00	71 32,9	N	125 00,5	W	95	Rosette in	214	210	10	-21.7	-0.96
18-Jan-08	16:15	71 32,9	N	125 00,5	W	95	Rosette out	212	210	9	-21.8	-0.96
18-Jan-08	16:32	71 32,9	N	125 00,5	W	95	Physics coring start	210	210	9	-22	-0.95
18-Jan-08	16:55	71 32,9	N	125 00,5	W	95	Rosette in	214	210	7	-22	-0.97
18-Jan-08	17:00	71 32,9	N	125 00,5	W	95	Physics coring end	214	210	8	-22	-0.96
18-Jan-08	17:12	71 32,9	N	125 00,5	W	95	EM scan start	214	210	9	-21.9	-0.98
18-Jan-08	17:15	71 32,9	N	125 00,5	W	95	Rosette out	212	210	9	-21.9	-0.99
18-Jan-08	18:00	71 32,9	N	125 00,5	W	95	Rosette in	215	210	6	-21.8	-0.99
18-Jan-08	18:15	71 32,9	N	125 00,4	W	95	Rosette out	215	210	7	-21.7	-1.02
18-Jan-08	18:38	71 32,9	N	125 00,3	W	95	EM scan end	214	260	7	-22.2	-1.01
18-Jan-08	18:57	71 32,9	N	125 00,3	W	95	Rosette in	213	270	5	-22.6	-1.01
18-Jan-08	19:12	71 32,9	N	125 00,3	W	95	Rosette out	214	270	5	-22.6	-1.02
18-Jan-08	20:03	71 32,9	N	125 00,2	W	95	Rosette in	215	285	5	-22.4	-1
18-Jan-08	20:15	71 32,9	N	125 00,2	W	95	Rosette out	215	300	9	-22.4	-0.99
18-Jan-08	20:57	71 32,9	N	125 00,1	W	95	Rosette in	216	315	9	-22.6	-0.97
18-Jan-08	21:10	71 32,9	N	125 00,1	W	95	Rosette out	216	310	9	-22.8	-0.96
18-Jan-08	22:05	71 32,8	N	125 00,0	W	95	Ice team Tao	214	340	11	-23.6	-0.97
19-Jan-08	7:01	71 32,7	N	124 59,9	W	95	Rosette in	213	330	7	-24.8	-1.01
19-Jan-08	7:15	71 32,7	N	124 59,7	W	94	Rosette out	212	330	8	-25	-1
19-Jan-08	8:40	71 32,8	N	124 59,8	W	95	Ice team	212	0	5	-24.7	-1
19-Jan-08	9:31	71 32,8	N	124 59,8	W	94	Hydrobios in	213	345	5	-24.8	-1.01
19-Jan-08	9:50	71 32,8	N	124 59,8	W	94	Hydrobios out	213	350	3	-24.8	-0.99
19-Jan-08	10:18	71 32,8	N	124 59,8	W	94	Tcker in (2x)	213	355	2	-24.7	-0.98
19-Jan-08	10:24	71 32,8	N	124 59,8	W	94	EM scan start	213	Calme		-24.7	-0.98
19-Jan-08	10:57	71 32,8	N	124 59,8	W	95	Tucker out	213	Calme		-24.8	-1
19-Jan-08	11:50	71 32,8	N	124 59,7	W	94	EM scan end	121	Calme		-24.7	-0.99
19-Jan-08	13:05	71 32,7	N	124 59,7	W	95	Rosette in	215	Calme		-25.5	-0.95
19-Jan-08	13:17	71 32,8	N	124 59,7	W	95	Rosette out	214	Calme		-24.4	-0.95
19-Jan-08	16:32	71 32,7	N	124 59,6	W	94	Physics core team	212	110	7	-24.7	-0.93
19-Jan-08	17:08	71 32,7	N	124 59,6	W	94	Em scan start	214	120	8	-25.2	-0.93
19-Jan-08	18:45	71 32,8	N	124 59,7	W	95	EM scan end	213	90	5	-24.9	-0.94
19-Jan-08	19:00	71 32,8	N	124 59,7	W	95	Rosette in	214	85	5	-25	-0.94
19-Jan-08	19:20	71 32,8	N	124 59,7	W	95	Rosette out	215	100	8	-24.9	-0.92

A	B	C	D	E	F	G	H	I	J	K	L	M
19-Jan-08	20:05	71 32,8	N	124 59,9	W	95	Ice team Tao	214	120	9	-25.4	-0.92
19-Jan-08	20:20	71 32,9	N	124 59,9	W	95	Ice team Russe	213	115	7	-25.4	-0.92
19-Jan-08	20:55	71 32,9	N	125 00,0	W	95	Ice team Russe end	213	90	8	-25.1	-0.95
19-Jan-08	22:00	71 33,0	N	125 00,2	W	95	Rosette in	215	115	9	-24.4	-0.96
19-Jan-08	22:15	71 33,0	N	125 00,3	W	95	Rosette out and Tao	214	110	10	-24.1	-0.99
20-Jan-08	7:00	71 33,9	N	125 03,2	W	97	Rosette in	224	110	14	-21.1	-1.14
20-Jan-08	7:22	71 33,9	N	125 03,4	W	97	Rosette out	224	110	12	-21.3	-1.14
20-Jan-08	20:35	71 34,2	N	125 04,2	W	98	Ice team Russe	230	105	9	-22.3	-1.09
20-Jan-08	9:03	71 34,2	N	125 04,4	W	98	Ice team Russe	230	100	10	-22.3	-1.06
20-Jan-08	9:11	71 34,2	N	125 04,5	W	98	Physics coring team	230	100	11	-22.2	-1.06
20-Jan-08	9:30	71 34,3	N	125 04,6	W	98	Hydrobios in	232	110	10	-22.1	-1.05
20-Jan-08	9:46	71 34,3	N	125 04,7	W	98	Hydrobios out	232	100	9	-22.1	-1.06
20-Jan-08	9:53	71 34,3	N	125 04,8	W	98	Physics coring team	236	100	8	-22.1	-1.09
20-Jan-08	10:05	71 34,3	N	125 04,9	W	98	EM scan on	235	105	7	-22.1	1.09
20-Jan-08	10:25	71 34,3	N	125 05,0	W	98	Tucker in (2x)	235	115	8	-22.2	-1.09
20-Jan-08	11:10	71 34,4	N	125 05,3	W	98	Tucker out	237	125	8	-21.7	-1.1
20-Jan-08	11:27	71 34,4	N	125 05,3	W	98	EM scan out	240	120	8	-21.7	-1.1
20-Jan-08	13:05	71 34,5	N	125 05,7	W	99	Rosette in	238	100	8	-21.3	-1.1
20-Jan-08	13:20	71 34,5	N	125 05,8	W	99	Rosette out	222	110	6	-21.3	-1.1
20-Jan-08	16:25	71 34,7	N	125 06,2	W	99	Physics core team	237	100	10	-17.2	-1.1
20-Jan-08	16:55	71 34,8	N	125 06,3	W	99	EM scan start	238	125	8	-16.5	-1.1
20-Jan-08	19:04	71 35,0	N	125 06,9	W	99	Rosette in	235	150	23	-14.9	-1.06
20-Jan-08	19:20	71 35,0	N	125 06,9	W	99	Rosette out	232	150	27	-14.8	-1.07
20-Jan-08	20:03	71 35,2	N	125 07,3	W	100	Ice team Tao	235	160	22	-14.8	-1.16
20-Jan-08	21:50	71 35,5	N	125 08,1	W	100	Ice team Tao	238	145	25	-16	-1.13
20-Jan-08	22:16	71 35,5	N	125 08,1	W	100	Rosette in	239	150	25	-16	-1.13
20-Jan-08	22:35	71 35,5	N	125 08,2	W	100	Rosette out	237	150	20	-16	-1.11
21-Jan-08	6:09	71 36,2	N	125 09,3	W	101	Hydrobios in	242	150	25	-16.9	-1.15
21-Jan-08	6:26	71 36,2	N	125 09,3	W	101	Hydrobios out	242	140	15	-16.9	-1.13
21-Jan-08	7:08	71 36,2	N	125 09,4	W	102	Rosette in	242	140	15	-17	-1.05
21-Jan-08	7:27	71 36,2	N	125 09,3	W	101	Rosette out	242	140	18	-17.2	-1.04
21-Jan-08	8:08	71 36,2	N	125 09,4	W	101	EM scan start	242	160	15	-17.7	-1.1
21-Jan-08	8:35	71 36,2	N	125 09,4	W	101	Ice team tower	235	160	13	-17.6	-1
21-Jan-08	9:00	71 36,2	N	125 09,4	W	101	EM scan end	242	160	17	-17.2	-0.99
21-Jan-08	9:55	71 36,2	N	125 09,4	W	102	Hydrobios in	242	180	15	-17	-0.98
21-Jan-08	10:20	71 36,2	N	125 09,4	W	102	Hydrobios out	242	175	15	-17.2	-0.99
21-Jan-08	10:37	71 36,2	N	125 09,4	W	102	Ice team Debbie	242	180	15	-17.3	-1
21-Jan-08	11:25	71 36,2	N	125 09,4	W	101	EM scan start	242	185	13	-17.2	-0.98
21-Jan-08	12:45	71 36,2	N	125 09,4	W	102	Rosette in	242	200	11	-16.6	-1
21-Jan-08	13:10	71 36,2	N	125 09,4	W	101	EM scan start	242	200	10	-16.4	-1.01
21-Jan-08	13:20	71 36,2	N	125 09,4	W	101	Rosette out	242	210	12	-16.3	-1.01
21-Jan-08	14:00	71 36,2	N	125 09,4	W	101	Hydrobios in	242	200	8	-16.1	-1.01
21-Jan-08	14:25	71 36,2	N	125 09,4	W	101	Hydrobios out	242	200	6	-15.5	-1
21-Jan-08	18:10	71 36,2	N	125 09,4	W	102	Hydrobios in	241	270	5	-15.2	-0.99
21-Jan-08	18:30	71 36,2	N	125 09,3	W	101	Hydrobios out	241	250	5	-15.1	-0.99
21-Jan-08	19:09	71 36,2	N	125 09,4	W	102	Rosette in	242	270	5	-14.1	-0.99
21-Jan-08	19:23	71 36,2	N	125 09,4	W	102	Rosette out	241	270	5	-15.9	-0.99
21-Jan-08	21:53	71 36,2	N	125 09,4	W	102	Rosette in	241	200	4	-16.7	-0.97
21-Jan-08	22:05	71 36,2	N	125 09,4	W	102	Rosette out	241	200	5	-16.9	-0.99
21-Jan-08	22:21	71 36,2	N	125 09,4	W	102	Hydrobios in	241	190	4	-17.1	-0.98
21-Jan-08	22:40	71 36,2	N	125 09,4	W	102	Hydrobios out	241	185	4	-17.6	-0.97
22-Jan-08	2:10	71 36,2	N	125 09,4	W	102	Hydrobios in	241	160	10	-19.5	-1.02
22-Jan-08	2:30	71 36,2	N	125 09,4	W	102	Hydrobios out	241	160	8	-19.2	-1.03
22-Jan-08	5:58	71 36,2	N	125 09,4	W	102	Hydrobios in	242	160	10	-15.5	-1.03
22-Jan-08	6:16	71 36,2	N	125 09,4	W	102	Hydrobios out	242	155	10	-14.9	-1
22-Jan-08	7:05	71 36,2	N	125 09,3	W	102	Rosette in	242	160	10	-13.6	-0.97
22-Jan-08	7:27	71 36,2	N	125 09,3	W	102	Rosette out	242	160	10	-13.7	-0.94
22-Jan-08	8:10	71 36,2	N	125 09,4	W	102	Ice team Tao	242	170	6	-12.7	-0.96
22-Jan-08	9:20	71 36,2	N	125 09,4	W	102	Ice team Tao	242	160	7	-12.4	-0.98
22-Jan-08	9:44	71 36,2	N	125 09,4	W	102	Rosette in	242	160	7	-12.5	-0.98
22-Jan-08	9:55	71 36,2	N	125 09,4	W	102	Rosette out	241	155	7	-12.2	-0.98
22-Jan-08	18:55	71 25,1	N	125 22,6	W	211	Tao+Ice core	308	140	18	-8.2	-1.34
22-Jan-08	20:20	71 25,3	N	125 22,9	W	211	Ice coring team	306	125	14	-9.4	-1.27
22-Jan-08	20:31	71 25,3	N	125 23,0	W	211	Ice team Tao	306	135	15	-9.3	-1.26
23-Jan-08	11:15	71 22,1	N	125 30,6	W	350	Echantillonnage	361	337	12	16.6	-1.49
23-Jan-08	12:00	71 21,8	N	125 33,1	W	1	Echantillonnage	372	335	12	16.5	-1.6
23-Jan-08	13:10	71 17,7	N	125 25,9	W	336	Ice cage start	360	320	8	-16.7	-1.43
23-Jan-08	13:10	71 17,7	N	125 25,9	W	336	EM scan start	360	320	8	-16.7	-1.43

A	B	C	D	E	F	G	H	I	J	K	L	M
23-Jan-08	13:55	71 17,8	N	125 25,9	W	333	Ice cage end	363	335	11	-16.7	-1.23
23-Jan-08	16:40	71 17,0	N	125 24,2	W	245	Ice team	338	355	12	-17.1	-1.14
23-Jan-08	17:40	71 16,8	N	125 24,0	W	245	EM scan start	338	325	12	-17.2	-1.24
23-Jan-08	19:10	71 16,2	N	125 23,4	W	245	EM scan stop	338	290	17	-17.9	-1.2
23-Jan-08	20:00	71 16,2	N	125 23,4	W	245	Light Tao	338	295	17	-18.2	-1.2
23-Jan-08	21:25	71 15,9	N	125 23,0	W	245	Light Tao	338	300	20	-18.1	-1.2
24-Jan-08	8:14	71 13,9	N	125 12,2	W	239	Rosette in	309	300	30	-18.3	-1.27
24-Jan-08	8:51	71 13,5	N	125 11,4	W	239	Rosette out	312	300	33	-19.3	-1.25
24-Jan-08	9:45	71 13,0	N	125 10,4	W	238	Hydrobios in	311	310	35	-19.6	-1.24
24-Jan-08	10:13	71 12,7	N	125 10,0	W	238	Hydrobios out	331	305	35	-19.6	-1.24
24-Jan-08	10:45	71 12,4	N	125 09,6	W	238	Tucker in	315	305	35	-19.6	-1.24
24-Jan-08	11:48	71 12,0	N	125 09,3	W	238	Tucker out	314	305	35	-21.1	-1.28
24-Jan-08	13:05	71 11,0	N	125 08,8	W	238	Rosette in	319	305	30	-22.1	-1.24
24-Jan-08	13:30	71 10,9	N	125 08,9	W	238	Rosette out	319	305	25	-22.4	-1.3
24-Jan-08	19:05	71 10,2	N	125 06,9	W	238	Rosette in	332	300	15	-23.2	-1.24
24-Jan-08	19:00	71 10,2	N	125 06,9	W	238	Ice team on ice	333	300	17	-23.2	-1.2
24-Jan-08	19:28	71 10,16	N	125 06,6	W	238	Rosette out	333	300	14	-23.1	-1.23
24-Jan-08	20:00	71 10,1	N	125 06,2	W	237	Tucker in	335	290	14	-23.1	-1.21
24-Jan-08	20:28	71 10,1	N	125 05,9	W	238	Ice team, fin tucker	333	300	16	-23	-1.22
24-Jan-08	22:03	71 10,0	N	125 05,1	W	238	Rosette in	326	300	13	-22.9	-1.22
24-Jan-08	22:20	71 10,0	N	125 05,1	W	238	Rosette out	326	300	12	-23	-1.2
25-Jan-08	6:00	71 10,7	N	125 05,4	W	238	Rosette in	326	170	12	-25.1	-1.2
25-Jan-08	6:21	71 10,8	N	125 05,3	W	238	Rosette out	326	160	11	-24.7	-1.19
25-Jan-08	7:00	71 10,9	N	125 04,9	W	238	Rosette in	325	160	12	-23.7	-1.21
25-Jan-08	7:17	71 10,9	N	125 04,8	W	238	Rosette out	324	160	11	-23.2	-1.21
25-Jan-08	8:01	71 11,1	N	125 04,4	W	238	Rosette in	324	145	15	-23.3	-1.16
25-Jan-08	8:18	71 11,2	N	125 04,2	W	238	Rosette out	324	160	17	-23.1	-1.16
25-Jan-08	8:44	71 11,3	N	125 04,0	W	238	Ice team, zooplankton	323	175	17	-22.6	-1.12
25-Jan-08	9:02	71 11,3	N	125 03,9	W	238	Rosette in	323	180	17	-22.8	-1.12
25-Jan-08	9:22	71 11,4	N	125 03,8	W	238	Rosette out	324	185	19	-22.8	-1.15
25-Jan-08	10:02	71 11,5	N	125 03,6	W	238	Rosette in	322	185	17	-22.9	-1.16
25-Jan-08	10:19	71 11,6	N	125 03,6	W	238	Rosette out	322	180	16	-22.9	-1.17
25-Jan-08	10:40	71 11,7	N	125 03,5	W	238	Ice team Andrea	322	185	15	-22.8	-1.16
25-Jan-08	11:02	71 11,7	N	125 03,4	W	237	Rosette in	322	200	14	-22.8	-1.13
25-Jan-08	11:20	71 11,8	N	125 03,4	W	237	Rosette out	319	200	14	-22.8	-1.13
25-Jan-08	12:05	71 11,9	N	125 03,3	W	237	Rosette in	319	210	12	-23	-1.16
25-Jan-08	12:20	71 11,9	N	125 03,3	W	237	Rosette out	319	220	12	-23	-1.13
25-Jan-08	13:05	71 11,9	N	125 03,3	W	237	Rosette in	316	240	13	-23.6	-1.11
25-Jan-08	13:25	71 12,0	N	125 03,3	W	237	Rosette out	316	250	12	-23.7	-1.14
25-Jan-08	14:05	71 12,0	N	125 03,3	W	237	Rosette in	316	260	11	-23.9	-1.13
25-Jan-08	14:20	71 12,0	N	125 03,3	W	237	Rosette out	316	270	11	-23.9	-1.14
25-Jan-08	15:03	71 12,0	N	125 03,4	W	237	Rosette in	317	260	8	-23.8	-1.09
25-Jan-08	15:25	71 11,9	N	125 03,4	W	237	Rosette out	317	260	10	-23.7	-1.08
25-Jan-08	16:00	71 11,9	N	125 03,4	W	237	Rosette in	319	260	9	-23.7	-1.12
25-Jan-08	16:27	71 11,9	N	125 03,2	W	236	Rosette out	319	255	9	-23.3	-1.2
25-Jan-08	17:05	71 11,8	N	125 03,0	W	236	Rosette in	319	315	8	-22.7	-1.21
25-Jan-08	17:20	71 11,8	N	125 02,9	W	236	Rosette out	319	310	7	-22.7	-1.2
25-Jan-08	18:05	71 11,7	N	125 02,6	W	236	Rosette in	320	320	9	-22.5	-1.18
25-Jan-08	18:23	71 11,7	N	125 02,4	W	236	Rosette out	321	320	7	-22.4	-1.18
25-Jan-08	19:02	71 11,6	N	125 02,1	W	235	Rosette in	320	320	7	-22.4	-1.18
25-Jan-08	19:25	71 11,5	N	125 02,0	W	235	Rosette out	321	320	8	-22.4	-1.19
25-Jan-08	19:35	71 11,5	N	125 01,8	W	235	Hydrobios in	317	300	9	-22.3	-1.21
25-Jan-08	20:05	71 11,4	N	125 01,6	W	234	Hydrobios out	317	300	15	-23	-1.22
25-Jan-08	20:18	71 11,3	N	125 01,4	W	234	Ice team Tao	316	300	19	-24.4	-1.25
25-Jan-08	22:00	71 10,8	N	125 00,4	W	233	Rosette in	314	300	19	-24.9	-1.27
25-Jan-08	22:20	71 10,7	N	125 00,3	W	233	Rosette out	313	305	17	-24.8	-1.28
26-Jan-08	7:00	71 08,1	N	124 58,5	W	233	Rosette in	306	320	22	-28.2	-1.29
26-Jan-08	7:30	71 08,0	N	124 58,2	W	233	Rosette out	306	320	20	-28.5	-1.29
26-Jan-08	8:15	71 07,7	N	124 57,9	W	233	Ice team Tao	309	320	20	-28.7	-1.3
26-Jan-08	8:20	71 07,7	N	124 57,8	W	233	Hydrobios in	307	315	25	-28.8	-1.3
26-Jan-08	8:50	71 07,6	N	124 57,6	W	233	Ice team Tower	308	310	20	-28.9	-1.3
26-Jan-08	9:10	71 07,4	N	124 57,5	W	233	Hydrobios out	307	310	24	-29.1	-1.3
26-Jan-08	9:55	71 07,3	N	124 57,2	W	233	Hydrobios in	308	315	20	-29.1	1.29
26-Jan-08	10:15	71 07,2	N	124 57,1	W	233	Hydrobios out	310	320	20	-29	-1.27
26-Jan-08	11:15	71 06,9	N	124 56,9	W	233	Ice team	309	325	20	-28.7	-1.27
26-Jan-08	13:05	71 06,7	N	124 56,7	W	233	Rosette in	312	326	18	-28.7	-1.25
26-Jan-08	13:58	71 06,6	N	124 56,6	W	233	Rosette out	315	325	20	-28.6	-1.25
26-Jan-08	14:15	71 06,5	N	124 56,6	W	233	Filet zooplancton	315	325	20	-28.6	-1.25

A	B	C	D	E	F	G	H	I	J	K	L	M
26-Jan-08	19:10	71 05,8	N	124 55,5	W	234	Rosette in	312	325	14	-29.1	-1.24
26-Jan-08	19:26	71 05,8	N	124 55,3	W	235	Rosette out	313	330	16	-29.1	-1.22
26-Jan-08	22:00	71 05,6	N	124 54,7	W	235	Rosette in	315	315	13	-28.7	-1.22
26-Jan-08	22:17	71 05,6	N	124 54,7	W	235	Rosette out	315	315	16	-28.6	-1.22
27-Jan-08	7:09	71 05,5	N	124 54,2	W	235	Rosette in	318	315	12	-28.7	-1.04
27-Jan-08	7:39	71 05,5	N	124 54,1	W	235	Rosette out	315	315	10	-28.3	-1.03
27-Jan-08	8:19	71 05,5	N	124 54,0	W	235	Hydrobios in	317	300	10	-28.3	-1
27-Jan-08	8:23	71 05,5	N	124 54,0	W	235	Ice team Tao	317	300	11	-28.2	-0.99
27-Jan-08	8:35	71 05,5	N	124 54,0	W	235	Bio-coring	316	300	11	-28.2	-1
27-Jan-08	8:42	71 05,5	N	124 54,0	W	235	Hydrobios out	316	300	10	-28.2	-0.97
27-Jan-08	8:55	71 05,5	N	124 54,0	W	235	Ice team tower	316	300	9	-28.2	-1
27-Jan-08	9:15	71 05,5	N	124 54,0	W	235	Tucker in no2	315	300	9	-28.2	-1.02
27-Jan-08	9:35	71 05,5	N	124 53,9	W	235	Ice team tower	314	300	9	-28.2	-1.06
27-Jan-08	9:40	71 05,5	N	124 53,9	W	235	Tucker out no1	314	300	10	-28.2	-1.05
27-Jan-08	9:50	71 05,5	N	124 53,9	W	235	Tucker in no2	315	300	10	-28.2	-1.03
27-Jan-08	10:08	71 05,5	N	124 53,9	W	235	Tucker out no2	316	290	10	-28.3	-1.03
27-Jan-08	10:28	71 05,5	N	124 53,8	W	235	Team Debbie Ice	316	285	7	-28.4	-1.07
27-Jan-08	11:30	71 05,6	N	124 53,8	W	235	Team Debbie Ice	313	295	9	-28.4	-1.09
27-Jan-08	12:20	71 05,6	N	124 53,7	W	235	Sampling new ice	314	260	10	-28.8	-1.1
27-Jan-08	12:35	71 05,6	N	124 53,7	W	235	Rosette in	315	260	10	-28.8	-1.11
27-Jan-08	12:55	71 05,6	N	124 53,7	W	235	Rosette out	314	260	10	-28.9	-1.1
27-Jan-08	15:55	71 05,6	N	124 53,7	W	235	Team Debbie Ice	314	245	8	-28.8	-0.97
27-Jan-08	19:10	71 05,6	N	124 53,5	W	235	Rosette in	316	290	8	-28.8	-1.11
27-Jan-08	19:27	71 05,6	N	124 53,5	W	235	Rosette out	316	290	8	-28.9	-1.09
27-Jan-08	22:00	71 05,6	N	124 53,3	W	235	Rosette in	320	295	7	-29	-1.04
27-Jan-08	22:20	71 05,6	N	124 53,3	W	235	Rosette out	319	295	8	-29.1	-1.05
28-Jan-08	7:00	71 05,6	N	124 53,2	W	235	Rosette in	318	310	8	-29.4	-1.19
28-Jan-08	7:16	71 05,6	N	124 53,2	W	235	Rosette out	318	310	7	-29.4	-1.19
28-Jan-08	8:05	71 05,6	N	124 53,2	W	235	Hydrobios in	318	320	6	-29.5	-1.11
28-Jan-08	8:30	71 05,6	N	124 53,2	W	235	Hydrobios out	318	310	5	-29.3	-1.07
28-Jan-08	8:47	71 05,6	N	124 53,2	W	235	EM scan start	318	310	5	-29.3	-1.05
28-Jan-08	9:05	71 05,6	N	124 53,2	W	235	Tucker in	318	320	5	-29.2	-1.03
28-Jan-08	9:58	71 05,6	N	124 53,2	W	235	Tucker out	318	315	7	-29.1	-0.95
28-Jan-08	10:10	71 05,6	N	124 53,2	W	235	Ice team Tao	318	315	8	-29.1	-0.98
28-Jan-08	10:30	71 05,6	N	124 53,2	W	235	EM scan end	318	300	7	-29	-1.02
28-Jan-08	10:40	71 05,6	N	124 53,2	W	235	Ice team Dustin	318	300	6	-28.9	-1.02
28-Jan-08	13:05	71 05,6	N	124 53,2	W	235	Rosette in	318	320	7	-28.6	-1.04
28-Jan-08	13:25	71 05,6	N	124 53,2	W	235	Rosette out	318	320	6	-28.6	-1.06
28-Jan-08	16:10	71 05,6	N	124 53,2	W	235	Ice team Tao	318	320	7	-28.4	-1.04
28-Jan-08	19:05	71 05,6	N	124 53,2	W	235	Rosette in	318	325	6	-28.4	-1.07
28-Jan-08	19:24	71 05,6	N	124 53,2	W	235	Rosette out	319	325	7	-28.5	-1.04
28-Jan-08	20:05	71 05,6	N	124 53,2	W	235	Ice team Tao	318	330	7	-28.2	-1.09
28-Jan-08	22:20	71 05,6	N	124 53,2	W	235	Ice team Tao	319	315	6	-28	-1.09
28-Jan-08	22:35	71 05,6	N	124 53,2	W	235	Rosette in	319	315	7	-27.9	-1.1
28-Jan-08	23:05	71 05,6	N	124 53,2	W	235	Rosette out	318	325	6	-28	-1.06
29-Jan-08	7:08	71 05,6	N	124 53,2	W	235	Rosette in	318	310	5	-27.8	-1.07
29-Jan-08	7:24	71 05,6	N	124 53,2	W	235	Rosette out	318	310	6	-27.8	-1.08
29-Jan-08	9:05	71 05,6	N	124 53,2	W	235	Ice team tower	318	335	5	-27.9	-1.1
29-Jan-08	9:50	71 05,6	N	124 53,2	W	235	Ice team tower	318	Calme	0	-27.8	-1.04
29-Jan-08	13:00	71 05,6	N	124 53,2	W	235	Rosette in	318	Calme	0	-27.4	-1.02
29-Jan-08	13:15	71 05,6	N	124 53,2	W	235	Rosette out	318	Calme	0	-27.3	-1
29-Jan-08	19:05	71 05,6	N	124 53,2	W	235	Rosette in	318	Calme	0	-27.8	-1.13
29-Jan-08	19:25	71 05,6	N	124 53,2	W	235	Rosette out	318	Calme	0	-27.7	-1.14
29-Jan-08	22:01	71 05,6	N	124 53,2	W	235	Rosette in	318	Calme	0	-28.2	-1.08
29-Jan-08	22:20	71 05,6	N	124 53,2	W	235	Rosette out	318	Calme	0	-28.1	-1.1
30-Jan-08	7:08	71 05,6	N	124 53,2	W	235	Rosette in	317	Calme	0	-28.7	-1.09
30-Jan-08	7:20	71 05,6	N	124 53,2	W	235	Rosette out	317	Calme	0	-28.7	-1.08
30-Jan-08	9:05	71 05,6	N	124 53,2	W	235	Ice team tower	317	Calme	0	-29.4	-1.05
30-Jan-08	9:45	71 05,6	N	124 53,2	W	235	Ice team tower	317	Calme	0	-29.5	-1.06
30-Jan-08	10:00	71 05,6	N	124 53,2	W	235	Ice team new ice	317	Calme	0	-29.7	-1.05
30-Jan-08	10:25	71 05,6	N	124 53,2	W	235	Ice team new ice	317	Calme	0	-29.7	-1.03
30-Jan-08	1300	71 05,6	N	124 53,3	W	235	Rosettte In	318	Calme	0	-29.8	-1.02
30-Jan-08	1315	71 05,6	N	124 53,3	W	235	Rosette Out	318	Calme	0	-29.8	-1.02

2. Team reports

2.1. Team 1

2.1.1. CTD/Rosette

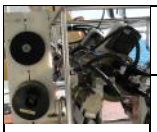
PI: Yves Gratton
Participants: Loïc Degroote, Véronique Lago (INRS-ETE, 490, Rue de la Couronne, Québec)

Objectives
Description of water masses and general circulation over a year in Beaufort Sea and Amundsen Gulf.

Materials
Physical parameters were recorded using a ship mounted RDInstruments Ocean Surveyor ADCP (150kHz), and a rosette frame equipped with 24 bottles of 12 L and the following sensors:

Table 1: Sensors used on the Rosette.

Photo	Item	Manufacturer	Type & Properties	Serial Number
	Nitrates	Satlantic	MBARI ISUS Range: 0.5 to 200 µM Accuracy: ± 2 µM	134
	PAR	Biospherical		4664
	SPAR	Biospherical		20147
	Fluorometer	Sea Point		2465
	Transmissometer	WetLab	Path length: 25 cm	CST-558DR
	Altimeter	Benthos		1061

	CTD	SeaBird	SBE-911 Sampling rate : 24 Hz	
	Temperature	SeaBird	SBE 3plus Range: –5°C to + 35°C Accuracy: 0.001	4204
	Pressure	SeaBird	Accuracy: 0.015% of full range	90584
	Conductivity	SeaBird	SBE 4C Range: 0 to 7 S/m Accuracy: 0.0003	2696
	Oxygen	SeaBird	SBE-43 Range: 120% of saturation Accuracy: 2% of saturation	0427 (cast 1 to 73) - 0420 (cast 74 to 158)
	pH	SeaBird	SBE-18 Range: pH from 0 to 14 Accuracy: pH 0.01	0444

Methods

For the whole leg, because of heavy ice conditions, the rosette was deployed from the Moonpool. CTD or Rosette casts were usually performed four times a day at 7 a.m., 1 p.m., 7 p.m. and 10 p.m. Four times, we did a 14 or 15 hours non-stop CTD sampling. Water was sampled according to each team requests. Here are examples of usual depths collected by them.

- *Nutrients* (Team 7; PI: Jean-Éric Tremblay): salinity of 33.1, 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300 and every 100 m up to the bottom.
- *DIC* (Team 6; PI: Lisa Miller): salinity of 33.1, 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300 and every 100 m up to the bottom.
- *Contaminants* (Team 8; PI: Gary Stern): 10, 25, 50, 100, 200 m and bottom.
- *DNA* (Team 7; PI: Connie Lovejoy):
- *Microbes* (Team 7; PIs: Carlos Pedros and Roxanne Maranger):
- *Nepheloid* (Team 7; PI: Jody Deming): bottom and/or nepheloid layer
- *pH/alkanilities* (Team 6; PI: Alfonso Mucci): salinity of 33.1, 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300 and every 100 m up to the bottom.

Sampling field

We focused on the Amundsen Gulf southwest of Banks Island.

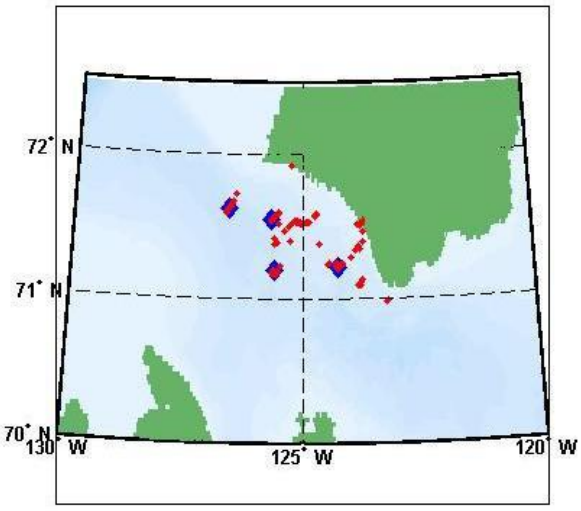


Fig. 1. Positions of Rosette casts shown as red dots; stations of 14 or 15-hour sampling periods indicted by blue diamonds.

Probe calibrations

Salinity: Samples were taken on many casts with small bottles of 200 mL. They were analysed with an autosal GuildLine, model 8400B. Its range spans 0.005 to 42 and its accuracy is < 0.002. The

results were satisfying. The difference between the salinity probe recordings and the samples was around 0.033.

pH: Tests were done twice using two buffers. The sensor is quite stable. Results are as follow:
Buffer 4.01 gave 3.9;
Buffer 7.00 gave 7.32.
Seawater is usually around pH 8; we can expect pH data to be a little over estimated.

Oxygen: Oxygen sensor calibration was performed using Winkler's method and a Mettler Toledo titration machine. Reagent blanks were performed twice; results show that chemicals are still good (m < 4). We sampled oxygen on eight casts. Each time, we choose five depths of different oxygen concentration and sampled three times. Until we changed the oxygen sensor between casts 073 and 074, the results were proportional, thougth not in the same range (m ≈ 0.6). A correction will need to be done on data. After the sensor had been changed, the results were very good; the probe recordings and the samples were always very similar.

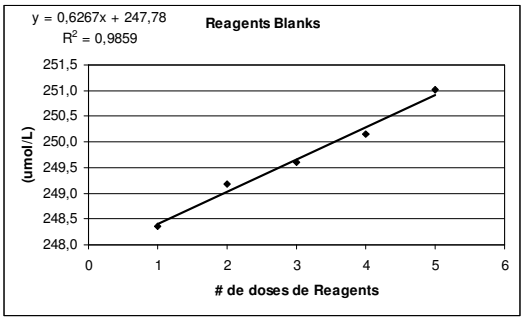


Fig. 2. Reagents blanks (m = 0.6267).

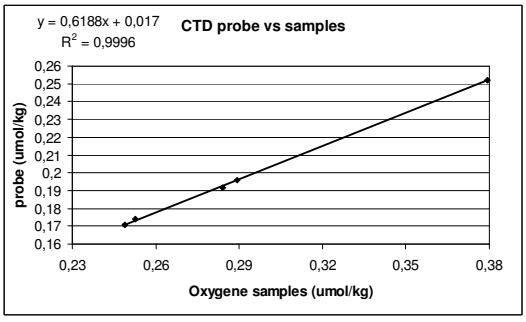


Fig. 3. Relation between samples and probe recordings during cast #045 (m = 0.62).

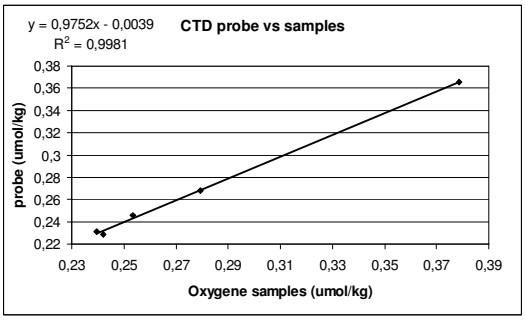


Fig. 4. Relation between samples and probe recordings during cast #074 (m = 0.98).

Problems

- **Sensors**

The oxygen sensor had a huge offset on casts 001 to 073. After that, the sensor was changed and worked properly. The nitrate sensor also had some problems. Thus, nitrate data from casts 134 to 138 are not valid.

- **Bottles**
  Some bottles leaked, a problem that has persisted for several legs. Bottle number 5 did not close all the time.
- **Deck material (winch, A-frame, etc.)**
  The cable guides broke a few times, which is also a recurring problem. The winch functioned without problems.
- **ADCP:** The currents were only partly measured during the last week of the leg. The ADCP could not determine the middle range of the water column currents for a reason that remains unknown. The ADCP also stopped receiving proper information on a few occasions due to ice under the ship.

Available data

All information concerning the Rosette casts are summarized in the CTD Logbook. It includes cast and station numbers, date and time of sampling in UTC, latitude and longitude, bottom and cast depth, comments concerning the cast and its name. A Rosette sheet was also created for every single cast. It includes the same information as the CTD Logbook plus the bottle distribution among every sampling team. The weather information is written in every Rosette Log as well as in a meteorological logbook. For every cast, data recorded at the moment of bottle closure were averaged and recorded in the so-called 'bottle files'. Averaged data are those recorded between 3 seconds before bottle closure and 7 seconds after it. They include the bottle position, time and date, pressure, temperature, salinity, transmissivity, chlorophyll, oxygen, irradiance and pH measurements. All those files are available on the 'Shares'.

- Rosette sheets and the CTD logbook : Shares\Leg5\Rosette\logs
- Bottles files : Shares\Leg5\Rosette\btl
- Plots of every cast including salinity, temperature, oxygen, transmissometer, nutrients, fluorometer and irradiance : Shares\Leg5\Rosette\plots

Between December 20th, 2007, and January 31st, 2008, 158 casts were performed.

Preliminary Results

The 14-hour marathons were performed on four different locations: stations 2007-12D, 2008-14D, 2008-17D and 2008-19D.

Fig. 5. Temperature and salinity data recorded during the 140-hour sampling period on station 2007-12D.

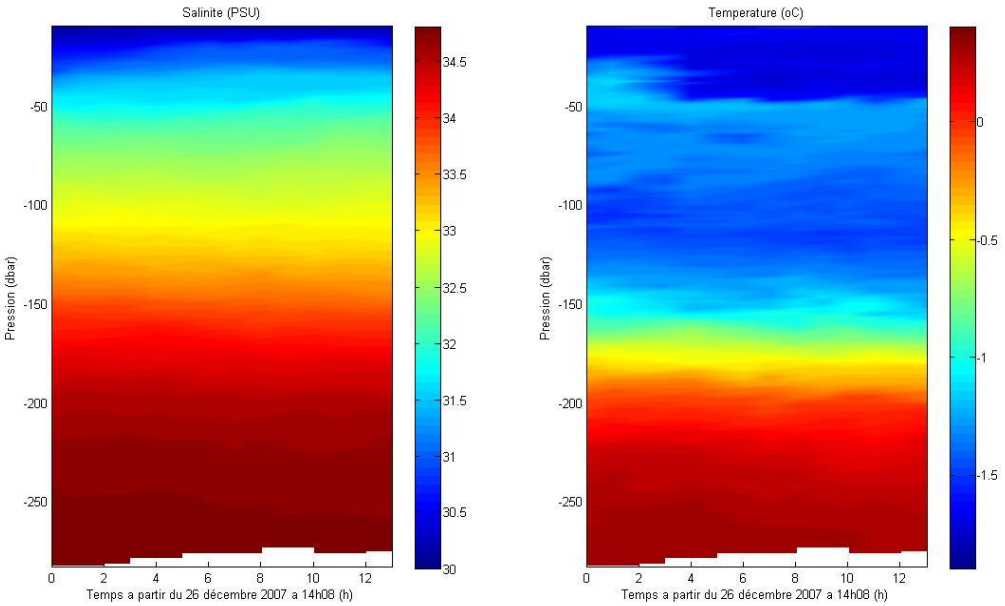


Fig. 6. Temperature and salinity data recorded during the 15-hour sampling period on station 2008-14D.

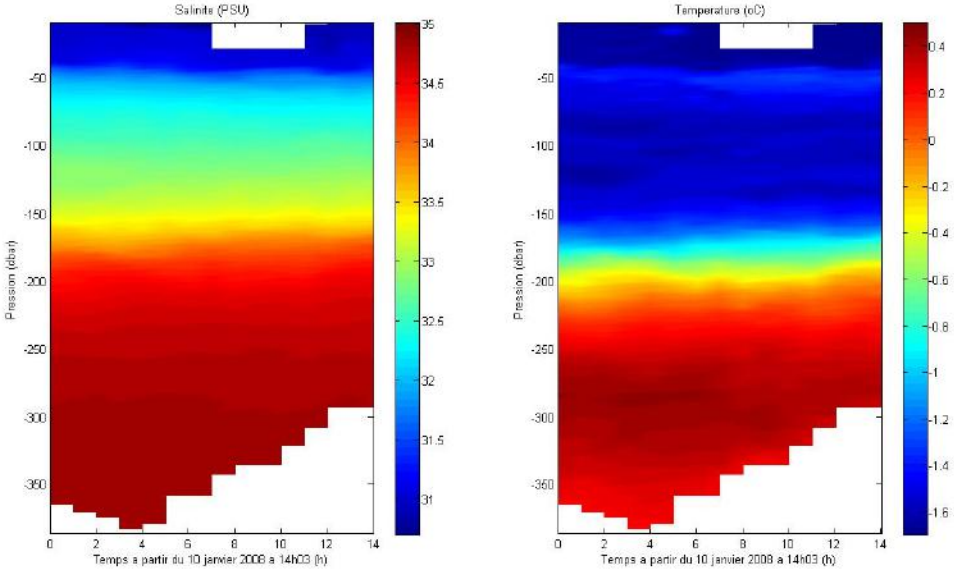


Fig. 7. Temperature and salinity data recorded during the 15-hour sampling period on station 2008-17D.

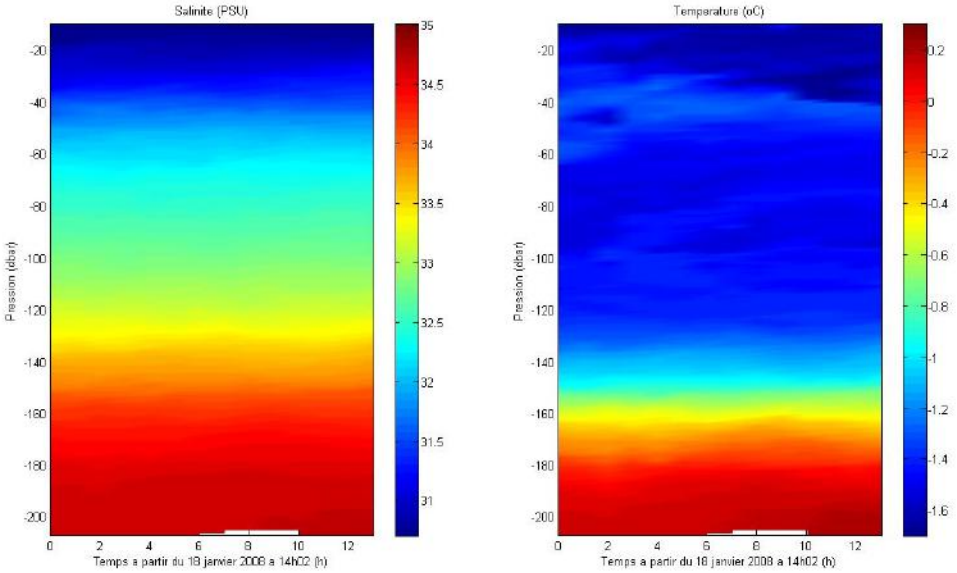
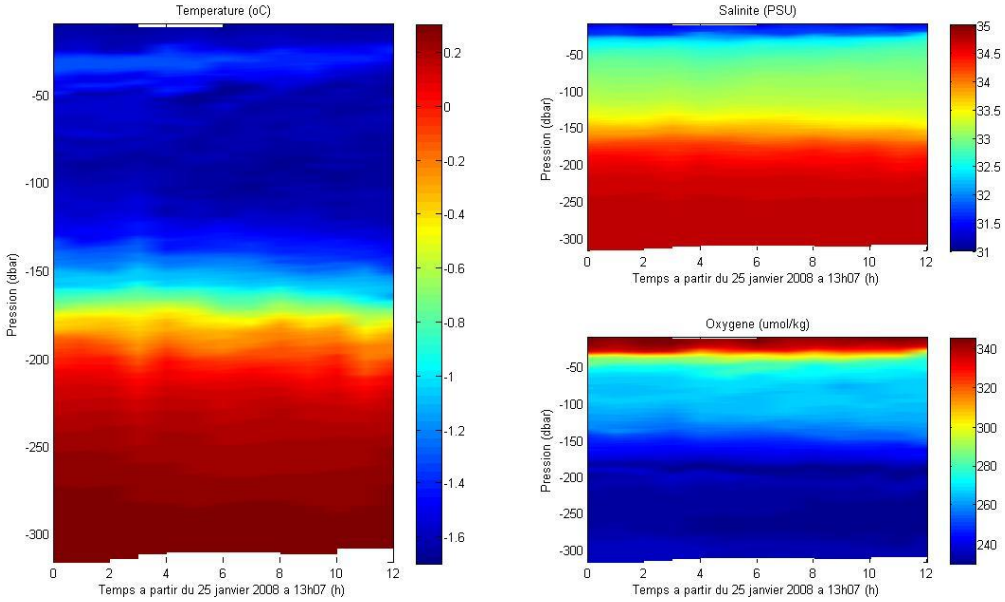


Fig. 8. Temperature, salinity and oxygen data recorded during the 14-hour sampling period on station 2008-19D.



2.1.2. Turbulence

PIs: Yves Gratton[1], Peter Galbraith[2], Daniel Bourgault[3] & Rick Marsden[4]
Participant: Graig Sutherland[3] (gsutherland@mun.ca)

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Introduction and objectives

Ocean turbulence acts to mix water properties, such as heat, salt, nutrients, pollutants, etc. In order to understand and predict the evolution of ocean properties at all time scales, from weather to climate time scale, we need to understand how these constituents get mixed given the background (e.g. stratification) and forcing conditions (winds, tides). The objective is to collect *in situ* measurements to quantify ocean mixing in the Beaufort Sea and Amundsen Gulf.

Methods

Turbulence acts first on the velocity field: the propagating waves create line vortices which continuously advect towards each other in complex ways. As those complex structures are relatively stable, the mixing mainly occurs in a region of intense strain created between nearby vortices. The large velocity gradients at small scales (1 mm to 1 cm) can be detected by an air-foil shear probe, a piezo-ceramic bender that generates an electrical charge in response to cross-axial forces. The signal collected by this probe (u') and the deduced shear (du'/dz) can be used to estimated the rate of kinetic energy loss under turbulent event ($\varepsilon \propto (\partial u'/\partial z)^2$, Wkg^{-1} or m^2s^{-3}). A *Vertical Microstructure Profiler* (VMP) equipped with two similar probes has been used in this CFL cruise to sample the turbulent vector field in open water. The VMP free-falls at around 0.6 ms^{-1} and has a sampling rate of 512 Hz, which allows it to measure at the millimetre scale. It is also equipped with a conventional Sea-Bird CTD (*Conductivity, Temperature and Depth* sensor, sampling rate: 64 Hz), two fast response thermistors , and a fast response conductivity probe. The fast response probes also sample at a rate of 512 Hz.

As the vortices are created, the scalars fields (i.e. temperature) are compressed by the strain create between the turbulent structures of the flow. The scalar variance is then driven to smaller scales via eddies as the energy cascade goes on. As soon as they are formed, these thermal anomalies blend into the background by molecular diffusivity at a rate χ, the rate of thermal variance loss ($°C^{-2}s^{-1}$), and this occurs at the far end of turbulence spectrum with the smallest physical scale of overturns. This turbulent mark can be detected by the *Self-Contained Autonomous Profiler* (SCAMP), which is designed to directly estimate the thermal variance produced by diapycnal mixing (which is the mixing across surfaces of constant density). This instrument has two fast response thermistors to measure the temperature gradient at every 0.01 s. As it falls at a rate of 0.1 ms^{-1}, the resulting precision is of 1 mm, which is sufficient to resolve the complete scalar spectrum and to estimate $\chi \propto (\partial T'/\partial z)^2$. The SCAMP is also fitted with PAR, accurate T, accurate C, pressure and fluorometer sensors.

A 600 kHz Acoustic Doppler Current Profiler was set up to measure the water currents directly below the ice surface. A small hole in the ice (~ 40 cm in diameter) is necessary to deploy the current profiler. The profiler is rigidly mounted to the ice in order to obtain turbulence measurements of the underlying current. This was performed as a trial experiment at the last station of this leg; at this time it is uncertain whether the ADCP will be used in this manner on the following legs.

Sampling stations and data management

There were 42 good VMP profiles collected during Leg 5 between December 25, 2007 and January 3, 2008. All of the information relative to each profile, such as position, depth, number of profiles collected, atmospheric conditions, etc., is logged into the Excel file: **LogBook_CFL_Leg5.xls**

There are additional data up until January 17, 2008, but these have numerous bad signals in them due to a bad connection. There are portions of profiles which may be salvageable, but there are no complete profiles after January 3, 2008. Refer to the file **LogBook_CFL_Leg5.xls** for more details on the list of problems with the VMP and the data recorded.

All data are stored on the VMP laptop and a backup copy is stored on G. Sutherland's personal laptop.

The table below summarizes the successful sampling carried out during Leg 5:

Date and Time (UTC)	Lat (N)	Lon (E)
Dec. 26, 2007, 14:46	71º 13.0’	-125º 26.1’
Dec. 27, 2007, 15:20	71º 12.9’	-124º 28.8’
Dec. 28, 2007, 3:42	71º 14.9’	-124º 35.0’
Dec. 28, 2007, 14:32	71º 17.6’	-124º 44.6’
Dec. 29, 2007, 2:18	71º 20.9’	-124º 55.4’
Dec. 29, 2007, 15:00	71º 22.7’	-125º 3.2’
Dec. 30, 2007, 2:20	71º 23.5’	-125º 7.9’
Jan. 1, 2008, 21:25	70º 58.8’	-123º 30.9’
Jan. 2, 2008, 2:34	70º 59.2’	-123º 30.9’
Jan. 3, 2008, 21:25	71º 14.0’	-124º 27.7’

Observations

Figure 1 is an example of a typical profile of temperature, salinity, and microstructure shear obtained with the VMP. The surface layer is well mixed to the halocline, the depth of constant salinity shown here at 40 m, which ranges between 30 and 80 m depth. After that the water column is mostly stably stratified with some variability in the temperature profile. The shear is predominantly low and varies little with depth. More detailed analyses are required to infer turbulent quantities from these measurements.

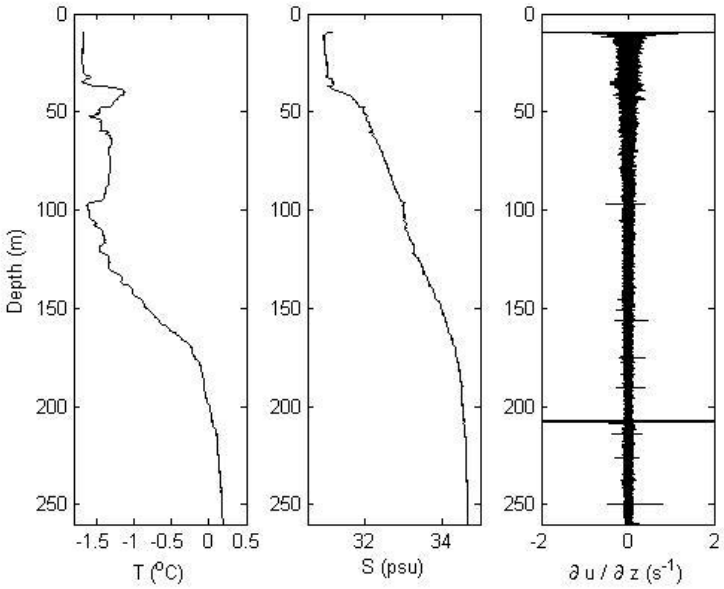


Figure 1: Example of raw temperature, salinity and micro-shear profiles obtained with the VMP on December 26, 2007.

Problems

One of the fast temperature probe channels (channel T2) did not work at all during the entire leg of the cruise. The VMP only obtained measurements for the first two weeks (until Jan 2008) until multiple errors began to appear in the data. Attempts were made to repair the VMP, but the repairs were beyond the scope of what was possible to achieve aboard the ship, so it will be shipped back to the company at the end of this leg. The VMP will be unavailable for the duration of the CFL project.

The SCAMP was not used on this leg as it required a new connector to function properly. This is being brought up for Leg 6 by Peter Galbraith and the SCAMP should be available for Leg 6.

2.2. Team 2

2.2.1. Ice dynamics

PI: David Barber
Participants: Monika Pucko, Mukesh Gupta, Dustin Isleifson, Andre April, Charles Hannah

General Ice Conditions
Throughout Leg 5 we mostly encountered large floes of first year ice, as expected for the drift portion of the CFL project. Towards the end of the leg we began to see snow accumulation with drifts up to ~35 cm. There were several opportunistic visits of other forms of ice, including newly forming sea ice in Leg 5B. Via helicopter we visited several multiyear ice floes for beacon deployment and on ice reconnaissance missions. An ice thickness camera system was operated during transit from the port side of the ship in order to observe the various ice thicknesses.

Physical Sampling
A standardized sampling program was implemented at the beginning of Leg 5, with further refinements in the sampling strategy appearing in Leg 5B. The goal is to obtain physical and microstructure measurements of the snow and sea ice. We were able to visit the site regularly via the gangplank on the ship. During the drift mode of the project it is imperative to set up a fence around the EM measurement location and have all crew informed of the need to respect the area, such that it would not be accidentally disturbed.

Our standard sampling plan includes measurements of snow and sea ice geophysical parameters. A weekly schedule was set up which included visiting the ice twice daily in order to develop some statistics on the snow and ice profiles. First, the ice surface condition was recorded and site photos were taken. Each visit included a full snow pit measurement including temperature profiles, salinity profiles, capacitance plate measurements, density measurements, and snow grain photos. Two ice cores were taken at each visit to obtain the temperature and salinity profiles. At each site the vertical microstructure and sometimes the horizontal microstructure was studied. Furthermore, ice core density profiles were regularly obtained.

The cold lab temperature was regularly maintained throughout Leg 5, even with a high frequency of use. The system goes through a defrost cycle daily and this worked to maintain the temperature at an appropriate value. Again, we found that it was useful to have a day every so often during which the cold lab was heated in order to defrost the condenser on the cooling unit. This is to maintain regular temperatures in the laboratory.

Six different sites were visited throughout Leg 5. Since we were in the drift mode stations we visited the ice each day to observe the diurnal variability, with the exception of Station 2008D18B since it was an ice raid implemented during transit between stations. The ice stations that were sampled are summarized in Table 1.

Table 1: Ice station sampling summary.

DATE	STATION	SNOW	ICE TYPE	ICE MICRO
25-Dec-07	2007D11	2 cm	First year ice (30.5 cm)	Vertical
27-Dec-07 to 31-Dec-07	2007D12	Frost flowers	First year ice (55 cm)	Vertical
01-Jan-08 to 06-Jan-08	2007D13	~2.5 – 4 cm	First year ice (105 cm)	Vertical
15-Jan-08 to	2008D17	<1 – 2.5 cm	First year ice, formed as	Vertical

21-Jan-08			consolidated pancake ice (90 – 100 cm)	& Horizontal
23-Jan-08	2008D18B	0	New ice (3 cm)	No
23-Jan-08 to 28-Jan-08	2008D19	~3.5 – 33 cm	First year ice (90 – 110 cm)	Vertical

Ship Based EM Measurements

EM measurements were conducted throughout Leg 5 in order to observe the interaction of electromagnetic radiation with various ice conditions. The collected data will be used in electromagnetic modeling studies and for calibration of satellite remote sensing data. The results of this study will allow for us to improve our knowledge of the temporal evolution of sea ice physical, thermodynamic, and electrical properties.

Scatterometer

A fully polarimetric scatterometer system was operated twice daily at each station. The system was mounted at a height of 8.2 m above the surface. Measurements from the ship were conducted with a sweep from -30° to 30° in the azimuth, requiring the 0° reference at a perpendicular line to the ship's side. The variation in elevation was measured with sweeps in the elevation at 5° increments on the range 20° to 60°. An infrared transducer (Everest, 4000L) was mounted on a rail near the scatterometer.

Upon arrival at Station 2008D19, we had issues with breaking too much ice in the field of view of radar. Even with several careful attempts the ice was turned up and/or flooded. We managed to reach a site with minimal breakage, but after one day we had to reposition the ship in order to clear out the moonpool. This resulted in the area becoming splashed with seawater and therefore unusable. With this, an interesting opportunity arose to place the scatterometer at a height of 13.5 m on the starboard side of the ship for a single day experiment. The scatterometer was successfully positioned and the scan region was thoroughly sampled. The device is currently located once again in its regular position on the port side in the scatterometer shed.

Fig. 1. Scatterometer mounted on the starboard side of the ship and overlooking the sample area that was previously marked out using flags.

At the beginning of Leg 5B, we noticed that sometimes the noise floor of the system rises and therefore some of the radar returns are lost in the noise and corrupted. The source of this problem has not yet been determined, but the data is still usable if in the final analysis the corrupted data points are removed.

Ship-Based Radiometer (SBR)
Dual polarized radiometers operating at 37 GHz and 89 GHz with a 6° were mounted about 13 m above the sea surface on the port side of the ship. During transect operation the radiometers were kept at an incident angle of 55°. Concomitant with the scatterometer operation, scans were performed, changing the incident angle from 30° to 150° using 5° steps. A network camera was used to monitor the surface conditions at a sampling rate of 10 s. The settings have not been changed otherwise. In addition, a hand-held camera is used at each site to provide more information on the surface conditions.

Ground Penetrating Radar
A ground penetrating radar system (GPR) was used to investigate snow and sea ice thickness and structure on an opportunistic basis. Due to time constrictions only the 1 GHz unit was used. Several interesting datasets were collected simply using stationary measurements, or small transects over ice cracks. We are currently awaiting the return of the odometer unit in order to provide better control of our data collection process in transect operations.

Atmospheric Sampling Program
The purpose of the atmospheric sampling program is to monitor cloud cover and cloud properties, upper level and boundary layer winds, temperature, and humidity. In general, there were no major problems to report with this aspect of our sampling program.

All-Sky Camera
The all-sky camera system is used to take pictures of sky in order that percentage and type of cloud cover may be determined throughout the cruise. Due to breakage of the reflecting dome, the system is not currently in operation.

Ceilometer
The ceilometer is used to measure the height of the cloud layers above the ship. The ceilometer was fully functional throughout all of Leg 5. Routine maintenance and backup was performed at regular intervals.

Profiling Radiometer
The profiling radiometer is used to measure the temperature, relative humidity, and pressure within the atmosphere. It was activated in Leg 4 and has been running continuously through Leg 5.

Laser Precipitation Gauge
This instrument was fully functional throughout Leg 5. The instrument continues to run, and all data has been downloaded and archived.

Ice Motion Beacons
We were able to deploy a total of four ice beacons during Leg 5. During this time we lost the one beacon that had intentionally been deployed on first-year ice, along with two others on multi-year ice in a linear geographical fashion near 2008D17 to assist with navigational issues and selection of the next drift floe.

Table 2: Ice motion beacon deployments.

Beacon ID	Date Deployed	Location Deployed	Status
25330	January 6, 2008	2008D14	ACTIVE
915930	January 15, 2008	FYI near 2008D17	LOST
917920	January 15, 2008	MYI near 2008D17	ACTIVE
20600	January 15, 2008	MYI near 2008D17	ACTIVE

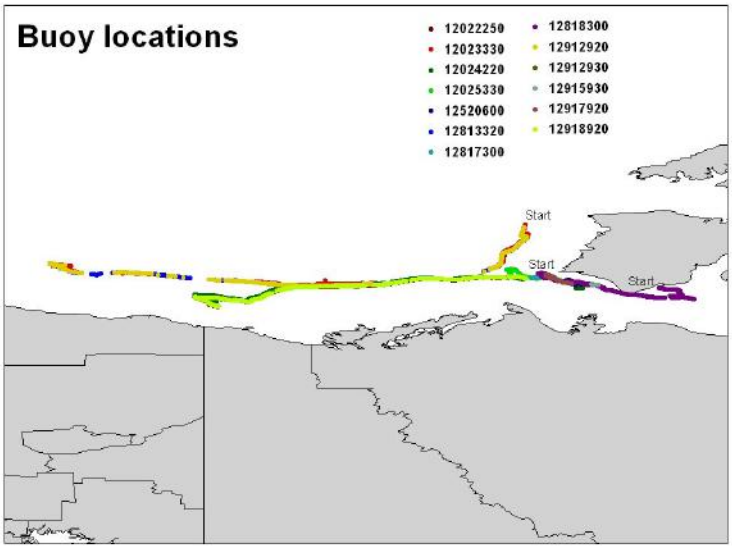


Fig. 2. Ice beacon locations as of January 28, 2008.

AVOS (Environment Canada MetObs System)
The data from the AVOS has continued to be regularly collected and monitored by our group throughout Leg 5 as part of our sampling plan.

Recommendations
The greatest challenge that we faced in Leg 5 was arriving in a site while not damaging the ice near the ship. Whereas before, when the ice was thinner, it was feasible to try several times and eventually succeed, it seems that during this part of the year it is nearly impossible to obtain an ideal EM site. The key aspect to avoid is the splashing of seawater on the surface since it will completely change the characteristics, as well as minimizing large cracks and overturned ice within 2 m of the ship. While nearly impossible to attain, with the care and skill in navigation that the crew of the *Amundsen* has demonstrated, a reasonable compromise can always be reached.

2.2.2. Satellite Imaging of the Ice Field

PI: Dave Barber
Participant: André April, Ph.D
Previsionniste des Glaces/Ice forecaster
Environnement Canada, Environment Canada
Ottawa
April.Andre@ec.gc.ca

I received by ftp 42 Radarsat and Envisat images to compare with 8 Palsar images (Japanese imagery). The first conclusion is that Palsar is very sensitive to roughness; telling the difference between thin ices and leads is difficult. But, this can be a plus for navigational purposes, because the dark black tones of thin ice and leads, which indicate navigable passages, are easy to detect. Ridges are easily identified on Palsar by their very bright white tone, mainly when they are higher than 6 feet. Old ice as multi-year ices are better seen on Radarsat, mainly because their rounded ridges are not reflective on Palsar images. Flat floes with the same average thickness are easily seen on Palsar images, better than on Radarsat or Envisat images, by the fact of their similar grey tones. Overall, it was possible to obtain a good understanding of winter arctic sea ice from the Palsar images. The next related effort must be in spring or autumn, when thinner ice is present, in order to focus on the signals reflected by this thin ice. Thank-you for everything, merci, pour tout -- it was for me a great experience.

Note added by Chief Scientist: In addition to his own work, Andre joined reconnaissance flights and assisted with evaluations of floe thickness. He also assisted with on-ice operations from the ship, helping other team 2 members with their projects, for which we are grateful.

2.2.3. Heat Fluxes and Ice Growth

Transformation of Air Masses and the Energy-Exchange Processes between the Ocean and Atmosphere in the Flaw Lead Area

PIs: Alexander Makshtas, Sergey Shutilin, Peter Bogorodsky
Participants: Sergey Shutilin, Peter Bogorodsky, Mikhail Makhotin

Background
Flaw leads are the centers of powerful energy exchange between ocean and atmosphere during the winter period. They have sizeable input to ice mass balance due to growth of young sea ice. Steep vertical and spatial gradients in temperature and humidity exist over the ice and water along with different atmospheric boundary layer stratifications over both of these surfaces. Vertical profiles of the primary atmospheric characteristics and stratification within the air mass move the ice edge, dividing the water in the lead from the surrounding ice. As a result the heat fluxes should change depending on distance from the edge, wind speed and direction, and values of initial temperature and humidity. They should be reflected in changes in ice growth rate. Mechanisms of ice cover structure formation in this area are closely connected to the processes of the atmospheric boundary layer transformation and the changes of the aerodynamic characteristics on the border between the ice and open water. These processes of air mass transformation can be reproduced by a combination of atmospheric and ice models, but to improve such models requires detailed study of the transformation processes in the atmospheric and ocean boundary layers and the features of the energy exchange at both interfaces near the border of fast ice and flaws.

Field work plan for Leg 5
Plans called for executing this complex work shipboard and on the ice at various distances between the points of measurements, depending on the different wind speed and direction relatively to the ice edge. Several multi-day series of profile and heat flux measurements should be accomplished, depending on weather conditions. Desired field observations consist of:
1. Measurements of air temperature and humidity, wind speed and direction within the surface atmospheric boundary layer carried out at two or three levels by using the sensors mounted on a mast or tower. The tower should be installed on the ice surface near to the open water in a lead or polynya itself;
2. Measurements in detailed profiles for all mentioned characteristics from the surface up to 1000-2000 meters height performed by sensors installed on a balloon. These profile measurements can be realized in parallel (synchronously) on the ice and shipboard.
3. Short- and long-wave radiation balance should also be measured on the ice and shipboard;
4. Direct measurements of the heat and moisture fluxes by the high frequency sensors for turbulent measurements;
5. Measurements of disturbances of water temperature and current velocity beneath ice bottom; and
6. Heat fluxes and ice growth rate calculation based on standard meteorological data and comparison to the direct measurements.

Meteorological and heat flux measurements
Meteorological information was collected from several different sources during the Leg. First, a wind sensor was installed on the front mast of the ship at a height of about 30 m, along with temperature and humidity sensors at bridge level at a height of about 15m. ***AVOS (Environment Canada MetObs System)*** with additional wind sensor at the top of the bridge provided information about the position of icebreaker, relative and true wind speed and direction, air and sea surface temperatures, relative humidity, ship's heading and speed.

A heat flux tower was installed in addition on the front deck and collected data about atmospheric pressure, air and sea surface temperatures at 18 m height, relative humidity, wind speed and direction for each minute during all time of the Leg (Fig.1).

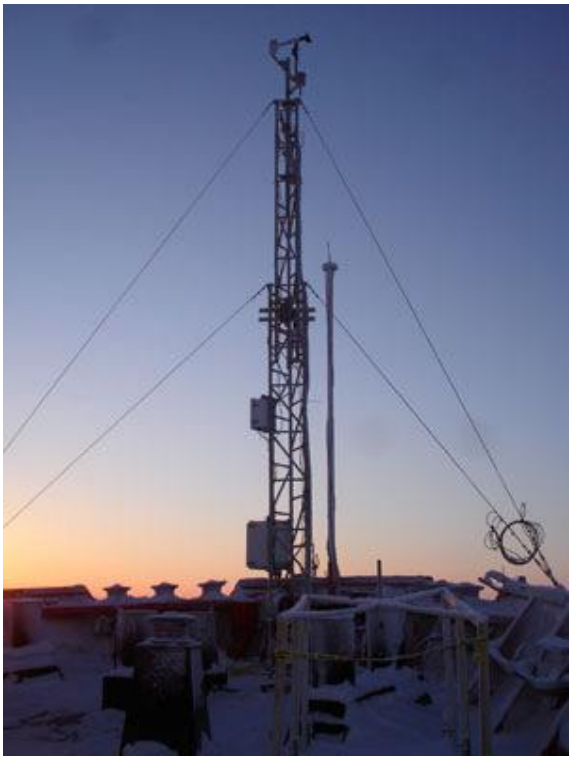


Fig.1. Meteorological tower installed at the front deck.

A heat flux tower and additional meteorological mast was installed for the first time during the Leg on January 9. It had been impossible do so earlier due maneuvers of the ship within compact ice cover and absence of enough open water in the neighborhood. The mast was deployed on the drifting ice floe at a distance of 300 meters from the lead and, at approximately the same distance, sensors were installed on the tower. First long-term measurements on the ice started 3:30 GMT on January 10 and continued until 14:25 GMT on January 11 (Fig. 2).

Fig. 2. Meteorological mast and heat flux tower at the ice station.

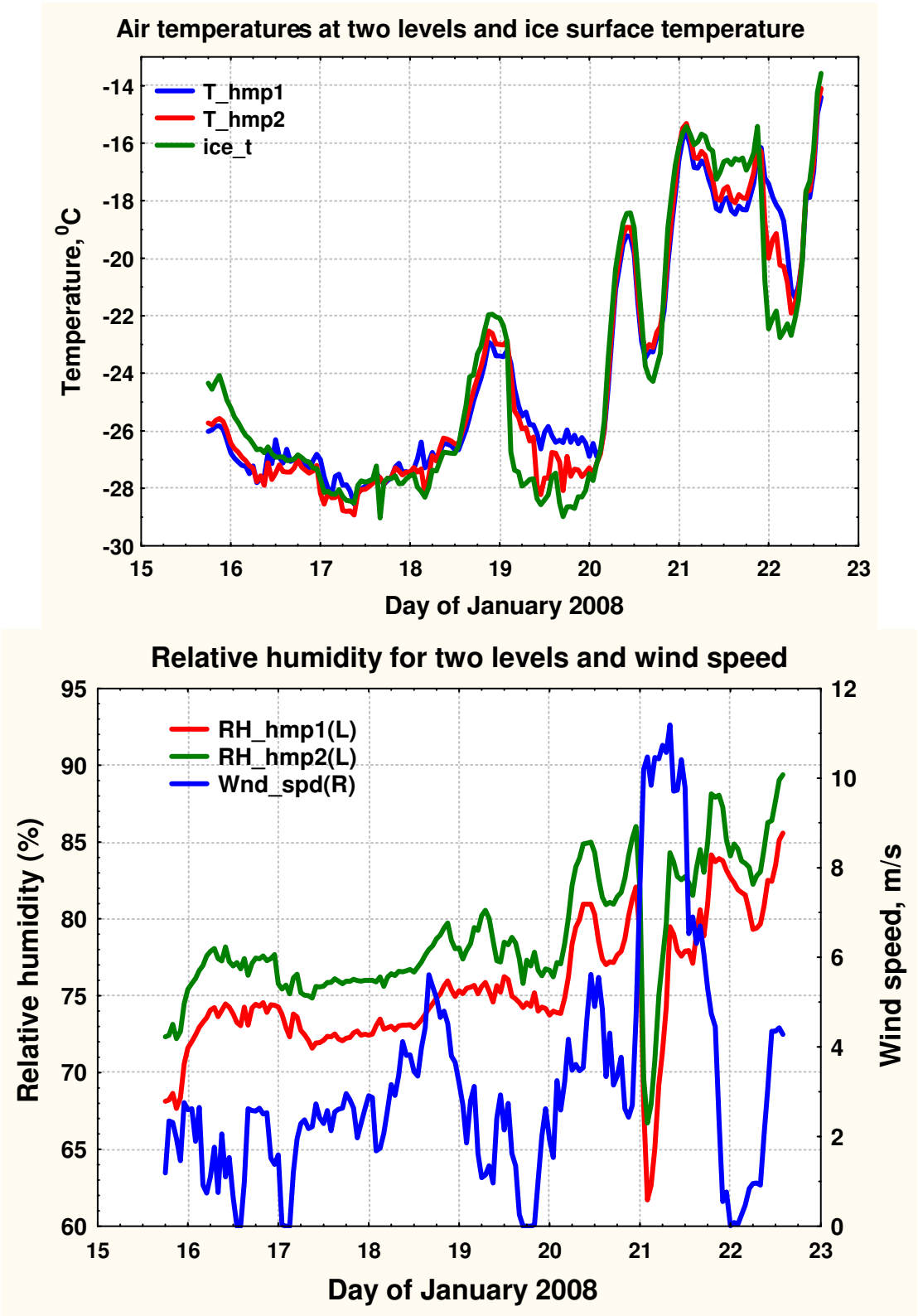


Fig. 3. Temporal variability at two different levels of air temperature and ice surface temperature (a), along with two levels of relative humidity and wind speed (b) from the meteorological tower installed on the ice.

The second part of the Leg was more successful for this part of the program. The next ice station began soon and the heat tower and meteorological mast were installed again on January 15. They remained in operation until January 22, when the ship had to relocate. For the last time, the ice mast

and tower were deployed on ice on January 25 and measurements continued until the end of Leg 5 on January 30. In total, the period of almost continuous measurements on the ice was 12 days during Leg 5. As an example, temporal variability of air temperatures and relative humidity at two levels along with ice surface temperature and wind speed, measured at the ice in period from January 15 to January 23 are shown in Fig.3. The vertical turbulent fluxes of sensible and latent heat were calculated, based on data of these measurements (Fig. 4).

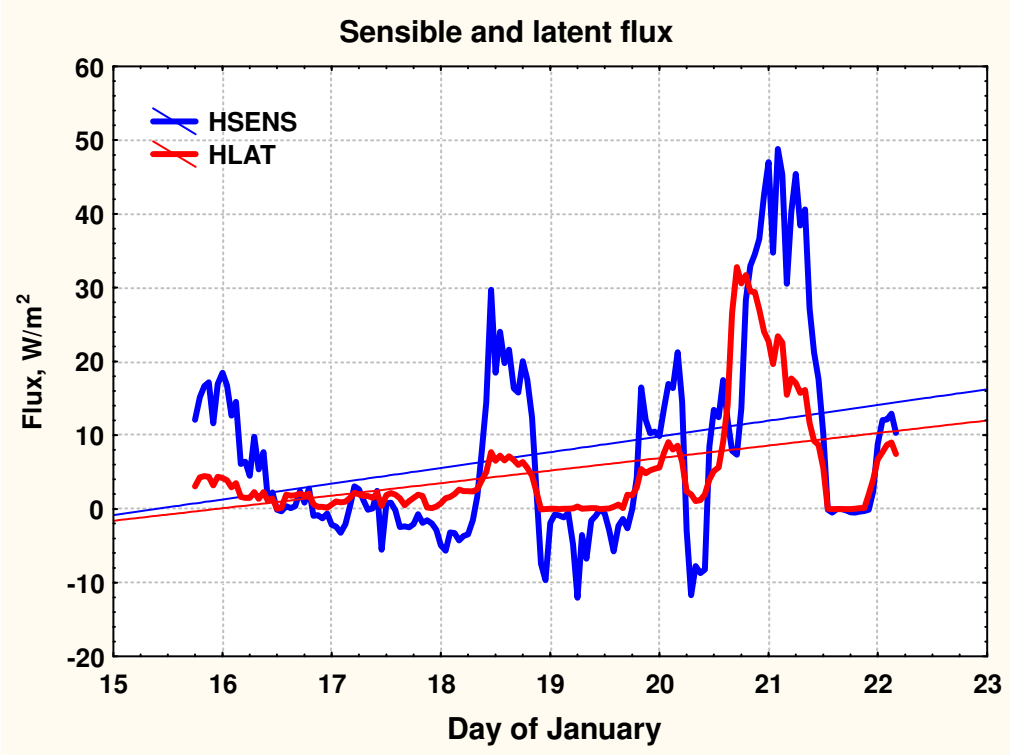


Fig. 4. Sensible and latent heat fluxes calculated from meteorological mast data.

Preliminary analysis of the Fig. 3 and Fig. 4 demonstrates that weather conditions during this ice station were unstable. Calm conditions were replaced by moderate winds and back again. Temperature variations reached values of 14^0C. As a result, essential variations in sensible heat flux values occurred. Even this flux changed direction from ice to atmosphere and back.

Ice cores were taken daily in the neighborhood of the mast position to determine the ice and snow thickness, along with temperature and salinity profile measurements within the ice. These measurements should provide the information to compare temperature distribution within the ice and ice growth rate simulated by the ice model with observational data.

Because the specially equipped balloon, designed to carry out the measurements of fine structure of the surface atmospheric boundary layer was unavailable, we attempted to use the standard block of sensors for ***Radiosondes (weather balloons)***. This block provides information about vertical distribution of the air temperature, humidity and atmospheric pressure, along with DigiCora System data for wind calculation based on GPS position of the ship and balloon. The tethering of balloons was carried out daily from the tent near to the starboard side of the *Amundsen* using a winch and fishing-line (Fig. 5). In total, we accomplished nine launchings of the balloon (Table 1) up to several hundred meters. A few attempts failed due strong wind. Maximal height of the balloon rising depended on wind speed and weather conditions. In addition, one full-scale launch of balloon was completed at the end of Leg 5. All data from the successful launches were stored in Climate archive on the *Amundsen* server. The weakness of this method is calm weather or wind speeds of less then 5 m/s during the launch, because speed of the line release cannot be higher than this value. Meanwhile, wind data received during the same procedure can be used as an estimation only, because the line itself placed

limitations of the degree of freedom of the balloon. A better approach would be to use a less filled balloon or add height to address the balloon's rise and speed. Using the special balloon described earlier with independent wind sensors can resolve this problem.

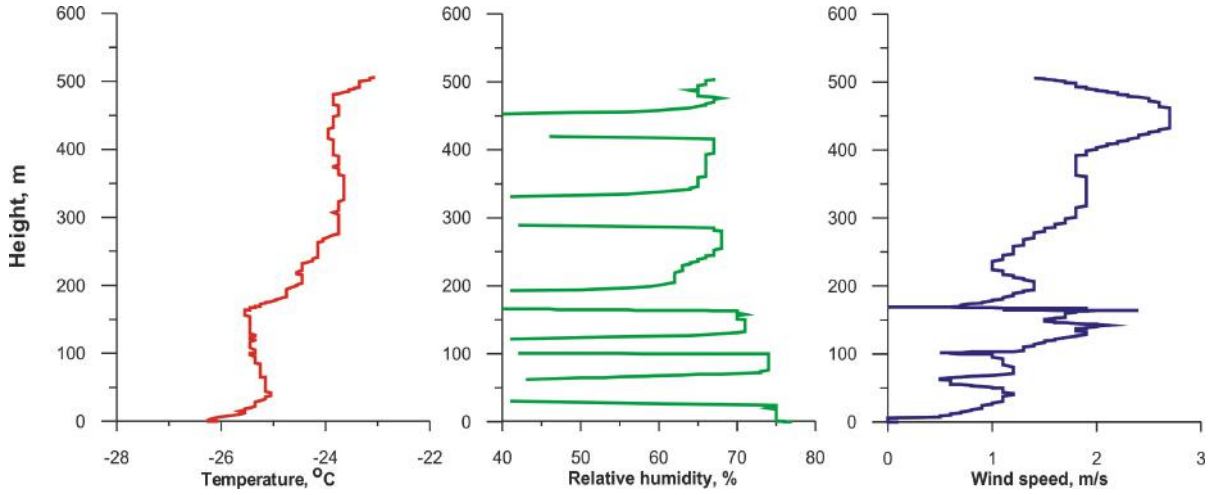
Fig. 5. Performing of the balloon launch.

Meanwhile, several events of vertical temperature inversion were detected by the launches. These inversions were driven by different reasons. In the first case, the inversion was produced by cooling of the surface boundary layer of atmosphere due to the contact with colder ice surface. In the second, advection of relatively warm and wet air masses from open water over the dry and cold ice surface caused the inversion.

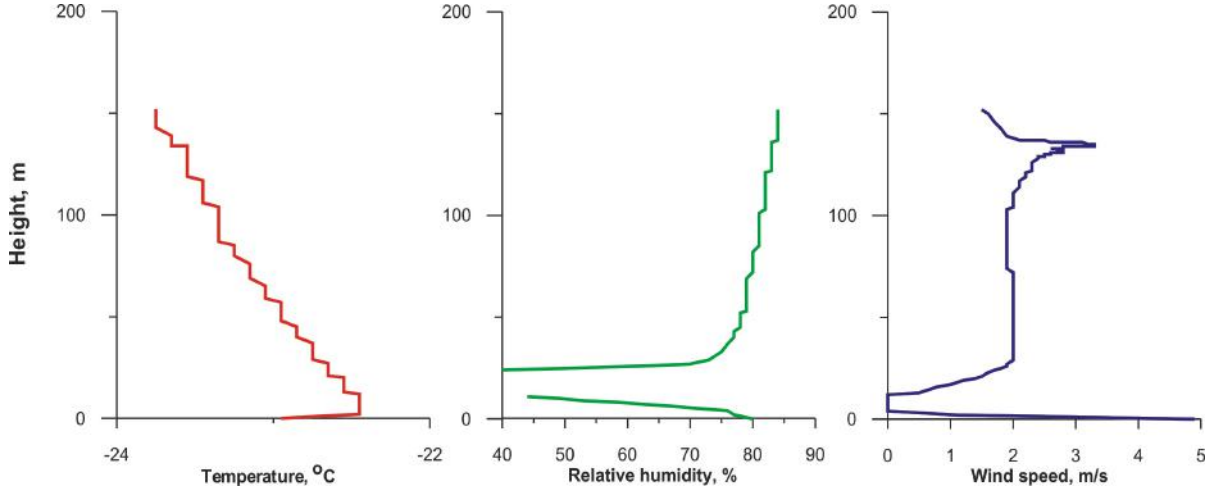
Table 1. Dates, places and maximal height of balloon launches from CCGS *Amundsen*.

N	Date	Coordinate		Max height
		Lat, N	Lon, W	
1	17.01.08	71.31 N	124.58 W	506
2	18.01.08	71.32 N	124.59 W	152
3	20.01.08	71.34 N	125.03 W	342
4	20.01.08 (2)	71.34 N	125.03 W	459
5	25.01.08	71.11 N	125.06 W	276
6	27.01.08	71.06 N	125.54 W	423
7	28.01.08	71.06 N	125.54 W	459
8	29.01.08	71.06 N	125.54 W	543
9	30.01.08	71.06 N	125.54 W	340

Some examples of the vertical profiles of air temperature, humidity and wind speed were shown at Figure 6. These data will be complemented by data provided by the ***Profiling Radiometer System.*** The profiling radiometer was used to measure the temperature, relative humidity, and pressure within the atmosphere. It was activated fully in the previous Leg since November and stayed in operation up to the end of Leg 5. The instrument has collected data on the standard high pressure inversions that are characteristic of this region, as well as boundary layer temperature and humidity profiles up to 10,000 meters.



17.01.08



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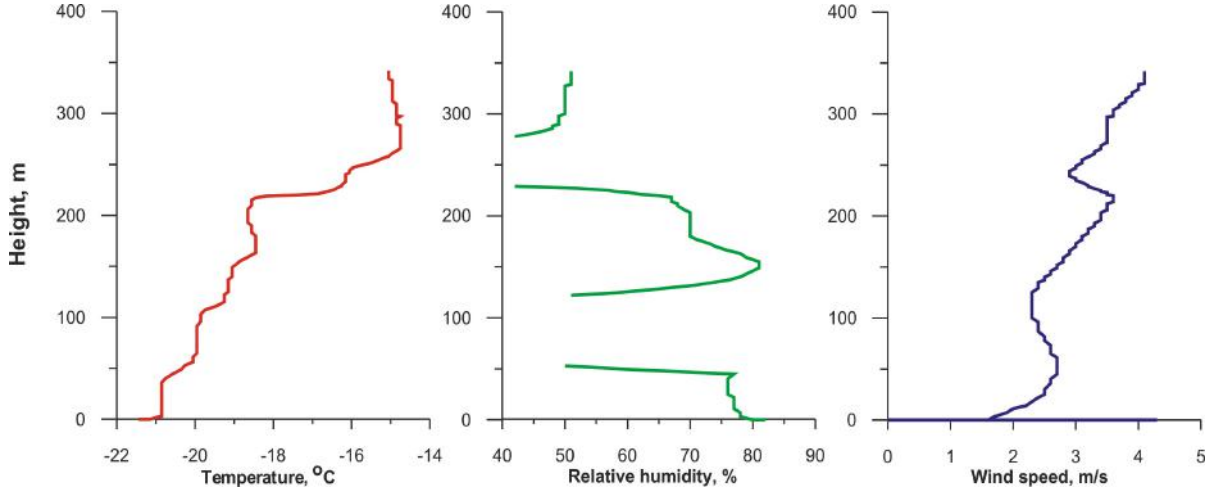

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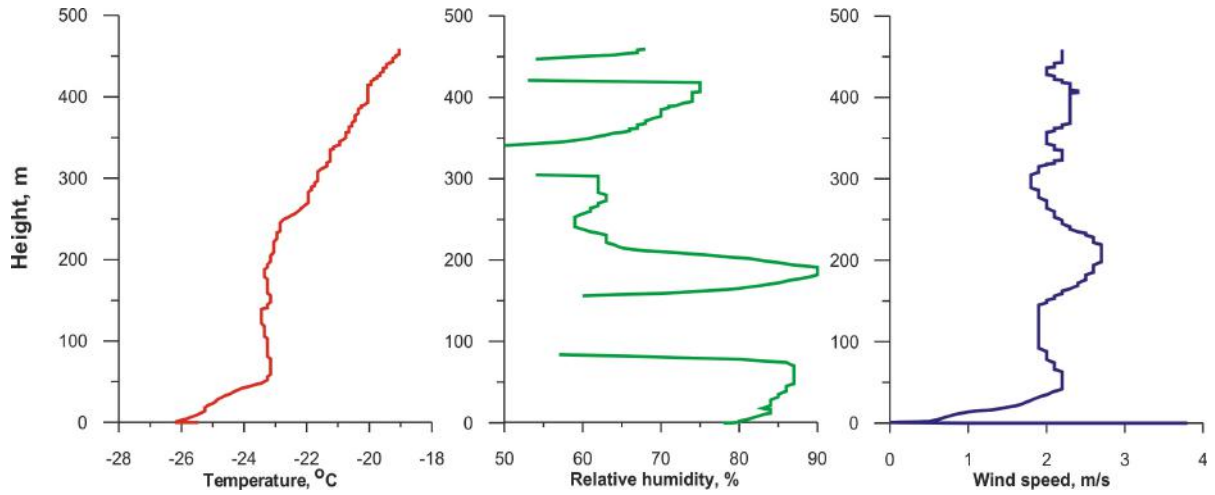
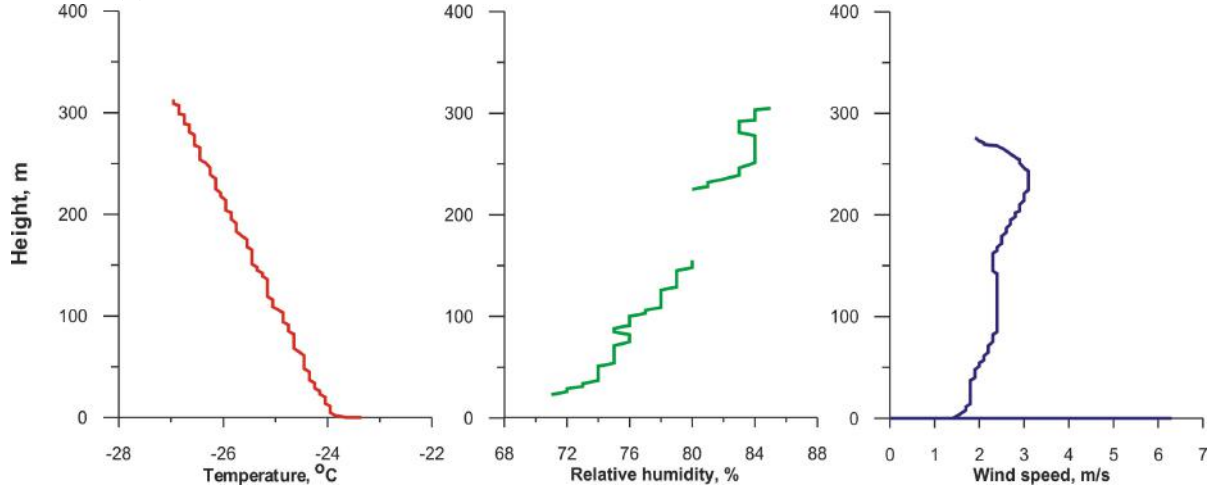


20.01.08 (2)



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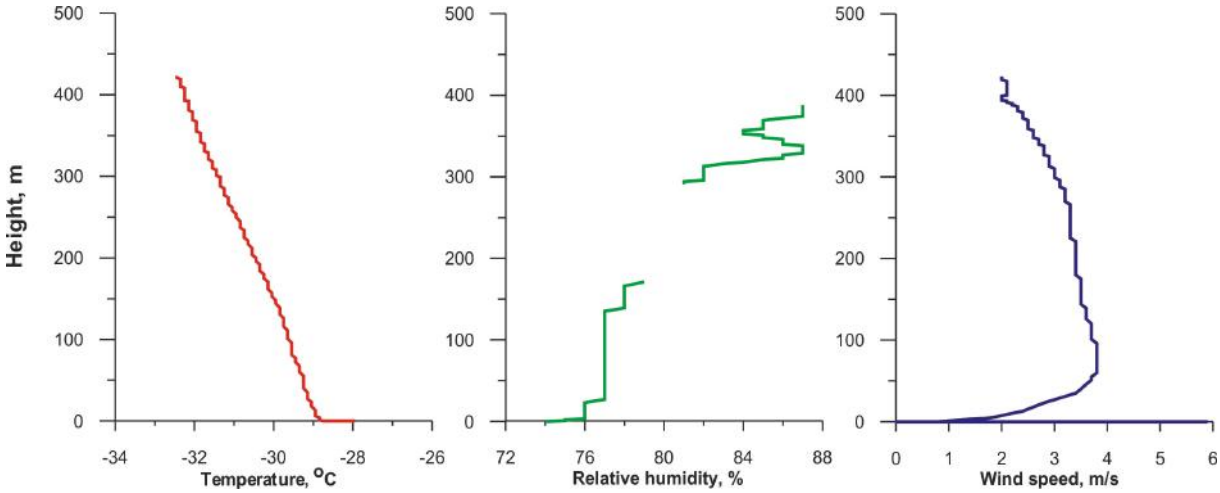

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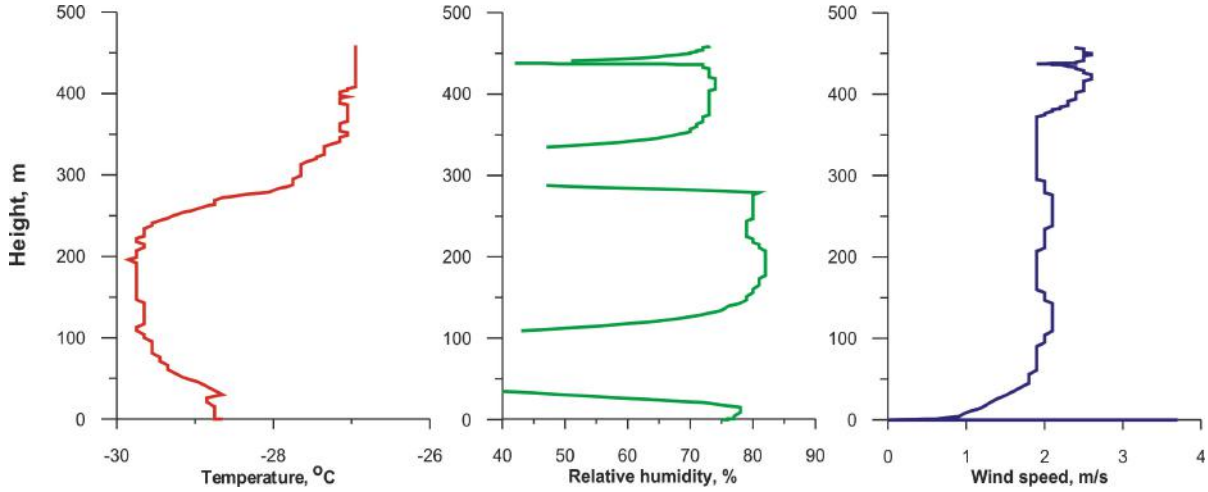

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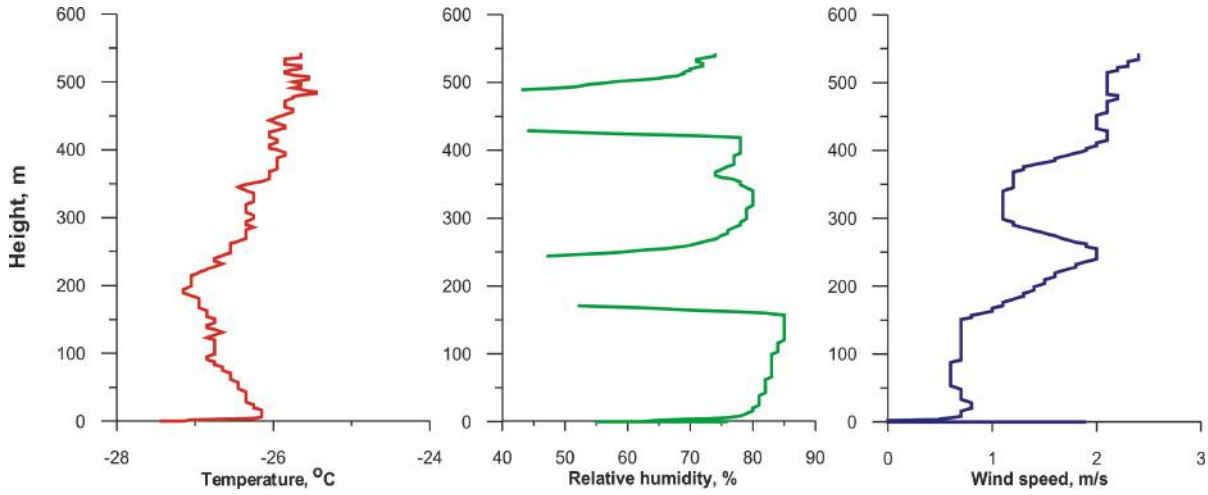

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Fig. 6. Vertical distribution of air temperature, relative humidity and wind speed received during the balloon operations.

Additional information

Additional information about turbulence beneath the ice bottom or current perturbation is important for correct calculation of ice growth rate and estimations of the heat flux through the snow-ice cover. Unfortunately, this information about turbulence for upper 10 m of water layer beneath the ice was unavailable, because standard ship ADCP is mounted at that depth, while the portable sensor for work from sea ice was inoperable.

Total cloudiness data are very important for correct calculation of long-wave radiation balance. This information should be available from ***All-Sky Camera device.*** The all-sky camera system is used to take pictures of sky in order that percentage and type of cloud cover may be determined throughout the cruise. The all-sky camera is now fully functional, and requires daily maintenance to ensure the dome is not frosty. The all-sky camera became non-functional during the Leg 5, due damage of sky-doom plastic cover.

Useful information about surface temperature is provided by the ***Ship-Based Radiometer (SBR).*** Dual polarized radiometers are mounted about 12 m above the sea surface on the port side of the ship. During transect operations the radiometers were kept at an incident angle of 55°. At station stops the system was operated in a scan mode, changing the incident angle from 30° to 150° using 5° steps. A network camera was used to monitor the surface conditions at a sampling rate of 10 s. The settings

have not been changed otherwise. In addition, a hand-held camera is used at each site to provide more information on the surface conditions.

Ice growth simulation

Detailed investigation of sea ice evolution can be performed using a variant of mushy (skeletal) zone classical model (see, among others, Ref. [1]), which describes the simultaneous sea ice growth and its surface heat budget depending on seawater initial temperature and salinity, and changing atmospheric conditions, the air temperature and humidity, the atmospheric pressure, the wind velocity, cloudiness and the snow accumulation. The one-dimensional, thermodynamic, nonlinear model is based on heat and mass transfer equations and boundary conditions imposed at the upper and lower unknown moving interfaces of mushy zone (Ref. [2]) and taking into account heat fluxes at the air-ice surface. Figures 7 and 8 demonstrate a scheme of the process and the model equations (the temperature field in the mushy zone is described by equations (1a), relationship (1b) describe the salinity field in form of Scheil equation and accordance with linear liquidus slope (1c), expressions (2) and (3) represent the heat and mass fluxes imposed at the phase transitions interfaces). As an example the calculations for two variants of sea ice growth differs by initial depth by the same variations of atmospheric conditions measured on meteorological tower in 15-22 January 2008 (see Fig. 3) is performed.

Initial thickness of ice in first variant was equal to the ice floe thickness at the place of tower deployment. The second variant corresponds to open water (lead). The information of seawater temperature and salinity was taken from the Ref. [3]. Figures 9a,b-12a,b shows model results for sea ice thickness, growth rate, interface temperatures and components of ice cover surface heat budget during 15-22 January 2008 for first (a) and second (b) variants at atmospheric and ocean heat fluxes parametrization found in Refs. [4,5]. The results obtained are in good agreement with experimental data (Figure 13). In particular, the growth of sea ice is not simple a square-root function of time. Further accumulation of meteorological information will allow analyzing sea ice thermodynamic evolution in the studied region from formation up to disappearance and also estimating variation of air-sea energy exchange parameters.

Governing Equations for the Mush

$$T_m(z,t)=\frac{T_2-T_1(t)}{h_m(t)-h_i(t)}\left(z-h_i(t)\right)+T_1(t)\,,\quad f_w\frac{\partial S_m}{\partial t}=-S_m\frac{\partial f_w}{\partial t}\,,\quad T_m(z,t)=-\gamma S_m(z,t)\,,\qquad h_i(t)\le z\le h_m(t)$$

(1a,b,c)

Boundary Conditions

$$\rho_i L f_{w1}\frac{dh_i}{dt}=k_i\frac{\partial T^-}{\partial z}-\left(k_i\left(1-f_{w1}\right)+k_w f_{w1}\right)\frac{\partial T^+}{\partial z}\,,\quad S^+\frac{dh_i}{dt}=-D f_{w1}\frac{\partial S^+}{\partial z}\,,\qquad z=h_i(t)$$

(2a,b,c)

$$\rho_i L f_{i2}\frac{dh_m}{dt}=\left(k_i\left(1-f_{w2}\right)+k_w f_{w2}\right)\frac{\partial T^-}{\partial z}+\rho_w C_w\alpha^* u^*\left(T_\infty-T_2\right),\qquad z=h_m(t)$$

(3a,b,c)

T is the temperature, S is the salinity, z is the vertical coordinate, t is the time, f is the local volume fraction, γ is the liquidus slope, h are the positions of interfaces, ρ is the density, L is the latent heat, k is the thermal conductivity coefficient, D is the diffusion coefficient, C is the specific heat, α^* is the turbulent coefficient, u^* is the friction velocity, subscripts "i", "m", "w", "1", "2", "∞" denote the solid zone, mushy zone, seawater (brine), upper and lower boundaries of mushy zone and far-field value, respectively, superscripts "+", "–"denote the upper and lower sides of interfaces, respectively.

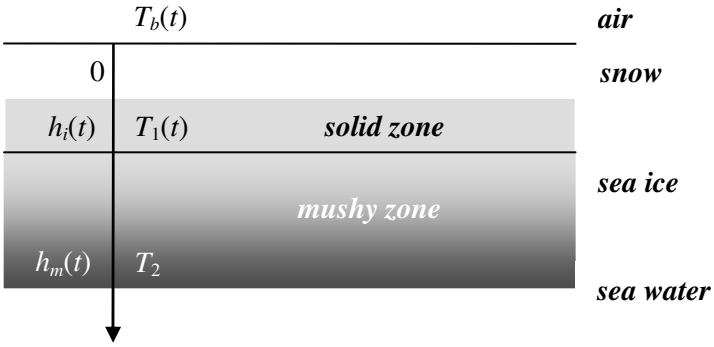

Fig. 8. A schematic diagram of the process.

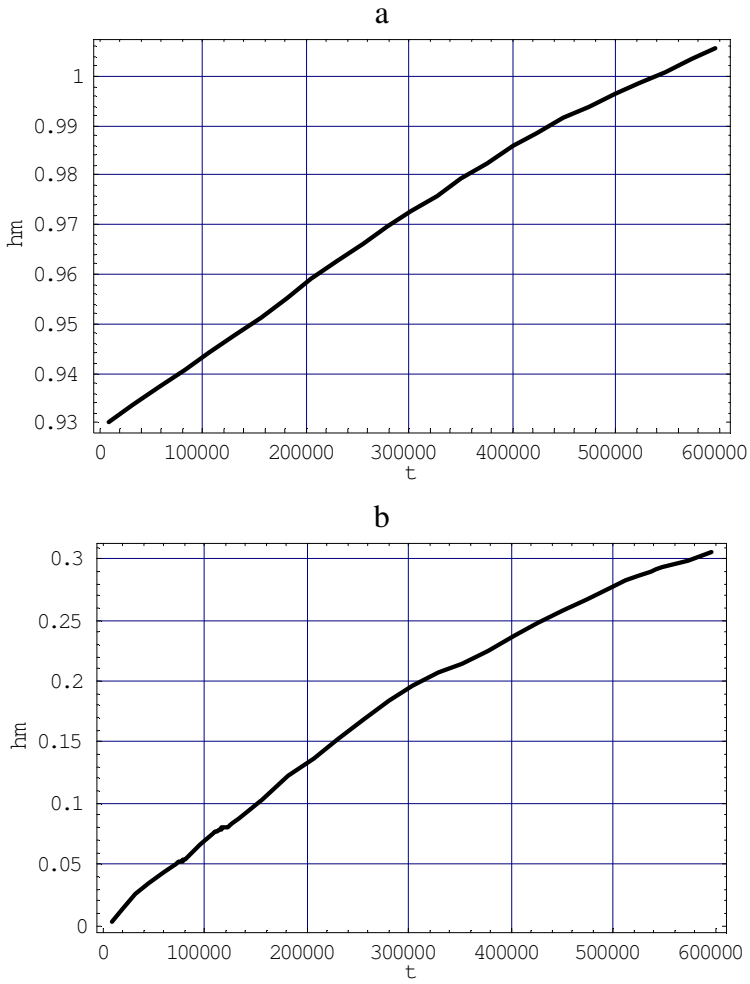

Fig. 9. Increasing of sea ice thickness h_m (m) as a function of time (s) for the first (a) and second (b) variant of calculations.

a

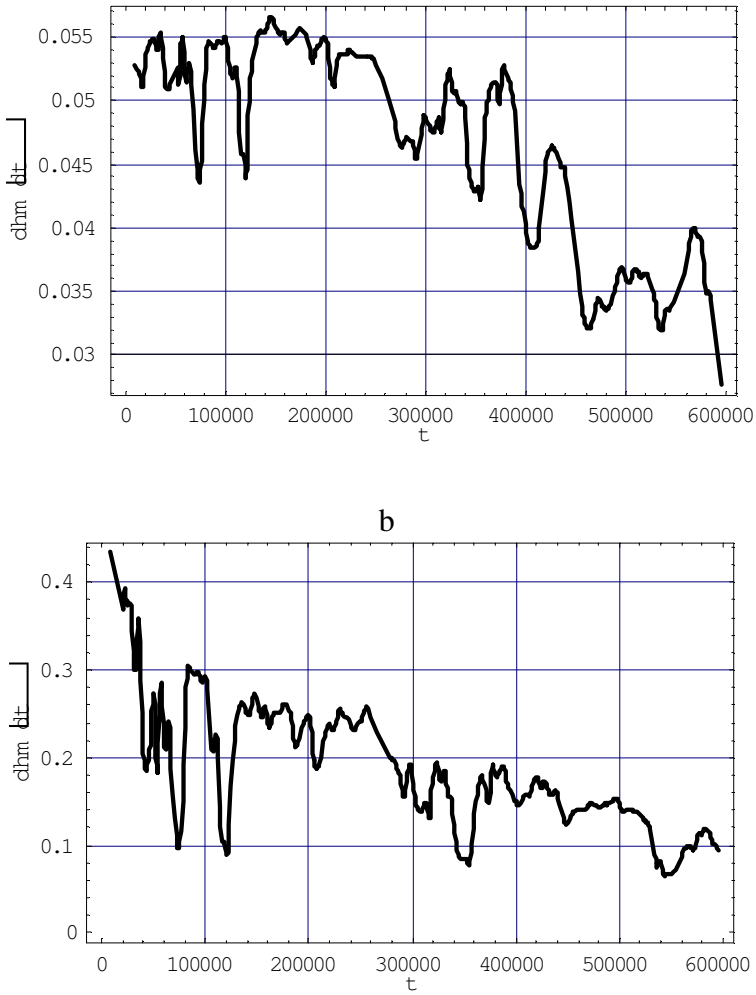

Fig. 10. Variations of sea ice growth rate dh_m/dt (cm/h) as a function of time (s) for the first (a) and second (b) variant of calculations.

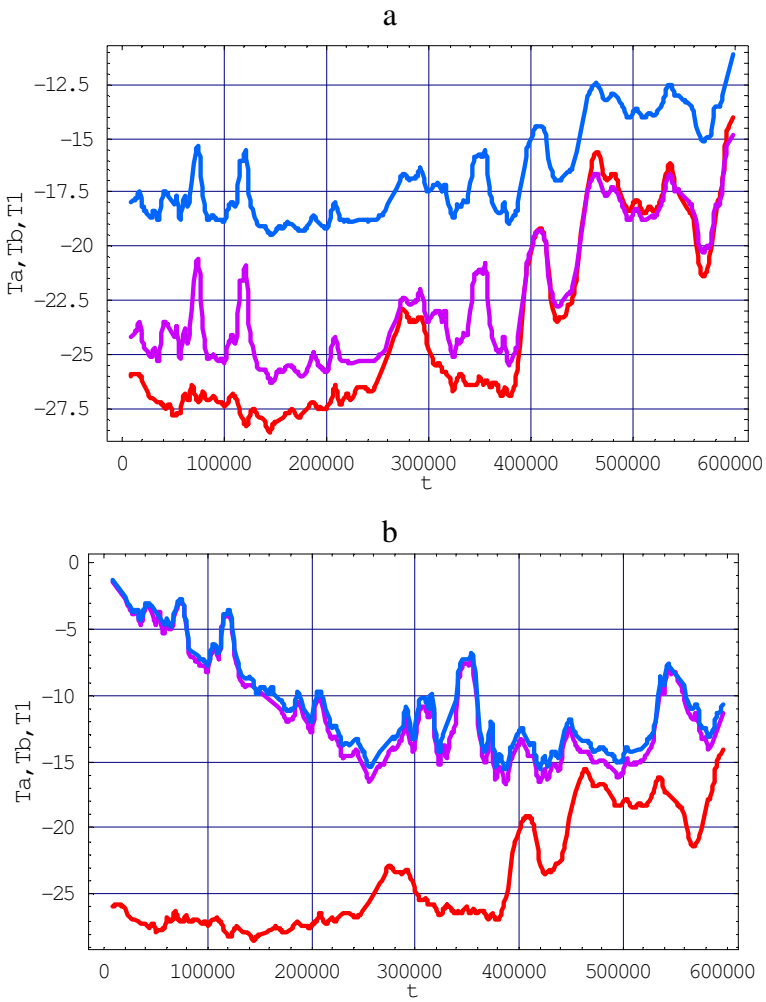

Fig. 11. Changing the sea ice interface temperature (°C) T_a (red line), T_b (violet line), T_1 (blue line).as a function of time (s) for the first (a) and second (b) variant of calculations.

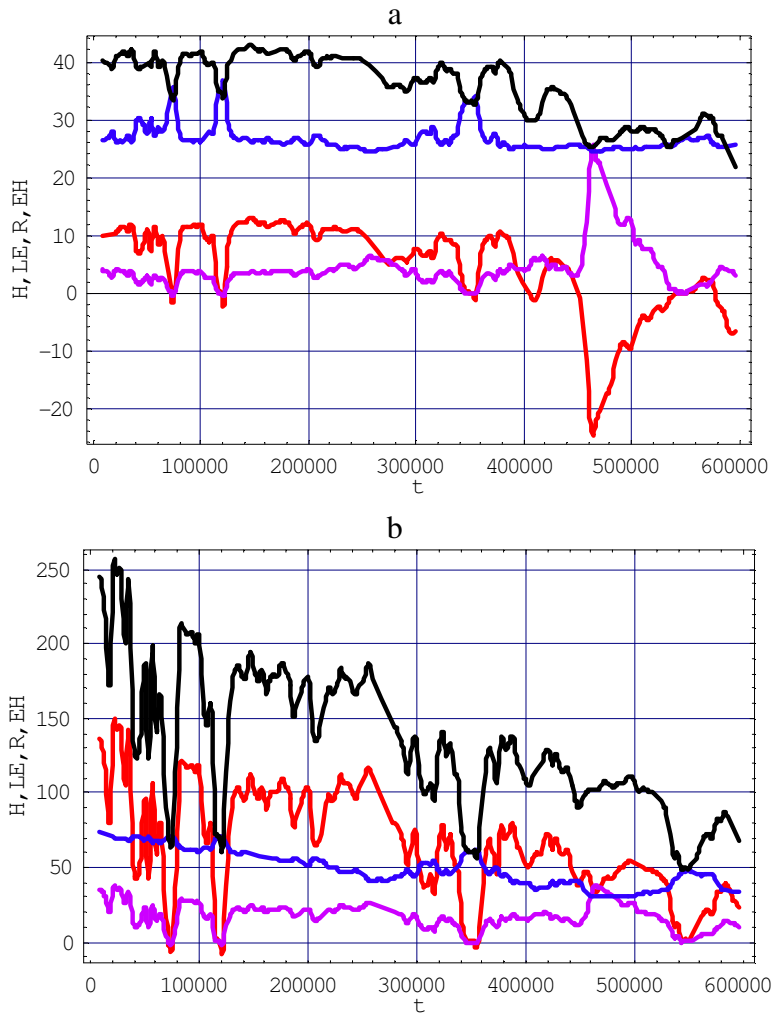

Fig. 12. Changing the sensible (*H*, red line) and latent (*LE*, violet line) heat fluxes, longwave radiation balance (*R*, blue line), and heat flux trough ice cover (*EH*, black line) (Wt/m^2) (d) as a function of time (s) for the first (a) and second (b) variant of calculations.

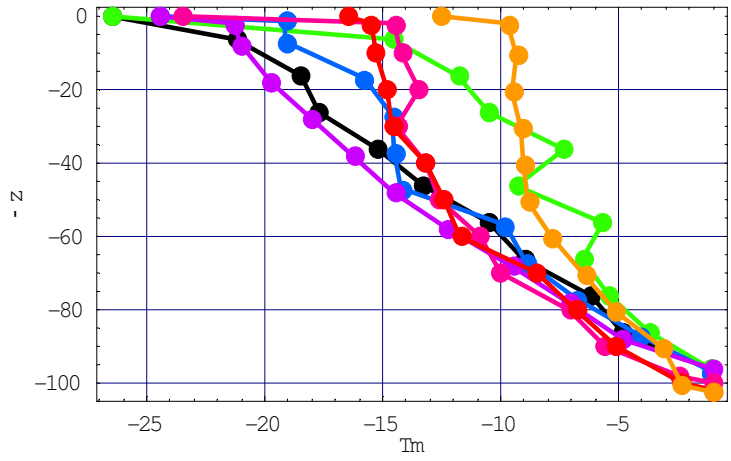

Fig. 13. Vertical profiles of sea ice temperature (°C), measured near meteorological tower during 16 (black line), 17 (green line), 18 (blue line), 19 (violet line), 20 (pink line), 21 (red line) and 22 (orange line) January 2008.

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2.2.4. Aeolian and Ice Transport of Matter in the Circumpolar Flaw Lead

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The aim is to study in detail particulate matter in snow, drifting ice and under-ice water in the areas of circumpolar flaw leads and to estimate their influence on sedimentation and pollution of the Arctic.

During Leg 5 the following studies were done:

Snow research
(composition of dissolved phase; particulate phase, including black carbon)

Snow samples were collected in clean polyethylene bags at a distance > 200 m from the ship upwind or > 150 m from the helicopter upwind. They were melted at room temperature in plastic buckets in a clean container room. Salinity/conductivity and pH were measured when melting was finished. After the snow had melted, the melt water was filtered through pre-weighed nuclear-pore lavsan (polyester) filters (47 mm in diameter, 0.45 µm pore size) and Whatman GF/F filters (47 mm in diameter).

The filtrate from the nuclear-pore filtration is collected for ion analysis (the small 50-ml bottles are stored in the refrigerator) and trace metal analysis (we add 0.5 ml of super pure nitric acid and store them). Filters will be weighed in Moscow to determine the concentration of particulate matter. After that, the elemental composition of particulate matter will be determined by atomic absorption method and scanning electron microscopy will be done (we will try to do it together with X-ray microprobe).

The filtrate from the GF/F filtration is collected for analysis of dissolved organic carbon. Samples are acidified with a few drops of H_3PO_4 and will be analyzed at the University of Manitoba.

GF/F filters will be used for determination of total and black carbon.

We collected 13 snow samples.

Analysis of snow samples could give us information about fluxes of matter from the atmosphere to the drifting ice and about the sources of this matter.

In a few samples of snow, elevated quantities of brownish mineral dust was registered. Detailed study of its composition and calculation of back trajectories of air mass transport may reveal possible source areas. Previously, a few cases of Asian dust and associated pollutant deposition in the Canadian and USA Arctic were reported [Wilkening et al., 2000; Stohl et al., 2002]. The data on the black carbon distribution in snow could be interesting from the Arctic warming point of view [Sharma et al., 2004]. Snow becomes dirty when soot from tailpipes, smoke stacks and forest fires enters the atmosphere and falls to the ground and ice. Dark surfaces absorb sunlight and cause warming, while bright surfaces reflect heat back into space and cause cooling.

Study of ice and under-ice water

Ice sampling consisted of several (3–5) ice cores taken at the same place on the same day. We cut cores into 3–4 subsamples, combined the corresponding pieces and melted them at room temperature.

Under-ice water samples were collected by a 2-l Niskin bottle.

We measured salinity/conductivity and pH in ice-melt and under-ice water, then filtered the water the same way as snow-melt water.

The filtrate after filtrating two cores was collected for trace metal analysis.

On the ice floe D-17 we carried out an *in situ* experiment. On January 15 we took 10 ice cores in the area of thin ice. The average ice thickness was 45 cm. Two sub-samples from these cores were obtained (layers 0–22 cm and 22–45 cm). We drilled at the same place on January 19 (ice thickness was 52 cm) and January 21 (ice thickness was 56 cm). Each time we cut a layer of newly formed ice (deeper then 45 cm). This approach gives us the possibility to study concentration and composition of newly formed ice. With the same goal, we took samples of nilas on the transit from ice floe D-17 to ice floe D-19 on January 23 together with other interested groups.

Our results will be compared with literature data from Siberian flaw leads and the Mackenzie River mouth zone to estimate the role of different source areas in the delivery of sedimentary matter to the Arctic by drifting ice and its role in modern sedimentation.

We collected 21 integrated ice cores and 13 samples of under-ice water.

This work is done within the framework of International Polar Year 2007/2008 project No. 323 "Aeolian and ice transport and fluxes of matter (including ecotoxicants) in the Arctic" included in the OASIS cluster.

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2.2.5. Optical Observation

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Objective
The goal of our experiment is to measure the attenuation coefficients of the vertical incident light through sea ice and snow of different thicknesses and to study the lateral scattering of light using an artificial light that has a spectrum of wavelength bands, simulating the Sun.

Materials and methods

Materials
The instruments used for optical observation are a high resolution Profiling Reflectance and Radiometer (PRR) made by Biospherical Instruments Inc. (BSI, USA). The system includes both an underwater profiler PRR-800 and a surface unit PRR-810, which collect signals simultaneously. Both instruments are multispectral units with very high resolution and sensitivity - enough to detect the light in dark conditions under sea ice. The parameters for the system are described below.

The following equipment is needed in the field：

No.	Name of equipment	Weight
1	Fluorescent lamp	20 kg
2	Optical instruments	15 kg
3	Cables + 250W lamp	15 kg
4	Power generator	10 kg
5	Jiffy driller	5 kg
6	Underwater frame	15 kg
7	Computer	2 kg

8	Desk box of optical instruments	4 kg
9	Tripod, ruler, toolbox, spade	3 kg

Fig 2.1. The equipment for the light experiment

Methods

The operations of the experiment for the attenuation coefficient of the sea ice are as follows:

Step	Operation	Note
1	Choose proper experiment field	Avoid stepping on the field
2	Start ice driller and drill a hole on ice	Measure ice thickness
3	Generate electricity	Use a connector with 3 plugs
4	Switch on the lamp	Preheat for about 15 minutes
5	Link and deploy PRR-800	Put in accurate position
6	Put PRR-810 on tripod	
7	Start instrument system	Keep computer warm before using
8	Measure downwellings with snow	
9	Calibrate with snow	
10	Remove snow and measure	Measure snow thickness
11	Calibrate without snow	
12	Finish	

The methods to measure the attenuation coefficient of the lateral scattering light through sea ice are as follows:

Step	Operation	Note
1	Choose proper experiment field	Avoid stepping on the field
2	Clear the snow at the place chosen	In order to move the lamp steadily
3	Drill three holes with depth of 50 cm	The holes do not reach the seawater
4	Generate electricity	Use a connector with 3 plugs

5	Switch on the lamp	Preheat for about 15 minutes
6	Link and deploy PRR-800 and PRR-810	Put in accurate position
7	Move the lamp in the different depths of the holes and record data	The depth of each 10 cm is required
8	Snow sampling for the density of the snow	
9	Finish	


Fig 2.2. The experiment on lateral scattering of the light

The operations of the experiment for the attenuation coefficient of the snow are following as:

Step	Operation	Note
1	Make a snow hill with 2.5m*1.5m*1.2m	
2	Measure snow hill thickness	
3	Generate electricity	Use a connector with 3 plugs
4	Switch on the lamp	Preheat for about 15 minutes
5	Link the equipment	
6	Put the lamp on the side of snow hill	
7	Deploy PRR-810 on the other side	Put in accurate position
8	Record data	
9	Calibrate the light field	Keep computer warm before using
10	Snow sampling for the density of the snow	
11	Clean the snow to the thickness of 10 cm on the side of PRR-810	
12	Repeat steps 7-11 till the thickness of the snow is less 10 cm	
13	Finish	

Fig 2.3. The experiment to measure the attenuation coefficient of the light through snow

The operations of the experiment for the attenuation coefficient of the snow at different depths are as follows:

Step	Operation	Note
1	Choose proper experiment field	Avoid stepping on the field
2	Measure snow thickness	
3	Start ice driller and drill three holes on ice	Measure ice thickness
4	Generate electricity	Use a connector with 3 plugs
5	Switch on the lamp	Preheat for about 15 minutes
6	Link and deploy PRR-800	Put on accurate position
7	Put PRR-810 on tripod	
8	Start instrument system	Keep computer warm before using
9	Measure downwellings with full snow	
10	Calibrate with the snow	
11	Remove some snow to change the thickness of snow	Measure snow thickness and snow sample for density
12	Measure downwellings with that snow	
13	Calibrate with the snow	Repeat steps 11-13 until ice surface is reached
14	Finish	

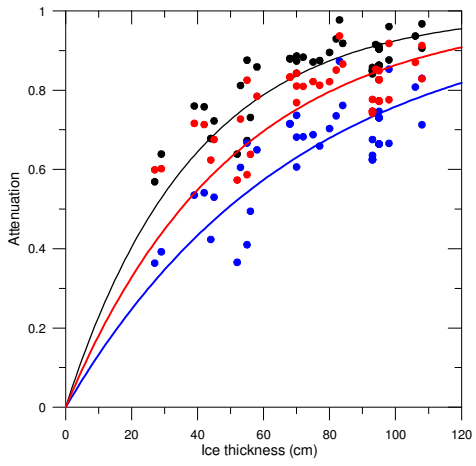
Fig 2.4. The experiment to measure the attenuation coefficient of the light through snow layers of different thicknesses.

The options of the CTD experiment are as follows:

Step	Operation	Note
	Get the water depth from bridge	Before being on the ice
1	Choose proper experiment field	
3	Start ice driller and drill three holes on ice	
4	Turn on the CTD and let it go down slowly	
5	Stay for 1 minute at depth of 60 m, then go up	
6	Turn off	

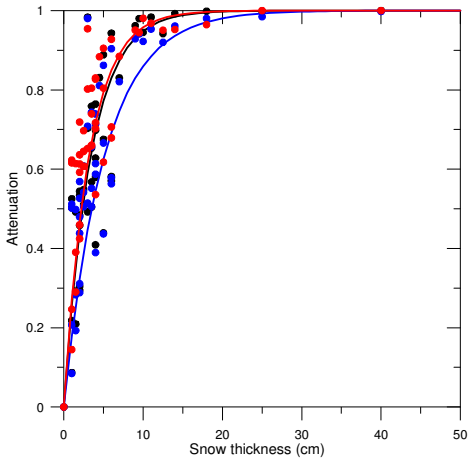
Results

Results of experiment on vertical attenuation of sea ice



The vertical attentuations of the light in sea ice of different thicknesses are shown in the dark (710 nm), blue (490 nm) and red (410 nm) lines, respectively. The dots are taken from the field experiments, while the lines fit the data to exponential form.

Results of experiment on vertical attenuation of snow



The vertical attentuations of light in snow of different thicknesses are shown in the dark (710 nm), blue (490 nm) and red (410 nm) lines. The data in dots are taken from the field experiments, while the lines fit the data to exponential form.

2.3. Team 4

2.3.1. Food web. Zooplankton and fish, Acoustic

PI: Louis Fortier
Participants: Marc Ringuette (U. Laval), Stéphane Thanassekos (U. Laval), Josée Michaud (U. Laval), and Steeve Gagné (electronic technician from U Laval).
Written by: Josée Michaud, Marc Ringuette and Stéphane Thanassekos

THE ZOOPLANKTON SAMPLING TEAM

Introduction

The fragmented, thin, and often absent ice cover in the flaw lead allows solar radiation to reach the surface layer of the ocean where it triggers photosynthesis by microscopic algae. Team 4, Pelagic and Benthic Food Web, will investigate how and to what extent the microalgae growing in the flaw lead are exploited by animals living in the plankton (the zooplankton) and on the sea floor (the benthos). Our simple hypothesis is that, relative to adjacent ice-covered regions, enhanced algal production in the flaw lead translates into biological hot spots where higher zooplankton and benthos abundances prevail. We will also investigate how the Arctic cod, a central species in the Arctic food web, uses the flaw lead for feeding, overwintering, reproduction, and as a nursery ground for their young stages (http://www.ipy-cfl.ca/page1/page1.html).

General objectives

The general objective of our team during Leg 5 of CFL was to collect indices of secondary production in the water column in winter (December and January). Our sampling program was designed to be consistent with the overarching goal of ArcticNet project 1.4 led by Dr. J.-É. Tremblay (U. Laval) 'Marine productivity and sustained exploitation of emerging fisheries,' which is to assess the impact of sea-ice cover reduction and increasing sea temperatures on biological productivity, fisheries resources and marine mammal populations of the coastal Canadian Arctic. Since October 18th, the start date of the CFL program, we have focused on how physical processes moderate biogeochemical processes within the changing northern flaw lead ecosystem nearby Banks Island (Beaufort Sea). Our multidisciplinary ArcticNet-CFL team is strongly linked with Team 7 (Carbon Fluxes – Tremblay) of the CFL program. For this Leg 5 of CFL, sampling efforts were concentrated on the pelagic secondary producers.

The primary objectives of our team during CFL-5 were:

1- To assess zooplankton / fish abundance and diversity by using various plankton nets.
2- To track zooplankton / fish biomass and distribution with the EK60 Echosounder.

Our secondary field objectives were to collect and use the zooplankton samples for:

1- The cycling of contaminants in zooplankton (G. Stern, U. Manitoba)
2- Identification of the sources and pathways of omega-3 in the arctic marine food chain (J. Michaud, E. Dewaily and L. Fortier, U. Laval). This project is linked to the CFL-URSUK program and the ArcticNet theme 1.5, focusing on the importance of omega-3 fatty acid in the traditional diet of Inuit communities.
3- Assessment of the biomass and respiration rates of the zooplankton community by the Electron Transfer System (ETS) activity at selected stations (G. Darnis and L. Fortier).
4- Stable isotope analysis on the food web structure and carbon fluxes. This is a joint project between Team 4 and 7 of CFL (A. Forest, L. Fortier, J-E. Tremblay).
5- Copepod *in-situ* egg production (EPr) and gonad maturation of *Calanus hyperboreus* and *Metridia longa* (M. Ringuette, G. Darnis, L. Fortier).
6- Opportunistic genetic studies of amphipods (F. Dufresne and A. Radulovici, UQAR).

Sampling program

Leg-5 sampling program was oriented towards ice work, when the ship was stationary on an ice flow for periods of time varying from 1 day to a week. Zooplankton sampling was performed at 7 of the 9 floes (Fig. 1), as the ship only stopped briefly at the two unsampled floes. For this leg, vertical sampling of the water column from the ice was added to the usual moon pool zooplankton sampling activities. This later vertical net tow allowed sampling the first 10 m of the water column that cannot be sampled from the moon pool.

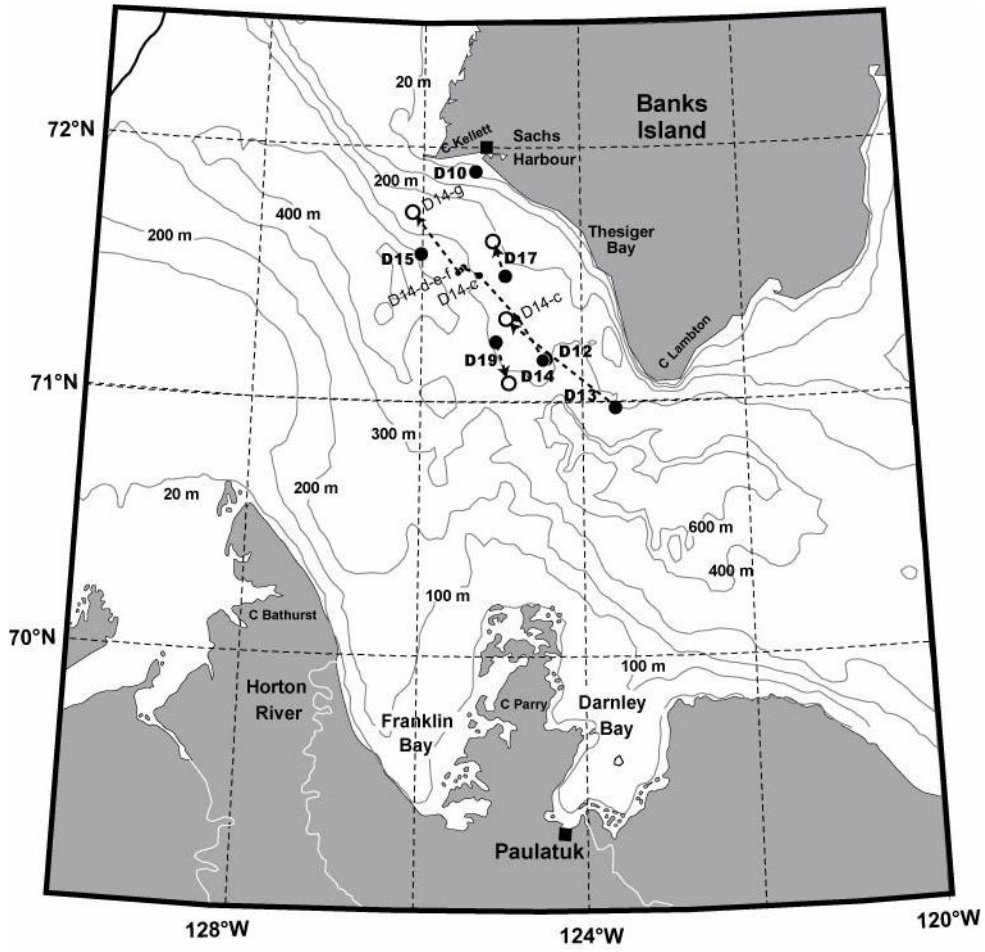


Fig. 1: Locations of CFL leg 5 drifting stations. Closed circles indicate the beginning of the rifting path while open circles marks the end.

Sampling gear and events

a) 1-m^2 Square net. Frame rigged with 1 square m^2 opening net (1 x 200, µm mesh), out-rigged with a 10 cm diameter net (50 µm) and equipped with a TSK flowmeter (Fig. 2a). This net is used for integrated water column sampling (summarized in Table 1). When deploying, downward winch speed was < 40 m/min to avoid mixing of the nets, and upward winch speed was 30 m/min. To obtain quantitative tow (i.e. for taxonomy and abundance estimates), the content of the 200 µm (TSK) and the 50 µm mesh-net were preserved in formaldehyde (Fortier). Qualitative tows (i.e. 'live tows') were also performed to obtain animals for contaminants, lipids, genetics, EPr and/or ETS studies. The weight and the wires out-rigging the net were replaced during the leg. On three occasions (2008D19-3, -4, and -5) the strong currents prevented the deployment of this net; the cast 2008D19-3 was annulled and casts2008D19-4 (taxonomy) and -5 (live tow) were performed using the heavier and thus more stable Hydrobios.

b) Hydrobios. Multi-depth plankton sampler (Fig. 1b) equipped with nine 200 µm-mesh nets (opening 0.5 m^2). This sampler allowed for depth-specific sampling of the water column. The *Hydrobios* is also equipped with a CTD to record water column properties while collecting biological samples. When deploying, downward winch speed was 40 m/min and the upward speed was 30 m/min. At most casts, the net collection was preserved in formaldehyde for taxonomic analysis but for some casts, the content of each net was divided: 50% for taxonomy (4% buffered formaldehyde), 25% for biomass estimates, and 25% for ETS analysis (Table 2). Note that the recurrent problem with the Hydrobios flowmeters observed during Legs 3 and 4 appear to be resolved, at the very least for the flowmeter

inside the Hydrobios frame; hence the TSK flowmeter that was placed on the Hydrobios during Legs 3 and 4 was removed.

c) Ring net. A 1-m diameter ring net equipped with a 200 □m mesh net and out-rigged with 10 cm diameter net (50 μm) and a flowmeter. This net was deployed twice per cast from a hole on the ice near the ship but at a site not influenced by the ship's presence (not downstream of it). Ice zooplankton sampling activities are summarized in Table 3. For the first station, a TSK flowmeter was used; however, it froze at each deployment and was replaced by a General Oceanic (G.O.) flowmeter filled with ethanol to prevent freezing. A Seabird 19 CTD was also fixed to the net frame, but was replaced by a RBR CTD after the first cast (2008D14-Ice1) when it was noticed that the pressure sensor was faulty and a depth profile could not be obtained. At each station cast, the first haul was from 10 m to the surface and the second haul from a maximum of 270 m to the surface. The net was lowered manually to the desired depth and pulled manually for the 10 m haul and using a snow mobile for the deep haul.

Overall, 105 sampling events occurred: 75 of the samples obtained were preserved for taxonomy and the remainder, the 'live tows', were used for further analysis and laboratory experiments as described above. Samples for lipid and stable isotope analysis were placed in cryovials and stored at –80˚C. A very small number of amphipods were preserved for genetic analysis as very few animals were collected and thus priority was given to the contaminant studies. Samples for contaminants were sorted and preserved by Gary Stern's team.

(a)

(b)

(c)

Fig. 2. Zooplankton sampling gear used during CFL-Leg 5: a) 1-m^2 Square net; b) Hydrobios, both deployed from the moonpool; and c) Ring net deployed from the ice.

Table 1: CLF-Leg 5 summary of sampling activities using the 1m^2 net.

Date (UTC)	Station	LAT	LONG	Sampling depth	Contami - nants	Taxo- nomy	Genetics	Lipids	Stable Isotopes	EPR	Biomass and ETS
2007-12-23	2007D10	71,915	125,432	27,1		X					
2007-12-23	2007D10	71,915	125,432	25	X						
2007-12-26	2007D12-1	71,249	124,485	274		X					
2007-12-26	2007D12-2	71,249	124,485	280	X						
2007-12-26	2007D12-3	71,249	124,485	280				X			
2007-12-26	2007D12-4	71,227	124,412	270	X						
2007-12-26	2007D12-5	71,220	124,430	270						X	X
2007-12-27	2007D12-6	71,203	124,452	270	X						
2007-12-27	2007D12-7	71,213	124,475	270,8	X						
2007-12-27	2007D12-8	71,213	124,475	270	X						
2007-12-27	2007D12-9	71,217	124,486	270	X						
2007-12-27	2007D12-10	71,225	124,512	280	X		X	X			
2007-12-27	2007D12-11	71,242	124,560	279	X						
2007-12-27	2007D12-12	71,245	124,573	279	X						
2007-12-28	2007D12-13	71,337	124,859	216							
2007-12-29	2007D12-14	71,388	125,114	260		X					
2007-12-29	2007D12-15	71,389	125,119	260						X	
2008-01-02	2008D13-1	70,990	123,538	250,6	X						
2008-01-02	2008D13-2	70,992	128,547	243,7				X			
2008-01-03	2008D14-1	71,242	124,500	280							X
2008-01-03	2008D14-2	71,245	124,514	260		X					
2008-01-04	2008D14-3	71,350	124,862	189,62		X					
2008-01-05	2008D14-4	71,488	125,340	281		X					
2008-01-05	2008D14-5	71,523	125,457	311,5		X					
2008-01-06	2008D14-6	71,542	125,528	342		X					
2008-01-07	2008D14-7	71,533	125,547	345,37		X					
2008-01-08	2008D14-8	71,527	125,632	352,14		X					
2008-01-08	2008D14-9	71,527	125,632	345				X	X		
2008-01-09	2008D14-0	71,527	125,632	343	X					X	
2008-01-09	2008D14-11	71,528	125,772	358,92							
2008-01-09	2008D14-12	71,528	125,772	350	X						X
2008-01-10	2008D14-13	71,640	126,093	331,8		X		X	X		
2008-01-12	2008D15-1	71,617	126,037	372,46		X					
2008-01-13	2008D17-1	71,465	124,995	213,36		X					
2008-01-15	2008D17-2	71,513	124,873	200				X	X	X	X
2008-01-15	2008D17-3	71,513	124,873	203,16		X					
2008-01-16	2008D17-4	71,508	124,920	220		X					
2008-01-16	2008D17-5	71,508	124,918	212	X						
2008-01-16	2008D17-6	71,508	124,918	220		X					
2008-01-17	2008D17-7	71,522	124,958	217		X					
2008-01-17	2008D17-8	71,522	124,958	217				X	X		
2008-01-18	2008D17-9	71,542	125,003	206		X					
2008-01-18	2008D17-10	71,542	125,003	206							
2008-01-19	2008D17-11	71,547	124,997	204		X					
2008-01-19	2008D17-12	71,547	124,997	203							X
2008-01-20	2008D17-13	71,572	125,083	230		X					
2008-01-20	2008D17-14	71,572	125,083	202				X	X		
2008-01-24	2008D19-1	71,207	125,160	233,6							
2008-01-25	2008D19-2	71,169	125,110	311		X					
2008-01-27	2008D19-6	71,092	124,900	304,7		X					

2008-01-27	2008D19-7	71,092	124,898	305				**X**	**X**	**X**
2008-01-28	2008D19-8	71,093	124,887	308,1		**X**				
2008-01-28	2008D19-9	71,093	124,887	309	**X**					

Table 2: CLF-Leg 5 summary of sampling activities using the Hydrobios.

Date (UTC)	Station	LAT	LONG	Sampling depth	Lipids	Stable Isotopes	Biomass and ETS	Taxonomy
2007-12-26	2007D12-A	71,249	124,452	280				**X**
2007-12-28	2007D12-B	71,328	124,830	210			**X**	**X**
2008-01-03	2008D14-A	71,239	124,484	275			**X**	**X**
2008-01-04	2008D14-B	71,385	124,958	215	**X**			**X**
2008-01-05	2008D14-C	71,488	125,315	275				**X**
2008-01-06	2008D14-D	71,543	125,535	333				**X**
2008-01-08	2008D14-E	71,532	125,573	345				**X**
2008-01-09	2008D14-F	71,527	125,715	345			**X**	**X**
2008-01-11	200814-G	71,723	126,222	230				**X**
2008-01-12	2008D15-A	71,617	126,037	370				**X**
2008-01-13	2008D15-A	71,467	124,990	215				**X**
2008-01-15	2008D17-B	71,513	124,890	201				**X**
2008-01-16	2008D17-C	71,508	124,918	213				**X**
2008-01-17	2008D17-D	71,520	124,952	207				**X**
2008-01-18	2008D17-E	71,537	124,995	207			**X**	**X**
2008-01-19	2008D17-F	71,547	124,997	204				**X**
2008-01-20	2008D17-G	71,572	125,078	222				**X**
2008-01-21	2008D17-H	71,603	125,155	231				**X**
2008-01-21	2008D17-I	71,603	125,157	231				**X**
2008-01-21	2008D17-J	71,603	125,157	231				**X**
2008-01-21	2008D17-K	71,603	125,157	231				**X**
2008-01-21	2008D17-L	71,603	125,157	231				**X**
2008-01-21	2008D17-M	71,603	125,157	231				**X**
2008-01-21	2008D17-N	71,603	125,157	231				**X**
2008-01-24	2008D19-A	71,212	125,173	303				**X**
2008-01-26	2008D19-B	71,192	125,030	309				**X**
2008-01-26	2008D19-C	71,128	124,958	297				**X**
2008-01-26	2008d19-4	71,122	124,953	298				**X**
2008-01-26	2008d19-5	71,122	124,953	298	**X**	**X**		
2008-01-27	2008D19-D	71,092	124,900	309			**X**	**X**
2008-01-28	2008D19-E	71,093	124,887	309				**X**

Table 3: CLF-Leg 5 summary of sampling activities using the 1 m diameter ring net on the ice. All samples were used for taxonomy purposes.

Date (UTC)	Station	LAT	LONG	Sampling depth
2008-01-08	2008D14-Ice1	71,527	125,617	281
2008-01-08	2008D14-ce1	71,527	125,617	281
2008-01-10	2008D14-ice2	71,588	125,980	10
2008-01-10	2008D14-ice2	71,588	125,980	196,6
2008-01-15	2008D17-Ice1	71,512	124,927	10
2008-01-15	2008D17-Ice1	71,512	124,927	216,7
2008-01-16	2008D17-Ice2	71,508	124,918	10
2008-01-16	2008D17-Ice2	71,508	124,918	218,2
2008-01-17	2008D17-Ice3	71,527	124,968	10
2008-01-17	2008D17-Ice3	71,527	124,968	218
2008-01-19	2008D17-Ice4	71,545	124,995	10
2008-01-19	2008D17-Ice4	71,545	124,995	217
2008-01-20	2008D17-Ice5	71,575	125,095	10
2008-01-20	2008D17-Ice5	71,575	125,095	216,5
2008-01-25	2008D19-Ice1	71,193	125,060	10
2008-01-25	2008D19-Ice1	71,198	125,055	245
2008-01-26	2008D19-Ice2	71,108	124,943	10
2008-01-26	2008D19-Ice2	71,108	124,943	235,2
2008-01-28	2008D19-Ice3	71,093	124,887	10
2008-01-28	2008D19-Ice3	71,093	124,887	10
2007-12-29	2007D12-Ice1	71,380	125,061	230

Laboratory analysis

Egg production rate experiments

Copepod *in-situ* egg production and gonad maturation (after Niehoff 1998) were monitored by incubating large calanoid species females at 0°C, a temperature similar to what they experience at depth. The presumed non-reproducing *Calanus glacialis* was monitored only twice during the leg in order to verify and confirm its non-reproductive state. *Metridia longa* and *C. hyperboreus* egg production was measured approximately every 5 or 6 days. *M. longa* did not produce any eggs but some females started to developed eggs by the end of January although gonadic index remained constantly low. Very few *C. hyperboreus*, females had matured eggs in late December, with less than 10% of the population having eggs in vitellogenesis. However, by mid-January, within only a week, the number of females with eggs in vitellogenesis increased rapidly from 18% to 60% and daily egg production rate went from 0 to 18 eggs f^{-1} d^{-1}. This corresponds only to the beginning of the reproduction season; rates should increase in the coming weeks.

Harsh winter conditions always provide difficulties in studying winter Arctic organisms. Because of this constraint, the metrics on the reproduction of *C. hyperboreus* is currently poorly documented. In order to measure the total production of *C. hyperboreus,* 50 immature females were placed in filtered seawater with their egg production monitored daily. Eggs produced were then used to measure the hatching rates for different eggs buoyancies (sinking vs. flotting). By the end of April we hope to get total reproductive output and the fate of this production. Finally an experiment was initiated to test the hypothesis arguing that *M. longa* can feed on *C. hyperboreus* eggs (Conover & Huntley 1991). The question here is if they simply feed on these eggs or if they use this consumption to fuel an early reproduction, before the onset of the algal production. Thirty females were fed every second day with a known number of freshly laid *C. hyperboreus* eggs. On the second day, the remaining eggs were counted and removed before providing new ones. Gonadic stages of *M. longa* were recorded weekly.

Biomass and Transfer System (ETS) activity

At five stations (Tables 1 and 2), samples were sorted for biomass and ETS activity essay. At these stations, each Hydrobios net was subdivided: 50% for taxonomy (i.e. preserved in formol); 25% for population biomass estimates; and 25% for ETS activity. To estimate biomass, the sub-sample (i.e. 25% of total sample) was fractionated with sieves in > 1000 □m and < 1000 □m size classes; these fractions were preserved at –20˚C. Subsamples for zooplankton population ETS activity essays (i.e. 25% of total sample) were also sieved into the same two size fractions. As no Sanyo incubator was available for the ETS experiments, samples were incubated in a Pyrex plate filled with water and heated to 40˚C on a hot plate. Temperature of this 'hot tub' prove to remain constant during the require incubation time. ETS experiments were also performed on individual copepods, females and copepodite stage 5, of *Calanus finmarchicus*, *C. hyperboreus* and *Metridia longa*

Acoustic monitoring

The Simrad EK-60 Echosounder of the *Amundsen* allowed our group to continuously monitor the spatial and vertical distribution of zooplankton and fish, the later mostly represented by Arctic cod (*Boreogadus saida*). The hull-mounted transducers are in operation 24 hours a day and will provide an extensive mapping of where the fishes were within the region of interest over a yearly cycle.

General Recommendations

As the drift of the ship while in a ice floe can be important, we recommend sampling every day with the Hydrobios and the 1-m^2 Square net in the moon pool and with the ring net from the ice. Sampling in the morning in the moon pool and from the ice in the afternoon proved to be the most convenient schedule for Leg 5.

Low temperature is the essence of all the measurements done with live animals. The very warm temperature in our laboratory may pose problems even to the environment chamber which shows difficulties to maintain the required 0°C. Setting the air conditioner system at 22°C remedied the problem. From now on, the AC should stay on and the laboratory door must remain closed.

When the ship is in transit, and the transit may last a few days, before stopping in a floe, particular attention should be given to the EK-60 sounder and the ADCP in order to make sure all sensors are cleared of ice before the shutting down of the engines. Otherwise the data recorded are simply unusable.

More importantly, enjoy this amazing experience in this harsh but beautiful environment, have fun and KEEP THE SPIRIT!!!

References

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Niehoff B (1998) The gonad morphology and maturation in Arctic Calanus species. J Mar Syst 15:53-59

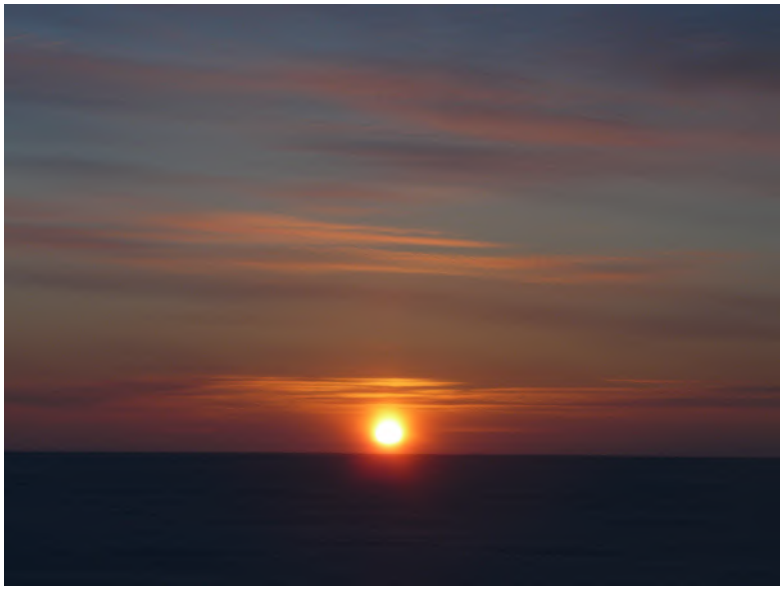
Acknowledgements

We thank the officers and the crew of *Amundsen* team B for their continuous effort and essential help; thank you for being able to repair or built anything we need! Special thanks to all who assisted us with sampling and digging holes in the ice and, finally, to Debbie Armstrong, Andrea Riedel and Jeff Latonas and the crew for being our bear watchers while we worked on the ice.

2.4. Team 6

2.4.1. Surface Meteorology and Flux Project

PI: Tim Papakyriakou, Centre for Earth Observation Science, University of Manitoba
Participants: Tim Papakyriakou, Bruce Johnson, Elizabeth Shadwick



Introduction
The surface meteorology and flux program (CFL Team 6) is designed to record basic meteorological conditions and to study exchanges of momentum, heat and mass across the atmosphere-sea ice-ocean interface. The main value of this program to the overarching objectives of Team 6 is the direct measurement of CO_2 fluxes.

Fluxes of CO_2 are measured by the eddy covariance technique, which is dependent only on atmospheric measurements. Although measurement of these fluxes is extremely useful information, it is essentially meaningless without an understanding of the processes (physical, biological and chemical) that drive gas exchange. In an open-ocean situation this context is largely provided by measurement of sea-surface pCO_2, but the situation becomes much more complex when a sea ice cover is included in the equation.

Micrometeorology and Eddy Covariance Flux Tower

Methods
The micrometeorological tower located on the front deck of the *Amundsen* (Fig. 1) provided continuous monitoring of meteorological variables and eddy covariance parameters. The tower consists of slow response sensors that record bulk meteorological conditions: wind speed and direction (1), air temperature and relative humidity (2), and surface skin temperature (10); and fast response sensors that record the eddy covariance parameters: CO_2/H_2O concentration (4 & 5), three-dimensional wind velocity (3), and three-dimensional ship motion (6). In addition, down-welling radiation sensors were installed on the roof of the wheelhouse to provide information on incoming longwave (7), shortwave (9), and photosynethetically active radiation (8). All data was logged to Campbell Scientific dataloggers; a model CR5000 logger was used for the fast response sensors, a CR1000 logger for the slow response meteorological sensors, and a CR23X for the radiation data. All loggers were synchronized to UTC time using the ship's GPS system as a reference.

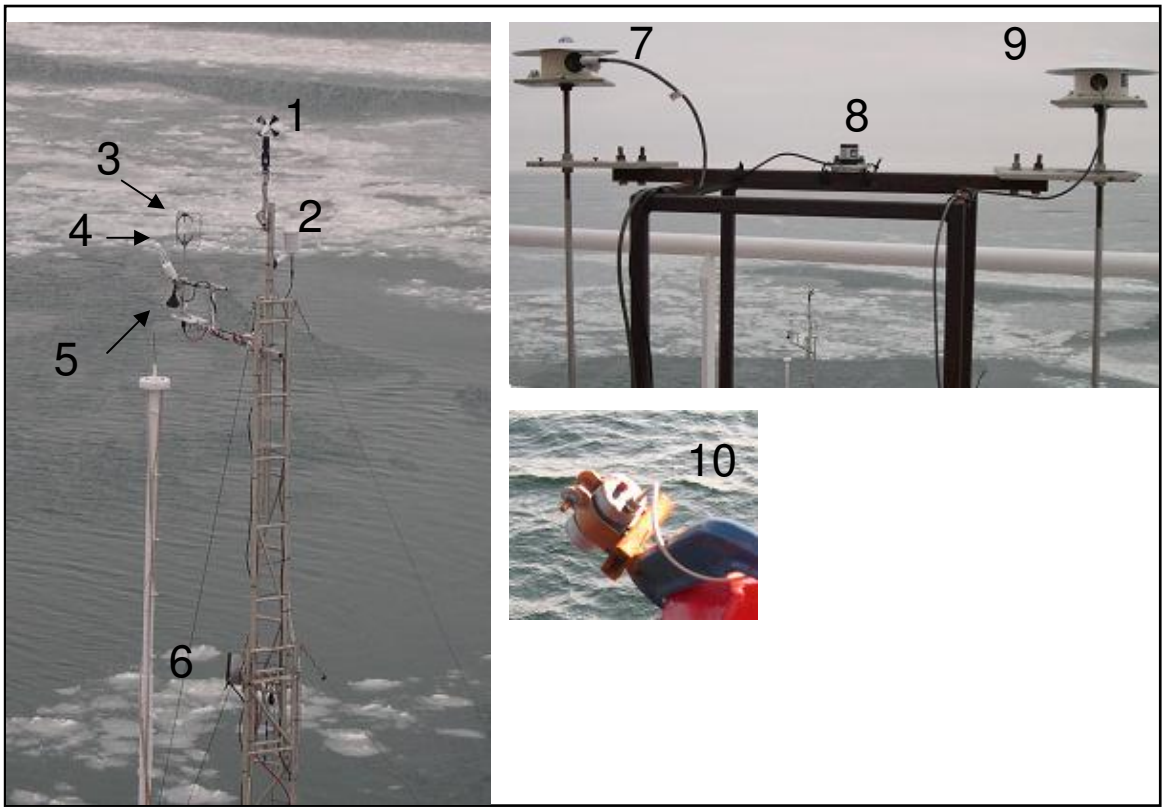


Fig. 1: Meteorology and flux program instrument setup.

The eddy covariance system on the tower makes use of two separate gas analyzers and a single three-dimensional sonic anemometer. The dual gas analyzers system allows us to make use of both closed-path and open-path eddy covariance systems. The open-path gas analyzer has the benefit of making measurements concurrently with the sonic anemometer, but the closed-path gas analyzer is not as easily disturbed by adverse weather conditions.

In order to make sure that the two systems are comparable, careful calibrations were performed on both instruments. The closed path system is based on a LI7000 gas analyzer that employs two optical cells, one of which was used to monitor the drift of the instrument by constantly passing a stream of ultra-high purity N_2. In addition, the sample cell of the instrument was calibrated daily using the ultra-high purity N_2 to zero the CO_2 and H_2O measurements, and a reference gas of known CO_2 concentration in air to span the instrument. Occasionally, a span calibration of the H_2O sensor was performed using a dew point generator (model LI-610). The open path gas analyzer (LI7500) could not be calibrated as conveniently, and so it was calibrated approximately every three weeks. In general, we find that this is effective for this particular instrument, which does not drift significantly over time.

Notes

The meteorological tower ran consistently for the duration of the leg (Dec 21 to Jan 31). However, for significant periods of time during this leg, data collected by some of the sensors were obviously erroneous due to atmospheric conditions. The most common problem encountered during this leg was frost covering the sensors due to the cold conditions. This problem most seriously affected the LI7500, which was very difficult to keep clean, and the radiation sensors, which were cleaned of frost on a daily basis. The frost problem also affected the sonic anemometer, but to a much lesser degree.

It was very difficult, and somewhat dangerous to climb the tower when everything was covered in frost. With this in mind, the tower was lowered to deck level whenever the sensors needed defrosting. Since we had two systems for measuring CO_2 and H_20 concentrations, and the LI7500 frosted over

very easily, the tower was generally only lowered for cleaning once the frost was bad enough to affect the sonic anemometer as well.

Ice-based Micrometeorology Tower

Methods

An 8-m tower was deployed on the ice in close proximity to the ship to measure meteorological data in conjunction with the data collected on the ship-based tower. The tower consisted of slow response sensors that recorded bulk meteorological conditions: wind speed and direction, air temperature and relative humidity at two heights, and surface skin temperature; and fast response sensors that recorded three-dimensional wind velocity. In addition, downward facing radiation sensors were installed on an adjacent 1m tall tower to provide information on upwelling longwave and shortwave radiation. All data was logged using a Campbell Scientific CR3000 datalogger that was synchronized to UTC time using the ship's GPS system.

Fig. 2: Ice-based meteorology tower at station D17 looking south.

Fig. 3. Ice-based meteorology tower at station D19 looking east towards ship.

Notes

The ice-based tower was deployed on three occasions during the latter half of the leg (i.e. Leg 5B) (refer to Table 1 for dates and specific location notes). The sensors on the tower were powered from a bank of 12V car batteries. Each morning a generator and charger was taken to the tower in order to

keep the batteries well charged. Other daily maintenance tasks included cleaning frost off the radiometers and IR transducer, and lowering the tower as necessary to clean frost off the sonic anemometer.

Deployment dates/locations

Table 1: Site and Deployment information for ice-based meteorology tower.

Site	Deployment Date	Removal Date	Notes
D14	Jan. 9	Jan. 11	Tower located ~200m north of ship; radiation sensors located ~8m northwest of main tower; sonic anemometer was not installed at this station
D17 (Fig. 2)	Jan. 15	Jan. 22	Tower located ~150m southeast of ship (ship's heading 90º); radiation sensors located ~8m west of main tower; sonic anemometer pointing to east
D19 (Fig. 3)	Jan. 25	Jan. 30	Tower located ~250m west of ship (ship's heading 235º); radiation sensors located ~6m east of main tower; sonic anemometer pointing to southeast

On-track *p*CO_2 System

Methods

A custom-built *p*CO_2 system was utilized on this leg to measure dissolved CO_2 at the sea surface in near real time. The system (Fig. 4) is located in the engine room of the *Amundsen*, and draws sample water from the ship's clean seawater intake. The water is passed into a sealed container through a shower head, maintaining a constant headspace. This set up allows the air in the headspace to come into equilibrium with the CO_2 concentration of the seawater, and the air is then cycled from the container into an LI7000 gas analyzer in a closed loop. Thermocouples are used to measure water temperature immediately before entering the equilibration chamber, and to measure the temperature of the air surrounding the chamber. All data are logged to a Campbell Scientific CR1000 datalogger.

The LI7000 gas analyzer was calibrated daily using ultra-high purity N_2 as a zero gas, and a gas with known CO_2 concentration in air as a span gas. Spanning of the H_2O channel was not necessary because a desiccant column removes H_2O from the air stream before passing into the sample cell. As with the closed-path eddy covariance system, a stream of N_2 is constantly cycled through the reference cell of the LI7000 to monitor and correct for drift of the instrument.

Fig. 4. The on-track pCO_2 system located in the engine room of the Amundsen.

Notes
The on-track pCO_2 system was active for the duration of the leg, with some minor interruptions for maintenance. Major interruptions in data collection were experienced when the ship was breaking ice, which either severely reduced the flow of water into the equilibration tank, or completely blocked it. In general, the system was turned off when the ship was breaking ice to prevent excessive wear and tear on the system's water pump.

During this leg, we experienced some major fluctuations in temperature where the system is located. The temperature was as high as 25º C at some times, and as low as –5º C on a couple of occasions. This proved disastrous during the night of Jan 19-20, when a suspected blockage in the outlet from the equilibration tank due to very low temperatures caused the closed air loop to become filled with water. Before this was discovered, seawater had entered the optical path of the LI7000.

The entire system was completely disassembled on Jan 20, and all the air lines were flushed with freshwater, and then dried with compressed air. The optical path of the LI7000 was removed from the instrument and cleaned thoroughly. The system was re-assembled and put back in to operation on Jan 23. Preliminary results seem to indicate that the cleaning was effective and the system is working properly.

The system was also shut down for ~ 6 hours on Jan 4 to exchange the gas analyzer and to clean the equilibration tank. The original LI7000 was experiencing problems with the DAC outputs which are used to send analog signals to the CR1000 datalogger. This problem was affecting all the analog input channels on the logger, so the decision was made to put a new analyzer into the system. Because the system was shut down, we also decided to clean the equilibration tank and shower head assembly. After cleaning, the system showed a marked improvement in water flow, indicating that cleaning should be done on a regular basis, at least once per leg.

2.4.2. CO_2 in Sea Ice

PI: Tim Papakyriakou, Centre for Earth Observation Science, University of Manitoba
Participants: Tim Papakyriakou, Bruce Johnson

Introduction
The primary focus of Team 6 is to gain a better understanding of the cycling of climatologically important gases in Arctic seas. A large base of knowledge already exists regarding air-sea gas exchange, but considerably less is known about the exchange of gases in an ice covered ocean. During CFL Leg 5, we continued a sampling program which was initiated during Leg 4 using silicon chambers (peepers).

Peepers

Methods
Silicon chambers (approximately 15 cm in length, 5 cm in diameter) were deployed in the ice, either in sackholes or in auger holes drilled completely through the ice. The silicone membrane is permeable to gas exchange. If the peeper is left in the ice for a long period of time (at least 24 h), the ambient gas in the peeper should come into equilibrium with gas that exists in brines and air pockets in the sea ice. Stainless steel tubing was used to sample the gas in the peepers with a gas analyzer (Licor model LI-820). The setup was designed to cycle air from the peepers through the gas analyzer in a closed loop. Data from the LI-820 was logged to a Campbell Scientific CR10X data logger at a frequency of 1 Hz. This allowed for the observation of a peak in CO_2 concentration as the gas in the peeper cycles through the gas analyzer. Although this eventually results in mixing of ambient atmosphere into the peeper chamber, we believe that the initial peak is representative of the CO_2 concentration in the ice.

Peeper notes
The peepers frozen into auger holes through to the ocean showed a continual increase of CO_2 concentration as long as they were left in the ice, which was 6 days at station D17 and 5 days at station D19.

With the peepers in sackholes, we had problems with brine filling the bottom of the holes. In many instances this caused the CO_2 concentration in the hole to exceed the limit of the gas analyzer (2000 ppm). This result led us to make the decision to move the peepers to shallower sackholes at station D17 on Jan 18, and to place the peepers in new sackholes each day at station D19. However, we still encountered problems with brine accumulation. The CO_2 concentration between peepers was quite variable depending on the amount of accumulated brine.

Deployment dates/locations

Table 1: Deployment date/location for peeper sampling.

Site	Deployment Date	Removal Date	Sample Dates/Time	Notes
D17	Jan 15	Jan 21	Jan 16, Jan 17 Jan 18, Jan 19 Jan 20, Jan 21	Deployed 3 peepers in auger holes to the ocean at depth of 20 cm. Deployed 3 peepers in 50 cm sackholes; these were removed and placed in 30 cm sackholes on Jan. 18.
D19	Jan 24	Jan 29	Jan 25, Jan 26 Jan 27, Jan 28 Jan 29	Deployed 3 peepers in auger holes to the ocean at depth of 20 cm. Deployed 3 peepers in 30 cm sackholes; these were removed after measurement and placed in new sackholes each day.

2.4.3. Dissolved Inorganic Carbon System (CFL Teams 6 & 7)

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Stelly Lefort (with PI Mucci)

The ocean's exchange of carbon dioxide with the atmosphere is governed by the biogeochemical cycling of carbon and physical processes throughout the water column, which determines the concentration of dissolved inorganic carbon in the surface waters. Of the seven relevant carbon system parameters, a minimum of two are needed to calculate the others and fully describe the inorganic carbon chemistry, over-determination of the system being beneficial. During CFL Leg 5, a total of 145 samples were analyzed for dissolved inorganic carbon (DIC) and total alkalinity (TA) and pH, yielding two/three relevant parameters.

Water samples were collected in parallel with the weekly, or once per station, nutrients rosette. Individual 250 ml bottles were used for DIC and TA, while samples for pH were collected in smaller plastic bottles. DIC samples were the first in the set to be taken from the Niskin bottles (preceded only by dissolved oxygen), with pH and TA following immediately at individual casts and depths. These

samples were then spiked with $HgCl_2$ and taken to the lab for analysis. Samples not analyzed right away were stored in the dark at 4°C.

When the contaminants group was sampling for mercury, DIC and TA samples were not spiked with $HgCl_2$ but analyzed within 24 hours of sampling. In the case of pH, the bottles were spiked outside of the rosette room, immediately after sampling.

Since we were using the moon pool for rosette sampling during Leg 5, the top 10 meters of the water column were missed. In addition, we found that the 10-meter depth samples were often contaminated. As a result, the final rosette sample was taken at 12 meters, and surface water sampling took place on the ice the same morning as the rosette sampling.

Surface water samples were collected from the zooplankton hole using a small pump run on a gas generator and lowered by hand to 1.5 or 2 meters below the surface. Bottles were filled using standard methods on the ice, and the samples returned to the ship immediately or kept from freezing in a cooler using hot water bottles. A 12 L Niskin bottle was also used to sample at a depth of approximately 7 m, following a CTD cast from the surface to 10 meters. The Niskin bottle was brought directly back to the ship for sampling, as the spigot would freeze when the bottle came out of the water.

DIC and TA were analyzed on board using a VINDTA 3C (Versatile Instrument for the Determination of Titration Alkalinity) by Marianda, and a TIM 865 automatic titrator from Radiometer Analytical. TA was determined by titrating a volumetrically accurate subsample using HCl as titrant. For DIC analysis, a volumetrically determined subsample was acidified with 8.5% H_3PO_4 to convert all inorganic carbon into gaseous CO_2. The CO_2 was then stripped out of the sample using ultra-pure N2 gas, transferred into a coulometric titration cell and detected using the coulometric method (Johnson et al., 1993). Samples were analyzed for pH using a HP 8453 spectrophotometer; pH was calculated using the absorbance measurements obtained from the coloration of water samples with Phenol Red and Cresol Purple.

In addition to water column sampling, an attempt was made to continue (to a lesser extent) the ice core work initiated by Team 6 on the previous leg. To this end, one core was collected at each new drift station. The top, middle, and bottom 10 cm of the core were cut and placed in plastic Tedlar bags – gas impermeable, with a clamp type seal and small spigot for withdrawing air or water. The core sections were laid out to thaw then transferred to DIC bottles. These samples were analyzed for DIC, TA, and conductivity.

Table 1: Stations sampled for DIC, TA and pH

STATION	**LAT °N min**	**LON °W min**	**CTD CAST**	DATE
12D	71° 12.906’	-124° 28.628’	2008_018	27/12/07
14D	71° 14.934’	-124° 32.1973’	2008_030	03/01/08
14Db	71° 29.765’	-124° 22.063’	2008_036	05/01/08
14Dc	71° 31.505’	-124° 42.403’	2008_053	09/01/08
17D	71° 31.53’	-124° 57.966’	2008_088	17/01/08
19D	71° 6.625’	-124° 56.684’	2008_142	26/01/08

Table 2: Stations where ice was sampled for DIC and TA

STATION	**LAT °N min**	**LON °W min**	**CORE DEPTH**	**ANALYSIS**	**DATE**
17D	71° 31.53’	-124° 57.966’	94 cm	DIC, TA	18/01/08
18D	71° 17.7’	-125° 25.9’	204 cm	DIC, TA	23/01/08
18DA	71° 21.9’	-125° 33.1’	New Ice, 1cm	DIC, TA	24/01/08
18DB	71° 17.8’	-125° 25.9’	New Ice, 3 cm	DIC, TA	24/01/08
19D	71° 6.65’	-124° 56.698’	92 cm	DIC, TA	26/01/08

Reference:
Johnson, K. M., K. D. Wills, D. B. Butler, W. K. Johnson and C. S. Wong. Coulometric total carbon dioxide analysis for marine studies: maximizing the performance of an automated gas extraction system and coulometric detector. Marine Chemistry, Vol. 44, pp. 167-187, 1993.

2.4.4. Barium

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In the Canadian Arctic, barium (Ba) is mainly released from the North American continent and can therefore be used as a tracer for terrestrial freshwater input. Together with ^{18}O, a tracer for freshwater input from precipitation and ice melt, all freshwater sources to the Arctic can be quantified.

Throughout Leg 5, samples for barium were taken from the rosette parallel to samples for ^{18}O, at approximate depths 10, 20, 50, 70, 100, 140, 200 and 300 m. Small plastic bottles (15 ml volume) were rinsed three times, then filled and spiked with 15 µl concentrated HCl. Sample bottles were then sealed with parafilm and kept for later analysis using isotope dilution mass spectrometry.

Table 1: Stations sampled for Barium.

STATION	**LAT °N min**	**LON °W min**	**CTD CAST**	DATE
12D	71° 12.906’	-124° 28.628’	2008_018	27/12/07
14D	71° 29.813’	-124° 22.063’	2008_030	03/01/08
14Db	71° 29.813’	-124° 22.063’	2008_036	05/01/08
14Dc	71° 31.505’	-124° 42.403’	2008_053	09/01/08
17D	71° 31.505’	-124° 42.403’	2008_088	17/01/08
19D	71° 6.625’	-124° 56.684’	2008_142	26/01/08

2.5. Team 7

2.5.1. Carbon & nutrients fluxes

Nutrients

PI: Jean-Éric Tremblay (Laval University)
Samples taken by Véronique Lago

Samples for nutrients, urea and ammonium were taken at the following stations:

Station	**Date**	**Latitude**	**Longitude**
2007-10D	23/12/07	71°55.294	125°25.984
2007-12D	27/12/07	71°12.906	124°28.628
2008-14D	03/01/08	71°14.934	124°32.197
2008-14D	05/01/08	71°29.765	125°22.063
2008-14D	09/01/08	71°31.505	125°42.337
2008-17D	17/01/08	71°31.530	124°57.966
2008-19D	26/01/08	71°6.650	124°56.698

Water was sampled at the following depths: the depth where salinity was 33.1 and at 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300 and every 100 m down to the bottom. The nutrient and urea samples were all frozen and will be analyzed on a future leg.

Sea ice

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Subproject: Pathways of cycling and export of organic material in the sea ice and flaw lead system.

The overall objective of this project is to further our understanding of the cycling and downward export of organic material in the sea ice, at the ice-water interface, and in the flaw lead system. Sea ice contains a diverse community of organisms which is integral to the cycling of organic matter in the Arctic Ocean. Microorganisms are incorporated into the sea ice during periods of ice formation (Riedel et al. 2007). During the spring, there is a conspicuous ice algal bloom that develops in response to increasing light availability. Sea-ice production is coupled with both pelagic and benthic production (e.g. Michel et al. 1996, Renaud et al. 2007) and may contribute 25% or more to total Arctic primary production (Legendre et al. 1992, Gosselin et al. 1997). However, little is known about the abundance and distribution of sea-ice carbon constituents within the flaw lead and during the dark winter period. Thus the objective for the Leg 5 of the CFL system study was to investigate dissolved and particulate sea-ice organic carbon pools during the dark winter period. Heterotrophic microbial carbon cycling and cell survival strategies (i.e. exopolymer cryoprotection) would also be assessed. This research will provide a better understanding of annual cycles of sea-ice carbon cycling.

Sample collection

Sea ice

Sea-ice associated samples collected during Leg 5 are summarized in Table 1. Complete ice cores were collected to obtain vertical profiles of the variables listed in Table 2, including nutrients and dissolved organic carbon (DOC) profiles. Therefore, the ice sections for the vertical profiles were melted in sterile Whirl-Pak bags without the addition of filtered seawater. The cores were cut into 10 cm sections, except for the bottom section (nearest the water) that was cut into a 0–3 cm and 3–10 cm section. Three complete cores were collected on each sampling day and the corresponding sections were combined to obtain enough volume for all analyses.

Bottom ice samples (0–3 cm and 3–10 cm sections only) were also collected on each sampling day. These samples were melted with the addition of filtered seawater (0.2 µm polycarbonate membrane filters) to minimize osmotic stress during the melting process (Garrison & Buck 1986). Again 3 cores were combined to obtain enough volume for the analyses (Table 2). All ice cores were collected with a manual ice corer (Mark II coring system, 9 cm internal diameter, Kovacs Enterprise). With each ice collection we measured the freeboard and ice and snow thickness.

Spatial variability of bottom ice carbon was also investigated on three occasions. We used a triangular sampling plan to assess the variability of chlorophyll *a* (chl *a*) and particulate organic carbon (POC) concentrations at 5, 3 and 1.5 m scales. At D19 we also sampled bottom sea ice from under different snow cover (12 versus 5 cm). In the spring, snow cover greatly influences sea-ice biomass and species composition due to light attenuation. We wanted to determine if there was detectable spatial variation in sea-ice constituents that could be linked to snow cover variability in the winter. Such variability could possibly be related to different rates of ice growth linked to the insulating properties of snow cover. Finally, newly formed sea ice (1 and 3 cm thick) from a flaw lead was collected on two occasions using a strainer. For these samples, surface water for analyses and ice melting was collected using a bucket.

Brine and surface water
On the majority of ice sampling days, interface water and brine samples were also collected (Table 1). The water was collected from the ice-water interface using an under-ice arm and hand pump. This water was analyzed as described in Table 2 and a portion was filtered for the melting of the bottom ice samples.

Partial ice cores were removed to make sac holes into which brine could drain. The brine holes were covered with Styrofoam plugs and left to drain for 2 to 24 h before the brine was collected with a sterile syringe. A minimum of 10 cm of ice remained in all brine holes to limit the infusion of surface water.

Table 1. Summary of sea-ice associated sampling conducting during Leg 5. Asterisk (*) indicates that bottom ice samples were collected at two ice thickness sites with high and low snow cover, respectively.

			Samples collected					
Date (mm/dd/yr)	Drift Station	Ice thickness (cm)	Ice profile	Bottom Ice	Spatial survey	Brine	Surface water	Trap deployment
12/25/07	D11	30	x	x		x	x	
12/27/07	D12	70						x
12/29/07	D12	70	x	x		x	x	
01/02/08	D14	104	x	x		x	x	
01/07/08	D14	107	x	x		x	x	x
01/10/08	D14	112			x			
01/15/08	D17	46	x	x	x	x	x	
01/15/08	D17	90						x
01/16/08	D17	69	x	x		x	x	
01/18/08	D17	71			x			
01/19/08	D17	51	x	x		x	x	
01/23/08	D18	1		x			x	
01/23/08	D18	3		x			x	
01/24/08	D19	94	x			x		
01/25/08	D19	92 and 94*		x			x	
01/26/08	D19	94 and 96		x				
01/27/08	D19	94 and 96		x				

Under-ice sediment traps
On three occasions short-term particle interceptor traps (sediment traps) were deployed at 1 m from the bottom of the ice. We wished to deploy the traps for a 5 to 6 d period to obtain a winter baseline of sinking organic matter. The first deployment (D12) lasted for only 2 d due to ice instability. The second deployment (D14) lasted for approximately 4 d, ending again when the ship was repositioned. During these deployments we were drifting as fast as 0.7 knots. At D17 we were able to install the traps for a full 6 d and the rate of drift was much slower. At D14 we "caught" two juvenile Arctic Cod in the sediment traps (given to the zooplankton team).

The sediment traps were PVC cylinders with an internal diameter of 10 cm and a height/diameter ratio of 7. Before each deployment, deep water (>200 m) was collected and filtered through a 0.2 µm polycarbonate membrane filter. The traps were filled with the filtered deep water so that the trap water would be denser than the surface waters in which the traps were deployed. Prior to deployment, the filtered seawater was analyzed for DOC, salinity, conductivity and temperature. Upon recovery of the traps, the total volume (~5.6 L) was used to assess POC, DOC and total chl *a* concentrations. Salinity, conductivity and temperature were again measured. Cell samples were also collected for fecal pellet (microscopic counts) and bacterial (flow cytometry) abundances as well as cell taxonomy (preserved with acidic lugols). Slides of exopolymeric substances (EPS) were prepared to assess their association with sinking material.

Rosette
DOC samples were collected at each depth of the five nutrient rosettes of Leg 5 (casts 018, 030, 036, 088, 123 and 142). Water was also collected at 10 and 40 m for the measurement of total chl *a* concentrations and preservation of cell taxonomy samples (M. Poulin collaboration).

Sample analyses
The variables assessed for the ice associated samples are summarized in Table 2. The methods used for these analyses are briefly described below.

Table 2. Summary of variables analyzed for sea-ice, brine, surface water and under-ice sediment trap samples during leg 5 of CFL. [1]samples collected for the enumeration of both bacteria and protists, [2]cell taxonomy includes counts of fecal pellets from under-ice sediment traps

	Ice profile	Bottom Ice	Sea-ice spatial survey	Brine	Surface water	Under-ice trap
Salinity	x	x		x	X	x
Conductivity	x	x		x	X	x
Temperature	x	x		x	X	x
pH	x	x		x	X	
Inorganic nutrients	x	x		x	X	
DOC/DON	x	x		x	X	x
POC/PON		x	x		X	x
Chl a/pheopigments	x	x	x	x	X	x
Flow cytometry[1]	x	x		x	X	x
Epifluorescence[1]	x	x		x	X	
EPS	x				X	
EPS slides	x			x	X	x
Cell taxonomy[2]	x	x		x	X	x
Bacterial activity		x		x	X	

DON/PON = dissolved/particulate organic nitrogen

Salinity, conductivity and temperature were determined with the hand-held meter (HACH Sension 5) provided by the physics/contaminant ice coring teams. When enough volume was present, a subsample was also saved (in cold room) for later determination of salinity with the Autosal (Model 8400B) analyzer. A desk-top meter was used to measure pH (Denver Instrument 250) after calibration with 3, 7 and 10 pH standards.

Subsamples for inorganic nutrients (NH_4, NO_2, NO_3, $Si(OH)_4$ and PO_4) were frozen in liquid nitrogen and then stored at –80°C for later analysis. There was no pre-filtration of the nutrient samples. When fresh ice samples were available on the nutrient rosette sampling day, a subsample of melted 0–3 cm or 3–10 cm ice was given to the nutrient team (Loic/Véronique) to determine the NH_4 concentration.

Duplicate DOC subsamples were filtered through precombusted Whatman GF/F filters. The filtrate was acidified with 50% H_2PO_4 and stored at 4ºC in the dark. POC subsamples were filtered onto precombusted Whatman GF/F filters and dried at 60°C for 24 h. We determined total chl *a* and phaeopigment concentrations using the onboard fluorometer (10AU Turner Designs). Duplicate subsamples were filtered on Whatman GF/F filters (total chl *a*) after which the chl *a* was extracted for 18 to 24 h in 90% acetone.

Cell samples for taxonomy (20 to 250 ml) were preserved with either acidic lugols or buffered formaldehyde. Bacterial and protist samples were collected for both epifluorescent microscopy and flow cytometery analyses. Subsamples for flow cytometery (heterotrophic bacteria and pico/nanoplankton) were preserved with a final concentration of 0.1% glutaraldehyde and stored at –80°C. Subsamples for epifluorescence were preserved with formaldehyde (1% final concentration),

stained with DAPI (4, 6-diamidino-2-phenylindole), at a final concentration of 1 µg ml^{-1}, and filtered onto 0.2 µm black Nuclepore filters. The prepared slides were stored at –80°C. The presence of active bacteria was investigated by incubating subsamples with 5-cyano-2,3-ditolyl tetrazolium chloride (CTC, final concentration 5 mM). The samples were incubated for 3 h at –1.5°C in the dark. Samples were preserved with a 5% final concentration of formalin and frozen.

EPS, defined as >0.4 µm acidic exopolysaccharides, were assessed with two methods. Bulk concentrations were estimated by Alcian blue staining of samples filtered on 47 mm 0.4 µm Nuclepore filters. EPS concentrations were also measured colorimetrically (787 nm, onboard JENWAY 6300 spectrophotometer) after a 2 h extraction in 80% H_2SO_4. EPS slides were also prepared by filtering subsamples on 25 mm 0.4 µm filters and staining with Alcian blue. The slides were prepared according to Logan et al. (1994), allowing for the observation of EPS using brightfield microscopy.

Preliminary observations

This leg of CFL provided a great opportunity to access different types of winter ice. The collection of the new ice was especially interesting. By visually inspecting filtered material (i.e. the GFF filters) it was obvious that the amount of organic/inorganic material in samples of winter sea ice and surface waters is quite variable within the flaw lead area we visited. It was also evident that material was still being incorporated into newly forming sea ice of the flaw lead. Chl *a* concentrations were low (<0.5 µg l^{-1}) and vertical profiles appeared to be similar to sea-ice salinity trends (Fig. 1). Highest chl *a* concentrations were found closest to the ice-water interface.

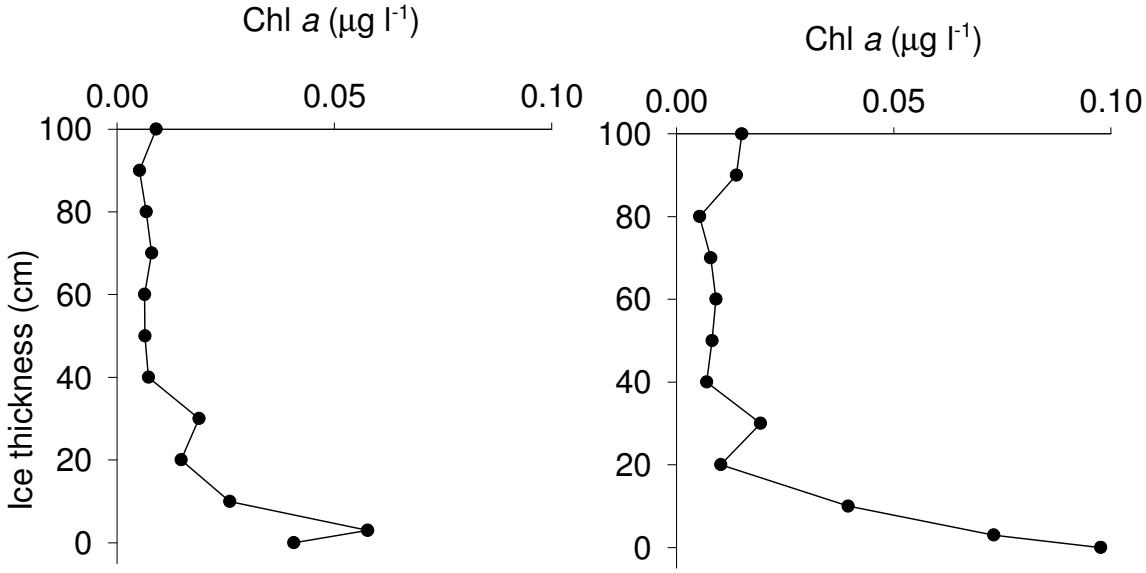

Figure 1. Vertical profiles of sea-ice chlorophyll *a* (chl *a*) concentrations at station D14. The ice thickness scale starts (0) at the ice-water interface

Acknowledgements

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2.5.2. Marine Molecular Microbiology Group

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Participants: Montserrat Coll (Pedrós-Alió team), Maria Raquel Rodriguez (Pedrós-Alió team), Ramon Terrado (Lovejoy team)

Introduction
Microorganisms (or microbes) are defined here as including all members of the domains of Archaea and Bacteria and the single-celled members of the Eukarya. As such a large group, microbes accomplish a multitude of different biological and biogeochemical processes that are key for the ecosystem. They lie at the base of the trophic web in the Arctic Ocean (as in any environment), which includes organisms that span a size range of seven orders of magnitude, from the smallest microbes, less than 1 µm, to the largest mammals on the scale of meters. All of these organisms are affected by the low temperatures and ice cover of the Arctic, as well as the lack of light during winter. Comparing the species composition and activities of microbial communities across diverse physical-chemical regimes helps to determine the importance of different forces to the microbial use and recycling of organic and inorganic matter and consequent influences on higher trophic levels of the food web. Such knowledge is needed to better predict the consequences of environmental changes, natural or anthropogenic, to trophic dynamics and ecosystems. It will also help us to evaluate the system's ability to buffer changes on short and long timescales.

Objectives
Our group had an ambitious sampling program for this leg. The protocols employed covered the work of 4 teams – Corina Brussard, Connie Lovejoy, Roxanne Maranger and Carles Pedrós-Alió – and many different aspects of the microbial world. Our overall objective was to gain a detailed view of the microbial diversity and processes occurring during the winter season.

Sampling
The sampling for this leg took place to the south and southwest off the coast of Banks Island. The comparison of samples collected during the different winter-season legs will allow a better understanding of the seasonal dynamic, while the comparison of the different geographical areas will provide valuable information on the diversity and distribution of microbes.

In total we sampled 12 stations. Date and location of the stations can be found in Table 1. Our sampling strategy was to obtain microbiological data from specific water masses through the water column with a special focus on the nitracline, the upper mixed layer, and deep waters. These water masses were identified during the downcast of the CTD, based on the readouts from the temperature, salinity, oxygen, nitrate, fluorescence, transmissometer and pH probes.

On an opportunistic basis, surface water (2-m depth) was collected off ship through a hole in the ice. These samples will be compared to the surface water (10-m depth) collected from the moon pool inside the ship.

Variables Sampled

Here we provide a brief description of the variables measured and protocols applied to the various samples collected, which are summarized in Table 2.

1. DNA

Samples for DNA were collected on every station at 4 different depths. Seawater was prefiltered through a 50 µm mesh to exclude larger organisms, then through a 3 µm polycarbonate filter followed by a 0.2 µm filter. This sampling protocol yielded two different samples, one containing the DNA from 50 µm to 3 µm fraction ("large fraction") and one containing the 3 µm to 0.2 µm fraction ("small fraction'). After collection samples were stored at –80 ºC for later processing in the Lovejoy laboratory at the Université Laval. These samples will give valuable information on the biodiversity and distribution of microorganisms.

a. Metagenomic DNA sampling

On station 2008-D17, in addition to sampling 4 different depths for DNA, all water from cast 119 was collected at a single depth (15 m) and a total of 24 liters were filtered for DNA. This specific sample will be used to construct a metagenomic library once the sample is processed in the laboratory off the ship.

2. RNA

Samples for RNA were collected on every station at 4 different depths. Seawater was prefiltered through a 50 µm mesh to exclude larger organisms, then filtered through a 3 µm polycarbonate filter followed by a 0.2 µm filter. This sampling protocol yielded two different samples, one containing the RNA from 50 µm to 3 µm fraction ("large fraction") and one containing the 3 µm to 0.2 µm fraction ("small fraction"). After collection samples were stored at –80 ºC for later processing in the Lovejoy laboratory at the Université Laval. These samples will give valuable information on the spatial expression of key genes.

3. Chlorophyll

Samples for chlorophyll analysis were taken on each station at six different depths. Two fractions were collected, one for the total fraction (from 200 µm to 0.6 µm) and one for the small fraction (from 3 µm to 0.6 µm). Samples were extracted onboard using acetone and read using a Turner TD-700 fluorometer.

4. HPLC

Samples for High Performance Liquid Chromatography (HPLC) analysis were taken on each station at six different depths. Two fractions were collected, one for the total fraction (from 200 µm to 0.6 µm) and one for the small fraction (from 3 µm to 0.6 µm). Samples were stored at –80 ºC for later analysis off the ship.

5. Viruses

Samples for several different variables related to viruses were collected.

a. Viral abundance

Samples were collected at 6 depths at every station for analysis by flow cytometry.

b. Burst Size

Samples were also collected at 6 depths for analysis by transmission electronic microscopy.

c. Viral production

Virus-free seawater was added to a bacterial concentrate and incubated with mitomycin C for 12 hours. Blank samples without mitomycin C were incubated for comparison with the mitomycin C samples in order to obtain an estimate of virus production on infected cells (lytic and lysogenic cycles). Subsamples were taken every 3 hours for analysis by flow cytometry.

d. Viral diversity

Two liters of surface seawater were concentrated to 50 mL using a Vivaflow system (30 kd cartridge). This concentrate will be used to analyze the diversity of viruses present.

6. Silica isotopes

Three different depths were sampled in order to obtain information on silica isotopes. Seawater was filtered through a 0.6 µm polycarbonate filter. Both filters and the filtered seawater filtered were stored for later processing.

7. Organic matter and phosphorus

Samples for the analysis of organic matter were collected on drift station 2008-D19. Using pre-combusted GF/F filters (47 mm diameter) in a passive filtration system (by gravity) samples for dissolved organic matter (DOM), total organic carbon (TOC), amino acids and carbohydrates were taken. Samples for total phosphorus without filtration were also collected.

8. Bacterial abundance (Bacteria and Archaea)

Samples for obtaining estimates of total bacterial abundance were prepared by filtering 20 ml of seawater fixed with formaldehyde, then staining with DAPI (which binds to the DNA). DAPI-stained slides for microscopy were prepared on all stations at 6 different depths and stored frozen (–20°C) for later cell counting. At some stations, samples were prepared using glutaraldehyde instead of formaldehyde as the fixative. These slides were frozen at –20ºC and counted onboard using the Olympus BX51 epifluorescence microscope onboard. The profile for station 200-14D can be found in Fig. 1.

9. Abundance of eukaryotic microbes

Samples for obtaining estimates of eukaryotic abundance were prepared by filtering 100 ml of seawater fixed with glutaraldehyde, then stained with DAPI (which binds to the DNA). DAPI-stained slides for microscopy were prepared on all stations at six different depths. These slides were frozen at –20ºC and counted onboard using the Olympus BX51 epifluorescence microscope onboard. Vertical profiles for the drift station 2008-14D can be found in Fig. 2 and 3.

10. Ciliates

Samples for estimating the abundance and diversity of ciliates were collected and preserved using a Lugol acid solution. These samples will be analyzed off the ship.

11. FISH: eukaryotes

Fluorescent In Situ Hybridization (FISH) is a powerful technique or quantifying specific groups of microorganisms. Samples for FISH were collected on all stations at 6 different depths. Samples were stored at –80ºC until analysis off the ship.

12. CARD–FISH: Bacteria and Archaea

Samples for the abundance and distribution of specific groups of Bacteria and Archaea were collected on all stations at 6 different depths. These samples were frozen at –20ºC until analysis with various oligonucleotide probes off the ship.

13. MarFISH: Bacteria and Archaea

Incubations with a radioactive substrate were carried out to detect active Bacteria and Archaea. Combined with the FISH technique this approach can give information on the phylogenetic identity of the active microorganisms. Subsamples collected via this technique were stored at –80ºC for later analysis off the ship.

14. Bacterivory – grazing on FLB

In order to acquire values of ingestion rates of bacteria by heterotrophic eukaryotes, Fluorescent Labelled Bacteria (FLB) obtained from a culture of *Brevundimonas diminuta* were used in bacterial grazing experiments. Three replicates and a 0.2 µm filtered seawater control were amended with 10^5 FLB/ml. Subsamples for microscopic observation of flagellates and bacteria and for measurements of bacterial production were collected at the beginning and after 48 hours of incubation at seawater temperature (in the cold room).

15. Herbivory – grazing on *Micromonas*

Two grazing experiments with the *Micromonas* strain RCC497 were performed in order to calculate an ingestion rate of *Micromonas* cells by heterotrophic flagellates. For each experiment, two replicates of 2000 ml seawater, prefiltered through a 200 µm filter, were incubated for 96 hours at surface seawater temperature (–1.4ºC). A control of 0.2 µm filtered seawater was run in parallel under the same conditions. Samples for FISH (to observe *Micromonas* ingestion) and flow cytometry (to observe *Micromonas* disappearance) were taken. Incubations were run during the second half of the leg, as the *Micromonas* cultures brought from Barcelona first had to adapt to the incubation conditions provided onboard. Experiments were conducted once exponential growth of the cultures was achieved.

16. Bacterial production

Bacterial production rates were measured using the leucine incorporation method (^{3}H labelled leucine) with 4 hours of incubation at 2°C. Rates of incorporation of radiolabelled leucine were measured using the scintillation counter onboard. Some problems were experienced with the scintillation counter at the beginning of the leg, but they were resolved with the help of Steeve Gagné.

17. Respiration

Bacterial/community respiration rates were measured using the FIBOX, which measures O_2 depletion over time using sensors glued to the bottom of 500 ml Erlenmeyer flasks. The consumption of O2 can be converted to CO2 production to compare carbon respiration rate to bacterial carbon production rates.

18. ETS

Due to the expected low respiration rates in Arctic winter waters, the ETS (electron transport system) method was also employed as a back-up method to obtain proxies for respiration rates. For this method, a large quantity (8L-10L) of seawater was filtered through GF/F filters to collect live cells and freeze them (–80°C) as quickly as possible. Once off the ship, filters will be thawed and the living cells will be subjected to various enzymatic tests to measure activity.

19. N_2O

Dissolved N2O measurements were carried out using the headspace equilibration method with 1.1 L of seawater. Three samples were taken from 3 depths for N2O analysis off the ship using an electron capture detector (GC).

Experimental program

1. BrdU incubations

Incubations with the thymidine analogue bromodeoxiuridine (BrdU) were carried out during 3 weeks. On a periodic basis, subsamples for DNA were taken. Once off the ship these samples can be used to determine the identity of the microbes that were active during the incubations, by applying antibodies specific for the BrdU incorporated into the DNA of the microorganisms.

2. Archaeal enrichments

Pierre Galand had started Archaeal enrichments on Leg 4. Two different depths of the upper mixed layer were sampled and 4 incubations initiated. Two incubations were amended with ammonia and phosphate, while the other two were not supplemented with any nutrients. In the middle of Leg 5, subsamples for FISH and CARD-FISH analyses were taken. These incubations were left to continue shipboard and will be terminated on Leg 6 by Laura Alonso.

3. Unamended seawater incubations

Surface seawater was collected, filtered with a 3 µm filter and incubated for 18 days at a surface seawater temperature. Subsamples for DNA, epifluorescence microscopy and fluorescence in situ hybridization (FISH) were taken every 2 days. In similar previous studies of other seawater samples (Norwegian Sea, Mediterranean Sea and Indian Ocean) this simple treatment had been observed to promote the growth of heterotrophic flagellates at rates (0.3 to 1.2 d^{-1}) typical of natural assemblages. By incubating 3 µm-filtered seawater in the dark, we expect bacteria growing on autochthonous substrates to support a moderate pulse of heterotrophic flagellates, which can then be identified with molecular tools. The subsamples from this experiment will be analyzed in Barcelona.

Other activities

The whole team participated in all of the planned social activities of the ship. Montserrat and Raquel also wrote a dispatch in 3 languages (English, Spanish, Catalan) for the CFL webpage. Ramon was responsible for maintenance of the MilliQ system. The system needs to have the UV lamp changed, but a replacement was not available onboard (expected for Leg 6). Ramon also helped the zooplankton team to dig holes in the ice and to sample. He also provided 0.2 µm filtered seawater. During the latter half of the leg, he continued a Spanish course that had been started by Laura Sims during the first 3 weeks.

Acknowledgments

The cruise was a success and we are grateful to our Chief Scientists, Tim Papakyriaku and Jody Deming, Captain Lise Marchand and the crew of the *Amundsen* for the excellent work accomplished during Leg 5. We thank Loïc Degroote and Veronique Lago for CTD Rosette operations, Steeve Gagné for technical assistance, and Debbie Armstrong and Elisabeth Shadwick for assistance with

under-ice surface water sampling.

Table 1. Station locations

Cast #	Drift Station	Date Start	Time Start	Latitude (north)	Longitude (west)
1	2007-10D	22.12.2007	10:00	71º 55.254	125º 25.98'
8	2007-12D	26.12.2007	09:45	71º 13.50º	124º 24.894'
23	2007-D12	30.12.2007	17:24	71º 22.7'	124º 4.06'
29	2008-D14	03.01.2008	20:43	71º 13.8'	124º 26'
35	2008-D14	05.01.2008	13:04	71º 28'	125º 17.32'
ICE-01	2008-D14	05.01.2008	13:04	71º 28'	125º 17.32'
48	2008-D14	08.01.2008	14:07	71º 31.58'	125º 35.76'
72	2008-D14	11.01.2008	14:09	71º 43.284’	126º 13.13’
78	2008-D17	15.01.2008	14.01	71º 30.72'	124º 55.709'
ICE-02	2008-D17	17.01.2008	10:45	71º 32'	125º0.81'
95	2008-D17	18.01.2008	18:02	71º 32.93'	125º 0.81'
119	2008-D17	22.01.2008	14:09	71º 36.23'	125º 9.407'
122	2008-D19	24.01.2008	15:15	71º 13.872'	125º 12.62'
141	2008-D19	26.01.2008	14:05	71º 8.143'	124º 58.486'

Table 2. Stations sampled during Leg 5, with number of depths sampled per protocol indicated.

Station information	**Date**	22/12/07	26/12/07	29/12/07	3/1/08	5/1/08	5/1/08	8/1/08	11/1/08	15/1/08	17/1/08	18/1/08	22/01/08	24/1/08	26/1/08
	Drift station	2007-10D	2007-12D	2007-12D	2008-14D	2008-14D	2008-14D	2008-14D	2008-14D	2008-17D	2008-17D	2008-17D	2008-17D	2008-19D	2008-19D
	Cast number	1	8	23	29	35	ice 1	48	72	78	ice 2	95	119	122	141
Protocols	**Bacterial production**	-	-	6	6	6	1	6	-	6	1	6	-	6	-
	ETS	-	-	-	-	2	-	2	-	-	-	2	-	2	-
	Respiration	-	-	-	-	-	-	3	-	-	-	-	-	3	-
	N2O	-	-	3	-	-	-	-	-	-	-	3	-	-	-
	Bacteria and Archaea abundance	2	4	6	6	6	1	6	6	6	1	6	1	6	6
	Eukaryotic microbes abundance	2	4	6	6	6	1	6	6	6	1	6	1	6	6
	DNA - Large	2	4	4	4	4	1	4	4	4	1	4	1	4	4
	DNA - Small	2	4	4	4	4	1	4	4	4	1	4	1	4	4
	RNA - Large	2	4	4	4	4	-	4	4	4	-	4	-	4	4
	RNA - Small	2	4	4	4	4	-	4	4	4	-	4	-	4	4
	Chlorophyll a Total	2	4	6	6	6	1	6	6	6	1	6	1	6	6
	Chlorophyll a Small	2	4	6	6	6	1	6	6	6	1	6	1	6	6
	HPLC Total	-	-	-	2	-	-	-	-	2	-	-	1	-	2
	HPLC Small	-	-	-	2	-	-	-	-	2	-	-	1	-	2
	Virus (abundance)	2	4	6	6	6	1	6	6	6	1	6	1	6	6
	Organic matter and Total phosphorus	-	-	-	-	-	-	-	-	-	-	-	-	-	6
	Ciliates	-	-	6	-	-	-	-	-	6	-	-	-	-	-
	CARD-FISH (bacteria)	2	4	6	6	6	1	6	6	6	1	6	1	6	6
	FISH (eukaryotes)	2	4	6	6	6	1	6	6	6	1	6	1	6	6
	MAR FISH	-	-	-	-	-	-	-	-	2	-	-	-	2	-
	Bacterivory	-	-	1	-	-	-	-	-	1	-	-	-	-	-
	Alguivory	-	-	-	-	-	-	-	-	-	-	1	-	1	-
	Virus (Diversity)	-	-	1	-	-	-	-	-	1	-	-	-	-	-
	Virus (TEM)	-	-	1	-	-	-	-	-	1	-	-	-	-	-
	Viral production	-	-	1	-	-	-	-	-	1	-	-	-	-	-
	Silica isotopes	-	-	-	-	3	-	-	-	-	-	-	-	3	-

Fig 1. Vertical profile of bacterial abundance on drift station 2008-14D.

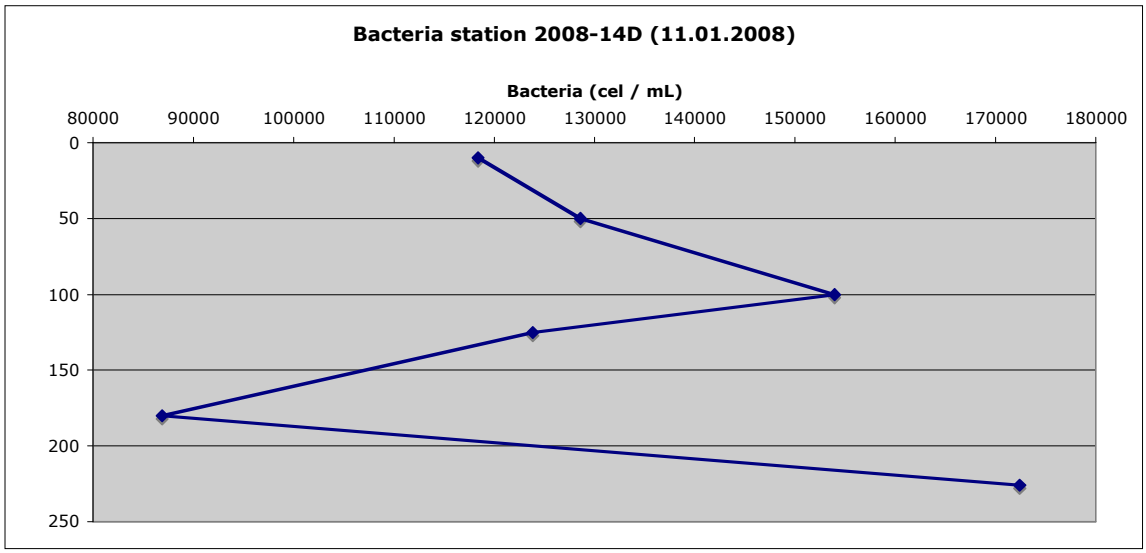
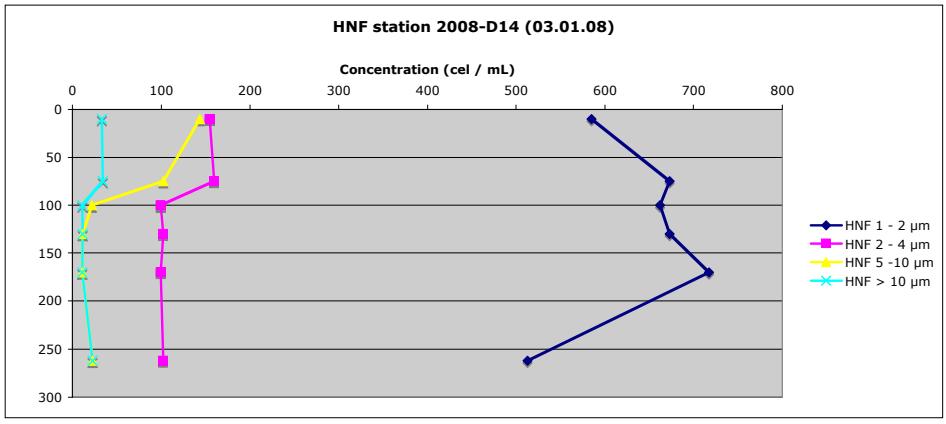
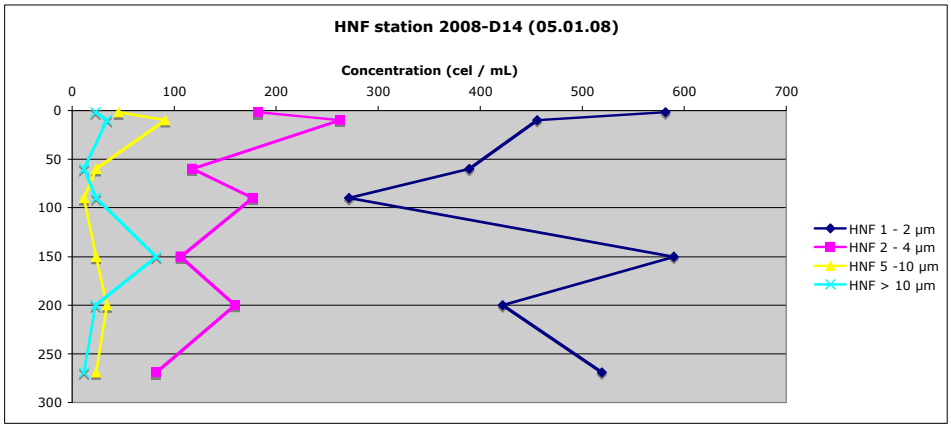
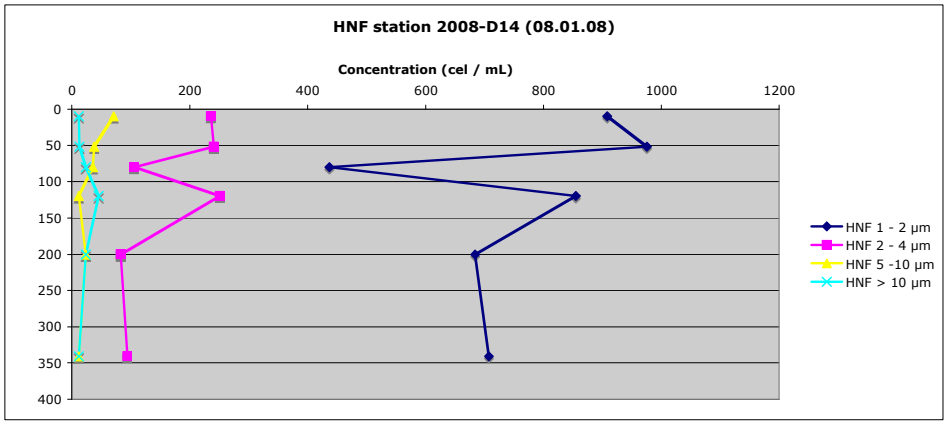


Fig. 2. Vertical profiles of heterotrophic eukaryotes on drift station 2008-14D.







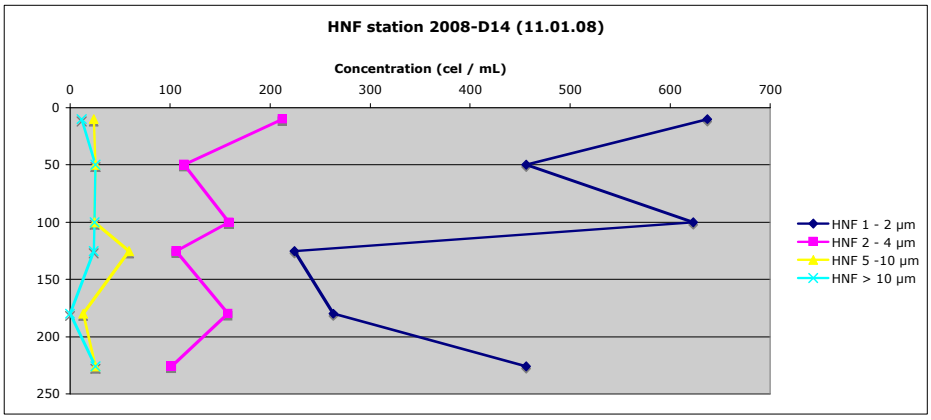
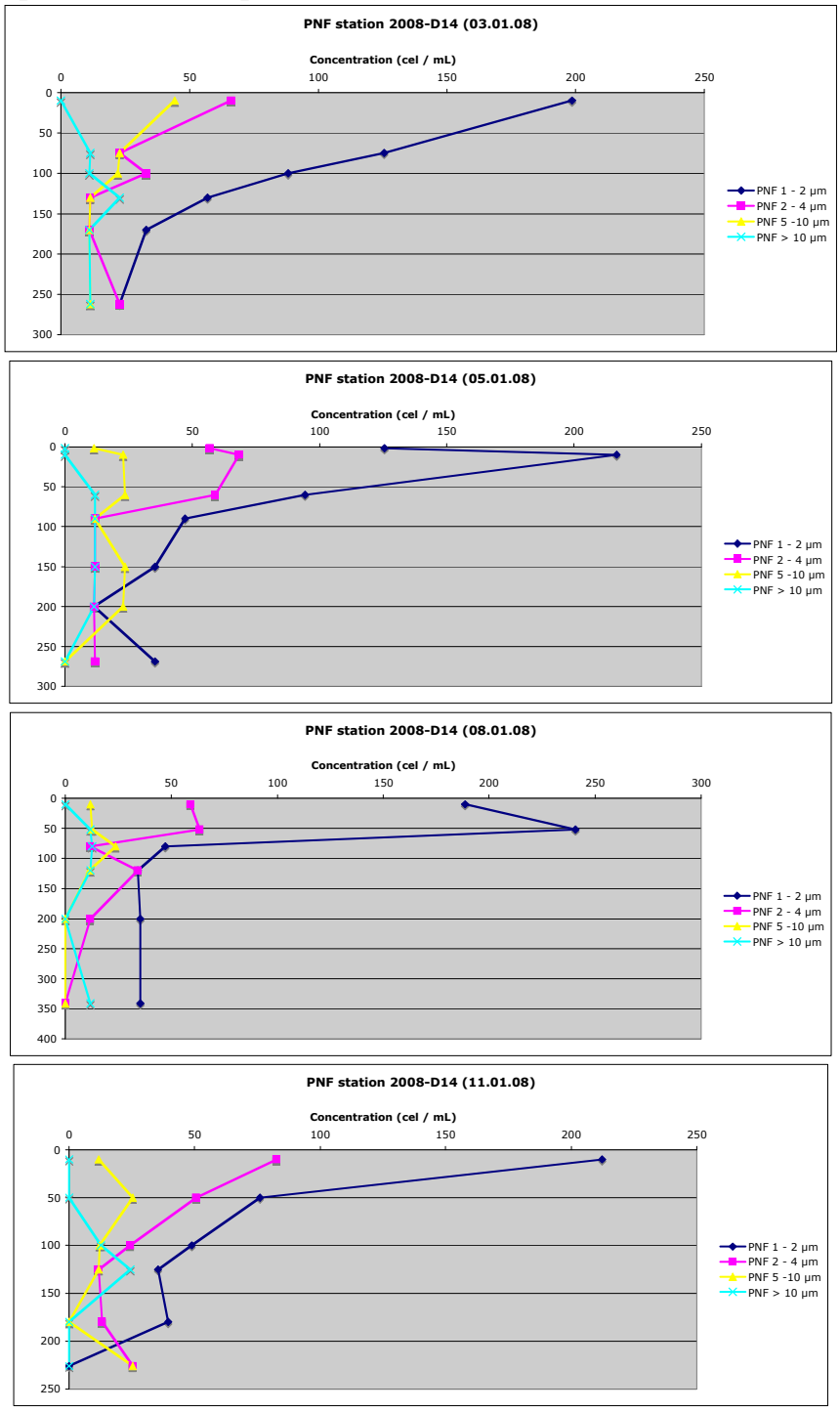


Fig. 3. Vertical profiles of autotrophic eukaryotes on drift station 2008-14D.



2.5.3. Carbon Flux, Exopolymers & Extremophiles

PI: Jody Deming
Participants: Jody Deming (Chief Scientist), Marcela Ewert Sarmiento and Minhui Lin

Group members: Jody Deming (PI), Eric Collins (graduate student Leg 4), Marcela Ewert Sarmiento (graduate student Leg 5B), Minhui Lin (graduate student Leg 5B), Colleen Evans Kellogg (graduate student, Leg 9), Shelly Carpenter (technician, Legs 9-10)

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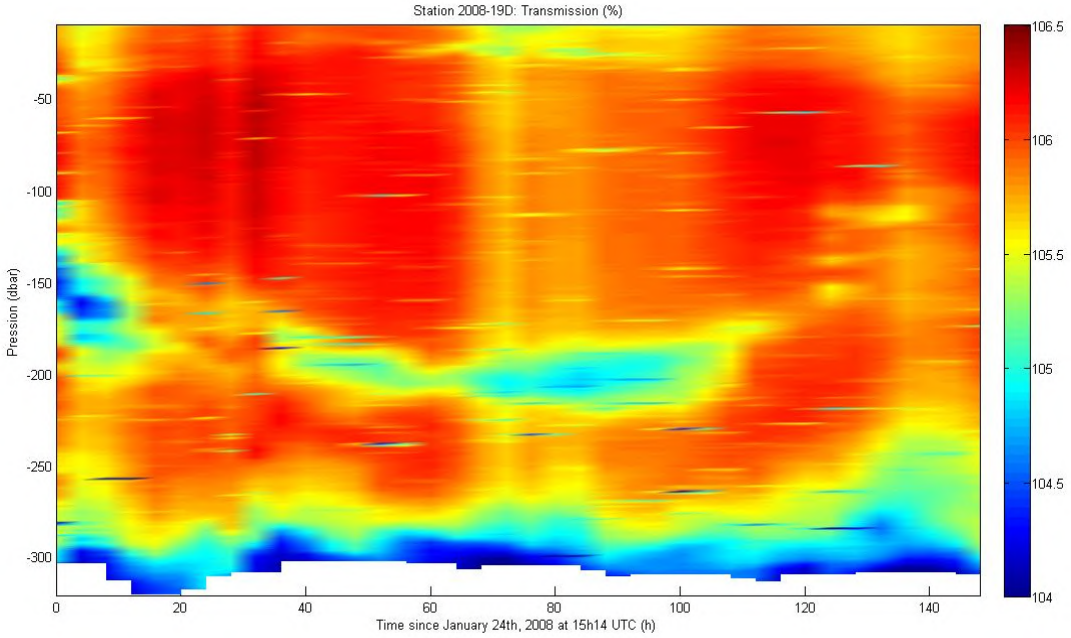
Carbon flux (Kellogg and Deming)

Building on prior work that had identified nepheloid layers as targets of interest for carbon flux in this region (Wells et al. 2006; Forest et al. 2006), seawater samples were collected from the Rosette in an attempt to detect and track a nepheloid layer of resuspended sediments and their associated organics and microbial assemblages moving laterally across shelf. Nepheloid layers were identified by a reduction in transmissivity and confirmed by the presence of angular shaped sediment grains on filters after filtering 30-70 liters. Samples collected were processed for later analyses of Bacteria and Archaea and of lipids that would indicate the presence of terrestrial Archaea. In general, nepheloid layers in the study region were weak, if present at all. While on station D19, however, a mid-water layer (in addition to the typical bottom layer) persisted in the beam transmission profiles at a depth of about 200 m for about 5 days, as shown below in the temporal plot of transmissivity data kindly provided by Veronique Lago.

Ultimately, five samples were processed by Min for further analysis by Colleen and Shelly, who will join later legs for further studies related to the role of particle-associated microbes in attenuating carbon fluxes:

Date	Station	Cast #	Depth (m)	Nepheloid layer
20 Jan 2008	D17	110	218	Bottom water
25 Jan 2008	D19	136	309	Bottom water
28 Jan 2008	D19	149	193	Mid-water
29 Jan 2008	D19	153	193	Mid-water
29 Jan 2008	D19	153	313	Bottom water



Exopolymers and their microbial producers (Ewert Sarmiento and Deming)

The Arctic winter environment provides an opportunity to explore some of the most extreme conditions of low temperature and high salinity that may be experienced by Earthly organisms. Winter sea ice, brines, frost flowers, and snow all present environments of interest to search for microorganisms adapted to low temperatures and/or high salinities. Microorganisms inhabiting some of these environments have been proposed to produce extracellular polymeric substances (EPS) as cryoprotectants. On this leg, a concerted effort was made to bring into culture microorganisms that may produce such substances.

Samples from a diversity of environments were cultured under various conditions of temperature and salinity, aiming to select for cold- and salt-adapted organisms. Among the environments sampled were: cores of first year ice (FYI), new ice (NI), brines collected from first year ice (B), frost flowers (FF), surface seawater (SSW) and sea water at different depths (SW). Sea ice samples were taken in collaboration with team 8.

A culture medium rich in complex organic substances was compared with a defined medium containing only one source of sugar, one source of amino acids and vitamins. Two salinities, 35 and 52, were also evaluated. Replicates of all inoculated media tubes were incubated throughout the leg at both –1.4°C and –7°C.

A new field method designed to select for organisms or substances with ice-affinity properties by circumferential freezing (CF) was also tested during this leg. This method consists of chilling a series of metal rods under sterile conditions in a –80°C freezer, then introducing the rods into the sample of interest in order to generate artificial ice. The process of ice generation is expected to cause the segregation of selected microbes into the ice sample, while others may be excluded from the ice, depending on their exterior properties. This method is partially based on the "cold finger apparatus" developed by Kuiper *et al.* (2003), which has been used to isolate cold-adapted microorganisms from soil samples (Wilson *et al.,* 2004).

To complement the culturing effort, parallel samples of the environments sampled were processed to measure dissolved and particulate EPS by the phenol–sulphuric acid method. Bacterial abundance will also be determined by epifluorescence microscopy.

Surface snow and frost flowers (all participants)

Taking advantage of the unique sampling opportunities offered by this leg, we added snow and frost flowers to our sampling plans. Snow samples were taken as early as possible after the ship was safely docked into a floe to minimize contamination from the ship (D17, D18, and D19). Prior to the ship entering floe D19, pristine snow was collected by helicopter landing. All snow samples were processed for analysis of bacterial abundance and diversity.

When seawater freezes, any impurities in the water are excluded from the ice as more water molecules stick together under freezing temperatures. Microbes and salts are known to be concentrated in the liquid that remains between ice crystals. By the same process, microbes are expected to be concentrated in the brine that forms frost flowers. Frost flowers were sampled starboard of the *Amundsen* after the ship had drifted for two days at station D17. Samples were processed for DNA (microbial diversity), EPS, and bacterial abundance, and used in culturing experiments. The melt water of ship-side frost flowers contained mm-size particles, some of which obviously resembled ship paint. This first sampling provided an opportunity to develop suitable sampling techniques, but given the contamination from the ship, we searched for newly formed frost flowers remote from the ship at station D19. On day two at floe D19, we visited an open lead about 300 m from the ship, much of which was growing new ice (0.5-inch thick). Two days later frost flowers had formed on top of an accessible new ice area. These newly formed frost flowers were sampled and processed as before. Microstructural analyses of individual crystals of the frost flowers were also conducted shipboard.

Photos showing the evolution of this lead from newly formed ice to fully formed frost flowers are presented below.

Other experiments (Ewert Sarmiento)

Two experiments were developed in collaboration with team 8 (contaminants). We are especially grateful to Monika Pucko, Wojciech Walkusz, Amanda Chaulk and Jeff Latonas for the help and training they provided.

Temporal evolution of an ice core during melting
When sea ice melts it releases to the underlying seawater both water molecules that had formed the solid phase of ice and salts and other molecules that had been trapped inside the brine channels and pockets. To approach the characteristics of this release, we joined team 8 in an experiment where first year ice cores were subjected to controlled melting.

Ice cores from station D19 stored inside clean plastic sleeves were hung in vertical position to allow dripping from the bottom of the plastic sleeve. The experiment set-up was at an air temperature of about 10–15° C to let them melt somewhat slowly. Meltwater from one of the cores was collected in a sterile bottle underlying the core (and sleaved to it with sterile foil). When the volume of the melt reached 1L, a sample was collected for salinity, bacterial counts and EPS measurements. Participants from team 8 collected samples for the measurement of HCH.

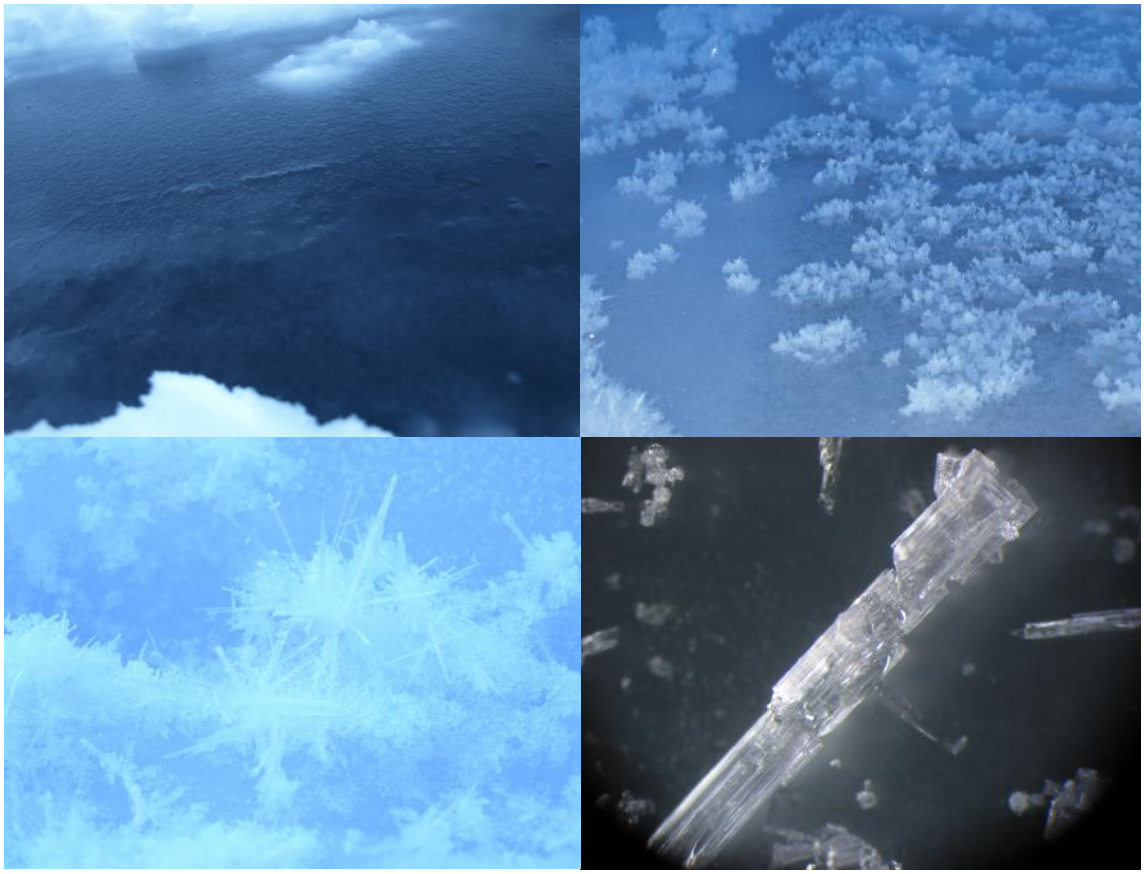
The experiment was replicated to measure with higher resolution the first 12 hours of the melting process and to include measurements of mercury concentration. In this second case, the meltwater was collected every 1.5 hours for salinity, bacterial counts and EPS measurements.

Mercury resistance
In order to select for microorganisms with potential mercury resistance, frost flower samples were cultured in 1/2x2216 marine broth under two conditions of salinity (35, 52) and increasing concentrations of mercury, from 0.5 to 4.0 ppt, and incubated at –1.4°C.

Table of samples collected during Leg 5B: new ice (NI), first year ice (FYI), brine (B), frost flowers (FF), snow, surface seawater (SSW), seawater at different depths (SW) and snow. Circumferential freezing experiments were conducted on selected samples (*). In collaboration with Monika Pucko and Wojciech Walkusz, from Team 2, melting core (MC) experiments were performed. Samples were processed for later analyses in the home laboratory of DNA content (DNA), lipid composition (lipids), environmental parameters (POC/PON, Chl *a*, SPM), bacterial abundance (DC) and bacterial cultures in liquid and solid media.

Station	Date	Day of the year	Type	Sample properties	DNA	Lipids	POC/PON ChloA SPM	DC	EPS	Cultures (Plates)	Liquid culture
D17A	1/15/08	15	FYI	2 – 21 cm	0	0	0	0	0	0	0
D17A	1/15/08	15	FYI	30 – 45 cm	0	0	0	0	0	0	0
D17B	1/15/08	15	FYI	3 – 19 cm	0	0	0	0	0	0	0
D17B	1/15/08	15	FYI	23 – 38 cm	0	0	0	1	1	2	0
D17A	1/15/08	15	SSW*	Surface	0	0	0	1	3	2	16
D17A	1/16/08	16	B*		1	0	0	1	3	4	16
D17 next to ship	1/17/08	17	FF	Next to the ship	1	0	0	3	1	2	26
D17C	1/18/08	18	Snow		0	0	0	0	0	0	1
D17C	1/18/08	18	FYI	13 – 19 cm	0	0	0	1	1	2	0
D17C	1/18/08	18	FYI	72 -79 cm	0	0	0	1	1	2	0
D17C	1/18/08	18	FYI	0 – 72 cm	0	0	0	0	0	0	0
D17	1/20/08	20	SW	224 m	3	3	9	9	0	0	0
D18	1/22/08	22	Snow		1	0	0	0	0	0	0
D18A	1/23/08	23	NI*	Surface	1	0	0	3	3	6	12
D18B	1/23/08	23	NI	Surface	0	0	0	0	1	2	2
D18B	1/23/08	23	FF	Surface	0	0	0	0	0	2	4
D19 helicopter flight	1/23/08	23	Snow		1	0	0	1	0	0	0
D19	1/25/08	25	MC	Time series	0	0	0	4	5	8	12
D19	1/25/08	25	B		1	0	0	2	1	1	4
D19	1/25/08	25	SW	218 m	3	3	0	9	0	0	0
D19	1/26/08	26	MC		0	0	0	1	1	0	0
D19- lead	1/26/08	26	NI	8cm thick	0	0	0	1	1	2	4
D19- lead	1/26/08	26	SSW	Surface	0	0	0	1	1	1	4
D19	1/26/08	26	SW	200 m	3	3	0	9	0	0	0
D19- lead	1/26/08	26	FF		1	0	0	0	0	2	4
D19	1/27/08	27	SW	10 m	0	0	0	0	1	0	1
D19	1/27/08	27	SW	25 m	0	0	0	0	1	0	1
D19	1/27/08	27	SW	50 m	0	0	0	0	1	0	1
D19	1/27/08	27	SW	100 m	0	0	0	0	1	0	1
D19	1/28/08	28	SW	180 m	3	3	0	9	0	0	0
D19	1/28/08	28	MC	Time series	0	0	0	8	6	2	4
D19- lead	1/28/08	28	FF		1	0	0	0	1	0	0
D19	1/29/08	29	SW	193 m	3	3	0	9	0	0	0
D19	1/29/08	29	SW	313 m	3	3	0	9	0	0	0
D19			Snow	soft				5			
D19			Snow	hard				5	34		

Photos
Day one at open lead at station D19 (upper left, meter scale, photo by Minhui Lin); Day three at the lead where frost flowers had formed within 2 days (upper right, half-meter scale, photo by Minhui Lin); frost flowers fully formed (cm-scale, photo by Marcela Ewert); and microstructure of frost flowers collected at station D19 (mm-scale, lower right, photo by Minhui Lin).



2.6. Team 8

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Wojciech Walkusz (DFO, Freshwater Institute)
Jason Pavlich (chemistry teacher, USA)

General objective
The question this project hopes to answer is how climate variability in physical forcing and the biogeochemical response to this primary forcing will affect the cycling of the contaminants hexachlorocyclohexane (HCH) and mercury (Hg)/methyl mercury (MeHg). Ultimately, we propose to relate changes in delivery and biogeochemical cycling of these contaminants to their levels in fish, marine mammals and the people who consume these tissues as part of their traditional diets.

2.6.1. Organic contaminants

(Pucko, Walkusz and Pavlich)

Hexachlorocyclohexane (HCH)

Technical HCH is a mixture of several isomers, the most abundant being □-HCH (60-70%), □-HCH (5-12%) and □-HCH (10-15%). Technical HCH and pure □-HCH (lindane, pesticide active isomer) have been used for over 50 years and are now ubiquitous in water throughout the northern hemisphere with the highest levels found in the surface water layers near pack ice in the Arctic Ocean.

Technical HCH was banned or heavily restricted by China, the former Soviet Union and India between the mid-1980s and 1990. Concentrations of □-HCH in arctic air responded quickly to these large-scale usage changes and declined by an order of magnitude from the early 1980s to mid-1990s in steps that closely matched global usage and emission estimates. As a consequence, the direction of net gas exchange in arctic waters reversed from deposition in the 1980s to air-water equilibrium or volatilization in the mid-1990s.

The □-isomer is the prominent one in Arctic air, water, biota and soil, and moves northward via cold-condensation, a process whereby the contaminant evades into the atmosphere, drifts with atmospheric currents, and condenses in colder climates, where colder temperatures increasingly favour the water and extensive ice cover inhibits further evasion. Hence the contaminant accumulates disproportionately in the Arctic.

Water sampling

Seawater (4L) was collected from the rosette every 4-6 days. Where feasible, transects across water bodies were collected. In the lab, water was pumped through a glass-fiber filter followed by an ENV+ solid-phase extraction (SPE) cartridge using peristaltic pumps. Filters and cartridges were frozen and brought back to the Freshwater Institute for analysis. $^{18}\delta O$ were also collected at each site and depth where HCH samples were taken.

Table 1. List of water samples collected during Leg 5.

Date	Station	Depth (m)
24-Dec-07	D11	9
		25
		50
		100
		150
		200
		285 (bottom)
29-Dec-07	D12	10
		25
		50
		100
		150
		200
		249 (bottom)
04-Jan-08	D14	10
		25
		50
		100
		150

		200 bottom (212)
10-Jan-08	D14	10 25 50 100 150 200 300 bottom (378)
16-Jan-08	D17	10 25 50 100 150 200 bottom (217)
21-Jan-08	D17	10 25 50 100 150 200 bottom (234)
27-Jan-08	D19	10 25 50 100 150 200 250 bottom (306)

During the last water sampling (27 Jan 2008) water from each depth was taken for culturing bacteria and processed by Marcela Ewert Sarmiento (Jody Deming's team). Bacterial cultures from different depths will be used in an HCH EF/bacterial degradation experiment during Leg 7/8.

Air Sampling

The air sampler was set up on the bow of the ship on the starboard side along with each ice sampling. Samples were collected on a glass fiber filter and polyurethane foam (PUF) for analysis of organic contaminants. Air sample collection time ranged between 4 and 10 hours. Filters and PUFs were frozen at –20°C and shipped frozen back to the FWI for HCH contaminant analysis.

Table 2. List of air samples collected during Leg 5.

Date	Station	Time on:	Time off:
25-Dec-07	D11	11:05	18:20
27-Dec-07	D12	14:10	22:20
01/02-Jan-08	D13	20:20	01:35
03-Jan-08	D14	17:05	23:40
15-Jan-08	D17	09:22	13:32
18-Jan-08	D17	09:21	16:35

20-Jan-08	D17	09:22	18:53
22-Jan-08	D18	18:30	23:21
23-Jan-08	D18b-D19	13:20	17:23
24/25-Jan-08	D19	21:10	01:50

Biotic Sampling (HCH, mercury, stable isotopes)
The main purpose of this study is to link physical and biological processes to mercury levels in the food web and to target biomagnification and bioaccumulation of HCH and mercury with stable isotopes and fatty acids in the pelagic food web. Thus, all biological samples collected will be measured for HCHs, total mercury and MeHg along with stable isotopes to place organisms into their associated trophic levels.

Biological samples were collected every 5-6 days. Various zooplankton families were collected using the vertically towed Tucker net (mesh size 0.2 mm). Zooplankton was sorted into families, placed into plastic vials and Whirlpak bags and frozen until they can be analyzed for HCH, THg, MeHg, stable isotopes and fatty acids.

Table 3. List of zooplankton samples collected during Leg 5.

Date	Station	Sorted species
25-Dec-07	D12	*Calanus hyperboreus AF, Calanus hyperboreus CV, Sagitta elegans* (Chaetognaths), *Calanus hyperboreus AM, Metridia longa, Paraeuchaeta, Calanus glacialis CV, Themisto abyssorum, Themisto libellula, Decapoda, Ostracoda, Clione limacina*
01-Jan-08	D13	*Calanus hyperboreus AF, Themisto abyssorum, Chaetognaths, Paraeuchaeta, Aglantha digitalae* (Jelly fish)
08-Jan-08	D14	*Calanus hyperboreus AF, Paraechaeta, Chaetognaths, Ostracoda, Themisto abyssorum, Clione limacina, Jelly fish (Aglantha digitalae), Themisto libellula, Onissimus, Decapoda*
16-Jan-08	D17	*Calanus hyperboreus AF, Clione limacina*
19-Jan-08	D17	*Calanus hyperboreus AF, Paraeuchaeta glacialis, Chaetognaths, Ctenophores, Ostracods*
24-Jan-08	D19	*Calanus hyperboreus AF, Ostracoda, Themisto libellula, Themisto abysorum, Chaetognatha, Paraeuchaeta glacialis*
28-Jan-08	D19	*Calanus hyperboreus AF, Ostracoda, Themisto abyssorum, Chaetognaths, Paraeuchaeta glacialis, Aglantha digitalae*

Ice sampling
Ice samples for concentration and enantiomeric composition of HCHs were collected. The samples for oxygen isotope composition ($\delta^{18}O$) and salinity were taken along with all ice samples. The ice samples were collected in collaboration with team 2; the ice microstructural and physical analyses were made on all of them (see team 2 cruise report). Ice cores were cut according to ice microstructure into 8-30 cm layers, melted (4-8L of water) and pumped through a glass-fiber filter followed by an ENV+ solid-phase extraction (SPE) cartridge using peristaltic pumps. Surface water (4L) was sampled along with every ice sampling using a Niskin bottle. The cartridges and GFFs were stored at –80°C and brought to the DFO (Winnipeg) for further chemical analysis.

Team 8 ice coring (from the left): Wojciech Walkusz, Amanda Chaulk, Jason Pavlich and Monika Pucko; photo by Ramon Terrado.

Sampling of newly formed ice in the lead Andrea Niemi and Debbie Armstrong; photo by Monika Pucko.

Table 4. Ice samples and surface water samples collected during Leg 5.

Date	Station	Sample	HCH sample ID
25-Dec-07	D11	surface water	Surface water
		frazil ice	ice 0-11cm
		transitional ice	ice 11-22cm
		columnar ice	ice 22-30.5cm
26-Dec-07	D12	surface water	Surface water
		frazil	ice 1
		columnar	ice 2
		columnar	ice 3
		columnar/transitional	ice 4
		transitional/frazil/columnar	ice 5
01-Jan-08	D13	surface water	Surface water
		frazil + transitional (0-7.5cm)	ice 1
		columnar + some frazil (7.5-32.5cm)	ice 2
		columnar (32.5-56cm)	ice 3
		big frazil + columnar above and below (56-70cm)	ice 4
		columnar (70-99.5cm)	ice 5
03-Jan-08	D14	surface water	Surface water
		frazil (0-10cm)	ice 1
		columnar (10-20cm)	ice 2
		columnar (20-40cm)	ice 3
		columnar (40-60cm)	ice 4

		columnar + small turbulence (60-80)	ice 5
		columnar (80-100cm)	ice 6
15-Jan-08	D17a	surface water (for D17a and b)	Surface water
		big frazil 4.5 cm + columnar (0-11cm)	ice 1
		columnar (11-22cm)	ice 2
		columnar (22-33cm)	ice 3
		columnar (33-46cm)	ice 4
15-Jan-08	D17b	frazil (0-10.5cm)	ice 1
		columnar (10.5-22cm)	ice 2
		bigger frazil (22-32cm)	ice 3
		transitional columnar (32-48cm)	ice 4
		columnar (48-68)	ice 5
18-Jan-08	D17c	surface water	Surface water
		big frazil (0-19cm)	ice 1
		transitional (19-33.5cm)	ice 2
		columnar (33.5-57cm)	ice 3
		big frazil (57-72cm)	ice 4
		columnar (72-95cm)	ice 5
20-Jan-08	D17d	surface water	Surface water
		frazil (0-17cm)	ice 1
		transitional (17-33cm)	ice 2
		columnar (33-56.5cm)	ice 3
		frazil/transitional (56.5-75.5cm)	ice 4
		columnar (75.5-91cm)	ice 5
22-Jan-08	D18	surface water	Surface water
		frazil/columnar (0-35cm)	ice 1
		transitional/columnar (35-73cm)	ice 2
		frazil/columnar (73-109cm)	ice 3
		columnar/transitional/frazil (109-154cm)	ice 4
		columnar/transitional (154-192cm)	ice 5
23-Jan-08	D18a	surface water	Surface water
		grease ice (1 cm thick)	ice
23-Jan-08	D18b	surface water	Surface water
		nilas (3 cm thick)	ice
24-Jan-08	D19	surface water	Surface water
		frazil/transitional (0-11cm)	ice 1
		columnar (11-32cm)	ice 2
		columnar (32-55cm)	ice 3
		columnar/frazil (55-73cm)	ice 4
		columnar (73-92cm)	ice 5

Ice experiment

At D14 site we did an ice experiment lasting 5 days. We cored at the same site every 12 hours to determine whether there are temporal (short-term) changes in HCH concentration and enantiomeric composition in the sea ice. Ice cores (4) were cut into 4 sections based on ice microstructure. Along with each ice coring, the suck hole was drilled (~ 75-80 cm deep) and left capped for 12 hours prior to brine collection. Ice temperature and salinity profiles were obtained and surface water, snow, oxygen 18, salinity and air samples were collected along with each sampling.

Table 5. List of ice, water and air samples collected during ice experiment.

Date	Station	Sample	HCH sample ID	Air sample
		Experiment 1 (8:30-9:30 am)		
06-Jan-08	D14	surface water	surface water	
		snow	snow	
		frazil (0-10 cm)	ice 1	
		columnar (10-40 cm)	ice 2	taken
		columnar (40-70 cm)	ice 3	
		columnar (70-bottom ~ 100 cm)	ice 4	
		Experiment 2 (8:30-9:30 pm)		
06-Jan-08	D14	surface water	surface water	
		snow	snow	
		brine	brine	
		frazil (0-10 cm)	ice 1	taken
		columnar (10-40 cm)	ice 2	
		columnar (40-70 cm)	ice 3	
		columnar (70-bottom ~ 100 cm)	ice 4	
		Experiment 3 (8:30-9:30 am)		
07-Jan-08	D14	surface water	surface water	
		snow	snow	
		brine	brine	
		frazil (0-10 cm)	ice 1	taken
		columnar (10-40 cm)	ice 2	
		columnar (40-70 cm)	ice 3	
		columnar (70-bottom ~ 100 cm)	ice 4	
		Experiment 4 (8:30-9:30 pm)		
07-Jan-08	D14	surface water	surface water	
		snow	snow	
		brine	brine	
		frazil (0-10 cm)	ice 1	taken
		columnar (10-40 cm)	ice 2	
		columnar (40-70 cm)	ice 3	
		columnar (70-bottom ~ 100 cm)	ice 4	
		Experiment 5 (8:30-9:30 am)		
08-Jan-08	D14	surface water	surface water	taken
		snow	snow	

		brine	brine	
		frazil (0-10 cm)	ice 1	
		columnar (10-40 cm)	ice 2	
		columnar (40-70 cm)	ice 3	
		columnar (70-bottom ~ 100 cm)	ice 4	
		Experiment 6 (8:30-9:30 pm)		
08-Jan-08	D14	surface water	surface water	
		snow	snow	
		brine	brine	
		frazil (0-10 cm)	ice 1	taken
		columnar (10-40 cm)	ice 2	
		columnar (40-70 cm)	ice 3	
		columnar (70-bottom ~ 100 cm)	ice 4	
		Experiment 7 (8:30-9:30 am)		
09-Jan-08	D14	surface water	surface water	
		snow	snow	
		brine	brine	
		frazil (0-10 cm)	ice 1	taken
		columnar (10-40 cm)	ice 2	
		columnar (40-70 cm)	ice 3	
		columnar (70-bottom ~ 100 cm)	ice 4	
		Experiment 8 (8:30-9:30 pm)		
09-Jan-08	D14	surface water	surface water	
		snow	snow	
		brine	brine	
		frazil (0-10 cm)	ice 1	taken
		columnar (10-40 cm)	ice 2	
		columnar (40-70 cm)	ice 3	
		columnar (70-bottom ~ 100 cm)	ice 4	
		Experiment 9 (8:30-9:30 am)		
10-Jan-08	D14	surface water	surface water	
		snow	snow	
		brine	brine	
		frazil (0-10 cm)	ice 1	taken
		columnar (10-40 cm)	ice 2	
		columnar (40-70 cm)	ice 3	
		columnar (70-bottom ~ 100 cm)	ice 4	
		Experiment 10 (8:30-9:30 pm)		
10-Jan-08	D14	surface water	surface water	
		snow	snow	
		brine	brine	
		frazil (0-10 cm)	ice 1	taken
		columnar (10-40 cm)	ice 2	
		columnar (40-70 cm)	ice 3	
		columnar (70-bottom ~	ice 4	

		100 cm)		
		Experiment 11 (8:30-9:30 am)		
11-Jan-08	D14	snow brine	snow brine	not taken

Zooplankton experiment

Calanus hyperboreus AF (Adult Females) were cultured for 6 weeks in 3 ng/L of α-HCH at various EFs (0.25, 0.5 and 0.75). Water spiked with pure acetone was treated as a control. The aim of this experiment was to determine whether they would come to an equilibrium HCH concentration and enantiomeric composition with water and, if so, how long it would take. The more general question of the experiment was: can zooplankton transfer HCHs in the water column during their vertical migrations?

Calanus hyperboreus AF (Adult Female)

Roughly 25 organisms were kept in each 1L jar closed with a lid. Water for the experiment was taken from ~ 50 m above bottom and filtered through GFF filter followed by 2 XAD columns set in a row to obtain HCH-free sea water. To obtain the final HCH concentrations and EFs HCH-free water was spiked with (+) and (–) HCH solution in cyclohexane (1)/acetone (3). Jars with zooplankton were kept in –0.5 to –1.0 °C in darkness. Half of the water in each jar was changed every 4 days.

Three-four replicates of ~ 25 organisms cultured at various HCH concentration/EF were frozen at –20 °C every 7 days and taken back to Winnipeg for further analysis. During the experiment set up zooplankton sample was taken to check the initial HCH concentration/EF.

Throughout the experiment water samples were collected to check HCH concentrations/EF: 3 blanks of HCH-free water, 3 sets of water after zooplankton culture and 2 HCH-free water samples spiked with 3 ng/L of HCH, EF =0.5. Water samples were spiked with 10 µL of standard HCH solution, filtered through GFF filters followed by SPE cartridges, frozen at –80 °C and taken back to Winnipeg for further analysis.

Table 6. List of water samples collected throughout zooplankton experiment.

Date	Sample code
24-Dec-07	blank 1 – HCH-free water
27-Dec-07	HCH-free water spiked with 3ng/L of HCH (EF = 0.5)
03-Jan-08	water after 1 week of culture, 0 HCH
03-Jan-08	water after 1 week of culture, 0 HCH +A (acetone)
03-Jan-08	water after 1 week of culture, 3ng HCH/L, EF=0.75
03-Jan-08	water after 1 week of culture, 3ng HCH/L, EF=0.5

03-Jan-08 water after 1 week of culture, 3ng HCH/L, EF=0.25

17-Jan-08 blank 2 - HCH-free water

20-Jan-08 water after 3 weeks and 4 days of culture, 0 HCH
20-Jan-08 water after 3 weeks and 4 days of culture, 0 HCH + A (acetone)
20-Jan-08 water after 3 weeks and 4 days of culture, 3ng HCH/L, EF=0.75
20-Jan-08 water after 3 weeks and 4 days of culture, 3ng HCH/L, EF=0.5
20-Jan-08 water after 3 weeks and 4 days of culture, 3ng HCH/L, EF=0.25

25-Jan-08 blank 3 - HCH-free water

29-Jan-08 water after 5 weeks of culture, 0 HCH/0 HCH + A (acetone)
29-Jan-08 water after 5 weeks of culture, 3ng HCH/L, EF=0.75
29-Jan-08 water after 5 weeks of culture, 3ng HCH/L, EF=0.5
29-Jan-08 water after 5 weeks of culture, 3ng HCH/L, EF=0.25

Ice experiment 2

The aim of this experiment was to determine at which point during spring ice melt HCHs are released into surface water. At station D19, along with ice sampling, 5 unbroken ice cores (92 cm long) were collected (24-Jan-08) and immediately hung upright in the aft chemistry lab (air temperature = 13.50–17.98 °C). Melt water was collected in equal portions from all cores to give a total volume between 2.93 and 6.48 L. A temperature profile was done on one of the cores every 4 hours until it was no longer possible due to core shrinkage. Five portions of melt water were collected, spiked with 10 µL of standard HCH solution, filtered through GFF filters followed by SPE cartridges, frozen at –80°C and taken back to Winnipeg for further analysis. Sub-samples for oxygen 18 composition and salinity were taken from each melt water.

Table 7. List of samples collected throughout ice experiment 2.

Date	Duration of melt [hours]	Volume [L]	HCH sample ID
25-Jan-08	0.00-9.00	6.28	1st melt water
25-Jan-08	9.00-14.17	6.35	2nd melt water
25-Jan-08	14.17-20.00	6.48	3rd melt water
26-Jan-08	20.00-28.00	5.00	4th melt water
26-Jan-08	28.00-46.00	2.93	5th melt water

Cores melting for ice experiment 2.

Table 8. List of temperature profiles measured throughout ice experiment 2.

Time = 0 hours	
T_{air}	13.50 °C
T_{2cm}	–5.05 °C
T_{17cm}	–5.54 °C
T_{32cm}	–5.99 °C
T_{47cm}	–6.17 °C
T_{62cm}	–5.18 °C
T_{72cm}	–5.56 °C
Time = 4 hours	
T_{air}	17.98 °C
T_{2cm}	–0.05 °C
T_{17cm}	–1.28 °C
T_{32cm}	–1.21 °C
T_{47cm}	–1.25 °C
T_{62cm}	–1.15 °C
T_{72cm}	–1.33 °C
Time = 8 hours	
T_{air}	14.43 °C
T_{2cm}	0.30 °C
T_{17cm}	–0.12 °C
T_{32cm}	0.09 °C
T_{47cm}	0.26 °C
T_{62cm}	0.11 °C
T_{72cm}	0.14 °C
Time = 12 hours (4 cm shorter core)	
T_{air}	14.97 °C
T_{2cm}	0.97 °C
T_{17cm}	0.83 °C
T_{32cm}	0.73 °C
T_{47cm}	0.74 °C
T_{62cm}	0.40 °C
T_{72cm}	0.80 °C
Time = 16 hours (still 4 cm shorter core and thinner)	
T_{air}	15.01 °C
T_{2cm}	1.23 °C
T_{17cm}	1.57 °C
T_{32cm}	0.73°C
T_{47cm}	0.49 °C
T_{62cm}	0.40 °C
T_{72cm}	0.02 °C
Time = 20 hours (6 cm shorter core and thinner 1/3)	
T_{air}	15.66 °C
T_{2cm}	2.02 °C
T_{17cm}	0.94 °C

T_{32cm}	0.60 °C
T_{47cm}	0.28 °C
T_{62cm}	0.49 °C
T_{72cm}	0.36 °C

Time = 24 hours (13 cm shorter core)

T_{air}	14.14 °C
T_{2cm}	3.20 °C
T_{17cm}	2.27 °C
T_{32cm}	0.73 °C
T_{47cm}	0.49 °C
T_{62cm}	0.39 °C
T_{72cm}	0.32 °C

Time = 28 hours (28 cm shorter core, conical shape, pointed top with blackish dot)

T_{air}	14.09 °C
T_{2cm}	2.69 °C
T_{17cm}	1.87 °C
T_{32cm}	1.33 °C
T_{47cm}	0.78 °C
T_{62cm}	0.33 °C

Time = 33 hours (47 cm shorter core, sharp pointed top with blackish dot)

T_{air}	13.77 °C
T_{2cm}	2.85 °C
T_{17cm}	2.09 °C
T_{32cm}	0.79 °C

2.6.2. Mercury and Methyl Mercury

(Armstrong, Chaulk, Latonas)

Mercury (Hg), long been known as a neurotoxin, has emerged as a contaminant of great concern in the Arctic. Although global Hg emissions are declining, marine mammals in certain areas in the arctic have exhibited increasing Hg concentrations during the past two decades. Hg concentrations have been observed in liver of beluga whales from the Beaufort Sea area since 1982, peaking at 29.0 µg/g (wet wt., age corrected; 41.5 µg/g without age correction) in 2002, and remaining as high as 13.5 µg/g in 2002 (consumption guidelines for fish tissue are 0.5 µg/g). The biomagnification of Hg throughout the foodweb is well documented; however, the cyclical behavior of Hg and how abiotic Hg interacts with the foodweb are not well understood. We are also interested in oceanic and riverine inputs/exports of Hg into or out of specific geographical regions such as Hudson Bay.

During Leg 5 of the CFL Expedition, the mercury team onboard the CCGS *Amundsen* began their work to study the cycling of Hg in the Arctic. Hg exists in many forms, elemental mercury Hg(0), reactive gaseous mercury Hg^{2+}, particle bound mercury, organic mercury and dissolved inorganic mercury. Team 8 is attempting to measure and monitor these forms and the movement of each that develops in both the winter season and with the onset of spring. After polar sunrise and throughout the spring ice begins to break up and as a result of this, open leads are formed. This open water and the halogens that are emitted from it are believed to play an important role in the cycling of mercury in this environment. It is believed that atmospheric mercury in the form of gaseous elemental mercury undergoes oxidation to reactive gaseous mercury which can fall to the surface in the form Hg^{2+} or bind

to particles in the air, becoming particulate mercury. This atmospheric process is known as mercury depletion events (MDEs). Not only does the open water affect the atmospheric chemistry of mercury but also offers a route for direct deposit into the water column.

Sampling Activities

1. Water samples for profiles of total mercury and methyl mercury in the water column were taken from the rosette in the moonpool, with surface water sampled from the ice. This sampling method represents mercury movement with horizontal oceanic water mass transport. O^{18} samples were also taken with every mercury sample.

Station	Depths
D14	1m
D14C	3m
D17	7m
D19	10 m
	20m
	30m
	40m
	50m
	60m
	70m
	80m
	100m
	120m
	140m
	160m
	180m
	200m
	250m

2. Atmospheric mercury systems were set up and partially running for gaseous elemental mercury GEM to measure the ambient levels in the atmosphere in this region and to indicate the onset of MDEs.

Tekran atmospheric mercury system on the foredeck of the ship.

3. Snow, brine and ice samples were taken to follow the movement of mercury and its forms through the snow/ice interface and the ice/brine interface. Both new (nilas) and old ice were sampled along with frost flowers where the opportunity presented itself. All ice was characterized with microstructure, temperature and salinity measurements. All coring activities coincided with the HCHs team and described above. At every station sac holes were dug for brine sampling the following morning. Surface snow grabs (triplicate) were a constant daily activity where time and weather permitted. A melt experiment was conducted at station D19 where the core was left to melt and sampled periodically in order to determine at which point mercury is released, a temperature profile was conducted simultaneously.

SNOW COLLECTION: D11, D12, D13, 5-day time series at each D14, D17, D19.

Frost flower sampling on the newly formed ice behind the ship.

New ice (nilas) sampling from the cage (Station D18a and D18b) during transit.

At the end of Leg 5 the contaminants team developed a 5 day recommended sampling plan to meet all the needs of the projects that have begun.

Contaminants 5 Day Sampling plan

Day 0 Site Setup

Setup site markers: choose site upwind and away from the current under the ship (ADCP); we use the zoo hole so make sure it matches this criteria Start Hg air instruments		
Day 1	Coring Day	
Check Hg air instruments - daily checks completed HCHs air started just before you core, turned off after ~ 5 hours		
Ice coring:	Hg x2 HCHs x7 + 1 for micro (ice 1m thick - 8 cores; if 50 cm thick then 10 cores) 4L surface water taken from core hole for HCHs -before you filter take a sample for salinity and O18 - give salinity sample to Amanda/Pascale to be measured bottoms for Alexis - #? -coordinate with Gosselin/Poulin/Michel group temperature of core salinity of core microstructure started	
Day 2	Brine/HCHs Day	
Check Hg air instruments - daily checks completed		
Ice sampling:	snow for Hg brine for Hg frost flowers for Hg (new formation time series) and for HCHs if there is a lot	
HCHs moonpool	profile: surface (after core taken), 10m, 25m, 50m, 100m, 150m, 200m, 300m, bottom with O18 zoo picking	(done every 5 days) (for HCHs)
Day 3	Water Day	
Check Hg air instruments - daily checks completed		
ice core work:	microstructure done: ice cut and scraped and left to melt	
Hg moonpool	on nutrients rosette: collect depth profile (duplicates at least) with O18 THg with nutrient depths, 10m, 20m, 30m, 40m, (or chl max) 50m, 60m, 80m, 100m, 120m, 140m, 160m, 180m,	

	200m, 250m, 300m, 500m, 750m, 1000m, bottom plus blanks MeHg: 10m, chl max, 50m, 100m, 150m, 500m, 1000m, bottom, blanks
minimum plan:	sample different water masses (varying temp, salinity, chl. Max, surface and bottom): 1m, 10m, chl max, 50m, 100m, bottom, blks)
Hg on ice	same day as the rosette: collect surface profile from zooplankton hole (before they do a net tow): with O18 THg and MeHg: 7m, 5m, 3m, 1m plus blanks (duplicates) snow sampling
Day 4	HCH Filter Day
Check Hg air instruments - daily checks completed	
Lab Work	microstructure finished sample decanting run THg (wait until all ice is melted)
HCHs	ice filtering- before you filter take a sample for salinity and O18 - give salinity sample to Amanda/Pascale to be measured
Hg Ice Work	snow sampling
New Ice ?	Cores if possible
snow pits	good after snowfall
Day 5	Extra Day/New Sites
Check Hg air instruments - daily checks completed	
Lab Work	run MeHg (every 2 or 3 stations)
Hg Ice Work	snow sampling
New Ice?	brine?

In conclusion, this leg proved to be quite challenging for the mercury team (whose problems will all be fixed shortly). Be sure you have fun, do good science and smile, the sun has risen!

Leg 6

01 February – 12 March 2008

edited and compiled by Robie Macdonald and Gary Stern
(Chief Scientists)

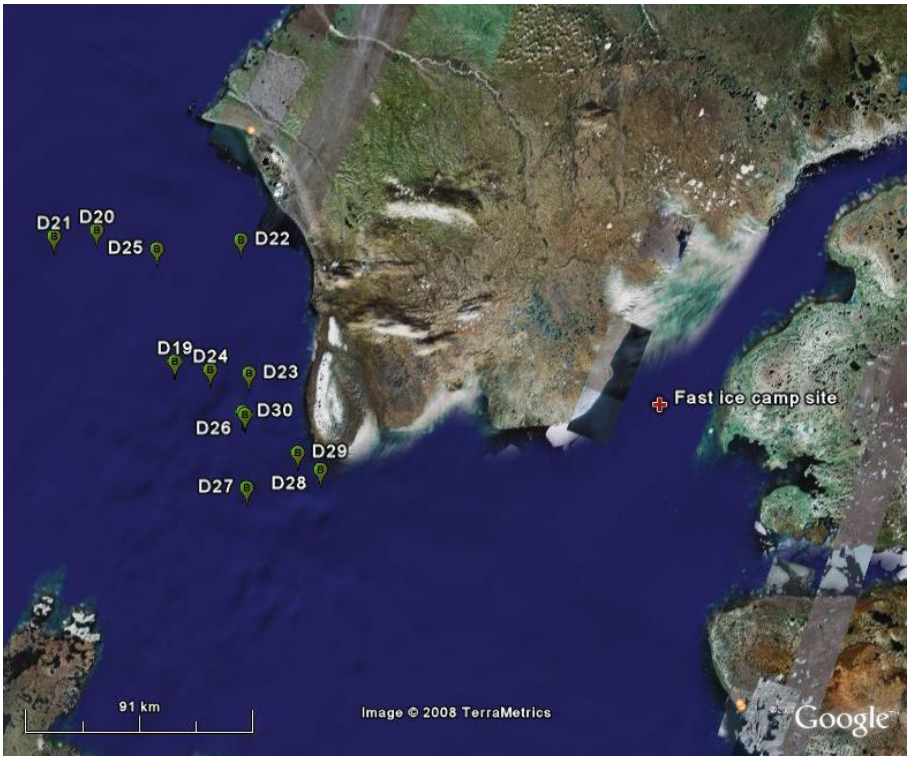
1. General overview

1.1. Science Personnel

Science, media and Schools on Board personnel (Legs 6A & 6B)

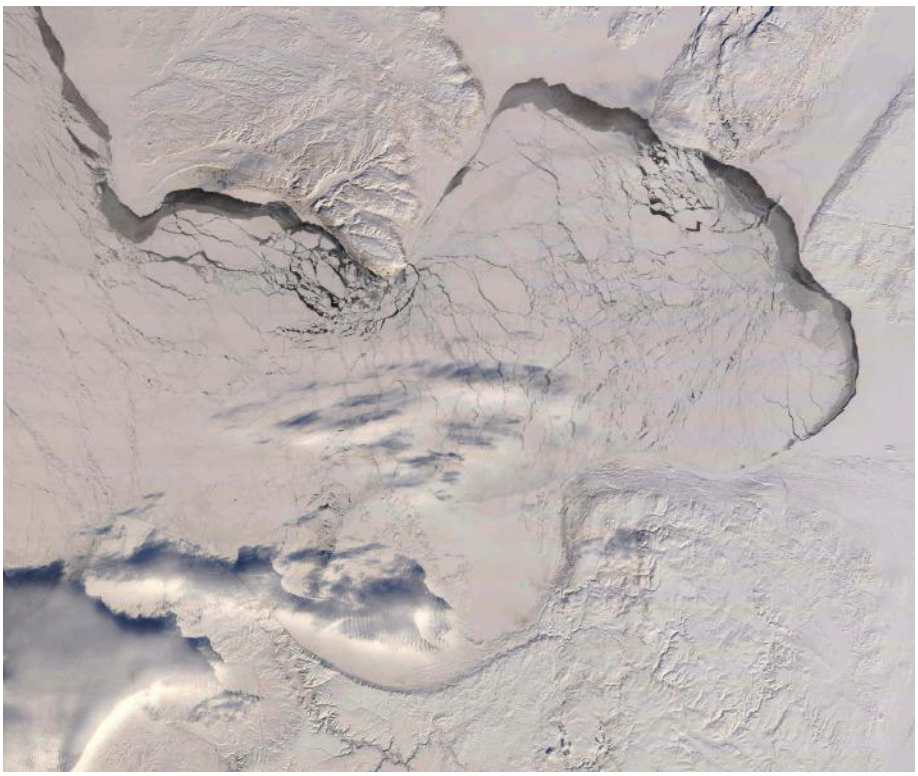
N	Leg	Name	N	Leg	Name
1	6A	**Robie Macdonald (CS)**	29	6A-B	Matra Estrada
2	6A	Blaine Vernon Amos	30	6A-B	Beatriz Fernandez
3	6A	Doug Barber	31	6A-B	Joanne DeLaronde
4	6A	Magaly Chambellant	32	6A-B	Gerald Darnis
5	6A	Peter Galbraith	33	6A-B	Jeff Latonas
6	6A	Klaus Hochheim	34	6A-B	Patrick Lee
7	6A	Bruce Johnson	35	6A-B	Marie-Emmannuelle Rail
8	6A	Dan Leitch	36	6A-B	Phillip Tackett
9	6A	Roger Memorana	37	6A-B	Leif Vogel
10	6A	Vlad Popovici	38	6B	Emily Chung (Media)
11	6A	Paul Shepson	39	6B	Gautier Deblonde (Media)
12	6A	Jim Whiteway	40	6B	Wayne Glowacki (Media)
13	6B	**Gary Stern (CS)**	41	6B	Bartley Kives (Media)
14	6B	Brent Else	42	6B	Guido Romeo (Media)
15	6B	Dustin Isleifson	43	6B	Lucette Barber (SonB)
16	6B	Jeff Seabrook	44	6B	Jianyinh Wu (SonB)
17	6B	Ralf Staebler	45	6B	Jose Carlos Marles (SonB)
18	6B	Helmuth Thomas	46	6B	Wendy Huston (SonB)
19	6A-B	Laura Alonso	47	6B	Mandi Szuplewski (SonB)
20	6A-B	Matthew Asplin	48	6B	Robin Gislason (SonB)
21	6A-B	Anais Aubert	49	6B	Susanne Hawkins (SonB)
22	6A-B	Frederic Brabant	50	6B	Emma Brown (SonB)
23	6A-B	Alexis Burt	51	6B	Alison Kopalie (SonB)
24	6A-B	Lauren Candlish	52	6B	Alysa Almojuela (SonB)
25	6A-B	Amanda Chaulk	53	6B	Patricia Alvarez (SonB)
26	6A-B	Clement Clerc	54	6B	Allsion Wolter (SonB)
27	6A-B	Helene Cloutier	55	6B	Mingfeng Zhou (SonB)
28	6A-B	Pascale Collin	56	6B	Dan Matchullis (SonB)

1.2. Cruise Track



CFL Legs 6A and 6B sampling sites (D19 – D30) and potential fast ice camp in Prince of Wales Strait

1.3. MODIS Image



MODIS image – March 9th, 2008 20:35 UTC

1.4. Ship Log of Science Activities

Station	Date	Hour	Latitude		Longitude		Cap	Activities	Depth (m)	Winds		T° Air ©	T° Water (C)	P Baro	Hum (%)	Ice
										Dir	Speed (kts)					
D19	**1/Feb/2008**	7:15 AM	71 04.7	°N	124 48.9	° W	234	CTD in	353	265	16	-26.7	-1.04	1006.52	77	10
D19	1/Feb/2008	8:00 AM	71 04.7	°N	124 48.9	° W	234	Rosette out								
D19	1/Feb/2008	12:57 PM	71 04.67	°N	124 48.84	° W	234	Rosette in	346	252	16	-26.7	-1	1005.8	75	10
D19	1/Feb/2008	1:05 PM	71 04.67	°N	124 48.84	° W	234	Cage ↓	346	252	16	-26.7	-1	1005.8	75	10
D19	1/Feb/2008	1:31 PM	71 04.67	°N	124 48.84	° W	234	Ice team back								
D19	1/Feb/2008	1:35 PM	71 04.67	°N	124 48.84	° W	234	Rosette out		252	14	-29	-0.9	1005.82	74	10
D19	1/Feb/2008	1:43 PM	71 04.67	°N	124 48.8	° W	234	Ice team Klaus								
D19	1/Feb/2008	2:30 PM	71 04.078	°N	124 48.81	° W	234	Ice team Louis								
D19	1/Feb/2008	3:05 PM	71 04.679	°N	124 48.81	° W	234	Ice team Klaus back	352	245	14	-30.2	-0.99	1008.87	73	10
D19	1/Feb/2008	3:50 PM	71 04.683	°N	124 48.779	° W	234	Ice team Louis back	353	248	16	-30.6	-0.93	1009.13	73	10
D19	1/Feb/2008	7:11 PM	71 04.689	°N	124 48.742	° W	234	Rossette ↓	353	240	14	-31.2	-0.92	1009.6	72	10
D19	1/Feb/2008	7:43 PM	71 04.69	°N	124 48.742	° W	234	Rosette ↑	353	240	15	-31.1	-0.92	1009.56	73	10
D19	1/Feb/2008	10:12 PM	71 04.69	°N	124 48.74	° W	234	Rossette ↓	346	234	15	-31.4	-0.95	1009.8	72	10
D19	**2/Feb/2008**	7:10 AM	71 04.69	°N	124 48.74	° W	234	Rossette ↓	353	235	11	-31.9	-0.98	1011.82	71	10
D19	2/Feb/2008	7:29 AM	71 04.69	°N	124 48.74	° W	234	Rosette ↑	353	240	11	-31.8	-1	1011.92	72	10
D19	2/Feb/2008	8:26 AM	71 04.69	°N	124 48.74	° W	234	Deploy Hydrobios	353	240	10/15	-31.5	-1	1012.08	96	10
D19	2/Feb/2008	8:40 AM	71 04.69	°N	124 48.74	° W	234	Hydrobios ↓	353	240	10/15	-31	-1	1012.08	96	10
D19	2/Feb/2008	8:54 AM	71 04.69	°N	124 48.74	° W	234	Hydrobios ↑	353	240	10/15	-31	-1	1009.44	96	10
D19	2/Feb/2008	9:23 AM	71 04.69	°N	124 48.74	° W	234	Hydrobios out of water	353	240	10/15	-31	-1	1009.6	96	10
D19	2/Feb/2008	9:44 AM	71 04.69	°N	124 48.74	° W	234	First Tucker ↓	353	240	10/15	-30	-1	1009.7	96	10
D19	2/Feb/2008	10:02 AM	71 04.69	°N	124 48.74	° W	234	First Tucker ↑	353	240	10/15	-30	-1	1009.7	96	10
D19	2/Feb/2008	10:08 AM	71 04.69	°N	124 48.74	° W	234	Snow and frost flower sampling	353	240	10/15	-31	-1	1009.6	96	10
D19	2/Feb/2008	10:10 AM	71 04.69	°N	124 48.74	° W	234	Second Tucker↓	353	240	10/15	-30	-1	1009.64	96	10
D19	2/Feb/2008	10:35 AM	71 04.69	°N	124 48.74	° W	234	Snow and frost flower sampling back	353	240	10/15	-30	-1	1009.7	96	10
D19	2/Feb/2008	10:39 AM	71 04.69	°N	124 48.74	° W	234	Ice team out	353	240	10/15	-30	-1	1009.7	96	10
D19	2/Feb/2008	10:44 AM	71 04.69	°N	124 48.74	° W	234	2nd Tucker ↑	357	240	15/20	-30	-1	1.009.8		10
D19	2/Feb/2008	10:51 AM	71 04.69	°N	124 48.74	° W	234	3rd Tucker ↓	357	240	15/20	-30	-1	1.009.8	73	10
D19	2/Feb/2008	11:20 AM	71 04.69	°N	124 48.74	° W	234	Tucker on board	353	240	10/15	-30	-1	1.009.8	73	10
D19	2/Feb/2008	1:05 PM	71 04.69	°N	124 48.74	° W	234.5	Rosette ↓	353	257	9	-30.8	-0.98	1013.26	72	10
D19	2/Feb/2008	1:35 PM	71 04.69	°N	124 48.74	° W	234.6	Rosette ↑	353	256	10	-30.7	-0.97	1013.51	72	10

D19	2/Feb/2008	6:30 PM	71 04.62	°N	124 49.02	° W	228.1	Balloon meteo	354	247	10	-30.3	-1.3	1015.08	73	10
D19	2/Feb/2008	7:20 PM	71 04.62	°N	124 49.02	° W	228.1	Rosette ↓	354	247	10	-30.3	-1.3	1015.08	73	10
D19	2/Feb/2008	7:38 PM	71 04.62	°N	124 49.02	° W	228.3	Rosette ↑	354	249	10	-30.3	-1.29	1015.23	73	10
D19	**3/Feb/2008**	7:10 AM	71 04.62	°N	124 49.02	° W	228.2	Rosette ↓	354	268	10	-29.2	-1.14	1018.89	74	10
D19	3/Feb/2008	7:40 AM	71 04.62	°N	124 49.02	° W	228.2	Rosette ↑	354	265	9	-29.4	-1.16	1019.51	74	10
D19	3/Feb/2008	10:30 AM	71 04.61	°N	124 49.02	° W	228.2	Rosette ↓	354	263	10	-29.6	-1.1	1017.4	74	10
D19	3/Feb/2008	10:30 AM	71 04.61	°N	124 49.02	° W	228.2	Ice team work depart	354	263	10	-29.6	-1.1	1017.4	74	10
D19	3/Feb/2008	11:11 AM	71 04.61	°N	124 49.02	° W	228	Rosette ↑	354	263	10	-29.6	-1.1	1017.4	74	10
D19	3/Feb/2008	11:40 AM	71 04.62	°N	124 49.02	° W	228	Ice team return	354	263	10	-29.6	-1.1		74	10
D19	3/Feb/2008	1:05 PM	71 04.62	°N	124 49.02	° W	228	Ice team on ice	355	264	10	-29.5	-1	1019.4	74	10
D19	3/Feb/2008	3:00 PM	71 04.62	°N	124 49.02	° W	228	Peter G finished in moonpool	357	267	11	-29.2	-1.07	1021.3	74	10
D19	3/Feb/2008	8:14 PM	71 04.62	°N	124 49.02	° W	228	Rosette ↓	357	267	10	-29.3	-1.06	1012.6	74	10
D19	3/Feb/2008	8:40 PM	71 04.62	°N	124 49.02	° W	228	Rosette ↑	357	258	10	-29.3	-1.06	1012.6	74	10
D19	3/Feb/2008	6:20 AM	71 04.62	°N	124 49.02	° W	228	Ice team on ice	354	270	10	-30.5	-1.03	1021.15	73	10
D19	**4/Feb/2008**	7:20 AM	71 04.62	°N	124 49.02	° W	228	Rosette ↓	354	281	8	-30.2	-1.03	1021.17	73	10
D19	4/Feb/2008	7:37 AM	71 04.62	°N	124 49.01	° W	228	Rosette ↑	354	286	6	-30	-1.02	1021.12	73	10
D19	4/Feb/2008	8:26 AM	71 04.62	°N	124 49.02	° W	228	Tucker ↓	355	268	6	-30	-1.02	1021.12	73	10
D19	4/Feb/2008	8:50 AM	71 04.62	°N	124 49.02	° W	228	Tucker ↑	355	268	6	-30	-1.02	1021.12	73	10
D19	4/Feb/2008	9:00 AM	71 04.62	°N	124 49.02	° W	228	Tucker ↓	355	268	6	-30	-1.02	1021.36	73	10
D19	4/Feb/2008	9:26 AM	71 04.62	°N	124 49.02	° W	228	Tucker ↑	355	268	6	-30	-1.02	1021.36	73	10
D19	4/Feb/2008	9:33 AM	71 04.61	°N	124 49.02	° W	228	Tucker ↓	356	279	6	-30.5	-1.01	1021.4	73	10
D19	4/Feb/2008	9:56 AM	71 04.61	°N	124 49.02	° W	228	Tucker ↑	356	248	5	-30	-1.01	1021.4	73	10
D19	4/Feb/2008	10:33 AM	71 04.61	°N	124 49.02	° W	228	Hydrobios preparation	354	268	5	-30	-1	1021.46	73	10
D19	4/Feb/2008	10:41 AM	71 04.61	°N	124 49.02	° W	228	Hydrobios ↓	354	268	5	-30	-1	1021.4	73	10
D19	4/Feb/2008	11:15 AM	71 04.62	°N	124 49.01	° W	228	Hydrobios ↑	355	272	8	-30.7	-1	1021.26	73	10
D19	4/Feb/2008	10:00 AM	71 04.62	°N	124 49.02	° W	228	Snow frostflower depart	355	272	8	-30.5	-1.09	1021.26	73	10
D19	4/Feb/2008	10:18 AM	71 04.62	°N	124 49.02	° W	228	Ice snow sampling depart	355	272	8	-30.5	-1.09	1021.26	73	10
D19	4/Feb/2008	10:20 AM	71 04.62	°N	124 49.02	° W	228	Snowfrost return	355	272	8	-30.5	-1.09	1021.6	73	10
D19	4/Feb/2008	11:32 AM	71 04.62	°N	124 49.02	° W	228	ice snow sampling return	355	272	8	-30.5	-1.09	1021.6	73	10
D19	4/Feb/2008	12:50 PM	71 04.6	°N	124 49.02	° W	228	moon pool Peter G ops	354	258	9	-30.7	-1.01	1021.14	72	10
D19	4/Feb/2008	1:15 PM	71 04.6	°N	124 49.02	° W	228	Rosette ↓	354	253	7	-30.7	-1	1021.14	72	10
D19	4/Feb/2008	2:10 PM	71 04.6	°N	124 49.02	° W	228	Rosette ↑/ 2Eg ice surface	354	257	9	-30.7	-1.01	1021.1	72	10
D19	4/Feb/2008	4:30 PM	71 04.62	°N	124 49.02	° W	228	Ice team snow Fit	354	252	6	-31.2	-1.01	1020.73	72	10
D19	4/Feb/2008	4:37 PM	71 04.62	°N	124 49.02	° W	228	Ice team surface water	354	252	6	-31.2	-1.01	1020.73	72	10
D19	4/Feb/2008	5:10 PM	71 04.62	°N	124 49.02	° W	228	Ice tema surface water return	354	261	7	-31.2	-1.02	1020.6	72	10

D19	4/Feb/2008	6:30 PM	71 04.62	°N	124 49.02	° W	228.3	Ice team on board physics	354	270	8	-31.1	-1.02	1020.75	72	10
D19	4/Feb/2008	7:40 PM	71 04.62	°N	124 49.02	° W	228.2	Rosette ↓	354	248	6	-31.3	-1.01	1020.4	72	10
D19	4/Feb/2008	7:55 PM	71 04.62	°N	124 49.02	° W	228.2	Rosette ↑	354	245	5	-31.4	-1.02	1020.28	72	10
D19	4/Feb/2008	10:30 PM	71 04.62	°N	124 49.02	° W	228	Depart snow frost flower	354	243	7	-31.9	-1.02	1019.96	72	10
D19	4/Feb/2008	11:00 PM	71 04.62	°N	124 49.02	° W	228	Return snow frost flower	354	238	8	-30	-1.02	1019.9	72	10
D19	**5/Feb/2008**	12:05 AM	71 04.62	°N	124 49.02	° W	228	snow frost flower on ice	354	254	8	-32	-0.99	1019.9	71	10
D19	5/Feb/2008	6:00 AM	71 04.62	°N	124 49.02	° W	228	snow frost flower on ice	354	229	8	-32.6	-0.99	1018.74	71	10
D19	5/Feb/2008	6:15 AM	71 04.62	°N	124 49.02	° W	228	snow frost flower on board	354	229	8	-32.6	-0.99	1018.74	71	10
D19	5/Feb/2008	7:10 AM	71 04.62	°N	124 49.02	° W	228	Rosette ↓	354	229	8	-32.8	-1	1018.66	71	10
D19	5/Feb/2008	7:30 AM	71 04.62	°N	124 49.02	° W	228	Rosette ↑	354	222	8	-32.7	-0.98	1018.63	71	10
D19	5/Feb/2008	8:10 AM	71 04.62	°N	124 49.02	° W	228	Rosette ↓	354	213	10	-32.7	-0.98	1018.36	71	10
D19	5/Feb/2008	8:28 AM	71 04.62	°N	124 49.02	° W	228	Rosette ↑	354	213	11	-32.7	-0.98	1018.36	71	10
D19	5/Feb/2008	9:10 AM	71 04.62	°N	124 49.02	° W	228	Ice core team depart	354	213	11	-32.7	-0.98	1018.36	71	10
D19	5/Feb/2008	9:13 AM	71 04.62	°N	124 49.02	° W	228	Rosette ↓	354	213	11	-32.7	-0.98	1018.36	71	10
D19	5/Feb/2008	9:30 AM	71 04.62	°N	124 49.02	° W	228	Rosette ↑	354	213	11	-32.7	-0.98	1018.36	71	10
D19	5/Feb/2008	9:36 AM	71 04.62	°N	124 49.02	° W	228	Ice core team return	354	213	11	-32.7	-0.98	1018.36	71	10
D19	5/Feb/2008	10:12 AM	71 04.62	°N	124 49.02	° W	228	Rosette ↓	354	217	5/10	-32.7	-0.98	1017.36	71	10
D19	5/Feb/2008	10:23 AM	71 04.62	°N	124 49.02	° W	228	Depart zooplankton	354	217	5/10	-32.7	-0.98	1017.8	71	10
D19	5/Feb/2008	10:23 AM	71 04.62	°N	124 49.02	° W	228	Depart snow frost flower	354	217	5/10	-32.7	-0.98	1017.8	71	10
D19	5/Feb/2008	10:50 AM	71 04.62	°N	124 49.02	° W	228	Snow frost return	354	217	5/10	-32.7	-0.98	1017.8	71	10
D19	5/Feb/2008	10:30 AM	71 04.62	°N	124 49.02	° W	228	Rosette ↑	355	217	5/10	-32	-1	1017.8	71	10
D19	5/Feb/2008	11:15 AM	71 04.62	°N	124 49.02	° W	228	Rosette ↓	355	217	5/10	-32	-1	1017.8	71	10
D19	5/Feb/2008	11:30 AM	71 04.62	°N	124 49.02	° W	228	Rosette ↑	355	205	13	-31.9	-0.95	1017	72	10
D19	5/Feb/2008	12:15 PM	71 04.62	°N	124 49.02	° W	228	Rosette ↓	357	201	14	-31.7	-0.95	1016.9	72	10
D19	5/Feb/2008	12:30 PM	71 04.62	°N	124 49.02	° W	228	Rosette ↑	357	202	15	-31.5	-0.95	1016.57	72	10
D19	5/Feb/2008	1:10 PM	71 04.62	°N	124 49.02	° W	228	Rosette ↓	357	206	14	-31.7	-0.95	1016.09	72	10
D19	5/Feb/2008	1:25 PM	71 04.62	°N	124 49.02	° W	228	Rosette ↑	358	203	14	-31	-0.96	1016	72	10
D19	5/Feb/2008	2:10 PM	71 04.62	°N	124 49.02	° W	228	Rosette ↓ Frost flower team on ice	354	196	13	-30.3	-0.92	1015.8	73	10
D19	5/Feb/2008	2:25 PM	71 04.62	°N	124 49.02	° W	228	Rosette ↑	357	200	14	-30.3	-0.91	1015.8	73	10
D19	5/Feb/2008	3:10 PM	71 04.62	°N	124 49.02	° W	228	Rosette ↓	355	195	13	-30.1	-0.92	1015.45	73	10
D19	5/Feb/2008	3:25 PM	71 04.62	°N	124 49.02	° W	228	Rosette ↑	357	200	13	-30.2	-0.93	1015.3	73	10
D19	5/Feb/2008	4:10 PM	71 04.62	°N	124 49.02	° W	228	Rosette ↓	356	213	14	-30.3	-0.96	1015.16	73	10
D19	5/Feb/2008	4:26 PM	71 04.62	°N	124 49.02	° W	228	Rosette ↑	356	214	14	-30.6	-0.98	1015.04	73	10
D19	5/Feb/2008	5:10 PM	71 04.62	°N	124 49.02	° W	228	Rosette ↓	356	229	14	-31.3	-0.99	1014.75	72	10
D19	5/Feb/2008	5:30 PM	71 04.62	°N	124 49.02	° W	228	Rosette ↑	356	219	12	-31.7	-0.99	1014.7	72	10

D19	5/Feb/2008	6:05 PM	71 04.62	°N	124 49.02	° W	228	Rosette ↓	354	225	12	-31.8	-1	1014.5	72	10
D19	5/Feb/2008	6:20 PM	71 04.62	°N	124 49.02	° W	228	Rosette ↑	355	225	12	-31.7	-1	1014.44	72	10
D19	5/Feb/2008	7:10 PM	71 04.62	°N	124 49.02	° W	228	Rosette ↓	354	217	11	-31.6	-1	1014.25	72	10
D19	5/Feb/2008	7:30 PM	71 04.62	°N	124 49.02	° W	228	Rosette ↑	356	222	10	-31.5	-0.99	1014.23	72	10
D19	5/Feb/2008	8:06 PM	71 04.62	°N	124 49.02	° W	228	Rosette ↓	356	222	10	-31.5	-0.99	1014.23	72	10
D19	5/Feb/2008	8:25 PM	71 04.62	°N	124 49.02	° W	228	Rosette ↑	355	220	10	-32	-1	1014.23	72	10
D19	5/Feb/2008	10:00 PM	71 04.62	°N	124 49.017	° W	228	show frost flower depart	355	220	10	-32	-1	1013.6	72	10
D19	5/Feb/2008	10:15 PM	71 04.62	°N	124 49.01	° W	228	snow frost flower arrive	355	220	10	-32	-1	1013.6	72	10
D19	**6/Feb/2008**	4:03 AM	71 04.62	°N	124 49.01	° W	228	Snow frost flower depart	355	260	7	-30.1	-0.98	1013.56	73	10
D19	6/Feb/2008	4:20 AM	71 04.62	°N	124 49.02	° W	228	snow frost flower arrive	355	256	7	-29.9	-0.98	1013.49	73	10
D19	6/Feb/2008	7:07 AM	71 04.62	°N	124 49.02	° W	228	Rosette ↓	355	304	8	-30.6	-0.98	1013.63	73	10
D19	6/Feb/2008	8:15 AM	71 04.62	°N	124 49.02	° W	228	depart snowfrost flower	355	300	10	-31	-0.98	1013.63	73	10
D19	6/Feb/2008	8:25 AM	71 04.62	°N	124 49.01	° W	228	Rosette ↑/frostflower return	355	300	10	-31	-0.98	1013.63	73	10
D19	6/Feb/2008	9:00 AM	71 04.61	°N	124 49.01	° W	228	hydrobios ↓	358	300	10	-31	-0.9	1013.75	73	10
D19	6/Feb/2008	9:30 AM	71 04.61	°N	124 49.01	° W	228	hydrobios ↑	355	300	10	-31	-0.9	1013.75	73	10
D19	6/Feb/2008	9:50 AM	71 04.62	°N	124 49.01	° W	228	ice sampling	355	300	10	-32	-0.9	1013.8	72	10
D19	6/Feb/2008	10:00 AM	71 04.62	°N	124 49.02	° W	228	Tucker 1 ↓	354	300	10	-32	-0.9	1013.8	72	10
D19	6/Feb/2008	10:15 AM	71 04.62	°N	124 49.02	° W	228	Tucker 1 ↑	354	300	10	-32	-0.9	1013.8	71	10
D19	6/Feb/2008	10:30 AM	71 04.62	°N	124 49.02	° W	228	Tucker 2 ↓	354	300	10	-32	-0.9	1014.1	71	10
D19	6/Feb/2008	10:45 AM	71 04.62	°N	124 49.02	° W	228	Tucker 2 ↑	355	300	10	-32	-0.9	1014.1	71	10
D19	6/Feb/2008	11:05 AM	71 04.62	°N	124 49.02	° W	228	Tucker 3 ↓	355	300	10	-32	-0.9	1014.1	71	10
D19	6/Feb/2008	11:30 AM	71 04.62	°N	124 49.02	° W	228	Tucker 3↑	355	300	10	-32	-1	1014.1	71	10
D19	6/Feb/2008	1:30 PM	71 04.62	°N	124 49.02	° W	228	Coring team leaves	356	300	10	-32.8	-0.92	1014.4	70	10
D19	6/Feb/2008	2:00 PM	71 04.62	°N	124 49.02	° W	228	Frostflower team leaves	355	300	9	-33	-0.93	1014.65	70	10
D19	6/Feb/2008	2:35 PM	71 04.62	°N	124 49.02	° W	228	Frostflower team back	356	295	10	-33.4	-0.96	1014.8	70	10
D19	6/Feb/2008	3:45 PM	71 04.62	°N	124 49.01	° W	228	Ice sample team on ice	356	290	8	-33.5	-0.95	1014.9	70	10
D19	6/Feb/2008	4:55 PM	71 04.62	°N	124 49.01	° W	228	Ice coring team on board	355	295	10	-33.7	-0.95	1015	70	10
D19	6/Feb/2008	5:22 PM	71 04.62	°N	124 49.01	° W	228	ice sampling team on board	355	300	10	-33.7	-0.94	1015.05	70	10
D19	6/Feb/2008	7:22 PM	71 04.62	°N	124 49.01	° W	228	Rosette ↓	355	300	10	-33.8	-0.94	1015.2	69	10
D19	6/Feb/2008	7:40 PM	71 04.62	°N	124 49.01	° W	228	Rosette ↑	355	300	10	-33.8	-0.94	1015.2	69	10
D19	6/Feb/2008	8:10 PM	71 04.62	°N	124 49.01	° W	228	snow/frostflower depart	355	300	10	-33.8	-0.94	1015.2	69	10
D19	6/Feb/2008	8:30 PM	71 04.62	°N	124 49.01	° W	228	snow/frostflower return	355	300	10	-33.8	-0.94	1015.2	69	10
D19	**7/Feb/2008**	7:10 AM	71 04.62	°N	124 49.01	° W	228	Rosette ↓	355	310	10	-34.8	-0.94	1016.62	68	10
D19	7/Feb/2008	7:36 AM	71 04.62	°N	124 49.01	° W	228	Rosette ↑	355	300	10	-34.9	-0.93	1016.61	68	10
D19	7/Feb/2008	8:25 AM	71 04.62	°N	124 49.01	° W	228	snow frost/flower depart	355	300	10	-34.9	-0.93	1016.61	68	10

D19	7/Feb/2008	8:45 AM	71 04.62	°N	124 49.01	° W	228	snow frost flower return	355	300	5/10	-35	-0.9	1016.89	68	10
D19	7/Feb/2008	9:45 AM	71 04.62	°N	124 49.01	° W	228	Depart ice sampling	355	300	5/10	-35	-1	1016.8	68	10
D19	7/Feb/2008	11:00 AM	71 04.62	°N	124 49.01	° W	228	Return ice sampling	355	310	5/10	-35	-0.93	1017.84	68	10
D19	7/Feb/2008	1:30 PM	71 04.62	°N	124 49.01	° W	228	Moon Pool Peter start	354	308	5/10	-34.7	-0.91	1018.8	68	10
D19	7/Feb/2008	1:55 PM	71 04.62	°N	124 49.01	° W	228	Finish moon pool ops	356	302	9	-34.7	-0.92	1018.9	68	10
D19	7/Feb/2008	3:35 PM	71 04.62	°N	124 49.01	° W	228	ice team, sampling on ice/moonpool Peter start	354	315	8	-34.7	-0.92	1019.49	68	10
D19	7/Feb/2008	4:25 PM	71 04.62	°N	124 49.01	° W	228	Finish moonpool turbulence	354	312	8	-34.6	-0.92	1019.88	68	10
D19	7/Feb/2008	4:43 PM	71 04.62	°N	124 49.01	° W	228	start turbulence profiling	355	316	9	-34.7	-0.92	1020.27	68	10
D19	7/Feb/2008	5:05 PM	71 04.62	°N	124 49.01	° W	228	finish turbulence profiling	355	301	7	-34.8	-0.92	1020.32	68	10
D19	7/Feb/2008	5:55 PM	71 04.62	°N	124 49.01	° W	228	ice sampling team on board	357	310	8	-34.9	-0.92	1020.68	68	10
D19	7/Feb/2008	7:17 PM	71 04.62	°N	124 49.02	° W	228	Rosette ↓	355	310	10	-35	-0.92	1021.23	68	10
D19	7/Feb/2008	7:39 PM	71 04.62	°N	124 49.02	° W	228	Rosette ↑	355	310	9	-34.9	-0.92	1021.52	68	10
D19	7/Feb/2008	7:52 PM	71 04.62	°N	124 49.02	° W	228	Turbulence profile ↓	355	315	10	-34.8	-0.92	1021.48	68	10
D19	7/Feb/2008	8:01 PM	71 04.62	°N	124 49.02	° W	228	Depart snow/frostflower	355	315	10	-34.8	-0.92	1021.48	68	10
D19	7/Feb/2008	8:10 PM	71 04.62	°N	124 49.02	° W	228	Turbulence profile ↑	355	315	10	-34.8	-0.92	1021.48	68	10
D19	7/Feb/2008	8:15 PM	71 04.62	°N	124 49.02	° W	228	Return snow/frost flower	355	315	10	-34.8	-0.92	1021.48	68	10
D19	7/Feb/2008	8:40 PM	71 04.62	°N	124 49.02	° W	228	Turbulence profile ↓	355	315	10	-34.8	-0.92	1021.48	68	10
D19	7/Feb/2008	9:25 PM	71 04.62	°N	124 49.02	° W	228	Turbulence profile ↑	355	320	12	-34.4	-0.9	1021.89	68	10
D19	**8/Feb/2008**	7:03 AM	71 04.62	°N	124 49.02	° W	228	Rosette ↓	355	290	12	-34	-0.92	1025.41	69	10
D19	8/Feb/2008	7:20 AM	71 04.62	°N	124 49.02	° W	228	Rosette ↑	355	289	14	-33.9	-0.92	1025.65	69	10
D19	8/Feb/2008	9:16 AM	71 04.62	°N	124 49.02	° W	228	hydrobios ↓	355	289	10/15	-34	-0.9	1025.65	69	10
D19	8/Feb/2008	9:35 AM	71 04.62	°N	124 49.02	° W	228	Dep;art ice sampling	355	289	10/15	-34	-0.9	1025.65	69	10
D19	8/Feb/2008	9:43 AM	71 04.62	°N	124 49.02	° W	228	hydrobios ↑	355	289	10/15	-33	-0.9	1026.05	69	10
D19	8/Feb/2008	10:10 AM	71 04.62	°N	124 49.02	° W	228	depart snowfrost flower	355	289	10/15	-34	-0.9	1026.05	69	10
D19	8/Feb/2008	10:23 AM	71 04.62	°N	124 49.02	° W	228	Tucker ↓	355	289	16	-33	-0.93	1025.95	70	10
D19	8/Feb/2008	10:35 AM	71 04.62	°N	124 49.02	° W	228	snow frostflower	355	289	16	-32.7	-0.9	1025.95	70	10
D19	8/Feb/2008	10:50 AM	71 04.62	°N	124 49.02	° W	228	Tucker #1↑	355	289	16	-32.7	-0.9	1025.95	70	10
D19	8/Feb/2008	10:55 AM	71 04.62	°N	124 49.02	° W	228	Tucker #2 ↓	355	289	16	-32.7	-0.9	1025.95	70	10
D19	8/Feb/2008	11:00 AM	71 04.62	°N	124 49.02	° W	228	Balloon meteor	355	289	16	-32.7	-0.9	1025.95	70	10
D19	8/Feb/2008	11:00 AM	71 04.62	°N	124 49.02	° W	228	Roger/Clement/Leif	355	289	16	-32.7	-0.9	1025.95	70	10
D19	8/Feb/2008	11:10 AM	71 04.6	°N	124 49.01	° W	228	Tucker #2 out	355	289	16	-32.7	-0.9	1025.95	70	10
D19	8/Feb/2008	11:20 AM	71 04.6	°N	124 49.01	° W	228	Tucker #3 in	355	289	16	-32.7	-0.9	1025.95	70	10
D19	8/Feb/2008	11:45 AM	71 04.6	°N	124 49.01	° W	228	Tucker #3 finished	355	290	15/20	-32.4	-0.92	1025.79	71	10
D19	8/Feb/2008	12:10 PM	71 04.6	°N	124 49.01	° W	228	ice sampling team on board	354	280	15/20	-32.1	-0.93	1025.6	71	10
D19	8/Feb/2008	12:20 PM	71 04.6	°N	124 49.01	° W	228	Ice team reflector on board	354	285	15/20	-31.9	-0.92	1025.7	71	10

D19	8/Feb/2008	1:05 PM	71 04.6	°N	124 49.01	° W	228	Rosette ↓	354	280	18	-30.9	-0.93	1025.4	72	10
D19	8/Feb/2008	2:05 PM	71 04.6	°N	124 49.01	° W	228	Rosette ↑			18	-30.9	-0.93		72	10
D19	8/Feb/2008	2:10 PM	71 04.56	°N	124 48.74	° W	228.3	Turbulence ↓, zooplankton on ice	356	285	20	-29.7	-0.91	1025.7	73	10
D19	8/Feb/2008	3:50 PM	71 04.44	°N	124 48.09	° W	227.7	Ice team sampling, zooplankton on board	361	295	22	-28.5	-0.9	1025.9	74	10
D19	8/Feb/2008	4:50 PM	71 04.33	°N	124 47.61	° W	228.3	ice sampling team on board	371	300	21	-29.1	-0.91	1026.39	74	10
D19	8/Feb/2008	7:16 PM	71 04.02	°N	124 46.50	° W	228	Rosette ↓	370	306	19	-29.9	-0.92	1026.78	73	10
D19	8/Feb/2008	7:32 PM	71 04.005	°N	124 46.383	° W	228.1	Rosette ↑	369	302	18	-29.9	-0.92	1026.75	73	10
D19	8/Feb/2008	7:37 PM	71 03.99	°N	124 46.37	° W	228.1	Turbulence profile	368	302	17	-29.9	-0.92	1026.75	73	10
D19	8/Feb/2008	8:45 PM	71 03.93	°N	124 46.16	° W	228.1	Ballon deployed	365	310	15/20	-30	-0.92	1026.25	73	10
D19	8/Feb/2008	9:08 PM	71 03.93	°N	124 46.16	° W	228.1	Turbulence finished	365	310	15/20	-30	-0.92	1026.25	73	10
D19	**9/Feb/2008**	7:03 AM	71 03.93	°N	124 46.15	° W	228.2	Rosette ↓	365	290	15	-29.5	-0.83	1025.54	74	10
D19	9/Feb/2008	7:21 AM	71 03.93	°N	124 46.14	° W	228.2	Rosette ↑	365	287	15	-29.5	-0.84	1025.57	74	10
D19	9/Feb/2008	8:05 AM	71 03.93	°N	124 46.14	° W	228.2	Rosette ↓	365	287	15	-29.5	-0.84	1025.5	74	10
D19	9/Feb/2008	8:40 AM	71 03.93	°N	124 46.14	° W	228.2	Rosette ↑	365	287	15	-29.5	-0.9	1025.5	74	10
D19	9/Feb/2008	9:00 AM	71 03.93	°N	124 46.14	° W	228.2	Rosette ↓	365	287	15	-30	-0.9	1025.5	74	10
D19	9/Feb/2008	9:15 AM	71 03.93	°N	124 46.14	° W	228.2	Rosette ↑	366	290	15/20	-30	-0.91	1024.72	74	10
D19	9/Feb/2008	9:30 AM	71 03.93	°N	124 46.15	° W	228.2	Depart ice sampling	366	290	10/15	-29	-0.91	1024.7	74	10
D19	9/Feb/2008	9:55 AM	71 03.93	°N	124 46.15	° W	228.2	Rosette ↓	366	290	15	-30	-0.91	1024.72	74	10
D19	9/Feb/2008	10:00 AM	71 03.93	°N	124 46.15	° W	228.2	depart snow sampling	366	290	15	-29	-0.91	1024.72	74	10
D19	9/Feb/2008	10:15 AM	71 03.93	°N	124 46.15	° W	228.2	Rosette on board	366	290	15	-29	-0.91	1024.72	74	10
D19	9/Feb/2008	10:32 AM	71 03.93	°N	124 46.15	° W	228.2	Tucker ↓	366	290	10/15	-29	-0.91	1025	74	10
D19	9/Feb/2008	11:00 AM	71 03.93	°N	124 46.15	° W	228.2	Tucker↑	366	290	10/15	-29	-0.91	1025	74	10
D19	9/Feb/2008	11:06 AM	71 03.93	°N	124 46.15	° W	228.2	Rosette ↓	364	273	12	-29.3	-0.92	1024.68	74	10
D19	9/Feb/2008	11:10 AM	71 03.92	°N	124 46.15	° W	228.2	Return ice sampling	365	273	14	-29.3	-0.92	1024.68	74	10
D19	9/Feb/2008	12:10 PM	71 03.93	°N	124 46.15	° W	228.2	Rosette ↓	367	280	14	-28.7	-0.93	1024	74	10
D19	9/Feb/2008	12:30 PM	71 03.93	°N	124 46.15	° W	228.2	Rosette ↑	366	280	15	-28.3	-0.93	1024.12	74	10
D19	9/Feb/2008	12:38 PM	71 03.93	°N	124 46.15	° W	228.2	Tucker ↓	365	280	14	-28.2	-0.93	1024.1	74	10
D19	9/Feb/2008	1:00 PM	71 03.93	°N	124 46.15	° W	228.2	Tucker↑, frost flower team on ice	364	280	13	-28.1	-0.93	1024.16	74	10
D19	9/Feb/2008	1:10 PM	71 03.93	°N	124 46.15	° W	228.2	Rosette ↓	364	280	13					
D19	9/Feb/2008	12:15 PM	71 03.93	°N	124 46.15	° W	228.2	Frost flower team on board	365	270	15	-27.9	-0.93	1023.8	74	10
D19	9/Feb/2008	1:30 PM	71 03.93	°N	124 46.15	° W	228.2	Rosette ↑ Turbulence ↓	365	270	15	-27.9	-0.93	1023.8	74	10
D19	9/Feb/2008	2:05 PM	71 03.93	°N	124 46.15	° W	228.2	Rosette ↓ Turbulence ↑	365	275	15	-27.4	-0.91	1023.6	74	10
D19	9/Feb/2008	2:30 PM	71 03.93	°N	124 46.15	° W	228.2	Rosette ↑	365	277	15	-27.2	-0.91	1023.3	74	10
D19	9/Feb/2008	3:10 PM	71 03.93	°N	124 46.15	° W	228.2	Rosette ↓	365	270	15	-26.9	-0.89	1023.35	74	10
D19	9/Feb/2008	3:25 PM	71 03.93	°N	124 46.15	° W	228.2	Rosette ↑	368	275	16	-26.8	-0.88	1022.8	74	10

D19	9/Feb/2008	3:56 PM	71 03.93	°N	124 46.14	° W	228.1	Rosette ↓	366	282	16	-26.9	-0.85	1022.76	75	10
D19	9/Feb/2008	4:12 PM	71 03.93	°N	124 46.15	° W	228.1	Rosette ↑	366	284	16	-26.7	-0.85	1022.45	75	10
D19	9/Feb/2008	4:36 PM	71 03.93	°N	124 46.15	° W	228.2	ice sampling team on board	367	280	19	-26.7	-0.84	1022.34	75	10
D19	9/Feb/2008	5:00 PM	71 03.93	°N	124 46.15	° W	228.2	Rosette ↓	368	279	18	-26.8	-0.83	1021.86	76	10
D19	9/Feb/2008	5:15 PM	71 03.93	°N	124 46.15	° W	228.2	Rosette ↑	368	273	15	-26.8	-0.82	1021.84	76	10
D19	9/Feb/2008	6:05 PM	71 03.93	°N	124 46.15	° W	228.2	Rosette ↓	368	275	16	-27.1	-0.83	1021.4	76	10
D19	9/Feb/2008	7:00 PM	71 03.93	°N	124 46.15	° W	228.2	Rosette ↓	365	290	15	-28.5	-0.83	1021.4	75	10
D19	9/Feb/2008	7:20 PM	71 03.93	°N	124 46.15	° W	228.2	Rosette ↑	365	280	16	-28.5	-83	1021.2	75	10
D19	9/Feb/2008	7:55 PM	71 03.93	°N	124 46.15	° W	228.2	depart snowfrost flower	365	280	15/20	-28.6	-0.83	1020.4	75	10
D19	9/Feb/2008	8:00 PM	71 03.93	°N	124 46.15	° W	228.2	Rosette ↓	365	280	15/20	-28.6	-0.83	1020.4	75	10
D19	9/Feb/2008	8:20 PM	71 03.93	°N	124 46.15	° W	228.2	Rosette ↑	365	280	15/20	-28.6	-0.83	1020.4	75	10
D19	9/Feb/2008	8:30 PM	71 03.93	°N	124 46.14	° W	228.2	Return snowfrost flower	365	280	15/20	-28.6	-0.83	1020.4	75	10
D19	**10/Feb/2008**	7:06 AM	71 03.93	°N	124 46.15	° W	228	Rosette ↓	367	290	10/15	-28.7	-0.81	1017.04	75	10
D19	10/Feb/2008	7:39 AM	71 03.93	°N	124 46.15	° W	228	Rosette ↑	365	304	12	-28.5	-0.81	1017.39	75	10
D19	10/Feb/2008	8:30 AM	71 03.93	°N	124 46.15	° W	228	Tucker ↓	366	305	10/15	-28.5	-0.81	1017.39	75	10
D19	10/Feb/2008	8:50 AM	71 03.93	°N	124 46.15	° W	228	Tucker ↑	366	305	10	-28.5	-0.81	1017.39	75	10
D19	10/Feb/2008	8:55 AM	71 03.93	°N	124 46.15	° W	228	Tucker ↓	366	305	10	-28.5	-0.81	1017.39	75	10
D19	10/Feb/2008	9:10 AM	71 03.93	°N	124 46.15	° W	228	Tucker ↑	366	305	10	-28.5	-0.81	1017.39	75	10
D19	10/Feb/2008	9:30 AM	71 03.93	°N	124 46.15	° W	228	Tucker ↓	366	305	10	-28.5	-0.81	1017.39	75	10
D19	10/Feb/2008	9:30 AM	71 03.93	°N	124 46.15	° W	228	Depart ice sampling	366	305	10	-28.5	-0.81	1016.54	75	10
D19	10/Feb/2008	9:50 AM	71 03.93	°N	124 46.15	° W	228	Tucker ↑	366	300	10	-27.6	-0.88	1016.54	76	10
D19	10/Feb/2008	10:00 AM	71 03.92	°N	124 46.15	° W	228	Hydrobios ↓	366	300	10	-27.6	-0.8	1016.54	76	10
D19	10/Feb/2008	10:00 AM	71 03.93	°N	124 46.14	° W	228	depart snowfrost flower	366	300	10	-27.6	-0.8	1016.54	76	10
D19	10/Feb/2008	10:20 AM	71 03.93	°N	124 46.14	° W	228	Return snowfrost flower	366	300	10	-27.5	-0.8	1016.5	76	10
D19	10/Feb/2008	10:38 AM	71 03.93	°N	124 46.14	° W	228	Hydrobios ↑	366	300	10	-28.5	-0.8	1016.17	76	10
D19	10/Feb/2008	10:45 AM	71 03.93	°N	124 46.15	° W	228	Turbulence start	366	300	10	-28.5	-0.8	1016.17	76	10
D19	10/Feb/2008	11:00 AM	71 03.92	°N	124 46.14	° W	228	Return ice sampling	366	300	10	-28.5	-0.8	1016.7	76	10
D19	10/Feb/2008	3:30 PM	71 03.93	°N	124 46.15	° W	228.1	Turbulence ↓	-	286	11	-23.8	-0.9	1015.46	78	10
D19	10/Feb/2008	4:00 PM	71 03.93	°N	124 46.15	° W	228.1	Frost team on ice	364	290	9	-23.7	-0.87	1015.38	78	10
D19	10/Feb/2008	4:10 PM	71 03.93	°N	124 46.15	° W	228.1	Frost team on board	364	290	10	-23.5	-0.85	1015.39	79	10
D19	10/Feb/2008	4:40 PM	71 03.93	°N	124 46.15	° W	228.2	Pofile turbulence ↑	364	295	8	-23.2	-0.82	1015.46	79	10
D19	10/Feb/2008	7:00 PM	71 03.93	°N	124 46.15	° W	228.1	Rosette ↓	366	345	5	-22.3	-0.81	1016.15	80	10
D19	10/Feb/2008	7:30 PM	71 03.93	°N	124 46.15	° W	228.1	Rosette ↑	365	350	5	-22.1	-0.81	1016.19	80	10
D19	**11/Feb/2008**	7:02 AM	71 03.93	°N	124 46.17	° W	228.2	Rosette ↓	365	116	26	-31.6	-0.85	1024.18	72	10
D19	11/Feb/2008	7:23 AM	71 03.94	°N	124 46.18	° W	228.2	Rosette ↑	366	119	23	-31.7	-0.85	1024.46	72	10

D19	11/Feb/2008	8:35 AM	71 04.00	°N	124 46.39	° W	228.2	Hydrobios ↓	368	120	25/30	-31.7	-0.81	1025.31	72	10
D19	11/Feb/2008	8:59 AM	71 04.03	°N	124 46.47	° W	228.3	Hydrobios ↑	370	115	20/30	-32.2	-0.81	1025.67	71	10
D19	11/Feb/2008	9:20 AM	71 04.06	°N	124 46.61	° W	228.3	Tucker in	370	115	25	-34.4	-0.78	1025.85	71	10
D19	11/Feb/2008	9:42 AM	71 04.09	°N	124 46.72	° W	228.3	Tucker ↑	370	124	23	-32.6	-0.77	1026.13	71	10
D19	11/Feb/2008	9:47 AM	71 04.10	°N	124 46.75	° W	228.3	Tucker ↓	369	120	28	-32.6	-0.77	1026.13	71	10
D19	11/Feb/2008	10:00 AM	71 4.12	°N	124 46.82	° W	228.3	ice sampling on the ice	370	125	20/30	-32.7	-0.74	1026.06	71	10
D19	11/Feb/2008	10:05 AM	71 4.13	°N	124 46.86	° W	228.3	depart snow sampling team	370	125	25/30	-32.5	-0.74	1026.06	71	10
D19	11/Feb/2008	10:15 AM	71 4.13	°N	124 46.86	° W	228.3	Tucker ↑	370	125	25/30	-32.5	-0.74	1026.06	71	10
D19	11/Feb/2008	10:25 AM	71 4.16	°N	124 46.94	° W	228.3	Return snow sampling team	370	100	25/30	-32.5	-0.74	1026.06	71	10
D19	11/Feb/2008	11:00 AM	71 4.22	°N	124 47.14	° W	228.3	Rosette ↓	371	100	25/30	-32.5	-0.74	1026.06	71	10
D19	11/Feb/2008	11:05 AM	71 4.23	°N	124 47.17	° W	228.3	ice sampling team return	371	110	25/30	-32.7	-0.72	1027.04	71	10
D19	11/Feb/2008	11:30 AM	71 4.29	°N	124 47.34	° W	228.3	Rosette ↑	371	110	25/30	-33	-0.74	1027.62	70	10
D19	11/Feb/2008	1:31 PM	71 4.54	°N	124 48.13	° W	228.7	Rosette ↓	361	110	25/30	-32	-0.7	1029.36	70	10
D19	11/Feb/2008	2:20 PM	71 4.67	°N	124 48.61	° W	228.7	Depart zooplankton	361	100	25	-33.1	-0.73	1029.85	70	10
D19	11/Feb/2008	2:30 PM	71 4.70	°N	124 48.71	° W	228.7	Rosette ↑	360	100	25	-33.1	-0.73	1029.85	70	10
D19	11/Feb/2008	2:45 PM	71 4.70	°N	124 48.71	° W	228.7	Turbulence profiling	356	100	25	-33.1	-0.73	1030.37	70	10
D19	11/Feb/2008	3:55 PM	71 4.88	°N	124 49.35	° W	229	zooplankton on board	-	125	23	-33.1	-0.75	1030.7	70	10
D19	11/Feb/2008	4:10 PM	71 4.92	°N	124 49.49	° W	229	ice sampling on the ice	-	125	25	-33.2	-0.78	1030.8	70	10
D19	11/Feb/2008	4:20 PM	71 4.95	°N	124 49.61	° W	229.1	turbulence ↑, ice sample on board	350	125	25	-33.5	-0.83	1030.9	70	10
D19	11/Feb/2008	7:00 PM	71 5.31	°N	124 51.43	° W	229.3	Rosette ↓	331	115	29	-33.6	-0.81	1031.9	70	10
D19	11/Feb/2008	7:25 PM	71 5.36	°N	124 51.73	° W	229	Rosette ↑	330	120	30	-33.7	-0.84	1031.9	70	10
D19	11/Feb/2008	8:40 PM	71 5.58	°N	124 52.89	° W	229	turbulence ↓	325	110	30	-33.5	-0.84	1031.7	70	10
D19	11/Feb/2008	9:35 PM	71 5.77	°N	124 53.72	° W	229	Turbulence ↑	323	115	30	-33.5	-0.93	1032.03	70	10
D19	**12/Feb/2008**	7:05 AM	71 8.40	°N	125 04.83	° W	230	Rosette ↓	323	120	30/35	-33.1	-1.1	1032.3	70	10
D19	12/Feb/2008	7:30 AM	71 8.46	°N	125 5.13	° W	230	Rosette ↑	330	120	30/35	-33	-1.1	1032.24	70	10
D19	12/Feb/2008	8:45 AM	71 8.72	°N	125 6.52	° W	230.4	Hydrobios ↓	341	120	30/35	-33	-1	1032.2	70	10
D19	12/Feb/2008	9:10 AM	71 8.91	°N	125 7.53	° W	230.4	Hydrobios ↑	347	120	30/35	-33	-1	1032.2	70	10
D19	12/Feb/2008	9:25 AM	71 8.91	°N	125 7.74	° W	230.4	Tucker ↓	347	120	30/35	-33	-1	1032.2	70	10
D19	12/Feb/2008	9:45 AM	71 09.02	°N	125 8.12	° W	230.4	Tucker ↑	352	120	35	-33	-1	1030.99	70	10
D19	12/Feb/2008	9:50 AM	71 09.02	°N	125 8.17	° W	230.4	Tucker ↓	352	120	35	-33.4	-1	1031	70	10
D19	12/Feb/2008	10:12 AM	71 09.13	°N	125 8.67	° W	230.4	2nd Tucker ↑	353	120	35	-33.4	-1.14	1030.83	70	10
D19	12/Feb/2008	10:15 AM	71 09.13	°N	125 9.22	° W	230.4	3rd Tucker ↓	351	120	35	-33.5	-1.15	1030.67	70	10
D19	12/Feb/2008	10:45 AM	71 09.27	°N	125 9.44	° W	231.1	3rd Tucker ↑	342	120	35	-33.4		1030.57	70	10
D19	12/Feb/2008	7:00 PM	71 11.54	°N	125 22.7	° W	233.3	Rosette ↓	336	125	30	-31.8	-1.2	1029.05	72	10
D19	12/Feb/2008	7:25 PM	71 11.64	°N	125 23.19	° W	233.8	Rosette ↑	342	125	30	-31.7		1028.9	72	10

D19	**13/Feb/2008**	7:10 AM	71 15.64	°N	125 43.06	° W	235.7	Rosette ↓	397	120	35/40	-30.1	-1.23	1027.41	73	10
D19	13/Feb/2008	7:25 AM	71 15.71	°N	125 43.36	° W	235.7	Rosette ↑	397							10
D19	13/Feb/2008	7:10 PM	71 20.4	°N	126 00.10	° W	64.8	Rosette ↓	412	120	30	-28.3	-1.33	1023.1	74	10
D19	13/Feb/2008	7:30 PM	71 20.53	°N	126 00.69	° W	64.7	Rosette ↑	413	120	30	-28.3	-1.33	1023.02	74	10
D19	**14/Feb/2008**	7:00 AM	71 25.04	°N	126 18.32	° W	64.7	Deploy Rosette								10
D19	14/Feb/2008	7:10 AM	71 25.08	°N	126 18.45	° W	64.7	Rosette ↓	467	120	25/35	-25.5	-1.31	1013.42	76	10
D19	14/Feb/2008	7:33 AM	71 25.27	°N	126 19.24	° W	64.7	Rosette ↑	467	120	25/35	-24	-1.3	1012.8	76	10
D19	14/Feb/2008	8:35 AM	71 25.59	°N	126 20.47	° W	64.7	Hydrobios ↓	465	120	25/35	-24	-1.32	1012.04	76	10
D19	14/Feb/2008	9:08 AM	71 25.83	°N	126 21.46	° W	64	Hydrobios ↑	453	120	35/45	-24	-1.31	1012.8	72	10
D19	14/Feb/2008	9:30 AM	71 25.9	°N	126 21.77	° W	64	1st Tucker ↓	463	120	25/35	-24	-1.31	1011.54	77	10
D19	14/Feb/2008	10:07 AM	71 26.01	°N	126 22.22	° W	64	1st Tucker ↑	463	120	25/35	-24	-1.31	1011.4	77	10
D19	14/Feb/2008	12:55 PM	71 27.11	°N	126 26.81	° W	65	Deployment								10
D19	14/Feb/2008	1:00 PM	71 27.15	°N	126 26.48	° W	65	Rosette ↓	456	120	25	-24	-1.31	1009.54	77	10
D19	14/Feb/2008	1:25 PM	71 27.15	°N	126 27.63	° W	65	Rosette ↑	453	120	25	-24	-1.31	2009.54	77	10
				□		□										
D20	**15/Feb/2008**	7:10 AM	71 22.47	°N	126 13.7	° W	84	Rosette ↓	460	120	20/25	-25	-1.18	1006.41	78	10
D20	15/Feb/2008	7:40 AM	71 22.56	°N	126 14.27	° W	84	Rosette ↑	460	120	20/25	-25	-1.18	1006.57	78	10
D20	15/Feb/2008	7:00 PM	71 21.52	°N	126 45.27	° W	222.5	Rosette ↓	446	100	10	-23.8	-1.3	1008.6	80	10
D20	15/Feb/2008	7:25 PM	71 21.58'	°N	126 45.66	° W	219	Rosette ↑/Turbulence ↓	447	100	10	-23.9	-1.3	1008.5	80	10
D20	15/Feb/2008	9:40 PM	71 21.88	°N	126 47.48	° W	222	turbulence ↑	436	115	7	-23.1	-1.25	1009.48	80	10
				□		□										
D21	**16/Feb/2008**	7:10 AM	71 17.18	°N	126 37.6	° W	126.4	Rosette deployment								10
D21	16/Feb/2008	7:20 AM	71 17.20	°N	126 37.8	° W	126.4	Rosette ↓	457	120	15	-24.6	-1.3	1017.4	72	10
D21	16/Feb/2008	8:35 AM	71 17.31	°N	126 38.5	° W	127.8	Hydrobios ↓	454	120	17	-24.2	-1.3	1017.9	72	10
D21	16/Feb/2008	9:05 AM	71 17.0	°N	126 38	° W	127.5	Hydrobios finished	454	120	15	-23.7	-1.25	1018.49	72	10
D21	16/Feb/2008	9:10 AM	71 17.00	°N	126 39.01	° W	127.5	1st Tucker ↓	457	120	15	-24	-1.3	1018.5	72	10
D21	16/Feb/2008	9:50 AM	71 17.40	°N	126 39.34	° W	127.5	1st Tucker ↑	457	120	15	-24	-1.3	1018.5	72	10
				□		□										
D22	**17/Feb/2008**	8:25 AM	70 58.18	°N	124 43.36	° W	70	ice coring	49?	130	20/30	-26	-1.18	1018.8	75	10
D22	17/Feb/2008	9:25 AM	70 58.19	°N	124 43.42	° W	70	ice coring complete	49?	130	20/30	-26.1	-1.15	1018.46	75	10
D22	17/Feb/2008	10:40 AM	70 58.69	°N	124 44.87	° W	66	Rosette down	341	125	20/30	-26.3	-1.31	1019.37	77	9/10+
D22	17/Feb/2008	11:30 AM	70 58.91	°N	124 45.49	° W	65	Rosette on deck	367	125	20/30	-26.3	-1.31	1019.37	77	9/10+
D22	17/Feb/2008	7:15 PM	71 12.46	°N	124 13.13	° W	51.6	Rosette ↓	326	135	35	-26.1	-1.33	1015.1	81	9/10+
D22	17/Feb/2008	7:30 PM	71 12.72	°N	124 13.7	° W	51.2	Rosette ↑	323	130	37	-21.5	-1.31	1014.9	82	9/10+

D22	**18/Feb/2008**	7:05 AM	71 17.47	°N	124 25.79	° W	43	Deploy Rosette	257	140	30/35	-18	-1.31	1009.7	84	9/10+
D22	18/Feb/2008	7:10 AM	71 17.47	°N	124 25.92	° W	43	Rosette ↓	257	140	30/35	-18	-1.31	1009.6	84	9/10+
D22	18/Feb/2008	7:20 AM	71 17.56	°N	124 26.06	° W	44	Rosette ↑	260	140	30/35	-18	-1.31	1009.6	84	9/10+
D22	18/Feb/2008	8:38 AM	71 17.92	°N	124 27.23	° W	44	Hydrobios ↓	262	140	30/35	-18	-1.31	1009.6	84	9/10+
D22	18/Feb/2008	8:40 AM	71 17.95	°N	124 27.35	° W	45	Klaus Roger Joanne depart		140	30/35	-18	-1.31	1009.6	84	9/10+
D22	18/Feb/2008	8:55 AM	71 17.95	°N	124 27.35	° W	45	Hydrobios ↑	262	140	30/35	-18	-1.31	1009.08	84	9/10+
D22	18/Feb/2008	9:10 AM	71 18.10	°N	124 27.88	° W	45	Tucker ↓	262	140	30/35	-18	-1.31	1009.08	84	9/10+
D22	18/Feb/2008	9:32 AM	71 18.18	°N	124 28.25	° W	42	Tucker out	263	140	30/35	-18.3	-1.19	1009.11	85	9/10+
D22	18/Feb/2008	9:37 AM	71 18.2	°N	124 28.28	° W	42	Tukcer 2 In	263	140	30/35	-18.2	-1.19	1009.2	85	9/10+
D22	18/Feb/2008	9:55 AM	71 18.3	°N	124 28.67	° W	42	Tucker 2 out	263	140	30/35	-18	-1.19	1009.3	85	9/10+
D22	18/Feb/2008	10:02 AM	71 18.3	°N	124 28.68	° W	42	Tucker 3 in	263	140	30/35	-17.9	-1.19	1008.95	85	9/10+
D22	18/Feb/2008	10:25 AM	71 18.4	°N	124 29.03	° W	42	Tucker out	263	140	30/35	-17.4	-1.19	1008.53	85	9/10+
D22	18/Feb/2008	11:15 AM	71 18.6	°N	124 29.81	° W	41	Cast CTD ↓	261	140	30/35	-17.6	-1.19	1008.3	85	9/10+
D22	18/Feb/2008	11:45 AM	71 18.84	°N	124 30.3	° W	41	CDT ↑	264	140	30/35	-18	-1.8	1.008.05	86	9/10+
D22	18/Feb/2008	11:50 AM	71 18.8	°N	124 30.3	° W	41	Ice core team return	264	140	25/30	-18	-1.8	1008.1	86	9/10+
D22	18/Feb/2008	11:30 AM	71 18.8	°N	124 30.3	° W	41	Deploy Rosette	267	140	25/30	-16	-1.4	1006.8	86	9/10
D22	18/Feb/2008	11:35 AM	71 18.8	°N	124 30.3	° W	41	Rosette ↓	267	140	25/30	-16	-1.4	1006.8	86	9/10
D22	18/Feb/2008	1:05 PM	71 19.0	°N	124 32	° W	41	Rosette ↓	267	140	20/25	-16	-1.4	1006.8	86	9/10
D22	18/Feb/2008	2:10 PM	71 19.0	°N	124 32	° W	41	Depart klaus snow and ice team	267	140	20/25	-16	-1.4	1006.9	86	9/10
D22	18/Feb/2008	2:25 PM	71 19.0	°N	124 32	° W	41	Rosette ↑	267	140	20/25	-16	-1.4	1006.9	86	9/10
D22	18/Feb/2008	2:55 PM	71 19.6	°N	124 32.55	° W	41	start turbulence profiling	267	140	20/25	-16.2	-1.18	1006.82	86	9/10
D22	18/Feb/2008	3:45 PM	71 19.79	°N	124 33.14	° W	41	Roger, Magali, Vernon, Pascale, depart ice core team	267	140	20/25	-16.2	-1.18	1004.8	86	9/10
D22	18/Feb/2008	4:10 PM	71 19.9	°N	124 33.34	° W	41	Turbulence ↑	266	140	26	-15.6	-1.19	1004.5	87	9/10
D22	18/Feb/2008	7:10 PM	71 20.64	°N	124 34.58	° W	52.6	Rosette ↓	261	160	25/30	-15.3	-1.17	1004.3	87	9/10
D22	18/Feb/2008	6:30 PM	71 20.71	°N	124 34.681	° W	54.6	Rosette ↑	260	155	28	-14.7	-1.16	1004.2	88	9/10
D22	18/Feb/2008	10:30 PM	71 21.28	°N	124 35.58	° W	70.8	test CTD	256	145	20	-15.1	-1.17	1004	87	9/10
D22	**19/Feb/2008**	6:55 AM	71 21	°N	124 35	° W	78	Deploy Rosette	251	180	2	-12	-1.25	1006.1	90	9/10
D22	19/Feb/2008	7:00 AM	71 21	°N	124 35	° W	78	Rosette ↓	251	180	2	-12	-1.25	1006.1	90	9/10
D22	19/Feb/2008	7:10 AM	71 21	°N	124 35	° W	78	Rosette ↑	251	180	2	-12	-1.25	1006.1	90	9/10
D22	19/Feb/2008	9:25 AM	71 21	°N	124 35	° W	78	Depart zooplankton	251	Calm	Calm	-12	-1.25	1007.6	91	9/10
D22	19/Feb/2008	9:30 AM	71.21	°N	124.35	° W	77	Weather balloon	251	Calm	Calm	-12	-1.2	1007.8	91	9/10
D22	19/Feb/2008	10:35 AM	71.21	°N	124.35	° W	78	gear relocalisation	244	270	2/3	-11	-1.2	1008.9	90	9/10
				□		□										
D23	**20/Feb/2008**	7:00 AM	71.09.04	°N	124 01.13	° W	121	Rosette ↓	436	110	15/20	-16	-1.1	1012.38	87	9/10+

D23	20/Feb/2008	7:45 AM	71 09.26	°N	124 02.43	° W	122	Rosette ↑	439	120	20/30	-15.6	-1.24	1012.31	87	9/10+
D23	20/Feb/2008	8:30 AM	71 09.6	°N	124 04	° W	120	Tucker ↓	361	120	25/30	-15	-1.24	1012.31	87	9/10+
D23	20/Feb/2008	8:35 AM	71 09.6	°N	124 04	° W	120	ice cage on ice	361	120	25/30	-15	-1.24	1012.31	87	9/10+
D23	20/Feb/2008	8:57 AM	71 09.6	°N	124 04	° W		tucker out	381	120	25/30	-15	-1.24	1012.31	87	9/10+
D23	20/Feb/2008	9:00 AM	71 09.6	°N	124 04	° W		tucker #2 in		120	25/30	-15	-1.24	1012.31	87	9/10+
D23	20/Feb/2008	9:00 AM	71 09.8	°N	124 05.2	° W	122	ice cage on board	381	120	25/30	-15	-1.24	1012.31	87	9/10+
D23	20/Feb/2008	9:26 AM	71 10.06	°N	124 05.88	° W	122	tucker #2 on board	416	120	30/40	-15	-1.24	1012.31	87	9/10+

D24	20/Feb/2008	7:30 PM	71 06.3	°N	124 25.3	° W	33	Rosette ↓	293	120	40	-18.3	-1.43	1006.8	83	9/10+
D24	20/Feb/2008	7:55 PM	71 06.55	°N	124 26.23	° W	31.5	Rosette ↑	291	125	40	-18.3	-1.42	1006.3	82	9/10+

D25	**22/Feb/2008**	7:10 PM	71 24.56	°N	125 31.71	° W	119.4	Rosette ↓	365	145	17	-15.3	-1.2	1007.98	85	9/10
D25	22/Feb/2008	7:30 PM	71 24.63	°N	125 32.04	° W	119.4	Rosette ↑	361	135	20	-15.3	-1.21	1008.2	84	9/10
D25	23/Feb/2008	6:50 AM	71 26.40	°N	125 39.25	° W		Rosette ↓	417	170	5	-17.8	-1.2	1015.02	70	9/10
D25	23/Feb/2008	7:12 AM	71 26.41	°N	125 39.34	° W	123.6	Rosette ↑	417	170	5	-17.8	-1.2	1015.02	70	9/10
D25	23/Feb/2008		71 26.45	°N	125 39.74	° W	123.8	Hydrobios in	419	168	7	-18.6	-1.07	1015.06	71	9/10
D25	23/Feb/2008	8:30 AM	71 26.47	°N	125 39.80	° W	124	Hydrobios in	418	168	7	-18.4	-1.1	1015.85	71	9/10
D25	23/Feb/2008	9:03 AM	71 26.47	°N	125 39.8	° W	124	Hydrobios out	425	168	7	-18.4	-1.1	1015.85	71	9/10
D25	23/Feb/2008	9:15 AM	71 26.5	°N	125 40.16	° W	124	tucker #1 in	426	168	7	-19.2	-1.1	1016.7	76	9/10
D25	23/Feb/2008	9:43 AM	71 26.5	°N	125 40.16	° W	124	tucker #1 out	426	168	7	-19.2	-1.1	1016.7	76	9/10
D25	23/Feb/2008	9:45 AM	71 26.58	°N	125 40.46	° W		tucker #2 in	426	120	5	-19	-1.11	1017.03	77	9/10
D25	23/Feb/2008	10:13 AM	71 26.6	°N	125 40.6	° W		tucker #2 out	426	100	5	-19	-1.11	1017.03	77	9/10

D26	**24/Feb/2008**	7:05 AM	71 00.72	°N	123 52.26	° W		Rosette ↓	325	335	15/20	-21	-1.26	1024.82	82	9/10
D26	24/Feb/2008	7:25 AM	71 00.00	°N	123 52.2	° W		Rosette ↑	327	335	15/20	-21	-1.25	1024.8	82	9/10
D26	24/Feb/2008	8:57 AM	71 00.15	°N	123 53	° W	124	tucker #1 in	334	335	15/20	-20	-1.2	1024.8	82	9/10
D26	24/Feb/2008	9:20 AM	71 00.11	°N	123 52.9	° W	124	tucker #1 out	333	335	15/20	-20.2	-1.05	1025.27	83	9/10
D26	24/Feb/2008	9:20 AM	71 00.1	°N	123 52.9	° W	144	Fence and scan core team leaving								9/10
D26	24/Feb/2008	9:37 AM	71 00.00	°N	123 53.0	° W	124	tucker #2 in	334	335	15/20	-20.2	-1.05	1025.37	83	9/10
D26	24/Feb/2008	9:53 AM	70 59.9	°N	123 53.21	° W	124	tucker #2 out	334	335	15/20	-20.2	-1.05	1025.37	83	9/10
D26	24/Feb/2008	9:56 AM	70 59.9	°N	123 53.21	° W	124	tucker #3 in	334	335	15/20	-20.2	-1.05	1025.3	83	9/10
D26	24/Feb/2008	10:22 AM	70 59.8	°N	123 53.4	° W	134	tucker #3 out	334	335	15/20	-20.2	-1.05	1025.3	83	9/10
D26	24/Feb/2008	10:40 AM	70 59	°N	123 53	° W	185	Hydrobios in	334	335	15/20	-19.4	-1.05	1025.7	82	9/10
D26	24/Feb/2008	11:35 AM	70 59	°N	123 53	° W	200	Fence and scan core team back	338	335	15/20	-18.9	-1.07	1026.03	82	9/10
D26	24/Feb/2008	11:40 AM	70 59	°N	123 53	° W	200	Hydrobios out	338	335	15/20	-18.9	-1.07	1026.07	82	9/10

D26	24/Feb/2008	12:42 PM	70 59.3	°N	123 54.5	° W	200	EM scan completed	344	335	15/20	-18.5	-1.06	1026.15	82	9/10
D26	24/Feb/2008	1:10 PM	70 59	°N	123 54	° W	200	Ice coring team leaving	340	335	15/20	-18.5	-1.06	1026.47	81	9/10
D26	24/Feb/2008	3:30 PM	70 58.82	°N	123 55.14	° W	200	balloon launch	342	335	15/20	-18.2	-1.03	1027.77	81	9/10
D26	24/Feb/2008	3:32 PM	70 58.79	°N	123 55.14	° W	200	EM scan started	343	330	15/20	-18.2	-1.03	1027.77	81	9/10
D26	24/Feb/2008	4:25 PM	70 58.56	°N	123 55.07	° W	200.8	Ice physics on board	353	330	21	-18.8	-1.03	1027.9	82	9/10
D26	24/Feb/2008	4:35 PM	70 58.5	°N	123 55.06	° W	200.8	EM scan complete	353	330	18	-18.6	-1.04	1028.1	82	9/10
D26	24/Feb/2008	5:30 PM	70 58.27	°N	123 54.98	° W	201.2	Coring team on board	354	325	12	-19	-1.03	1028.6	83	9/10
D26	24/Feb/2008	7:00 PM	70 57.9	°N	123 54.78	° W	201.4	Rosette ↓	355	330	12	-19	-1.07	1029.2	83	9/10
D26	24/Feb/2008	7:25 PM	70 57.87	°N	123 54.74	° W	201.3	Rosette ↑	354	325	15	-19.2	-1.08	1029.35	84	9/10
D26	**25/Feb/2008**	6:50 AM	70 56.6	°N	123 55.22	° W	200	Rosette ↓	360	315	12	-20.1	-1.07	1035.04	83	9/10
D26	25/Feb/2008	7:05 AM	70 55.2	°N	123 56.5	° W	200	Rosette ↑	360	315	12	-20.1	-1.07	1035.04	83	9/10
D26	25/Feb/2008	8:08 AM	70 56.3	°N	123 55.0	° W	200	Hydrobios in	355	320	14	-20.2	-1.05	1035.59	75	9/10
D26	25/Feb/2008	8:35 AM	70 56.2	°N	123 55.00	° W	200	Hydrobios out	360	320	14	-20.4	-1.06	1035.59	77	9/10
D26	25/Feb/2008	9:00 AM	70 56.2	°N	123 55.0	° W	201	tucker #1 in	363	320	17	-20.4	-1.05	1036.04	74	9/10
D26	25/Feb/2008	9:20 AM	70 56.1	°N	123 55.0	° W	200.8	tucker #1 out	362			-20.4	-1.04	1036.19	73	9/10
D26	25/Feb/2008	9:27 AM	70 56.1	°N	123 55.0	° W	200	tucker #2 in	363	320	16	-20.4	-1.04	1036.19	73	9/10
D26	25/Feb/2008	9:52 AM	70 56.1	°N	123 55.1	° W	201	tucker #2 out	360	340	13	-20.2	-1.04	1036.52	73	9/10
D26	25/Feb/2008	9:56 AM	70 56.0	°N	123 55.1	° W	200.4	tucker #3 in	360	340	14	-19.8	-1.04	1036.52	72	9/10
D26	25/Feb/2008	10:24 AM	70 56.0	°N	123 55.2	° W	201.2	tucker #3 out	357	340	13	-19.4	-1.03	1037.88	72	9/10
D26	25/Feb/2008	10:40 AM	70 56.0	°N	123 55.3	° W	201	Rosette ↓	358	340	13	-19.4	-1.05	1037	72	9/10
D26	25/Feb/2008	11:14 AM	70 56.0	°N	123 55.5	° W	200	Rosette ↑	360	340	13	-18.9	-1.06	1038.21	70	9/10
D26	25/Feb/2008	12:50 PM	70 55.92	°N	123 56.16	° W	200	Rosette ↓	361	340	13	-18.6	-1.06	1038.12	69	9/10
D26	25/Feb/2008	1:45 PM	70 55.9	°N	123 56.5	° W	200	Rosette ↑	363	342	15	-18.6	-1.06	1038.52	70	9/10
D26	25/Feb/2008	2:00 PM	70 55.86	°N	123 56.86	° W	200	Zoo nets on ice								
D26	25/Feb/2008	2:35 PM	70 55.86	°N	123 56.86	° W	200	work on ice behind ship	363	342	15	-18.6	-1.06	1038.52	70	9/10
D26	25/Feb/2008	2:40 PM	70 55.8	°N	123 57.2	° W	200	CO2 flux team on ice	372	349	13	-18.9	-1.8	1039.14	74	9/10
D26	25/Feb/2008	2:45 PM	70 55.8	°N	123 57.2	° W	200	balloon launch	372	349	13	-18.9	-1.8	1039.14	74	9/10
D26	25/Feb/2008	3:40 PM	70 55.8	°N	123 57.2	° W	200	EM scan started	372	349	13	-18.9	-1.8	1039.14	74	9/10
D26	25/Feb/2008	3:40 PM	70 55.8	°N	123 57.2	° W	200	CO2 flux team back on board	372	349	13	-18.9	-1.8	1039.14	74	9/10
D26	25/Feb/2008	3:40 PM	70 55.8	°N	123 57.2	° W	200	zoo team back on board	372	349	13	-18.9	-1.8	1039.14	74	9/10
D26	25/Feb/2008	3:40 PM	70 55.8	°N	123 57.2	° W	200	Ice core team on ice	372	349	13	-18.9	-1.8	1039.14	74	9/10
D26	25/Feb/2008	4:10 PM	70 55.8	°N	123 57.2	° W	200	Ice core team back	372	349	13	-18.9	-1.8	1039.14	74	9/10
D26	25/Feb/2008	4:50 PM	70 55.69	°N	123 57.54	° W	200	EM scan finish	371	340	10/15	-18.8	-1.8	1039.62	75	9/10
D26	25/Feb/2008	7:00 PM	70 55.46	°N	123 57.83	° W	200	Rosette ↓	378	340	10/15	-19.7	-1.06	1039.87	73	9/10
D26	25/Feb/2008	7:30 PM	70 55.42	°N	123 57.88	° W	200	Rosette ↑	378	340	10/15	-19.6	-1.06	1039.8	73	9/10

D26	**26/Feb/2008**	6:45 AM	70 55.35	°N	123 59.01	° W	200	Rosette ↓	384	330	10	-22	-1.06	1039.07	74	9/10+
D26	26/Feb/2008	7:05 AM	70 55.34	°N	123 58.99	° W	200	Rosette ↑	384	330	7	-22	-1.06	1038.9	75	9/10+
D26	26/Feb/2008	8:00 AM	70 55.34	°N	123 58.95	° W	201	Rosette ↓	384	333	7	-22.1	-1.07	1038.6	77	9/10+
D26	26/Feb/2008	8:20 AM	70 55.33	°N	123 58.95	° W	201	Rosette ↑	384	337	8	-22.2	-1.07	1038.5	78	9/10+
D26	26/Feb/2008	8:30 AM	70 55.33	°N	123 58.95	° W	201	tucker in	384	340	9	-22.4	-1.08	1038.4	79	9/10+
D26	26/Feb/2008	9:00 AM	70 55.33	°N	123 58.95	° W	201	tucker out	384	345	9	-22.5	-1.07	1038.2	80	9/10+
D26	26/Feb/2008	9:10 AM	70 55.32	°N	123 58.94	° W	201	Rosette ↓	384	360	8	-22.5	-1.07	1038.2	80	9/10+
D26	26/Feb/2008	9:30 AM	70 55.32	°N	123 58.94	° W	201	Rosette ↑	384	26	4	-21.5	-1.08	1038.2	82	9/10+
D26	26/Feb/2008	9:35 AM	70 55.32	°N	123 58.94	° W	201	Tucker in / physics team on ice / EM scan start	384	80	3	-21.5	-1.09	1038.15	83	9/10+
D26	26/Feb/2008	10:05 AM	70 55.33	°N	123 58.95	° W	201	tucker out	384	124	6	-22.3	-1.08	1037.8	81	9/10+
D26	26/Feb/2008	10:10 AM	70 55.33	°N	123 58.95	° W	201	Rosette ↓	384	124	8	-22.2	-1.07	1037.8	81	9/10+
D26	26/Feb/2008	10:34 AM	70 55.33	°N	123 58.95	° W	201	Rosette ↑ / zoo team on ice	384	124	8	-22.2	-1.07	1037.8	81	9/10+
D26	26/Feb/2008	10:55 AM	70 55.34	°N	123 59.00	° W	201	EM scan completed / physics team on board	384	120	8	-22.4	-1.07	1037.6	79	9/10+
D26	26/Feb/2008	11:00 AM	70 55.34	°N	123 59.00	° W	201	Weather balloon tether start	384	120	8	-22.4	-1.07	1037.6	79	9/10+
D26	26/Feb/2008	11:15 AM	70 55.34	°N	123 59.00	° W	201	Rosette in	385	120	9	-22.5	-1.06	1037.4	79	9/10+
D26	26/Feb/2008	11:30 AM	70 55.34	°N	123 59.00	° W	201	Rosette out	385	130	7	-22.6	-1.05	1037.3	79	9/10+
D26	26/Feb/2008	11:45 AM	70 55.35	°N	123 59.07	° W	201	Zoo team back on board	386	125	5	-22.4	-1.05	1037.3	79	9/10+
D26	26/Feb/2008	12:30 PM	70 55.36	°N	123 59.14	° W	201	Rosette in	386	110	6	-22.3	-1.06	1037.13	78	9/10+
D26	26/Feb/2008	12:50 PM	70 55.36	°N	123 59.17	° W	201	Rosette out	384	110	6	-22.4	-1.07	1037	77	9/10+
D26	26/Feb/2008	1:14 PM	70 55.37	°N	123 59.2	° W	201	Rosette in	385	110	5	-22.3	-1.07	1036.7	76	9/10+
D26	26/Feb/2008	1:35 PM	70 55.38	°N	123 59.23	° W	201	Rosette out	385	105	5	-22.1	-1.06	1036.7	76	9/10+
D26	26/Feb/2008	2:15 PM	70 55.38	°N	123 59.27	° W	201	Rosette in	386	114	4	-21.9	-1.05	1036.5	76	9/10+
D26	26/Feb/2008	2:35 PM	70 55.38	°N	123 59.29	° W	201	Rosette out	386	110	4	-22	-1.06	1036.4	76	9/10+
D26	26/Feb/2008	3:00 PM	70 55.38	°N	123 59.30	° W	201	physics team on ice	386	calme	calme	-21.7	-1.07	1036.2	74	9/10+
D26	26/Feb/2008	3:15 PM	70 55.38	°N	123 59.30	° W	201	Rosette in / balloon launch	386	calme	calme	-21.7	-1.07	1036.2	74	9/10+
D26	26/Feb/2008	3:25 PM	70 55.38	°N	123 59.30	° W	200	sampling team ? On ice / EM scan start	386	calme	calme	-21.6	-1.07	1036.1	74	9/10+
D26	26/Feb/2008	3:30 PM	70 55.38	°N	123 59.30	° W	200	Rosette out	386	calme	calme	-21.6	-1.07	1036.1	74	9/10+
D26	26/Feb/2008	4:15 PM	70 55.36	°N	123 59.30	° W	200	Rosette in	386	calme	calme	-21.8	-1.06	1035.9	76	9/10+
D26	26/Feb/2008	4:30 PM	70 55.36	°N	123 59.29	° W	200	Rosette out	386	calme	calme	-21.8	-1.08	1035.9	74	9/10
D26	26/Feb/2008	4:40 PM	70 55.36	°N	123 59.29	° W	200	EM scan finish	386	calme	calme	-21.8	-1.08	1035.9	74	9/10
D26	26/Feb/2008	5:00 PM	70 55.36	°N	123 59.28	° W	200	Rosette in	386	calme	calme	-21.8	-1.08	1035.9	74	9/10
D26	26/Feb/2008	5:20 PM	70 55.35	°N	123 59.26	° W	200	Rosette out	386	calme	calme	-21.8	-1.08	1035.9	74	9/10
D26	26/Feb/2008	5:35 PM	70 55.35	°N	123 59.26	° W	200	Near ice edge sampling / CO2	386	calme	calme	-21.8	-1.08	1035.9	74	9/10
D26	26/Feb/2008	6:02 PM	70 55.34	°N	123 59.20	° W	200	Rosette in	385	calme	calme	-21.8	-1.08	1034.44	79	9/10

D26	26/Feb/2008	6:20 PM	70 55.34	°N	123 59.16	° W	200	Rosette out	385	calme	calme	-22.8	-1.1	1033.95	81	9/10
D26	26/Feb/2008	7:05 PM	70 55.33	°N	123 59.13	° W	200	Rosette in	386	calme	calme	-22.7	-1.09	1033.79	81	9/10
D26	26/Feb/2008	7:20 PM	70 55.33	°N	123 59.10	° W	200	Rosette out	386	calme	calme	-22.7	-1.09	1033.79	81	9/10
D26	26/Feb/2008	8:02 PM	70 55.33	°N	123 59.05	° W	200	Rosette in	386	calme	calme	-22.6	-1.09	1032.84	81	9/10
D26	26/Feb/2008	8:25 PM	70 55.33	°N	123 59.05	° W	200	Rosette out	386	calme	calme	-22.5	-1.09	1032.84	81	9/10
D26	**27/Feb/2008**	6:50 AM	70 55.3	°N	123 58.8	° W	200	Rosette in	383	280	8	-24.8	-1.06	1026.7	79	9/10+
D26	27/Feb/2008	7:10 AM	70 55.3	°N	123 58.8	° W	200	Rosette out	383	275	7	-24.8	-1.04	1026.6	78	9/10+
D26	27/Feb/2008	8:30 AM	70 55.3	°N	123 58.5	° W	200	hydrobios in	384	290	9	-24.8	-1.06	1026	78	9/10+
D26	27/Feb/2008	9:00 AM	70 55.3	°N	123 58.3	° W	200	hydrobios out	381	275	8	-24.9	-1.04	1025.6	79	9/10+
D26	27/Feb/2008	9:15 AM	70 55.3	°N	123 58.3	° W	200	tucker #1 in	383	270	9	-24.8	-1.05	1025.5	79	9/10+
D26	27/Feb/2008	9:30 AM	70 55.3	°N	123 58.16	° W	200	EM scan started / physics team on ice	381	270	8	-24.8	-1.06	1025.3	79	9/10+
D26	27/Feb/2008	9:45 AM	70 55.3	°N	123 58.12	° W	200	tucker #1 out / tucker #2 in	381	273	8	-24.7	-1.06	1025.2	79	9/10+
D26	27/Feb/2008	10:20 AM	70 55.25	°N	123 57.95	° W	200	tucker #2 out / tucker #3 in	380	260	8	-24.9	-1.07	1024.8	79	9/10+
D26	27/Feb/2008	10:30 AM	70 55.25	°N	123 57.95	° W	200	physics team back on board	380	260	8	-24.9	-1.07	1024.8	79	9/10+
D26	27/Feb/2008	10:50 AM	70 55.25	°N	123 57.8	° W	200	tucker #3 out	380	260	7	-24.6	-1.06	1024.7	79	9/10+
D26	27/Feb/2008	10:55 AM	70 55.25	°N	123 57.8	° W	200	EM scan finish	380	260	7	-24.6	-1.06	1024.7	79	9/10+
D26	27/Feb/2008	1:00 PM	70 55.27	°N	123 57.07	° W	201	Weather balloon team on ice	377	265	7	-23.8	-1.07	1023.8	79	9/10+
D26	27/Feb/2008	1:26 PM	70 55.27	°N	123 56.97	° W	201	Weather balloon tether	377	275	9	-23.7	-1.07	1023.8	79	9/10+
D26	27/Feb/2008	2:10 PM	70 55.28	°N	123 56.75	° W	200	zoo team on ice	377	265	11	-23.4	-1.08	1023.6	79	9/10+
D26	27/Feb/2008	3:15 PM	70 55.28	°N	123 56.35	° W	200	CO2 team on ice / zoo on board	374	255	10	-23.1	-1.05	1023.2	78	9/10+
D26	27/Feb/2008	3:30 PM	70 55.28	°N	123 56.25	° W	200	EM scan started / physics team on ice	375	250	10	-22.9	-1.04	1022.9	77	9/10+
D26	27/Feb/2008	4:20 PM	70 55.27	°N	123 55.95	° W	200	physics team on board	375	260	10	-23	-1.04	1022.5	77	9/10+
D26	27/Feb/2008	4:40 PM	70 55.30	°N	123 56.00	° W	200	EM scan finish	375	260	10	-23	-1.04	1022.5	77	9/10+
D26	27/Feb/2008	6:55 PM	70 55.20	°N	123 54.82	° W	200	Rosette in	374	250	10	-23	-1.04	1021.08	79	9/10+
D26	27/Feb/2008	7:15 PM	70 55.20	°N	123 54.82	° W	200	Rosette out	374	250	10	-23	-1.04	1021.25	79	9/10
D26	**28/Feb/2008**	7:00 AM	70 55.76	°N	123 51.35	° W	198	Rosette in	370	230	9	-24.9	-1.09	1014.4	79	9/10+
D26	28/Feb/2008	7:30 AM	70 55.76	°N	123 51.29	° W	198	Rosette out	369	225	10	-24.9	-1.06	1014.06	79	9/10+
D26	28/Feb/2008	8:30 AM	70 55.79	°N	123 51.10	° W	198	tucker #1 in	365	220	9	-24.6	-1.06	1013	79	9/10+
D26	28/Feb/2008	9:00 AM	70 55.8	°N	123 51.03	° W	198	tucker #1 out / tucker #2 in	366	220	8	-24.5	-1.06	1012.6	79	9/10+
D26	28/Feb/2008	9:30 AM	70 55.8	°N	123 50.9	° W	198	EM scan start / physics team on ice / tucker #2 out / tucker #3 in	368	225	10	-24.4	-1.06	1012.14	79	9/10+
D26	28/Feb/2008	10:00 AM	70 55.8	°N	123 50.8	° W	198	tucker #3 out	370	235	9	-24.3	-1.02	1011.7	79	9/10+
D26	28/Feb/2008	10:25 AM	70 55.8	°N	123 50.79	° W	198	physics team on board	371	230	9	-24	-1	1011.3	79	9/10+
D26	28/Feb/2008	10:55 AM	70 55.8	°N	123 50.7	° W	198	EM scan finish	368	230	9	-23.8	-1.03	1011.14	79	9/10+

D26	28/Feb/2008	2:00 PM	70 55.8	°N	123 50.3	° W	198	zoo team on ice	369	235	8	-22	-1.04	1008.75	80	9/10+
D26	28/Feb/2008	2:30 PM	70 55.8	°N	123 50.3	° W	197	frost flowers & CO2	369	235	8	-22	-1.04	1008.75	80	9/10+
D26	28/Feb/2008	3:25 PM	70 55.8	°N	123 50.3	° W	197	zoo team back on board	369	235	8	-22	-1.04	1008.75	80	9/10+
D26	28/Feb/2008	3:30 PM	70 55.8	°N	123 50.3	° W	197	EM Scan and physics team on ice	369	235	8	-22	-1.04	1008.75	80	9/10+
D26	28/Feb/2008	4:50 PM	70 55.8	°N	123 50.3	° W	197	EM Scan completed	369	235	8	-22	-1.04	1008.75	80	9/10+
D26	28/Feb/2008	7:00 PM	70 55.23	°N	123 48.97	° W	197	Rosette in	373	310	5/10	-23.2	-1.04	1008.15	78	9/10+
D26	28/Feb/2008	7:20 PM	70 55.23	°N	123 48.97	° W	197	Rosette out	373	310	5/10	-23	-1.04	1008.15	78	9/10+
D26	**29/Feb/2008**	6:50 AM	70 51.72	°N	123 41.91	° W	198	Rosette in	412	286	21	-32.2	-1.09	1014	71	9/10+
D26	29/Feb/2008	7:10 AM	70 51.64	°N	123 41.54	° W	198	Rosette out	411	290	22	-32.1	-1.09	1014.15	71	9/10+
D26	29/Feb/2008	8:55 AM	70 51.29	°N	123 39.92	° W	198	Tucker #1 in	417	290	20	-32.3	-1.12	1015.12	70	9/10+
D26	29/Feb/2008	9:25 AM	70 51.20	°N	123 39.5	° W	198	tucker #1 out / tucker #2 in	418	290	18	-32.3	-1.07	1015.35	70	9/10+
D26	29/Feb/2008	9:30 AM	70 51.15	°N	123 39.92	° W	198	balloon launch	420	290	16	-32.4	-1.09	1015.6	70	9/10+
D26	29/Feb/2008	10:00 AM	70 51.10	°N	123 39.92	° W	198	tucker #2 out / tucker #3 in	423	280	17	-32.2	-1.12	1015.7	70	9/10+
D26	29/Feb/2008	10:40 AM	70 51.00	°N	123 39.92	° W	198	tucker #3 out	431	280	15	-31.7	-1.13	1016.2	70	9/10+
D26	29/Feb/2008	10:55 AM	70 50.97	°N	123 39.92	° W	198	hydrobios in	431	280	16	-31.6	-1.11	1016.3	70	9/10+
D26	29/Feb/2008	11:25 AM	70 50.90	°N	123 39.92	° W	198	hydrobios out	432	280	15	-31.5	-1.1	1016.4	70	9/10+
D26	29/Feb/2008	1:05 PM	70 50.73	°N	123 39.92	° W	198	Rosette in	442	270	13	-30.4	-1.14	1017.7	69	9/10+
D26	29/Feb/2008	2:00 PM	70 50.67	°N	123 39.92	° W	198	Rosette out	444	275	12	-30.1	-1.12	1018.2	69	9/10+
D26	29/Feb/2008	3:30 PM	70 50.57	°N	123 39.92	° W	199	EM scan start / CO2 sampling on ice	448	270	10	-29	-1.14	1018.7	70	9/10+
D26	29/Feb/2008	3:40 PM	70 50.57	°N	123 39.92	° W	199	Physics team & cont on ice	448	270	10	-29	-1.14	1018.7	70	9/10+
D26	29/Feb/2008	5:00 PM	70 50.54	°N	123 39.92	° W	200	EM scan finished	551	270	10	-29	-1.14	1018.7	70	9/10+
D26	29/Feb/2008	7:00 PM	70 50.55	°N	123 35.13	° W	200	Rosette in	452	260	5/10	-28.1	-1.04	1020.39	74	9/10+
D26	29/Feb/2008	7:30 PM	70 50.55	°N	123 35.13	° W	200	Rosette out	452	260	5/10	-28.1	-1.04	1020.39	74	9/10+
D26	**1/Mar/2008**	6:00 AM	70 50.4	°N	123 36	° W	196	hydrobios in	450	320	10/15	-27.8	-1.08	1023.9	75	9/10+
D26	1/Mar/2008	6:40 AM	70 50.37	°N	123 35.9	° W	196	hydrobios out	451	315	10	-27.8	-1.07	1023.8	75	9/10+
D26	1/Mar/2008	6:55 AM	70 50.35	°N	123 35.8	° W	196	Rosette in	451	317	13	-27.7	-1.08	1023.7	75	9/10+
D26	1/Mar/2008	7:30 AM	70 50.28	°N	123 35.7	° W	196	Rosette out	451	320	14	-27.5	-1.11	1023.6	75	9/10+
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D27	1/Mar/2008	11:50 AM	70 46.7	°N	123 31.94	° W	284	EM Scan start	541	280	13	-27.2	-1.46	1025.21	74	9/10+
D27	1/Mar/2008	12:45 PM	70 46.27	°N	123 31.03	° W	181	EM Scan start	-	290	14	-25.8	-2.38	1025.08	74	9/10+
D27	1/Mar/2008	12:55 PM	70 46.26	°N	123 30.97	° W	181	Contaminant team in cage	-	295	13	-25.9	-2.4	1025.19	73	9/10+
D27	1/Mar/2008	1:40 PM	70 46.24	°N	123 30.6	° W	181	Contaminant team back on board	-	295	15	-26.3	-1.4	1025.66	72	9/10+
D27	1/Mar/2008	1:55 PM	70 46.2	°N	123 30.5	° W	181	Physics and CO2 team in cage	-	295	17	-26.3	-1.37	1025.7	72	9/10+
D27	1/Mar/2008	3:20 PM	70 46.2	°N	123 29.8	° W	180	physics and CO2 team on board	-	290	18	-26.4	-1.3	1025.8	71	9/10+
D27	1/Mar/2008	6:00 PM	70 45.6	°N	123 27.52	° W	238	Rosette in	-	290	15/20	-28.5	-1.3	1025.55	74	9/10+

D27	1/Mar/2008	7:00 PM	70 45.65	°N	123 26.62	° W	238	Rosette out	±550	290	15/20	-28.5	-1.3	1025.55	74	9/10
D27	1/Mar/2008	9:00 PM	70 45.68	°N	123 24.19	° W	238	Rosette in	±550	258	20/25	-29.1	-1.62	1025.19	74	9/10
D27	1/Mar/2008	9:20 PM	70 45.66	°N	123 23.23	° W	238	Rosette out	±550	260	20/25	-29.2	-1.62	1025.3	74	9/10
D27	1/Mar/2008	10:10 PM	70 45.65	°N	123 22.62	° W	238	Rosette in	±550	260	20/25	-29.5	-1.58	1024.9	73	9/10
D27	1/Mar/2008	10:30 PM	70 45.65	°N	123 22.62	° W	238	Rosette out	±550	260	20/25	-30	-1.58	1025	73	9/10
D27	1/Mar/2008	11:00 PM	70 45.65	°N	123 21.41	° W	238	Rosette in	±550	260	20/25	-30	-1.58	1025	73	9/10
D27	1/Mar/2008	11:20 PM	70 45.64	°N	123 20.92	° W	238	Rosette out	±550	260	20/25	-30	-1.02	1024.9	73	9/10+
D27	1/Mar/2008	11:55 PM	70 45.64	°N	123 20.92	° W		Rosette in	±550	260	20/25	-30	-1.02	1024.9	73	9/10+
D27	**2/Mar/2008**	12:20 AM	70 45.7	°N	123 19.80	° W	238	Rosette out	±550	260	20/25	-30	-1.02	1024.68	73	9/10
D27	2/Mar/2008	1:00 AM	70 45.71	°N	123 18.55	° W	238	Rosette in	±550	260	20/25	-30	-1.03	1024.66	73	9/10
D27	2/Mar/2008	1:20 AM	70 45.72	°N	123 18.11	° W	238	Rosette out	±550	260	20/25	-29.8	-1.46	1024.6	73	9/10
D27	2/Mar/2008	2:00 AM	70 45.82	°N	123 17.24	° W	238	Rosette in	540	260	20/25	-29.8	-1.4	1024.42	73	9/10
D27	2/Mar/2008	2:20 AM	70 45.82	°N	123 17.24	° W	238	Rosette out	540	260	20/25	-29.8	-1.4	1024.42	73	9/10
D27	2/Mar/2008	3:00 AM	70 46.00	°N	123 15.43	° W	238	Rosette in	360	240	20/25	-29.8	-1.4	1024.88	73	9/10+
D27	2/Mar/2008	3:15 AM	70 46.00	°N	123 15.43	° W	238	Rosette out	-	240	20/25	-29.8	-1.4	1024.88	73	9/10+
D27	2/Mar/2008	4:00 AM	70 46.12	°N	123 14.3	° W	238	Rosette in	-	240	21	-29.1	-1.35	1023.8	73	9/10+
D27	2/Mar/2008	4:18 AM	70 46.16	°N	123 13.96	° W	238	Rosette out	-	240	21	-29	-1.34	1023.7	73	9/10+
D27	2/Mar/2008	5:00 AM	70 46.29	°N	123 12.86	° W	238	Rosette in	-	245	25	-28.7	-1.31	1023.4	74	9/10+
D27	2/Mar/2008	5:30 AM	70 46.39	°N	123 12.27	° W	239	Rosette out	-	245	26	-28.4	-1.31	1023.16	74	9/10+
D27	2/Mar/2008	6:00 AM	70 46.47	°N	123 11.49	° W	239	Rosette in	-	250	27	-28.2	-1.27	1022.9	74	9/10+
D27	2/Mar/2008	6:25 AM	70 46.55	°N	123 10.9	° W	239	Rosette out	-	250	25	-28.2	-1.26	1022.7	74	9/10+
D27	2/Mar/2008	7:00 AM	70 46.68	°N	123 09.94	° W	239	Rosette in	-	255	25	-28.3	-1.23	1022.8	73	9/10+
D27	2/Mar/2008	7:40 AM	70 46.8	°N	123 09.03	° W	239	Rosette out	-	255	24	-28.2	-1.22	1022.8	73	9/10+
D27	2/Mar/2008	8:05 AM	70 46.88	°N	123 08.4	° W	239	Hydrobios in	-	255	21	-27.8	-1.2	1022.7	73	9/10+
D27	2/Mar/2008	8:40 AM	70 47.00	°N	123 07.5	° W	239	Hydrobios out	-	260	21	-27.5	-1.19	1022.7	74	9/10
D27	2/Mar/2008	9:00 AM	70 47.07	°N	123 06.99	° W	239	tucker #1 in	-	250	21	-27.2	-1.19	1022.6	74	9/10
D27	2/Mar/2008	9:30 AM	70 47.18	°N	123 06.16	° W	239	tucker #1 out / tucker #2 in	-	250	22	-27.2	-1.18	1022.2	74	9/10
D27	2/Mar/2008	10:05 AM	70 47.3	°N	123 05.2	° W	239	tucker #2 out / tucker #3 in	-	245	20	-27.3	-1.15	1022.3	74	9/10
D27	2/Mar/2008	10:35 AM	70 47.37	°N	123 04.61	° W	239	tucker #3 out	-	250	21	-27.3	-1.14	1022.3	74	9/10
D27	2/Mar/2008	10:50 AM	70 47.46	°N	123 03.9	° W	239	Rosette in	~370	248	20	-27.1	-1.12	1021.9	74	9/10
D27	2/Mar/2008	11:30 AM	70 47.55	°N	123 03.29	° W	239	Rosette out	-	245	22	-27.1	-1.13	1021.7	73	9/10
D27	2/Mar/2008	1:10 PM	70 47.89	°N	123 00.85	° W	239	physics & cont on ice	-	240	23	-26.2	-1.08	1021.3	74	9/10
D27	2/Mar/2008	2:10 PM	70 48.04	°N	122 59.67	° W	239	physics & cont back on board	-	240	21	-26.5	-1.06	1020.8	74	9/10
D27	2/Mar/2008	7:04 PM	70 48.65	°N	122 54.94	° W	240	Rosette in	-	240	15/20	-25.4	-1.01	1019.4	76	9/10
D27	2/Mar/2008	7:28 PM	70 48.65	°N	122 54.94	° W	240	Rosette out	-	240	15/20	-25.4	-1.01	1019.02	76	9/10+

D27	**3/Mar/2008**	6:55 AM	70 48.87	°N	122 53.51	° W	240	Rosette inr	-	290	14	-25.9	-1.04	1017.1	75	9/10+
D27	3/Mar/2008	7:15 AM	70 48.87	°N	122 53.51	° W	240	Rosette out	-	295	14	-25.7	-1.04	1017.09	76	9/10+
D27	3/Mar/2008	8:45 AM	70 48.87	°N	122 53.5	° W	240	Hydrobios in	~352	300	10	-25.5	-1.04	1017.59	76	9/10+
D27	3/Mar/2008	9:10 AM	70 48.87	°N	122 53.5	° W	240	Hydrobios out	340	300	10	-25.5	-1.04	1017.59	76	9/10+
D27	3/Mar/2008	9:20 AM	70 48.87	°N	122 53.5	° W	240	tucker #1 in	340	315	10	-25.5	-1.04	1017.59	76	9/10+
D27	3/Mar/2008	9:56 AM	70 48.87	°N	122 53.5	° W	240	tucker #1 out	340	315	10	-25.5	-1.04	1017.59	76	9/10+
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D28	3/Mar/2008	12:55 PM	70 56.58	°N	122 52.89	° W	310	EM Scan start	-	70	5/8	-23.2	-1.43	1018.45	77	7/10+
D28	3/Mar/2008	1:45 PM	70 56.58	°N	122 52.9	° W	310	Ice surface water ice cage	-	80	9	-22.5	-1.3	1018.6	75	7/10+
D28	3/Mar/2008	2:15 PM	70 56.58	°N	122 52.93	° W	310	Ice surface water back on board	286	85	11	-23.5	-1.26	1018.9	76	7/10+
D28	3/Mar/2008	2:35 PM	70 56.57	°N	122 52.94	° W	312	Cont. Team in ice cage	287	85	10	-24.6	-1.26	1019.08	76	7/10+
D28	3/Mar/2008	3:04 PM	70 56.57	°N	122 52.94	° W	312	Cont. Team back on board								
D28	3/Mar/2008	3:30 PM	70 56.51	°N	122 52.88	° W	121	surface water sampling (fred&BA) on ice								
D28	3/Mar/2008	3:42 PM	70 56.51	°N	122 52.88	° W	121	surface water sampling back on board								
D28	3/Mar/2008	3:55 PM	70 56.5	°N	122 53.08	° W	152	surface water sampling (Johanne) on ice	295	80	12	-27.2	-1.36	1019.6	76	7/10+
D28	3/Mar/2008	4:10 PM	70 56.5	°N	122 53.09	° W	140	surface water sampling back on board	290	80	12	-27.2	-1.36	1019.6	76	7/10+
D28	3/Mar/2008	4:45 PM	70 57.8	°N	122 54.03	° W	10	balloon launched	290	80	12	-27.5	-1.4	1019.6	76	7/10+
D28	**4/Mar/2008**	10:00 AM	70 59.8	°N	122 59.67	° W	41	Brent & Fred in ice cage	187	85	20	-32	-1.36	1029.65	67	9/10+
D28	4/Mar/2008	10:00 AM	70 59.8	°N	122 57.67	° W	41	EM Scan start	187	85	20	-32	-1.36	1029.65	67	9/10+
D28	4/Mar/2008	10:45 AM	70 59.8	°N	122 00.25	° W	41	EM Scan stop								
D28	4/Mar/2008	11:35 AM		°N		° W		Brent & Fred back in board								

D29	4/Mar/2008	4:00 PM	70 57.94	°N	123 10.77	° W	150	physics team on ice	242	87	24	-30	-1.29	1030.03	72	9/10+
D29	4/Mar/2008	4:45 PM	70 57.94	°N	123 10.77	° W	150	EM Scan fence finish	242	87	24	-30	-1.29	1030.03	72	9/10+
D29	4/Mar/2008	7:00 PM	70 58.34	°N	123 12.42	° W	150	Rosette in	250	90	25	-33	-1.1	1028		9/10+
D29	**5/Mar/2008**	6:10 AM	71 00.8	°N	123 23.3	° W	157	Hydrobios in	249	90	40	-26.9	-1.34	1021.4	75	9/10+
D29	5/Mar/2008	6:40 AM	71 00.98	°N	123 23.75	° W	157	Hydrobios out	248	90	35	-26.7	-1.34	1020.9	74	9/10+
D29	5/Mar/2008	6:50 AM	71 01.06	°N	123 23.9	° W	157	Rosette in	247	90	34	-26.8	-1.33	1020.6	74	9/10+
D29	5/Mar/2008	7:10 AM	71 01.18	°N	123 24.1	° W	157	Rosette out	248	90	38	-26.9	-1.34	1020.5	75	9/10+
D29	5/Mar/2008	8:25 AM	71 01.75	°N	123 25.25	° W	157	tucker #1 in	246	95	30	-26.6	-1.34	1019.4	73	9/10+
D29	5/Mar/2008	8:55 AM	71 02.00	°N	123 25.67	° W	157	tucker #1 out / tucker #2 in	241	95	37	-26.4	-1.33	1018.7	73	9/10+
D29	5/Mar/2008	9:25 AM	71 02.19	°N	123 25.93	° W	157	tucker #2 out / tucker #3 in	240	100	35	-25.9	-1.32	1018.2	72	9/10+
D29	5/Mar/2008	9:45 AM	71 02.36	°N	123 26.142	° W	157	tucker #3 out	247	100	34	-25.8	-1.31	1017.9	70	9/10+
D29	5/Mar/2008	10:10 AM	71 02.52	°N	123 26.34	° W	157	hydrobios in	249	100	34	-25.6	-1.31	1017.9	71	9/10+

D29	5/Mar/2008	10:35 AM	71 02.67	°N	123 26.50	° W	157	dydrobios out	245	95	33	-25.2	-1.31	1017.4	70	9/10+
D29	5/Mar/2008	1:00 PM	71 03.40	°N	123 27.04	° W	157	rosette in	258	105	31	-23.6	-1.21	1015.8	77	9/10+
D29	5/Mar/2008	1:20 PM	71 03.48	°N	123 27.07	° W	157	rosette out	260	100	25	-23.2	-1.22	1015.9	78	9/10+
D29	5/Mar/2008	2:00 PM	71 03.61	°N	123 27.11	° W	157	hydrobios in	261	110	30	-21.6	-1.23	1015.15	79	9/10+
D29	5/Mar/2008	2:25 PM	71 03.67	°N	123 27.11	° W	157	hydrobios out	260	100	28	-21.4	-1.2	1015.4	79	9/10+
D29	5/Mar/2008	3:30 PM	71 03.81	°N	123 27.08	° W	157	EM Scan start	259	105	23	-20.4	-1.18	1014.5	79	9/10+
D29	5/Mar/2008	3:40 PM	71 03.81	°N	123 27.08	° W	157	physics team on ice	259	105	23	-20.4	-1.18	1014.5	79	9/10+
D29	5/Mar/2008	5:10 PM	71 03.92	°N	123 27.02	° W	157	EM Scan finish	271	101	25	-20	-1.02	1013.32	80	9/10+
D29	5/Mar/2008	6:05 PM	71 03.94	°N	123 27.00	° W	157	hydrobios in	267	104	25	-19.4	-1.12	1012.13	81	9/10+
D29	5/Mar/2008	6:35 PM	71 03.95	°N	123 27.01	° W	157	hydrobios out	267	104	25	-19.4	-1.12	1012.13	81	9/10+
D29	5/Mar/2008	7:05 PM	71 03.96	°N	123 27.03	° W	157	Rosette in	270	109	18	-19.7	-1.13	1011.82	81	9/10+
D29	5/Mar/2008	7:35 PM	71 03.96	°N	123 27.03	° W	157	Rosette out	275	110	19	-19.7	-1.13	1011.14	82	9/10+
D29	5/Mar/2008	9:56 PM	71 04.02	°N	123 27.13	° W	158	hydrobios in	245	120	20	-17.5	-1.08	1009.51	82	9/10+
D29	5/Mar/2008	7:50 PM	71 04.00	°N	123 27.03	° W	158	balloon launched	245	120	20	-17.5	-1.08	1009.5	82	9/10+
D29	5/Mar/2008	10:23 PM	71 04.08	°N	123 27.13	° W	158	hydrobios out	242	120	20	-17.4	-1.08	1009.5	82	9/10+
D29	5/Mar/2008	10:55 PM	71 04.13	°N	123 27.11	° W	158	Rosette in	242	120	20	-17.4	-1.08	1009.05	82	9/10+
D29	5/Mar/2008	11:15 PM	71 04.16	°N	123 27.07	° W	158	Rosette out	242	120	20	-17.4	-1.08	1008.41	82	9/10+
D29	**6/Mar/2008**	2:00 AM	71 04.3	°N	123 27.01	° W	158	hydrobios in	236	116	20	-16.5	-1.13	1006.12	82	9/10+
D29	6/Mar/2008	2:20 AM	71 04.29	°N	123 27.02	° W	155	hydrobios out	236	113	20	-18.1	-1.19	1005.77	84	9/10+
D29	6/Mar/2008	7:00 AM	71 05.13	°N	123 29.90	° W	162	Rosette in	239	110	34	-16.4	-1.32	1001.3	85	9/10+
D29	6/Mar/2008	7:20 AM	71 05.24	°N	123 30.21	° W	162	Rosette out	233	115	35	-15	-1.34	998.13	86	9/10+
D29	6/Mar/2008	9:35 AM	71 05.75	°N	123 31.69	° W	162	EM Scan start; physics team on ice	240	115	28	-14.5	-1.3	997.18	87	9/10+
D29	6/Mar/2008	11:05 AM	71 06.02	°N	123 32.32	° W	162	EM Scan complete; physics team on board	257	115	21	-16	-1.2	997.3	86	9/10+
D29	6/Mar/2008	1:40 PM	71 06.05	°N	123 32.38	° W	162	Zoo on ice / ?	252	115	14	-15.6	-1.14	996.5	86	9/10+
D29	6/Mar/2008	6:30 PM	71 05.14	°N	123 32.40	° W	161	Balloon launched	249	330	20/25	-19.7	-1.22	1001.24	83	9/10+
D29	6/Mar/2008	7:00 PM	71 05.00	°N	123 32.39	° W	161	Rosette in	250	330	20/25	-19.7	-1.22	1001.24	83	9/10+
D29	6/Mar/2008	7:25 PM	71 05.02	°N	123 32.37	° W	161	Rosette out	250	330	20/25	-19.7	-1.22	1001.24	83	9/10+
D29	**7/Mar/2008**	7:00 AM	71 01.40	°N	123 29.67	° W	150	Rosette in	250	295	15	-25.4	-1.31	1013.14	78	9/10+
D29	7/Mar/2008	7:30 AM	71 01.36	°N	123 29.37	° W	150	Rosette out	250	300	15	-25	-1.31	1013.07	79	9/10+
D29	7/Mar/2008	8:30 AM	71 01.32	°N	123 29.20	° W	150	hydrobios in	269	305	14	-24.8	-1.31	1013	77	9/10+
D29	7/Mar/2008	8:55 AM	71 01.28	°N	123 29.08	° W	150	hydrobios out	265	295	13	-25.8	-1.29	1013.15	77	9/10+
D29	7/Mar/2008	9:10 AM	71 01.25	°N	123 29.02	° W	150	tucker #1 in	262	295	12	-26.4	-1.29	1013.12	77	9/10+
D29	7/Mar/2008	9:35 AM	71 01.25	°N	123 28.93	° W	150	Em Scan start / tucker #1 out / tucker #2 in	257	290	14	-26.1	-1.3	1013.25	77	9/10+
D29	7/Mar/2008	9:40 AM	71 01.21	°N	123 28.93	° W	150	physics team on ice	257	290	14	-26.1	-1.3	1013.25	77	9/10+
D29	7/Mar/2008	10:00 AM	71 01.19	°N	123 28.84	° W	150	tucker #2 out / tucker #3 in	255	285	13	-25.9	-1.32	1013.4	77	9/10+

D29	7/Mar/2008	10:25 AM	71 01.16	°N	123 28.70	° W	150	tucker #3 out	249	285	14	-25.6	-1.33	1013.94	77	9/10+
D29	7/Mar/2008	10:40 AM	71 01.14	°N	123 28.61	° W	150	Rosette in	247	290	15	-25.7	-1.31	1013.9	77	9/10+
D29	7/Mar/2008	10:50 AM	71 01.13	°N	123 28.55	° W	150	physics team on board / Em Scan complete	246	300	15	-25.7	-1.31	1013.9	77	9/10+
D29	7/Mar/2008	11:05 AM	71 01.10	°N	123 28.45	° W	150	Rosette out	246	295	13	-25.7	-1.3	1014.2	77	9/10+
D29	7/Mar/2008	1:20 PM	71 00.114	°N	123 27.58	° W	150	Weather Balloon launched / zoo on ice	244	295	14	-24.9	-1.31	1014.2	78	9/10+
D29	7/Mar/2008	2:50 PM	71 00.45	°N	123 27.12	° W	149	zoo on board	250	300	11	-23	-1.24	1013.8	80	9/10+
D29	7/Mar/2008	4:55 PM	71 00.25	°N	123 26.85	° W	149	EM Scan finish	247	325	8	-23.3	-1.2	1013.76	80	9/10+
D29	7/Mar/2008	6:55 PM	71 00.28	°N	123 27.17	° W	149	depart atm gaz team	247	321	5	-24	-1.16	1013.14	79	9/10+
D29	7/Mar/2008	7:05 PM	71 00.29	°N	123 27.22	° W	150	Rosette in	257	321	5	-24	-1.16	1013.14	79	9/10+
D29	7/Mar/2008	7:20 PM	71 00.29	°N	123 27.22	° W	151	Rosette out	257	calme	calme	-24	-1.16	1013.14	79	9/10+
D29	7/Mar/2008	7:35 PM	71 00.29	°N	123 27.22	° W	151	atm gaz team on board	257	calme	calme	-24	-1.17	1012.4	79	9/10+
D29	**8/Mar/2008**	6:55 AM	71 00.62	°N	123 38.14	° W	159	Rosette in	307	90	32	-23.7	-1.38	1007.5	79	9/10
D29	8/Mar/2008	7:20 AM	71 00.64	°N	123 38.73	° W	160	Rosette out	305	90	27	-23.2	-1.39	1007.5	79	9/10
D29	8/Mar/2008	8:35 AM	71 00.72	°N	123 40.39	° W	162	Hydrobios in	305	30	10	-21.4	-1.37	1007.5	79	9/10
D29	8/Mar/2008	9:00 AM	71 00.74	°N	123 40.83	° W	163	hydrobios out	305	90	20	-21.4	-1.38	1007.7	79	9/10
D29	8/Mar/2008	9:20 AM	71 00.74	°N	123 41.20	° W	164	tucker #1 in	307	90	25	-21.6	-1.38	1007.7	79	9/10
D29	8/Mar/2008	9:50 AM	71 00.77	°N	123 41.91	° W	164	physics team on ice / tucker #1 out / tucker #2 in / Em scan start	312	90	31	-22.1	-1.39	1007.4	78	9/10
D29	8/Mar/2008	10:20 AM	71 00.79	°N	123 42.63	° W	165	tucker #2 out / tucker #3 in	314	80	29	-21.8	-1.39	1007.3	77	9/10
D29	8/Mar/2008	10:45 AM	71 00.82	°N	123 43.28	° W	167	tucker #3 out	316	85	23	-21.2	-1.39	1007.1	74	9/10
D29	8/Mar/2008	11:00 AM	71 00.83	°N	123 43.64	° W	167	physics team on ice	314	80	25	-21.3	-1.38	1007.2	74	9/10
D29	8/Mar/2008	1:00 PM	71 00.92	°N	123 46.38	° W	173	Rosette in	319	85	23	-20.4	-1.39	1007.5	70	9/10
D29	8/Mar/2008	1:55 PM	71 00.96	°N	123 47.45	° W	175	Rosette out / weather balloon lauched	319	85	23	-19.8	-1.37	1008.1	66	9/10
D29	8/Mar/2008	2:00 PM	71 00.97	°N	123 47.68	° W	175	CO2 team on ice	319	85	24	-19.6	-1.37	1008.4	67	9/10
D29	8/Mar/2008	2:10 PM	71 00.97	°N	123 47.68	° W	175	zoo team on ice	319	85	24	-19.6	-1.37	1008.4	67	9/10
D29	8/Mar/2008	3:15 PM	71 00.98	°N	123 48.99	° W	175	zoo team on board	319	60	3	-18.2	-1.37	1009.7	75	9/10
D29	8/Mar/2008	4:45 PM	71 00.98	°N	123 49.19	° W	175	CO2 back on board	324	70	5	-18.3	-1.37	1009.7	74	9/10
D29	8/Mar/2008	3:40 PM	71 00.98	°N	123 48.98	° W	175	physcis team on ice	319	60	5	-18.3	-1.24	1009.5	75	9/10
D29	8/Mar/2008	5:00 PM	71 01.21	°N	123 49.14	° W	175	Physics team back on board	320	70	5	-18	-1.23	1009.4	75	9/10
D29	8/Mar/2008	6:55 PM	71 01.20	°N	123 51.22	° W	174	Rosette in	323	110	10 / 15	-19	-1.32	1009.73	69	9/10
D29	8/Mar/2008	7:20 PM	71 01.20	°N	123 51.25	° W	174	Rosette out	322	110	10/15	-19	-1.32	1009.7	69	9/10
D29	**9/Mar/2008**	7:00 AM	71 01.79	°N	123 52.88	° W	170	Rosette in	324	115	14	-24.1	-1.15	1019.5	72	9/10
D29	9/Mar/2008	7:20 AM	71 01.79	°N	123 52.88	° W	171	Rosette out	324	115	13	-24.1	-1.11	1019.7	72	9/10
D29	9/Mar/2008	9:30 AM	71 01.86	°N	123 53.01	° W	170	Tucker #1 in	324	110	17	-25.9	-1.17	1020.3	73	9/10
D29	9/Mar/2008	9:45 AM	71 01.87	°N	123 53.04	° W	170	EM Scan start / physics team on	317	105	14	-25.7	-1.16	1020.3	72	9/10

								ice								
D29	9/Mar/2008	9:50 AM	71 01.88	°N	123 53.05	° W	170	tucker #1 out / tucker #2 in	324	105	13	-25.6	-1.17	1020.4	72	9/10
D29	9/Mar/2008	10:18 AM	71 01.91	°N	123 53.12	° W	170	tucker #2 out	327	109	16	-25.6	-1.22	1020.35	72	9/10
D29	9/Mar/2008	10:22 AM	71 01.91	°N	123 53.12	° W	170	tucker #3 in	327	109	16	-25.6	-1.22	1020.35	72	9/10
D29	9/Mar/2008	10:46 AM	71 01.91	°N	123 53.12	° W	170	tucker #3 out	327	109	16	-25.4	-1.24	1020.54	71	9/10
				□		□										
D30	9/Mar/2008	2:15 PM	71 01.10	°N	123 54.39	° W	211	EM Scan start	323	100	17	-24.9	-1.42	1020.7	71	9/10
D30	9/Mar/2008	2:50 PM	71 01.10	°N	123 54.41	° W	211	Contaminant team in cage	323	100	17	-24.7	-1.38	1020.7	71	9/10
D30	9/Mar/2008	3:07 PM	71 01.099	°N	123 54.43	° W	204	Contaminant team back on board	323	110	13	-24.7	-1.38	1020.7	71	9/10
D30	9/Mar/2008	3:10 PM	71 01.10	°N	123 54.43	° W	304	CO2 team in cage	323	105	13	-24.7	-1.38	1020.7	71	9/10
D30	9/Mar/2008	3:43 PM	71 01.10	°N	123 54.44	° W	202	CO2 back on board	323	105	15	-24.7	-1.38	1020.7	71	9/10
D30	9/Mar/2008	4:20 PM	71 01.10	°N	123 54.44	° W	202	Ice cage on ice	325	105	15	-24.8	-1.38	1020	71	9/10
D30	9/Mar/2008	4:36 PM	71 01.10	°N	123 54.44	° W	202	Ice cage back on board	325	105	15	-24.8	-1.37	1019.34	71	9/10
D30	9/Mar/2008	6:25 PM	71 01.10	°N	123 54.44	° W	202	Ice cage on ice	327	105	15/20	-25	-1.35	1019.24	71	9/10
D30	9/Mar/2008	6:45 PM	71 01.10	°N	123 54.44	° W	202	Ice cage back on board	327	100	20	-25	-1.32	1019.1	72	9/10

D29	9/Mar/2008	9:03 PM	71 02.19	°N	123 54.44	° W	134	Rosette in	327	90	20	-25.1	-1.32	1019.09	72	9/10
D29	9/Mar/2008	9:20 PM	71 02.19	°N	123 54.44	° W	134	Rosette out	327	90	20	-25.1	-1.32	1019.09	72	9/10
D29	**10/Mar/2008**	6:55 AM	71 02.31	°N	123 54.62	° W	134	Rosette in	327	95	16	-23.5	-1.14	1018.4	77	9/10
D29	10/Mar/2008	7:15 AM	71 02.31	°N	123 54.62	° W	134	Rosette out	327	100	14	-23.5	-1.13	1018.4	75	9/10
D29	10/Mar/2008	8:30 AM	71 02.31	°N	123 54.62	° W	134	Hydrobios in	327	95	16	-24.3	-1.14	1018.6	76	9/10
D29	10/Mar/2008	9:05 AM	71 02.31	°N	123 54.62	° W	134	Hydrobios out	327	95	17	-24.5	-1.08	1018.5	77	9/10
D29	10/Mar/2008	9:20 AM	71 02.31	°N	123 54.62	° W	134	Tucker #1 in / EM Scan start	328	95	17	-24.4	-1.04	1018.5	77	9/10
D29	10/Mar/2008	9:30 AM	71 02.31	°N	123 54.62	° W	134	physics team on ice	327	95	15	-24.3	-1.03	1018.5	77	9/10
D29	10/Mar/2008	9:50 AM	71 02.31	°N	123 54.62	° W	134	tucker #1 out / tucker #2 in	327	95	15	-24.2	-1.03	1018.6	77	9/10
D29	10/Mar/2008	10:20 AM	71 02.31	°N	123 54.62	° W	134	tucker #2 out / tucker #3 in	327	105	13	-24.1	-1.05	1018.7	77	9/10
D29	10/Mar/2008	10:45 AM	71 02.31	°N	123 54.62	° W	134	physics team back on board	327	110	11	-23.9	-1.06	1018.9	76	9/10
D29	10/Mar/2008	10:50 AM	71 02.31	°N	123 54.62	° W	134	tucker #3 out	327	110	11	-23.9	-1.06	1018.9	76	9/10
D29	10/Mar/2008	11:00 AM	71 02.31	°N	123 54.62	° W	134	Rosette in / Em Scan complete	327	110	13	-23.9	-1.06	1018.9	75	9/10
D29	10/Mar/2008	11:35 AM	71 02.31	°N	123 54.62	° W	134	Rosette out	328	100	11	-23.8	-1.11	1019	75	9/10

2. Team reports

2.1. Team 1

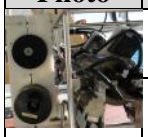
2.1.1. CTD/Rosette

PI: Yves Gratton
Participants: Clément Clerc, Marie-Emmanuelle Rail (INRS-ETE, 490, Rue de la Couronne, Québec)

Objectives
Description of water masses and general circulation over a year in Beaufort Sea and Amundsen Gulf.

Materials
Physical parameters were recorded using a ship mounted RDInstruments Ocean Surveyor ADCP (150kHz), and a rosette frame equipped with 24 bottles of 12 L and the following sensors:

Table 1: Sensors used on the Rosette.

Photo	Item	Manufacturer	Type & Properties	Serial Number
	CTD	SeaBird	SBE-911 Sampling rate : 24 Hz	
	Temperature	SeaBird	SBE 3plus Range: -5°C to + 35°C Accuracy: 0.001	4204
	Pressure	SeaBird	Accuracy: 0.015% of full range	90584
	Conductivity	SeaBird	SBE 4C Range: 0 to 7 S/m Accuracy: 0.0003	2696
	Oxygen	SeaBird	SBE-43 Range: 120% of saturation Accuracy: 2% of saturation	0420

	pH	SeaBird	SBE-18 Range: pH from 0 to 14 Accuracy: pH 0.01	0444
	Nitrates	Satlantic	MBARI ISUS Range: 0.5 to 200 µM Accuracy: ± 2 µM	134
	PAR	Biospherical		4664
	SPAR	Biospherical		20147
	Fluorometer	Sea Point		2465
	Transmissometer	WetLab	Path length: 25 cm	CST-558DR
	Altimeter	Benthos		1061

Method

For the whole leg, because of heavy ice conditions, the rosette was deployed from the Moonpool. CTD or Rosette casts were usually performed two times a day at 7a.m. and 7pm. Four times, we did a 13 hours non-stop CTD sampling. Water was sampled according to each team requests. Here are examples of usual depths collected by them.

- *Nutrients* (Team 7; PI: Jean-Éric Tremblay): salinity of 33.1, 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300 and every 100 m up to the bottom.
- *DIC* (Team 6; PI: Lisa Miller): salinity of 33.1, 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300 and every 100 m up to the bottom.
- *Contaminants* (Team 8; PI: Gary Stern): 10, 25, 50, 100, 200 m and bottom.
- *Microbes* (Team 7; PIs: Carlos Pedros and Roxanne Maranger):
- *pH/alkanilitys* (Team 6; PI: Alfonso Mucci): salinity of 33.1, 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300 and every 100 m up to the bottom.

Sampling field

We focus on the Amundsen Gulf.

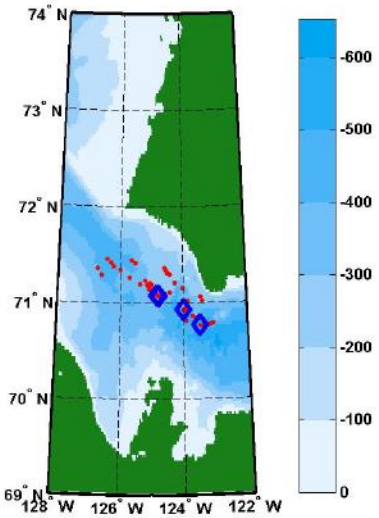


Figure 1: Positions of Rosette casts are shown as red dots and stations of 13 hours sampling are blue diamonds.

Probes calibration

Salinity: Samples were taken on many casts with small bottles of 200 mL. They were analysed with an autosal GuildLine, model 8400B. Its range goes from 0.005 to 42 and its accuracy is <0.002. The results were satisfying. The difference in between the salinity probe recordings and the samples was around 0.033.

Oxygen: Oxygen sensor calibration was performed using Winkler's method and a Mettler Toledo titration machine. Reagent Blanks were performed once, results show that chemicals are still good (m<4). We sampled oxygen on eight casts. Each time, we choose five depths of different oxygen concentration and sampled it three times. Results were really goods, the probe recordings and the samples were always pretty similar.

pH: Tests were done using two buffers. The sensor is quite stable. Results are as follow:
Buffer 4.01 gave 4.09
Buffer 7.00 gave 7.45
Sea water is usually around pH=8, we can expect pH data to be a little over estimated.

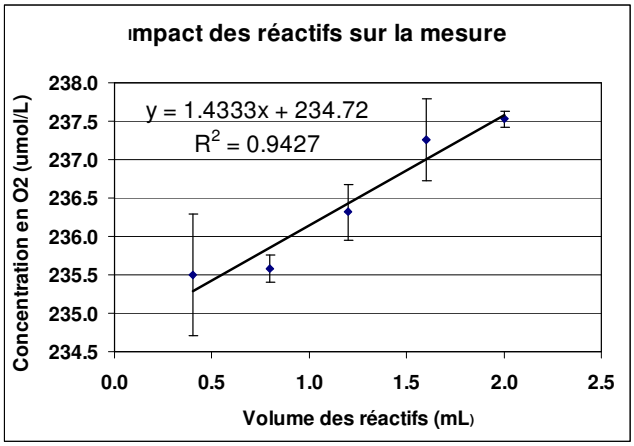


Figure 2: Reagents Blanks (m=1.4333).

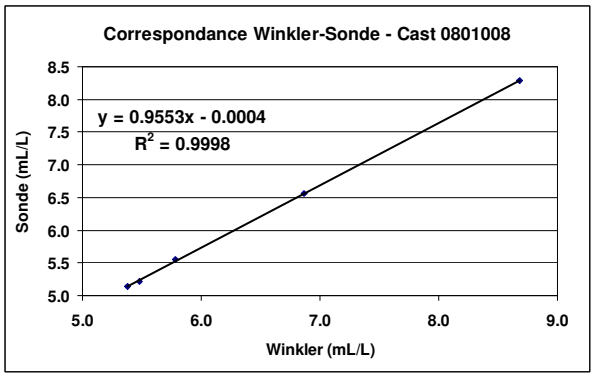


Figure 4: Relation between samples and probe recordings during cast #008 (m=0.955).

Problems

- **Sensors**
  No real problem. Only some water infiltration once in a while.
- **Bottles**
  Some bottles are leaking, which is a problem that persists since a few legs. There is also bottle number 5 that was not closing all the time.
- **Deck material (winch, A-frame, etc.)**
  The cable guides broke a few times which is also a recurring problem. The winch got no problem.
- **ADCP :** It's something difficult to get data on the whole water column. We were really carefull and we try to remove ice from under ship each time we took position so I'm not sure why we don't get data on the whole water column. Frazil?

Available data

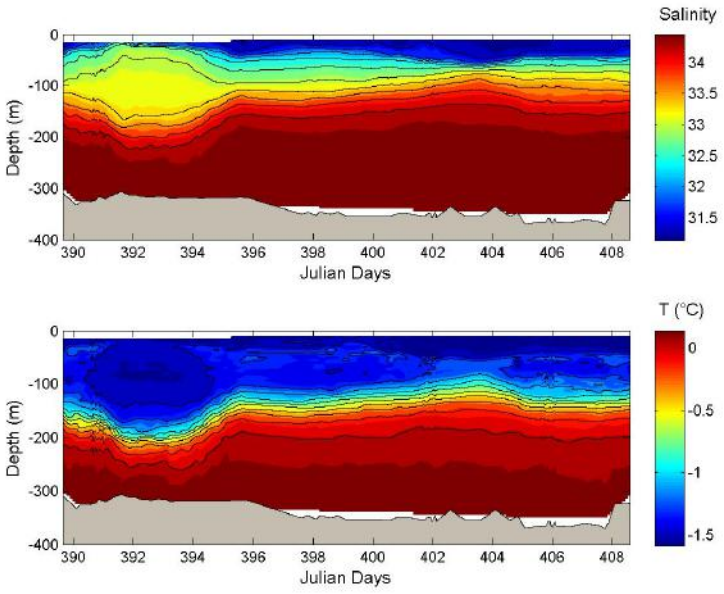
All information concerning the Rosette casts are summarized in the CTD Logbook. It includes cast and station numbers, date and time of sampling in UTC, latitude and longitude, bottom and cast depth, comments concerning the cast and its name. A Rosette sheet was also created for every single cast. It includes the same information than the CTD Logbook plus the bottle distribution among every sampling team. The weather information is written in every Rosette Log as well as in a meteorological logbook. For every cast, data recorded at the moment of bottle closure were averaged and recorded in the so-called 'bottle files'. Averaged data are those recorded between 3 seconds before bottle closure and 7 seconds after it. It includes the bottle position, time and date, pressure, temperature, salinity, transmissivity, chlorophyll, oxygen, irradiance and pH measurements. All those files are available on the 'Shares'.

- Rosette sheets and the CTD logbook : Shares\Leg6\Rosette\logs
- Bottles files : Shares\Leg6\Rosette\btl
- Plots of every cast including salinity, temperature, oxygen, transmissometer, nutrients, fluorometer and irradiance : Shares\Leg6\Rosette\plots

Between January 31st, 2008 and March 12th, 2008 137 casts were performed.

Preliminary Results

This time serie represented data recorded on station D19 from the end of Leg 5 to the second week of Leg 6. We may have recorded an eddy carrying its own water masses by the end of January.



2.2. Team 2

2.2.1. Ice dynamics

PI: David Barber
Participants: Matthew Asplin, Lauren Candlish, Pascale Collin, Klaus Hochheim (6A only), Dustin Isleifson (6B Only), Dan Leitch (6A only)

General Ice Conditions
Leg 6 started with the ship stationed in a long-term drift station within medium first-year ice (FYI) where the ice thicknesses ranged from 90 to 100 cm. Severe southeasterly winds created significant ice divergence and motion which consequently forced us to move from our station (D19) on February 13th. We examined ice at various stages of formation, from open water up to greater than one metre-thick ice. The prolonged southeasterly winds led to the break-up of nearly the entire Amundsen Gulf ice sheet, thus impacting the formation of the fast ice bridge between Nelson Head and Cape Parry.

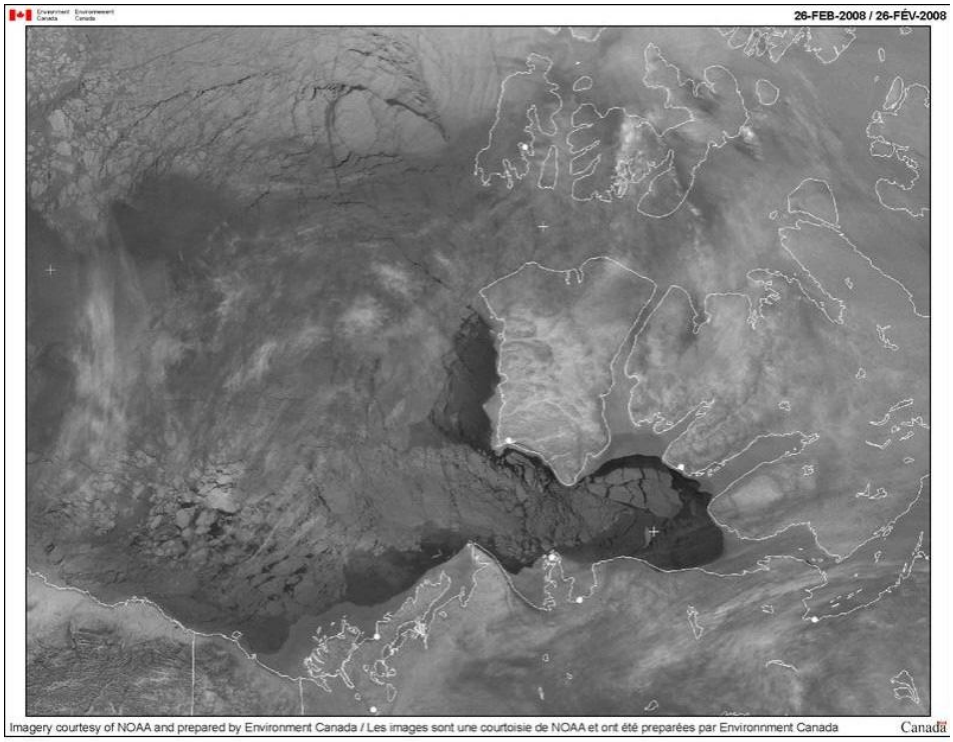


Figure 1. AVHRR image from February 26, 2008.

Physical Sampling
The Team 2 CFL ice raid program continued throughout Leg 6 following the protocol that was previously established in Leg 5. We have termed this sampling "Drift Mode Sampling." The goal is to obtain physical and microstructure measurements of the snow and sea ice, and for twice-daily sampling to occur at the same time as the passage of a train of arctic monitoring satellites at 9:30 and 3:30pm. We continued the drift mode sampling protocol, protecting our EM scanning site with a fence, and performing twice-daily sampling in areas indicative of the area being scanned. There were several chances to visit the flaw lead and consequently examine thin and newly forming ice and therefore samples were taken on an opportunistic basis to optimize our data collection.

The ice surface condition was recorded and site photos were taken. The nature of ice coring and snow pit work depended on how many days we had been at that site, but in general we followed the sampling protocol outlined in Table 1.

Table 1. Drift Station Physical Sampling Protocol.

DAY	ICE (AM)	SNOW (AM)	ICE (PM, TOP 40 CM ONLY)	SNOW (PM)
Day 1	T, Sal, VMS, D	T, Cap, SGA, D, depth	T, Sal	T, Cap, SGA, D, depth
Day 2	T, Sal	T, Cap, SGA, D, depth	T, Sal	T, Cap, SGA, D, depth
Day 3	T, Sal, HMS, D	T, Cap, SGA, D, depth	T, Sal	T, Cap, SGA, D, depth
Day 4	T, Sal	T, Cap, SGA, D, depth	T, Sal	T, Cap, SGA, D, depth
Day 5	T, Sal	T, Cap, SGA, D, depth	T, Sal	T, Cap, SGA, D, depth
Day 6	T, Sal	T, Cap, SGA, D, depth	T, Sal	T, Cap, SGA, D, depth
Day 7	T, Sal	T, Cap, SGA, D, depth	T, Sal	T, Cap, SGA, D, depth
Week 2 at site	Repeat from day 1	Repeat from day 1	Repeat from day 1	Repeat from day 1

Ice: T = temperature profile (T = core temperature profile, Sal = core for Salinity, VMS = core for vertical microstructure, D = core for density, HMS = core for horizontal microstructure
Snow Pits: T = temperature profile, Cap = capacitance plate, SGA = snow grain analysis, D = density

In summary, we took ice cores twice per day for salinity and temperature profiles, with the 3:30 pm ice cores limited to the top 40 cm. A core was taken for vertical microstructure on day 1, and for horizontal microstructure on day 4. We intended to take an additional core for ice density; however, due to equipment problems with the bandsaw we had no means to make accurate cuts and therefore did not perform this task. We also performed a twice-daily snow pit measurement according to our standard procedure. This includes temperature profiles, salinity profiles, capacitance plate measurements, and snow grain photos.

Figure 2. Typical snowpit measurement procedure.

Table 2. Ice Sampling Summary

DATE	STATION	SNOW	ICE TYPE	ICE MICRO
03-Feb-08 to 11-Feb-08	2008D19	Variable (4 – 18 cm)	First year ice (105 cm)	Vertical & Horizontal
17-Feb-08	2008D21	3 cm	First year ice (69 cm)	n/a
18-Feb-08 to 19-Feb-08	2008D22	Variable 2.5 – 7 cm	First year ice (69 – 97 cm)	n/a
24-Feb-08 to 29-Feb-08	2008D26	Uniform (3 – 5 cm)	First year ice (110 cm)	Vertical & Horizontal
01-Mar-08	2008D27	0	Thin FYI (16 cm)	No
01-Mar-08 & 03-Mar-08	2008D28	0	Thin FYI (16.5 cm & 9 cm)	Vertical
05-Mar-08 to 08-Mar-08	2008D29	Main (9 cm) Drift (36 cm)	First year ice (120 cm)	Vertical & Horizontal
09-Mar-08	2008D30	0	New ice (from open water up to 2 cm)	No
10-Mar-08	2008D29 (returned)	Uniform (4 cm)	First year ice (130 cm)	No

At the end of Leg 6 we returned to Station 2008D29. However, the ship was positioned in a different section of the ice where the snow had not been distributed in large drifts. The naming convention requires this station to remain as 2008D29; however, it should be noted that the snowpack is different, whereas the ice floe is the same.

Ship Based EM Measurements

EM measurements were conducted throughout Leg 6 in order to observe the interaction of electromagnetic radiation with various ice conditions. The collected data will be used in electromagnetic modeling studies and for calibration of satellite remote sensing data. The results of this study will allow for us to improve our knowledge of the temporal evolution of sea ice physical, thermodynamic, and electrical properties during the winter ice growth period. We had an exciting opportunity to observe sea ice grow from open water up to 2 cm thick in a large flaw lead at Station 2008D30.

Figure 3. New ice forming in the open lead of Station 2008D30.

Scatterometer
A fully polarimetric scatterometer system was operated at each station stop. The height of the instrument above the surface has been regularly measured and maintained in the operations log. Measurements from the ship were conducted with a sweep from -30° to 30° in the azimuth, requiring the 0° reference at a perpendicular line to the ship side. The variation in elevation was measured with sweeps in the elevation at 5° increments on the range 20° to 60°. An infrared transducer (Everest, 4000L) was mounted on a rail near the scatterometer.

At the beginning of Leg 5B, we had noticed that sometimes the noise floor of the system would rise and therefore some of the radar returns would be lost in the noise and corrupted. The occurrence of this problem has significantly reduced in frequency during Leg 6. We have communicated with the manufacturer and they have assured us that no field maintenance can be performed to further improve the problem; however, the data is still usable. At this point in time, our course of action is to continue to collect data and we will deal with the major increase in post-processing time and data filtering in our final analysis back at the University of Manitoba.

It should be noted that a data collection flaw was discovered during the leg with the IR transducer. The data logger did not have enough memory to log more than 3 hours of data, and the attached storage module was not configured to log at all! This was rectified by reduction of the sampling resolution to once per minute and the eventual employment of a 16MB storage module – the existing storage module was only 512KB.

Ship-Based Radiometer (SBR)
Dual polarized radiometers operating at 37 GHz and 89 GHz with a 6° beamwidth were mounted about 12 m above the sea surface on the port side of the ship. The SBR conducted twice daily scans to correspond with our physical sampling program. The system was operated in a scan mode, changing the incident angle from 30° to 150° using 5° steps. During transit, the radiometers were kept at an incident angle of 55°. A network camera was used to monitor the surface conditions at a sampling rate of 10 s while in transit. The settings have not been changed otherwise. In addition, a hand-held camera is used at each site to provide more information on the surface conditions.

Laser Profiler
The laser profiler was disassembled and put in storage during Leg 5, and thus was not operated during Leg 6.

Skippyboat
The purpose of the skippyboat is to allow us to investigate several sites using the ship based EM equipment, and still return to the sites to perform physical sampling. The skippyboat was winterized at the end of Leg 4, and thus was not deployed during Leg 6. It should be noted that the skippyboat cover was destroyed by intense 50 knot winds, and the skippyboat is now exposed to the elements.

Coloured Dissolved Organic Matter (CDOM), Fluorescence of Dissolved Organic Matter (FDOM), Salinity and Oxygen Isotope ($\delta^{18}O$)

Dissolved organic matter (DOM) plays a major role in the ocean as carbon and energy sources for the microbial food web, and for consumers at higher trophic levels that feed on microbes or on DOM directly. The coloured fraction of this dissolved organic matter is a complex pool of autochthonous materials, derived from in situ photosynthetic activity and processed microbially, and allochthonous materials, that are rich in humic substances and largely derived from terrestrial environments.

This coloured dissolved organic matter (CDOM) is photochemically active and also influences the spectral underwater regime that in turn affects primary production. The composition and reactivity of CDOM in aquatic ecosystems are still poorly understood. The sources and dynamics of DOM are of special interest in the coastal Arctic Ocean. These environments receive inputs of freshwater from large rivers that drain arctic tundra and peatlands as well as subarctic boreal forest. To increase the understanding of this tracer we are coupling the sampling with $\delta^{18}O$ which is a conservative tracer of freshwater masses. It has been estimated that more than 25% of the world's soil carbon lies in these catchments, and there is concern about how ongoing climate change may mobilize these stocks and transport them to arctic seas. The carbon derived from arctic rivers appears to be a major source of terrigenous DOM to the deep ocean, and changes in the magnitude and composition of this material therefore have broader oceanographic implications.

Global circulation models predict that the arctic basin will experience greater and more rapid warming than elsewhere over the course of this century, and there is increasing evidence that global climate change has already begun to have significant impacts on permafrost degradation and terrestrial vegetation dynamics at high northern latitudes.

Water was collected onboard using the rosette from the moonpool. The ice was collected at stations D22 (see Table 3). The water was collected at 0 m, 5 m, 12 m, 25 m, 50 m, 100 m and 250 m on contaminant (THg) casts. The surface samples were always collected using a niskin bottle from the ice at 0 m and 5 m. $\delta^{18}O$ was collected by Team 5 for each station each depth.

The station D22 was selected for CDOM and FDOM in ice. $\delta^{18}O$ and salinity has been collected as well. Physical properties of sea ice have been noted and vertical microstructure analysis has been processed.

Due to problems with the spectrophotometer Cary 50, the CDOM samples has been store at 4°C and measurements of CDOM will be completed at University of Manitoba. Unfiltrated DOC sample was collected at station D27 to cover the different water layer composing the water column at depth surface, 100 m and 250 m. DOC as been stored frozen at -20°C until further analysis can be performed.

Preliminary Results:
CDOM and FDOM analysis will be performed after the cruise in laboratories at the University of Manitoba. Stable isotope analysis of water and ice samples will be analyze outside of the university.

Table 3. CDOM and FDOM sample locations.

Date (mm-dd-yyyy)	Station (#)	Cast (#)
02-08-2008	19D	33
02-11-2008	19D	52
02-19-2008	D22	68
01-03-2008	D27	103

Please note that station 19D 02-11-2008 has been process from the same bottle as that of Team 6 (Carlos Pedros from Spain) to analyze organic compounds and functional and structural bacterial diversity.

Atmospheric Sampling Program
The purpose of the atmospheric sampling program is to monitor cloud cover and cloud properties, upper level and boundary layer winds, temperature, and humidity.

All-Sky Camera
The all-sky camera system is used to take pictures of sky in order that percentage and type of cloud cover may be determined throughout the cruise. The all-sky camera was non-functional upon our

arrival onboard the ship due to the destruction of the hemispheric dome during Leg 5B. Two new domes were brought to the ship. We were successfully able to heat the dome to keep it frost-free by installing a dense network of heating wire and an ambient heat source inside the dome. Furthermore, the lens hole was enlarged on the webcam enclosure. The camera-system is now fully functional and taking pictures at a 15-minute interval; however, sun glare will continue to be a problem until an appropriate lens can be installed at the start of Leg 7.

Ceilometer

The ceilometer is used to measure the height of the cloud layers above the ship. The ceilometer was fully functional throughout all of Leg 6. Routine maintenance and backup was performed at regular intervals.

Profiling Radiometer

The profiling radiometer is used to measure the temperature, relative humidity, and pressure within the atmosphere. The profiling radiometer has been running smoothly, with only occasional crashing of the interface software on the laptop due to a memory leak. Data collection was not affected. A liquid nitrogen calibration was conducted on February 26, and will be one more time during CFL during Leg 8. The instrument has collected wonderful data on various different atmospheric circulation patterns including highs, cyclones, weak low-pressure depressions, and strong geostrophic flow situations.

Radiosondes (weather balloons)

There were 18 balloon launches during Leg 6. Balloon launches were conducted to correspond mainly with low-pressure depressions and cyclones, but a small number profiled high pressure systems, and low-level inversions. The balloon tether system, constructed by our Russian team 2 collaborators during Leg 5, was improved and employed on several occasions in an attempt to collect time-series data at approximately 250m above the ground. Battery charge life, and changing wind conditions prevented us from collecting time series greater than 4 hours. Balloons used for tethered experiments were generally re-used immediately after as regular profiling balloons due to no storage location for the balloons. Furthermore, our limited helium supply precluded us from re-inflating the same balloon repeatedly. A radiosonde was also successfully attached to a kite, courtesy of Doug Barber.

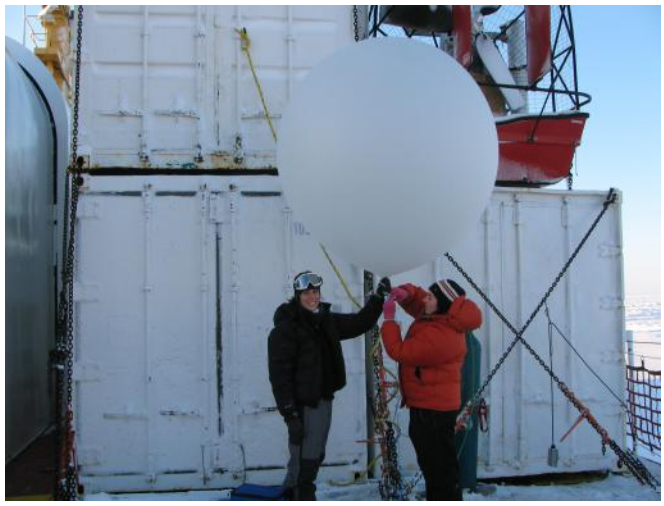


Figure 4. Attaching a radiosonde to a balloon for an atmospheric profile.

Laser Precipitation Gauge

This instrument was fully functional throughout Leg 6. The instrument continues to run as per normal, and all data has been downloaded and archived.

Ice Motion Beacons
Ice beacon deployment was initially delayed by our "Jiffy" auger having died during Leg 5. Upon arrival of a new auger at the start of Leg 6B, we were able to begin to deploy ice beacons during Leg 6, and future deployments will be at approximately 2 week intervals or as significant opportunities arise (MYI floes).

Table 4: Ice motion beacon deployments.

Beacon ID	Date Deployed	Location Deployed	Status
20610	Feb 23	D23	ACTIVE
13330	Feb 24	D26	ACTIVE
14310	Feb 27	By Heli near D26	ACTIVE
19300	Mar 6	Near D29	ACTIVE

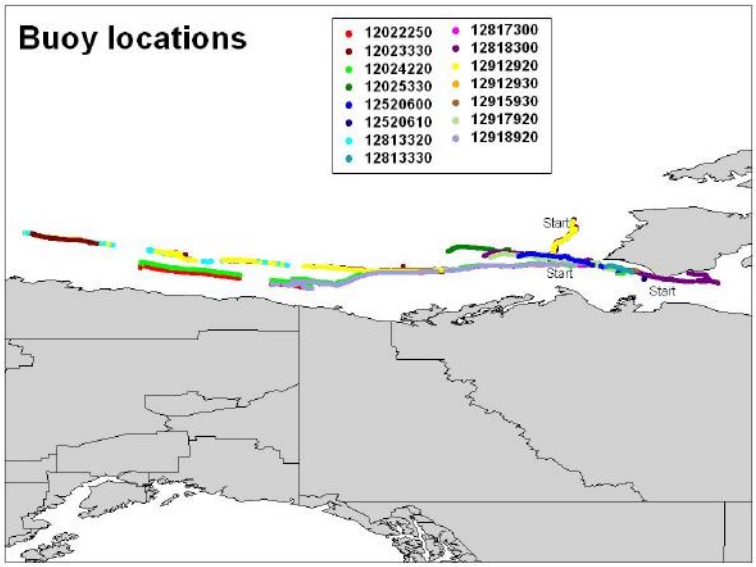


Figure 5. Ice motion buoy locations as of February 25, 2008.

Met-ocean MOBS Buoys
Two improved MOBS buoys were received, but could not be operated due to the direction finder having not been shipped up. The buoys are presently stored near and inside the benthic lab.

Met-ocean POPS Buoy
No POPS buoys were on the ship during Leg 6.

AVOS (Environment Canada MetObs System)
This system was operating normally, with the exception of a few glitches in data transmission that were worked out by the ship's electronics officer.

Recommendations
In general, the data collection is proceeding as planned with no major issues that have not been resolved. As time progresses and we enter the winter it is imperative that all exposed instruments must be free of frost buildup and must be maintained at correct operating temperatures. We also recommend close monitoring of the usage of the core barrels as we became dangerously short on pins.

The cold lab temperature was regularly maintained throughout Leg 6. We were advised by Frederic (PI Tison) to reduce the temperature of the cold room to below -23C, as this is a critical temperature at which brine drainage can occur while processing horizontal microstructure samples. We recommend continued defrosting of the lab every 10 days to minimize frost build-up and to keep the

temperature at or below -23C. We also employed usage of the microtome for making very clean shaven surfaces on the microstructure work. We also found that it can be helpful to flip the ice on the plate and shave the bottom so that the sample would be free of air bubbles.

2.3. Team 4

2.3.1. Zooplankton and fish Acoustic

PI: Louis Fortier
Participants: Anaïs Aubert (U. Laval), Hélen Cloutier (U. Laval), Gérald Darnis (U. Laval), Louis Létourneau (U. Laval), and Steve Gagné (electronic technician from U Laval)
Written by: Gérald Darnis, Hélen Cloutier, Anaïs Aubert and Louis Létourneau

Introduction

The fragmented, thin, and often absent ice cover in the flaw lead allows solar radiation to reach the surface layer of the ocean where it triggers photosynthesis by microscopic algae. Team 4, Pelagic and Benthic Food Web, will investigate how and to what extent the microalgae growing in the flaw lead are exploited by animals living in the plankton (the zooplankton) and on the sea floor (the benthos). Our simple hypothesis is that, relative to adjacent ice-covered regions, enhanced algal production in the flaw lead translates into biological hot spots where higher zooplankton and benthos abundances prevail. We will also investigate how the Arctic cod, a central species in the Arctic food web, uses the flaw lead for feeding, overwintering, reproduction, and as a nursery ground for their young stages (http://www.ipy-cfl.ca/page1/page1.html)

General objectives

The achievements of the members of our team during the previous leg 5 served as an example to build the sampling program of CFL leg 6. Thus the general objective of our team during this leg-6 CFL was again to collect indices of the ecosystem biological production -essentially the water column secondary production- in winter (February-March). Our sampling program was designed in the continuity of the overarching goal of ArcticNet project 1.4 led by Dr. J.-É. Tremblay (U. Laval) 'Marine productivity and sustained exploitation of emerging fisheries' which is to assess the impact of sea-ice cover reduction and increasing sea temperatures on biological productivity, fisheries resources and marine mammal populations of the coastal Canadian Arctic. Since October 18th, date the CFL program started, we focus on how the physical processes moderate biogeochemical processes within the changing northern flaw lead ecosystem nearby Banks Island (Beaufort Sea). Our multidisciplinary ArcticNet-CFL team is strongly linked with Team 7 (Carbon Fluxes – Tremblay) of the CFL program. For this leg-6 of CFL, sampling efforts were concentrated on the pelagic secondary producers.

The primary objectives of our team during CFL-6 were:

1- To assess zooplankton / fish abundance and diversity by using various plankton nets.
2- To track zooplankton / fish biomass and distribution with the EK60 Echosounder.

Our secondary field objectives were to collect and use the zooplankton sample for:

1- The cycling of contaminants in zooplankton (G. Stern, U. Manitoba)
2- Identification of the sources and pathways of omega-3 in the arctic marine food chain (J. Michaud, E. Dewaily and L. Fortier, U. Laval). This project linked to the CFL-URSUK program and the ArcticNet theme 1.5, focussing on the importance of omega-3 fatty acid in the traditional diet of Inuit communities.
3- Assessment of the biomass and respiration rates of the zooplankton community by the Electron Transfer System (ETS) activity at chosen stations (G. Darnis and L. Fortier).

4- Stable isotope analysis on the food web structure and carbon fluxes; this is a joint project between Team 4 and 7 of CFL (A. Forest, L. Fortier, J-E. Tremblay)
5- Copepod *in-situ* egg production (EPr) and gonad maturation of *Calanus hyperboreus* and *Metridia longa* (M. Ringuette, G. Darnis, L. Fortier)

Sampling program

Leg-6 sampling program was oriented towards ice work, when the ship was stationary on an ice flow for periods of time varying from 1 day to a week. Vertical sampling of the water column from the ice, initiated during the previous leg, was continued as well as the usual moon pool zooplankton sampling activities. We added a 60-0m ice tow to the usual 10-0 and 250-0m vertical tows to augment our sampling effort to catch Arctic Cod. Furthermore, building on a previous unintended collection of fish in short term sediment traps, we also deployed for 24-hour periods a line holding 3 traps in the ice hole serving for net sampling.

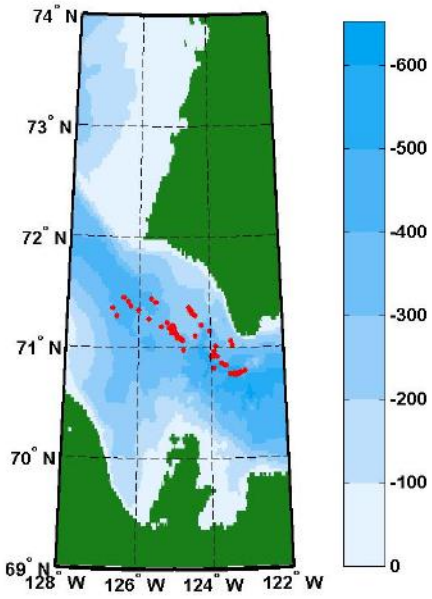


Fig 1: Locations of CFL leg 6 drifting stations.

1) Sampling gear and events

a) 1-m^2 Square net. Frame rigged with 1 square m^2 opening net (1 x 200, µm mesh), out-rigged with a 10 cm diameter net (50 µm) and equipped with a TSK flowmeter (Figure 1a). This net is used for integrated water column sampling that is summarized in table 1. When deploying, downward winch speed was <40 m/min to avoid mixing of the nets, and upward winch speed was 30m/min. To obtain quantitative tow (i.e. for taxonomy and abundance estimates), the content of the 200 µm (TSK) and the 50 µm mesh-net were preserved in formaldehyde (Fortier). Qualitative tows (i.e. 'live tows') were also performed to obtain animals for contaminants, lipids, EPr and/or ETS studies.

b) Hydrobios. Multi-depth plankton sampler (Figure 2b) equipped with nine 200 µm-mesh nets (opening 0.5 m^2). This was allowing for depth specific sampling of the water column. The *Hydrobios* is also equipped with a CTD to record water column properties while collecting biological samples. When deploying, downward winch speeds was 40m/min and the speed up was 30m/min. At most casts, the net collection was preserved in formaldehyde for taxonomic analysis but for some casts, the content of each net was divided: 50% for taxonomy (4% buffered formaldehyde) 25% for biomass estimates and 25% for ETS analysis (Table 2). The Hydrobios flowmeters appeared again to be

functioning perfectly after the troubles of leg 3 and 4. On one occasion, the Hydrobios hit the sea floor due to a wrong reading of the ship's echosounder. From then on, it was decided to check also the EK 60 when depths given by the bridge seemed doubtful. There was one incident in which the cable guide was damaged and needed a one-day repair. This prevented the deployment of the Hydrobios for one morning. A 24-hour Hydrobios sampling involving 4-hour intervals deployments was made during the leg. The targeted date for this sampling event was close to mid-leg but continual repositioning of the ship due to heavy drifting postponed this to the end of the second last week of the leg.

c) Ring net. A 1m diameter ring net equipped with a 200 □m mesh net and out-rigged with 10 cm diameter net (50 µm) and a flowmeter. This net was deployed three times per cast from a hole on the ice at proximity of the ship but at a site not influenced by its presence. Ice zooplankton sampling activities are summarized in table 3. A RBR CTD was always added to the net frame. At each station cast, the first haul was from 10 m to the surface and the second haul from a maximum of 270 m to the surface. Very soon after the start of the leg, it was decided to perform a last tow from 60 m to the surface to augment the sampling effort to collect Arctic cod larvae and juveniles. The net was lowered manually to the desired depth and pulled manually for the 10 m haul and using a snow mobile for the deep haul during the first cast. After many snow mobile breakdowns, we were asked to use the four wheeler to tow the nets. This engine proved to be better for the purpose as it provides more grip on the ice than the snow mobiles. On two occasions, the 50 µm

Overall, 139 sampling events occurred and 93 of the samples obtained were preserved for taxonomy, and the remainder, the 'live tows', were used for further analysis and laboratory experiments as described above. Samples for lipid and stable isotope analysis were placed in cryovials and stored at -80˚C. Samples for contaminants were sorted and preserved by Gary Stern's team

(a)

(b)

(c)

Figure 2. Zooplankton sampling gear used during CFL-Leg 6: a) 1-m^2 Square net, b) Hydrobios, both deployed from the moonpool and c) Ring net deployed from the ice.

Table 1: CFL-Leg 6 summary sampling activities using the 1m^2 -net

Date (UTC)	Station	LAT	LONG	Sampling depth	Contami-Nants	Taxo-nomy	Lipids	Stable Isotopes	EPR	Biomass and ETS
2008-02-02	2008D19-1	71,046	124,487	330					X	
2008-02-02	2008D19-2	71,046	124,487	330		X				
2008-02-02	2008D19-3	71,046	124,487	348	X					
2008-02-04	2008D19-4	71,046	124,490	335		X				
2008-02-04	2008D19-5	71,046	124,490	330			X	X		X
2008-02-04	2008D19-6	71,046	124,490	330	X					
2008-02-06	2008D19-7	71,046	124,490	331		X				
2008-02-06	2008D19-8	71,046	124,490	331	X					
2008-02-06	2008D19-9	71,046	124,490	331					X	
2008-02-08	2008D19-10	71,046	124,490	335		X				
2008-02-08	2008D19-11	71,046	124,490	330	X					
2008-02-08	2008D19-12	71,046	124,490	331					X	
2008-02-09	2008D19-13	71,039	124,461	345						
2008-02-09	2008D19-14	71,039	124,461	330	X					
2008-02-10	2008D19-15	71,039	124,461	345		X				
2008-02-10	2008D19-16	71,039	124,461	345						X
2008-02-10	2008D19-17	71,039	124,461	345	X					
2008-02-11	2008D19-18	71,040	124,466	348		X				
2008-02-11	2008D19-19	71,041	124,467	348						
2008-02-11	2008D19-20	71,041	124,468	348	X					
2008-02-12	2008D19-21	71,089	125,077	298		X				
2008-02-12	2008D19-22	71,091	125,086	294	X					
2008-02-12	2008D19-23	71,092	125,094	298					X	
2008-02-14	2008D19-24	71,259	126,217	375		X				
2008-02-16	2008D20-1	71,170	126,392	426	X				X	
2008-02-18	2008D22-1	71,181	124,278	247		X				
2008-02-18	2008D22-2	71,182	124,282	250	X					
2008-02-18	2008D22-3	71,183	124,286	247			X	X		
2008-02-20	2008D23-1	71,096	124,040	311		X				
2008-02-20	2008D23-2	71,096	124,040	325					X	
2008-02-23	2008D25-1	71,265	125,401	416		X				X
2008-02-23	2008D25-2	71,265	125,404	406					X	
2008-02-24	2008D26-1	71,001	123,53	314		X				
2008-02-24	2008D26-2	71,00	123,53	314						X
2008-02-24	2008D26-3	70,599	123,532	314	X					
2008-02-25	2008D26-4	70,562	123,55	345		X				
2008-02-25	2008D26-5	70,561	123,55	342			X	X		
2008-02-25	2008D26-6	70,56	123,551	345	X					
2008-02-26	2008D26-7	70,553	123,589	365		X				
2008-02-26	2008D26-8	70,553	123,589	360						
2008-02-27	2008D26-9	70,553	123,581	365		X				
2008-02-27	2008D26-10	70,553	123,581	365	X					
2008-02-27	2008D26-11	70,552	123,579	365					X	X
2008-02-28	2008D26-12	70,557	123,511	345		X				
2008-02-28	2008D26-13	70,558	123,510	355	X					
2008-02-28	2008D26-14	70,558	123,509	345						
2008-02-29	2008D26-15	70,512	123,399	372		X				
2008-02-29	2008D26-16	70,512	123,395	372						X
2008-02-29	2008D26-17	70,51	123,399	379	X					
2008-03-02	2008D27-1	70,470	123,069	365		X				

2008-03-02	2008D27-2	70,471	123,061	365						X	
2008-03-02	2008D27-3	70,473	123,052	365	X						
2008-03-03	2008D27-4	70,488	122,535	345		X	X	X			
2008-03-05	2008D29-1	71,017	123,252	220		X					
2008-03-05	2008D29-2	71,02	123,256	223						X	
2008-03-05	2008D29-3	71,021	123,259	223	X						
2008-03-07	2008D29-4	71,012	123,290	240		X					
2008-03-07	2008D29-5	71,012	123,289	237							X
2008-03-07	2008D29-6	71,011	123,288	233	X						
2008-03-08	2008D29-7	71,007	123,412	281		X					
2008-03-08	2008D29-8	71,007	123,419	284	X						
2008-03-08	2008D29-9	71,008	123,426	284							X
2008-03-09	2008D29-10	71,018	123,530	304		X					
2008-03-09	2008D29-11	71,018	123,530	308						X	
2008-03-09	2008D29-12	71,019	123,531	308	X						
2008-03-10	2008D29-13	71,023	123,546	314		X					
2008-03-10	2008D29-14	71,023	123,546	314	X						
2008-03-10	2008D29-15	71,007	123,426	314				X	X		
2008-03-12	2008D29-16	-	-	-						X	
2008-03-12	2008D29-17	-	-	-							

Table 2: CFL-Leg 6 summary sampling activities using the Hydrobios.

Date (UTC)	Station	LAT	LONG	Sampling depth	Lipids	Stable Isotopes	Biomass and ETS	Taxonomy
2008-02-02	2008D19-A	71,046	124,487	330				X
2008-02-04	2008D19-B	71,046	124,490	325			X	X
2008-02-06	2008D19-C	71,046	124,490	346				X
2008-02-08	2008D19-D	71,046	124,490	330				X
2008-02-10	2008D19-E	71,039	124,461	340				X
2008-02- 11	2008D19-F	71,040	124,463	340	X			X
2008-02-12	2008D19-G	71,089	125,075	315			X	X
2008-02-14	2008D19-H	71,255	126,204	440				X
2008-02-16	2008D20-A	71,173	126,385	425				X
2008-02-18	2008D22-A	71,175	124,260	240			X	X
2008-02-23	2008D25-A	71,264	125,398	400	X			X
2008-02-24	2008D26-A	70,59	123,53	320				X
2008-02-25	2008D26-B	70,563	123,55	335			X	X
2008-02-27	2008D26-C	70,553	123,585	360				X
2008-02-29	2008D26-D	70,509	123,399	405				X
2008-03-01	2008D26-E	70,504	123,36	425				X
2008-03-02	2008D27-A	70,468	123,084	390				X
2008-03-03	2008D27-B	70,488	122,535	340			X	X
2008-03-05	2008D29-A	71,008	123,233	230				X
2008-03-05	2008D29-B	71,025	123,263	230	X			X
2008-03-05	2008D29-C	71,036	123,271	240				X
2008-03-06	2008D29-D	71,039	123,27	255				X
2008-03-03	2008D29-E	71,040	123,271	230				X
2008-03-06	2008D29-F	71,043	123,270	220				X
2008-03-07	2008D29-G	71,013	123,292	245				X
2008-03-08	2008D29-H	71,007	123,403	280				X
2008-03-10	2008D29-I	71,023	123,546	300			X	X

Table 3: CLF-Leg 6 summary sampling activities using the 1 m diameter ring net on the ice.

Date (UTC)	Station	LAT	LONG	Sampling depth
2008-02-01	2008D19-Ice 1	71,040	124,488	10
2008-02-01	2008D19-Ice 1	71,046	124,779	320
2008-02-03	2008D19-Ice 2	71,046	124,490	280
2008-02-03	2008D19-Ice 2	71,046	124,490	10
2008-02-05	2008D19-Ice 3	71,046	124,490	10
2008-02-05	2008D19-Ice 3	71,046	124,490	273
2008-02-07	2008D19-Ice 4	71,046	124,490	10
2008-02-07	2008D19-Ice 4	71,046	124,490	282
2008-02-07	2008D19-Ice 4	71,046	124,490	71
2008-02-08	2008D19-Ice 5	71,045	124,487	10
2008-02-08	2008D19-Ice 5	71,045	124,487	72
2008-02-08	2008D19-Ice 5	71,045	124,487	72
2008-02-09	2008D19-Ice 6	71,039	124,461	10
2008-02-09	2008D19-Ice 6	71,039	124,461	282
2008-02-09	2008D19-Ice 6	71,039	124,461	71
2008-02-11	2008D19-Ice 7	71,046	124,486	10
2008-02-11	2008D19-Ice 7	71,046	124,486	279
2008-02-11	2008D19-Ice 7	71,046	124,486	72
2008-02-25	2008D26-Ice 1	70,558	123,568	10
2008-02-25	2008D26-Ice 1	70,558	123,568	281
2008-02-25	2008D26-Ice 1	70,558	123,568	71
2008-02-26	2008D26-Ice 2	70,553	123,589	10
2008-02-26	2008D26-Ice 2	70,553	123,589	283
2008-02-26	2008D26-Ice 2	70,553	123,589	71
2008-02-27	2008D26-Ice 3	70,552	123,567	10
2008-02-27	2008D26-Ice 3	70,552	123,567	250
2008-02-27	2008D26-Ice 3	70,552	123,567	60
2008-02-28	2008D26-Ice4	70,558	123,503	10
2008-02-28	2008D26-Ice4	70,558	123,503	288
2008-02-28	2008D26-Ice4	70,558	123,503	70
2008-03-07	2008D29-Ice 1	71,001	123,275	10
2008-03-07	2008D29-Ice 1	71,001	123,275	218
2008-03-07	2008D29-Ice 1	71,001	123,275	72
2008-03-08	2008D29-Ice 2	71,009	123,476	10
2008-03-08	2008D29-Ice 2	71,009	123,476	273
2008-03-08	2008D29-Ice 2	71,009	123,476	68
2008-03-10	2008D29-Ice 3	71,023	123,546	10
2008-03-10	2008D29-Ice 3	71,023	123,546	280
2008-03-10	2008D29-Ice 3	71,023	123,546	70
2008-03-11	2008D29-Ice 4	71,019	123,538	10
2008-03-11	2008D29-Ice 4	71,019	123,538	282
2008-03-11	2008D29-Ice 4	71,019	123,538	71

Laboratory analysis

1) Egg production rate experiments

Copepod *in-situ* egg production and gonad maturation (after Niehoff 1998) were monitored by incubating large calanoid species females at 0°C, thus at a similar temperature they experience at depth. The presumed non-reproducing *Calanus glacialis* was monitored weekly during the leg in order to verify and confirm its non-reproductive state. *Metridia longa* and *Calanus hyperboreus* egg production was measured approximately every 5 or 6 days. *Metridia longa* did not produce any eggs

but some females started to develop eggs and were close to spawning although gonadic index remains constantly low for the population. By the start of February, the entire population of female *C. hyperboreus* were having eggs in vitellogenesis, a sign that reproduction of the species was fully on. Measurements of daily egg production rates varied between 19 and 51 eggs f^{-1} d^{-1}. Some spent females start to appear in the live samples. On several occasions, eggs were sampled for dry weight measurements. Approximately 200 eggs were put to dry on a pre weighed GF/F filter that will be weighed again on a microbalance at Laval University.

Harsh winter conditions always provide difficulties in studying winter Arctic organisms. Because of this constraint, the metrics on the reproduction of *C. hyperboreus* is currently poorly documented. In order to measure the total production of *C. hyperboreus,* 50 immature females have been placed in filtered sea water during leg 5 and their egg production monitored daily. Eggs produced were then used to measure the hatching rates for different eggs buoyancies (sinking vs. floating). By the end of April we hope to get total reproductive output and the fate of this production. At this stage of the season, already 13 of the 50 females have spawned more than 1000 eggs. The record is presently held by female number 41 with a total of 1750 eggs spawned. Finally an experiment has been initiated to test the hypothesis arguing that *Metridia longa* can feed on *C. hyperboreus* eggs. (Conover & Huntley 1991). The question here is if they simply feed on these eggs or if they use this consumption to fuel an early reproduction, before the onset of the algal production. Thirty females are fed every second day with a known number of freshly laid *C. hyperboreus* eggs. On the second day, the remaining eggs are counted and removed before providing new ones. Gonadic stages of *M. longa* were recorded weekly.

2) Biomass and Transfer System (ETS) activity

On six occasions, corresponding to four stations (Table 1 and 2), samples were sorted for biomass and ETS activity essay. At these stations, each Hydrobios net was subdivided: 50% for taxonomy (i.e. preserved in formol), 25% for population biomass estimates and 25% for ETS activity. For biomass estimate, the sub-sample (i.e. 25% of total sample) was fractionated with sieves in > 1000 □m and < 1000 □m size classes; these fractions were preserved at -20˚C. Sub-samples for zooplankton population ETS activity essays (i.e. 25% of total sample) were also sieved into the same two size fractions. As no Sanyo incubator was available for the ETS experiments, samples were incubated in a Pyrex plate filled with water and heated to 40˚C on a hot plate. Temperature of this 'hot tub' proved to remain constant during the required incubation time. ETS experiments were also performed on individual copepods, females and copepodite stage 5, of *Calanus glacialis*, *C. hyperboreus* and *Metridia longa*.

3) Respiration experiments

To derive respiration from the activity of the Electron transfer system a ratio of respiration on ETS activity is required. Thus incubations were carried out to measure oxygen consumption of copepods in sealed chambers. A Qubit® respirometry system was installed in the cold room at 0°C in the aft labs. The first experiment showed that the temperature in the cold room varied substantially and cyclically during the course of the measurement, decreasing the quality of the data collected. Another team experienced the same problem while measuring bacterial metabolism. For next leg, the Qubit® respirometry system will be installed in the cold room in the zooplankton lab on the front deck if it is possible to control its temperature. A new oxygen meter was stranded for weeks with the rest of the scientific equipment that did not make it with the crew change. This limited seriously our capability to carry out respiration measurements on zooplankton assemblages until we could get hold of our hand oxygen meter.

4) Taxonomic analysis of the zooplankton small size fraction

Every 2-4 days (depending on the net sampling possibilities), one 50µm tucker net sample was prepared for small fraction taxonomy. Most of the samples were analysed on the ship and the rest will be studied at Laval University. For each sample, 300 copepods specimens were identified under the stereomicroscope. A total of 9 samples were processed for small size fraction taxonomy during leg 6. For each sample preserved, one other 50 µm tucker net sample was preserved for biomass measurement. The codend content was filtered through a 1000µm sieve (in order to eliminate the

large organisms) then filtered through a 50µm sieve. The zooplankton was then placed on a preweighed GF/F filter that will be weighed back in Québec. Moreover, for every 50 µm sample analysed, the females *Calanus hyperboreus* and *Paraeuchaeta glacialis* were counted in one 200 µm Tucker net sample of the same cast. This counting will permit to estimate, related to the egg production rate experiments, the expected number of eggs in the 50 µm sample.

Acoustic monitoring

The Simrad EK-60 Echosounder of the Amundsen allowed our group to continuously monitor the spatial and vertical distribution of zooplankton and fish, the later mostly represented by Arctic cod (*Boreogadus saida*). The hull-mounted transducers are in operation 24h a day and will provide an extensive mapping of where the fishes are within the region of interest over a yearly cycle.

General Recommendations:

We will keep the same recommendations given on the leg-5 zooplankton team report:

As the drift of the ship while in a ice floe can be important, we recommend sampling every day with the Hydrobios and the 1-m^2 Square net in the moon pool and with the ring net from the ice. Sampling in the morning in the moon pool and from the ice in the afternoon prove to be the most convenient schedule for Leg-5 and 6

Low temperature is the essence of all the measurements done with live animals. The very warm temperature in our laboratory may pose problems even to the environment chamber which shows difficulties to maintain the required 0°C. The air conditioner system set at 22°C remedied to the problem. From now on, the AC should stay on and the laboratory door must remain closed.

When the ship is in transit, and that may last a few days, and then stops in a flow, particular attention should be given to the EK-60 sounder and the ADCP in order to make sure all sensors cleared of ice before the shutting down of the engines. Otherwise the data recorded are simply unusable.

More importantly, enjoy this amazing experience in this harsh but beautiful environment, have fun and KEEP THE SPIRIT!!!

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Acknowledgements. We thank the officers and the crew of Amundsen team A for their continuous effort and essential help; thank you for being able to repair or built anything we need! Special thanks to all that assisted us with sampling and digging holes in the ice and finally, to Clément Clerc, Beatriz Fernandez for her communicative joy of life and help for coiling back the rope on the spool, Marta Estrada, Laura Alonso and Alexis Burt.

THE ZOOPLANKTON SAMPLING TEAM

2.4. Team 5

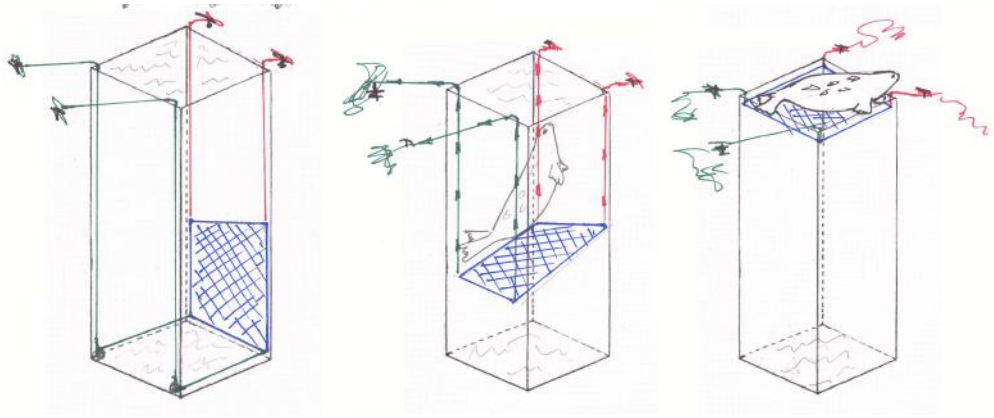
2.4.1. Ringed seal Tagging Project

PI: Steve Ferguson (DFO)
Project leader: Lois Harwood (DFO)
Project team: Tom Smith (EMC); Roger Memorana; Magaly Chambellant (DFO)

Background

Objectives
Understand movements and diving behaviour of seals from different age classes in the CFL area. Deploy satellite transmitters (PTT) coupled with time-depth recorders (TDR) on ringed seals using the CFL.

Methodology
Ringed seals have been reported to enter and use extensively the moon pool on multiple occasions during the CASES project. Seal capture will be performed from the moon pool on board the CCGS Amundsen. A net has been designed for this purpose and rely on the presence of ringed seals in the moon pool:



The net will be deployed in the moon pool in a "resting" position. When a seal enters the moon pool, the green ropes will be pulled up to close the moon pool and trap the seal. Both red and green ropes will then be pulled up to bring the seal to the surface. The seal will be captured, restrained, measured and a transmitter will be attached on its back before release.

Results

General information
Roger Memorana and Magaly Chambellant arrived on board the CCGS Amundsen on January 31st, 2008 for the beginning of leg 6a. Satellite transmitters and associated gear were brought back on board at the same time. Net parts were sent to Quebec in July and were stored in the cargo space on board the ship. Roger and Magaly were supposed to stay on board for 2 weeks, but decided to extent their stay by 1 week and live at mid-leg.

Logistic
Transmitters
Five SPLASH PTT/TDR from Wildlife Computers were programmed and tested successfully on February 1st, 2008.

Moon Pool
Attempts were made to obtain the exact dimensions and the different measurements of the moon pool from the original architect design. We succeed in obtaining some plans but no measurements were provided or were available at the time we left the ship. The moon pool is not perfectly squared and 2 pipes located on 1 side are preventing the net to perfectly fit the moon pool, created a gap of approximately 6"x88", big enough for a seal to escape. At mid-depth, a gusset and its extension is present in which the net can get caught. The pipes represents another trouble to pull the net up properly as the corners of the net can get caught in the pipes and create a gap between the moon pool and the net on the other side. Two "taquet" have been welded to the side of the moon pool on the rosette room side for people to lock the ropes quickly and easily in case of a capture.

Net
The aluminium poles to build the frame part of the net were not to be found anywhere on the ship. The mechanics team on board built us a metallic frame to replace the missing one and on February 6th, 2008, the net was ready to be deployed. After meeting with the Captain, chief officer and chief scientist, it was decided that the net should not be deployed, even in "resting" mode, when other activities would be taking place in the moon pool. The net will be deployed at night or during the day when the moon pool will be available. The moon pool will be left open every night, weather permitted, and an underwater light will be installed and left on. The best deploying position for the net in "resting" mode will be the have it lined up against the wall facing the pipes, just above the gusset and its extension. Ropes could then be pulled from the rosette room.

Ringed seals
An adult male ringed seal came in the moon pool during the night of 9-10 February, 2008. He was first spotted around 12:30 am and was observed up to around 3:00am; at what time, people when to bed. The seal was doing regular apnea of around 6 minutes and was resting on the surface for typically less than a minute. At around 7:00 am on the 10th, the seal was still using the moon pool and was staying at the surface for longer periods of time (around 5 minutes). It was last spotted around 9:00 this morning. At around 12:00pm, the same seal came back and used the moon pool with the same regular pattern as during the night but stayed longer and longer at the surface, eyes closed. At one stage, the seal started to splash heavily the water with its left fore flipper several times. He then stayed, apparently sleeping at the surface, for more than ½ hour. The seal eventually left around 13:45 when people from the ship came to weld pieces onto the moon pool side. The ringed seal came back twice very shortly around 20:10 but was very scared and disappeared as soon as it saw people. It came back around 23:45 and started to use the moon pool as before.

Capture
We deployed the net in the moon pool around 20:00 on February 10th, 2008. We attempted to capture the seal at around 12:30. While the seal was "sleeping" at the surface, we gently pulled the net to close the moon pool. Once trapped, the seal dove violently and bounced back when it hit the net. People pulling the "green" ropes had to keep pulling hard to prevent the seal to escape from the gap created between the net and the pipes in the moon pool. The net was thus deployed at an angle. The seal kept diving and bouncing back on the net until it found a small gap between the wall of the moon pool and the net and escaped. This gap was created due to the angle we gave to the net and the difference of pulling strength and lack of synchronisation from the 4 net deployers. We came to the conclusion that the net, as designed, was not functional to catch a seal, due to the configuration of the moon pool and the human factor.

After multiple trials and a lot of brain storming, a new net was designed using the mesh from the helicopter cargo (10" stretch mesh) and the same frame. Net deployment would be similar to the first net but the size of the mesh and of the net itself would make the difference. The new net is not tensed on the frame but instead is loose, creating a big pouch. The idea is that when the seal will be trapped and will dive, it will go down in the pouch, will not bounce back and eventually will get entangled in the mesh.

Trials of the new net in the moon pool were conclusive. Some drawbacks still persist though:

1) the mesh is not heavy enough to sink properly and there are risks for the seals to get entangled in the net when still in a resting position. This could result in the seal being drown without being noticed by the team.
   - a possible solution would be to attached a lead line or leads to the bottom of the pouch to have the mesh lying down the wall when the net is in "resting" mode

2) the net as built is relatively heavy and concerns have been raised on how heavy it will be to lift the net up when a seal will be caught.
   - an option would be to use a mesh made in monofilament like lumpfish nets used by hunters and scientists to catch ringed seals in the Belcher Islands.

3) it could be potentially dangerous and not very functional to pull up the net manually and with the rope provided.
   - an option would be to have a bigger rope and/or to use pulleys to pull up the net. There are good spots on top of the moon pool to fix such devices.

Conclusion

Even if no seal has been caught and deployed during the 3 weeks we spent on board, it was a very fruitful trip. We ruled out the net as designed in the first place as a good seal catching device in the moon pool and created a new design that should be more functional. We worked in close collaboration with the Captain, chief officer and crew members to deploy the net in the best conditions and improve our technique. It is too bad we were not able to try the new net out, but since we moved a lot after February 14th, no seal came in the moon pool. We are confident though that a future attempt to catch seal on board the CCGS Amundsen will have more chances to be successful.

Acknowledgements

We are thankful to all the crew members of the Amundsen and to our fellow scientists who helped in many ways to keep our hopes and motivation high, and to have made this trip a success after all. We would like to thanks particularly Martin for his endless dedication at watching the moon pool day and night; Pierre, Stephane, Nicolas and Pierre-Olivier without who we wouldn't have a functional net; Clement and Frederic who volunteered to be part of the seal catching team and get to pull many times on the ropes for nothing; and Stephane, Rene, Dan and Robbie who were very supportive of our work and made it possible.

2.5. Team 6

2.5.1. Gas Fluxes

PIs: Tim Papakyriakou (U of M), Helmuth Thomas (Dalhousie), Jean-Louis Tison (U.L.B.)
Participants: Frederic Brabant (U.L.B.), Bruce Johnson – 6a (U of M), Brent Else – 6b (U of M), Helmuth Thomas (Dalhousie)

Surface Meteorology and Flux Project
Brent Else

Introduction
The surface meteorology and flux program (CFL Team 6) is designed to record basic meteorological conditions and to study exchanges of momentum, heat and mass across the atmosphere-sea ice-ocean interface. The main value of this program to the overarching objectives of Team 6 is the direct measurement of CO_2 fluxes.

Fluxes of CO_2 are measured by the eddy covariance technique, which is dependent only on atmospheric measurements. Although measurement of these fluxes is extremely useful information, it is essentially meaningless without an understanding of the processes (physical, biological and chemical) that drive gas exchange. In an open-ocean situation this context is largely provided by measurement of sea-surface pCO_2, but the situation becomes much more complex when a sea ice cover is included in the equation.

This section of the CFL Team 6 cruise report reviews the atmospheric and sea surface pCO_2 measurements that were made during Leg 6. Other sections of the report will deal with the sea ice measurements that were made in support of the CO_2 flux measurements.

Micrometeorology and Eddy Covariance Flux Tower

Methods

The micrometeorological tower located on the front deck of the Amundsen (Figure 1.1) provided continuous monitoring of meteorological variables and eddy covariance parameters. The tower consists of slow response sensors that record bulk meteorological conditions (air temperature, humidity, wind speed/direction, surface temperature) and fast response sensors that record the eddy covariance parameters (CO_2/H_2O concentration, 3D wind velocity, 3D ship motion, air temperature) (Table 1.1). In addition, radiation sensors (Figure 1.1, Table 1.1) were installed on the roof of the wheelhouse to provide information on incoming longwave, shortwave and photosynethetically active radiation. All data was logged to Campbell Scientific dataloggers; a model CR5000 logger was used for the eddy covariance data, a CR1000 logger for the slow response met data, and a CR23X for the radiation data. All loggers were synchronized to UTC time using the ship's GPS system as a reference.

The eddy covariance system on the tower makes use of two separate gas analyzers and a single 3D sonic anemometer. The dual gas analyzers system allows us to make use of both closed path and open path eddy covariance systems. The open path gas analyzer has the benefit of making measurements concurrently with the sonic anemometer, but the closed path gas analyzer is not as easily disturbed by adverse weather conditions.

In order to make sure that the two systems are comparable, careful calibrations were performed on both instruments. The closed path system is based on a LI-7000 gas analyzer which employs two optical cells, one of which was used to monitor the drift of the instrument by constantly passing a stream of ultra-high purity N_2. In addition, the sample cell of the instrument was calibrated daily using the ultra-high purity N_2 to zero the CO_2 and H_2O measurements, and a reference gas of known CO_2 to span the instrument. Occasionally, a span calibration of the H_2O sensor was performed using a dew point generator (model LI-610). In the previous leg, we encountered a problem with the LI-7500 instrument under extremely cold conditions. In light of this problem, and given that atmospheric conditions make the LI-7500 very difficult to operate in the cold, the open path sensor was not used for the majority of this leg.

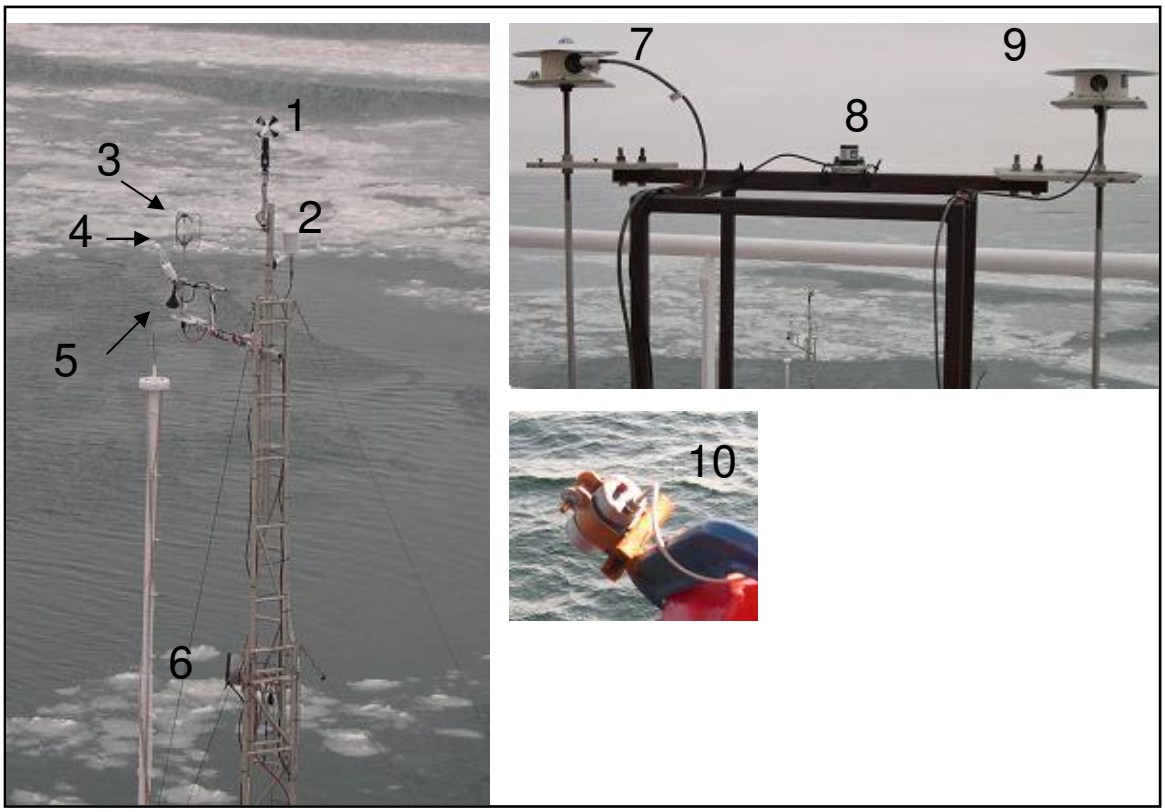


Figure 1.1: Meteorology and flux program instrument setup. See Table 1 for description of instruments based on the numbers. Note that on Nov. 18 the Motion Pak (6) was moved to the rear face of the tower to facilitate easier motion correction.

Table 1.1: Description of instruments shown in Fig. 1.1.

Fig 1	Sensor	Variables	Units	Ht from deck (m)	Scan (s) / Ave (min)	Specs
1	wind monitor (RMYoung 05103)	wind speed/directio	m/s; °	8.45	2/1	±0.6 m/s ±3° deg
2	temperature/relative humidity probe (Vasailla HMP45C212)	T and RH	°C; %	7.53	2/1	Humidity ±2% 0-90% @ 20°C ±3% 90-100% @ 20°C 0.05% RH/°C Temperature ± 0.1 °C
3	3D wind velocity (Gill R3 ultra-sonic anemometer)	u,v,w, speed o sound (SOS)	m/s	7.1	10 Hz	RMS noise <1% offset <0.01 m/s SOS < 0.5% accuracy
4	LI7500 open path gas analyzer	CO_2/H_2O	µmol/m^3 mmol/m^3	7.1	10 Hz	RMS noise ±0.1 µmol/mol zero drift 0.1 µmol/mol/°C gain drift 0.1%/°C
5 (inlet, analyzer not shown)	LI7000 closed path gas analyzer	CO_2/H_2O	µmol/m^3 mmol/m	inlet at 7.1	10 Hz	RMS noise ±0.1 µmol/mol zero drift 0.3 µmol/mol/°C gain drift 0.2%/°C
6	multi-axis inertial sensor (MotionPak, Systron Donner)	rate x,y,z accel x,y,z	°/s; g	6.48	10 Hz	rate <0.004°/s acc <10 µg
7	pyranometer (Eppley, model PSP)	SW_in	W/m^2	7.0	2/1	~±5%

8	quantum sensor (Kipp & Zonen, PARLite	PAR	µmol/m^2/s	7.6	2/1	~±5%
9	pyrgeometer (Eppley, model PIR)	LW_in	W/m^2	7.0	2/1	~±10%
10	surface temperature (Everest infrared transduc model 4000.44ZL)	Tsrfc	ºC	1.6 m	3/1	±0.5 ºC accuracy
not shown	pressure transducer (RM Young, 61205V)	Patm	kPa		2/1	

Sample data

As an example of the slow response meteorological data, Figure 1.2 shows the evolution of air temperature and wind speed over one day at Station D29 (a first year sea ice floe with a mean level ice thickness of ~120cm). An example of the rapid response flux data is shown in Figure 1.3, which shows 10 minutes of vertical wind speed and CO_2 concentration. A great deal of processing will be required to calculate actual fluxes of CO_2, and to filter out erroneous data.

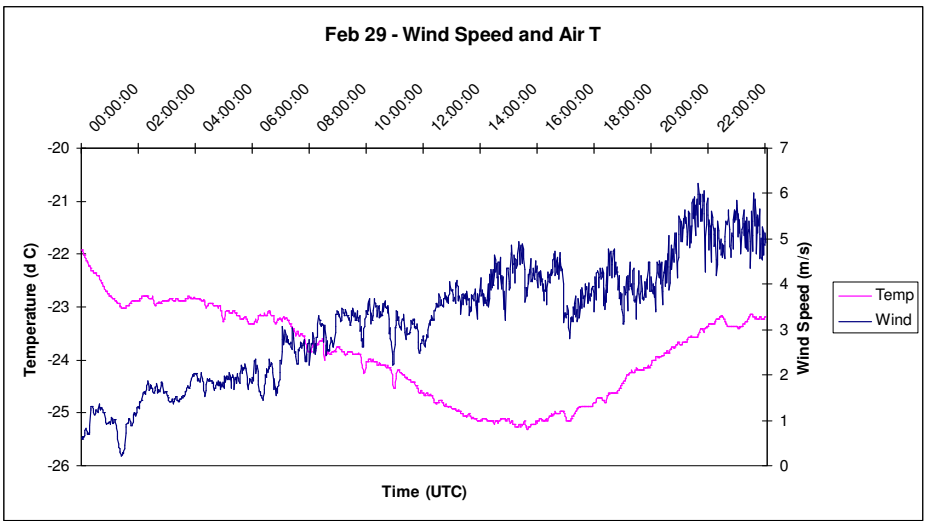


Figure 1.2: Slow response meteorological data example; wind speed and air temperature (24 hrs).

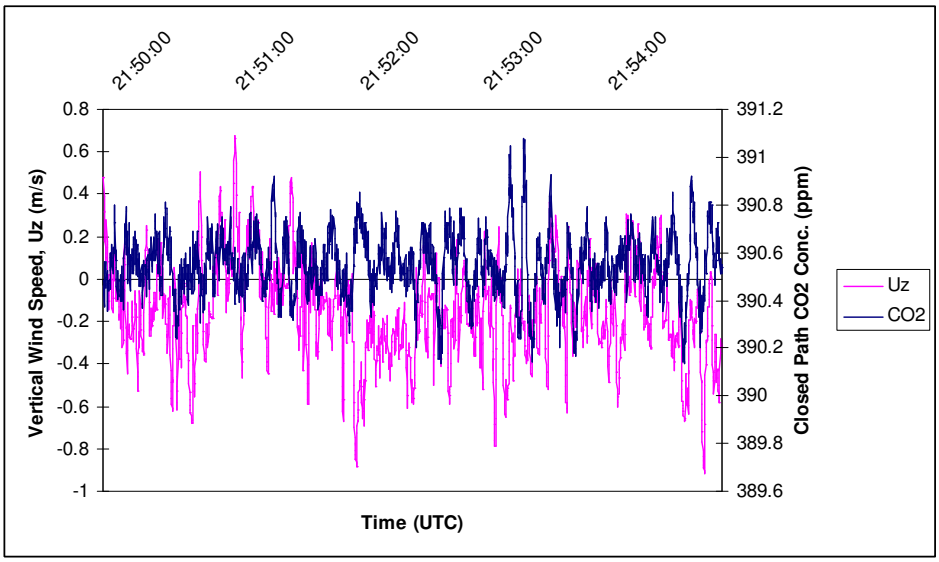


Figure 1.3: Fast response flux data example; vertical wind speed and closed path $_{CO2}$ concentration (10 min).

Notes
The meteorological tower ran consistently for the duration of the leg (Jan 30 –Mar 13) with the exception of brief periods when the tower was taken down for maintenance. However, for significant periods of time during the leg certain sensors were inoperable due to atmospheric conditions. The most common problem encountered during this leg was riming due to the cold, moist conditions. The extent of data lost due to atmospheric conditions cannot be estimated at this time, and will only be known once post processing is complete.

On-track pCO_2 System
Methods
A custom-built pCO_2 system was utilized on this leg to measure dissolved $_{CO2}$ at the sea surface in near real time. The system (Figure 1.4) is located in the engine room of the Amundsen, and draws sample water from the ship's clean water intake. The water is passed into a sealed container through a shower head, maintaining a constant headspace. This set up allows the air in the headspace to come into equilibrium with the CO_2 concentration of the seawater, and the air is then cycled from the container into a LI-7000 gas analyzer in a closed loop. Thermocouples are used to measure water temperature immediately before entering the equilibration chamber, and to measure the temperature of the air in the chamber. All data is logged to a Campbell Scientific CR1000 datalogger.

The LI-7000 gas analyzer was calibrated daily using ultra-high purity N_2 as a zero gas, and a gas with known CO_2 concentration as a span gas. Spanning of the H_2O sensor was not necessary because a desiccant column removes H_2O from the air stream before passing into the sample cell. As with the closed path system, a stream of N_2 is constantly cycled through the reference cell of the LI-7000 to monitor and correct for drift of the instrument.

Figure 1.4: The on-track pCO_2 system located in the engine room of the Amundsen. The equilibration chamber is the clear cylinder (left bottom) and the gas analyzer is the box with the digital display.

Sample Data
Figure 1.5 shows an example of a single day of CO_2 data recorded by the on-track system, along with water temperature. Further processing must still be undertaken to correct the values for changes in temperature that occur due to the length of the sample line, and to properly calculate pCO_2.

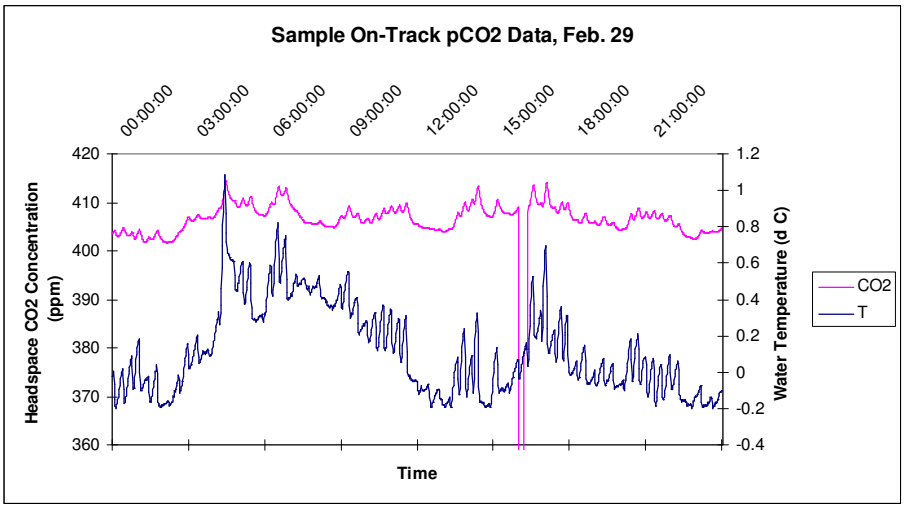


Figure 1.5: Sample on-track pCO_2 data (CO_2 and water temperature). The drop in pCO2 at 15:00 corresponds to a calibration run.

Notes
The on-track pCO_2 system was active for the duration of the leg, with some minor interruptions for maintenance. Major interruptions in data collection were experienced when the ship was breaking ice, which either reduced the flow of water into the equilibration tank, or completely blocked it. In the case of blocked flow, the data is lost, but tests will have to be conducted to determine if data obtained with low water flow is useful. The only change to the system on this leg was the addition of an electric solenoid valve that is triggered by a floating switch if the water level becomes too high.

CO2 in Sea Ice Project
Brent Else/Frederic Brabant

Introduction
The primary focus of Team 6 is to gain a better understanding of the cycling of climatologically important gases in Arctic seas. A large base of knowledge already exists regarding air-sea gas exchange, but considerably less is known about the exchange of gases in an ice covered ocean. During CFL Leg 6, a sampling program was carried out to examine CO_2 in sea ice with the goal of creating a context against which measurements made by the eddy covariance flux system (section 1) can be interpreted.

To gather this contextual information, several different methods were used to understand the distribution of CO_2 in sea ice. To determine fluxes of CO2 directly associated with the sea ice, a flux chamber was used. This sampling provides a very unique dataset that will allow us to understand the state of sea ice with respect to CO2 early in the ice growth season. Ice cores and surface water samples were also taken to analyze DIC/TA content.

Peepers
No peepers were deployed during this leg, in an attempt to conserve some peepers for the upcoming fast ice camp.

Brine Sampling
No brine samples were attempted during leg 6a due to personnel constraints. During leg 6b, attempts to collect brine were made, but the cold temperatures made it difficult to obtain a measurable amount of brine.

Flux Chamber

Methods

When measuring fluxes of CO_2 with the eddy covariance system, there is always some ambiguity regarding the "footprint" of the measurement. This is a problem when dealing with a highly spatially variable icescape such as the one encountered in Leg 6. To resolve some of this ambiguity, a flux chamber was deployed over certain ice types to directly measure the flux of CO_2.

The flux chamber is a sealed cylinder connected the LI-820 gas analyzer used in the peeper and brine experiments (Figure 2.1). Gas is continually cycled through the chamber and the analyzer in a closed loop, and 1 second measurements are recorded as 30 second averages on the CR10X datalogger. A small fan in the top of the flux chamber homogenizes the air to ensure that a gradient of CO_2 does not build up in the chamber. The theory of operation is quite simple – if the concentration of CO_2 in the chamber changes, a flux of CO_2 must be occurring related to the sea ice. Normally, ice cores were taken in conjunction with these measurements for salinity and temperature profiles.

Figure 2.1: Deployment of the flux chamber. Gas analyzer is located in the white cooler.

Sample Dates and Locations

During Leg 6, we were able to collect flux data over very thin ice; something we have not measured in previous legs. The thin ice that was sampled was either "artificially created" by the broken track behind the Amundsen, or in natural leads.

Table 2.1: Deployment dates and locations of flux chamber. All times UTC.

Station	Date/Time	Notes
D26	Feb 26, 2245	-3 runs on 17cm ice behind ship
D26	Feb 27, 2230	-3 runs on 22.5 cm ice behind ship
D26	Feb. 28, 2145	-3 runs on 23.5 cm ice behind ship
D26	Feb. 28, 2330	-3 runs on new natural flaw lead near the ship (5cm thk)
D26	Feb. 29, 2230	-3 runs on 26.5 cm ice behind ship
??	Mar. 1, 2100	-2 runs on 16cm ice at newly formed lead
??	Mar 4, 1700	-2 runs on 15cm ice at newly formed lead

Sample Data

Figure 2.2 shows sample data from a run over thin ice at a newly formed lead near station D29. The data shows a clear outgassing of CO_2. This is an interesting result that was not observed in previous legs.

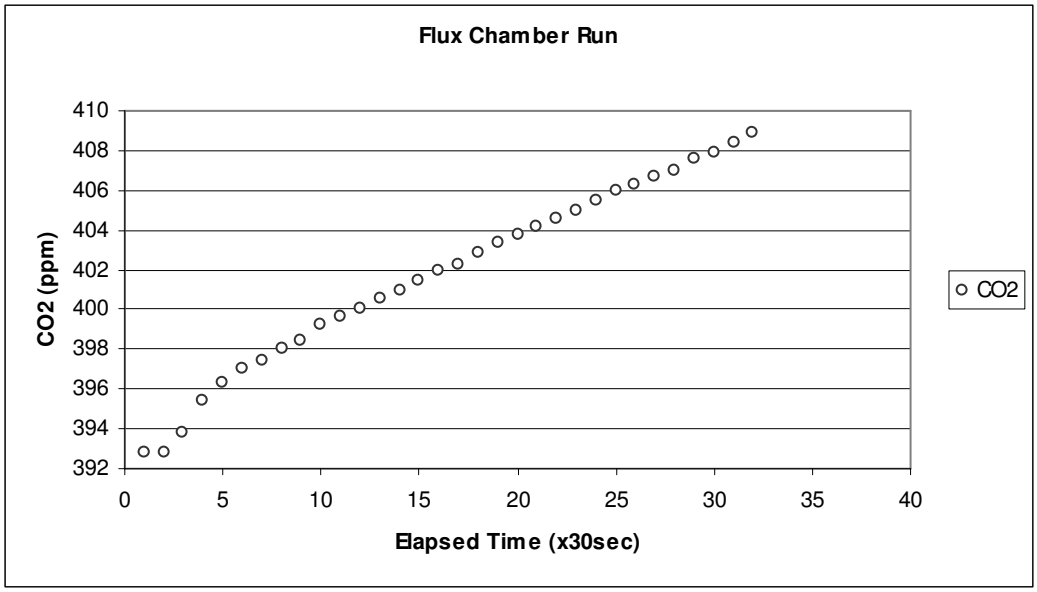


Figure 2.2: Sample flux chamber data over newly formed lead, Feb 28 (5cm thick)

Dimethyl Sulphur (DMS) Project
Frederic Brabant

Introduction
I was here as a PhD student from Universite Libre de Bruxelles (U.L.B.) to go on with the collaboration between Belgian (team leaders: Dr Jean-Louis Tison and Dr Bruno Dellile) and Canadian scientists on CFL studying the sea ice biogeochemistry in a climate change perspective within Team 6 (Gas Fluxes). As previously mentioned, this collaboration is expected to continue until the end of Leg 8B.

Aim of the study
In order to better understand the impact of the sea ice biogeochemistry on the dynamic of the climatically significant gases (CO_2, DMS), multi-parametric analyses have to be conducted. The table below (Table 3.1.) shows the measurements that are routinely performed in the framework of such a multi-parametric analysis.

Table 3.1: List of parameters that will be analysed by the Belgian members of Team 6

List of Variables
Temperature
Salinity
$\delta^{18}O$
Thin Sections
DMS,P,O
Total gas content
O2, N2, CH4, Ar, CO2
Nutrients
Chla
Iron and TM

As previously mentioned, such a data collection should allow a better understanding of the processes driving the gas dynamics in sea ice at different periods of the year, necessary for further modelling purposes. In the framework of both Gauthier Carnat's project (University of Manitoba – Legs 4B, 8 A&B) and my own research project, I was focusing during this Leg on the dynamics of CO_2

(collaborating with Brent Else and Bruce Johnson on this leg) and DMS (and related compounds DMSP and DMSO) both within the sea ice cover and at its interfaces (atmosphere and ocean).

Material and methods

Field measurements

The participation to CFL Leg 6 A&B, allowed us to sample and perform measurements on cold winter sea ice (main station with complete set of biogeochemical variables), which is of primary importance since few studies have been previously focused on this period of the year. As already mentioned above, the opportunity was also given, during this leg, to sample and carry out fluxes measurement on newly formed ice ('flux chamber' stations with CO_2 flux measurement at the ice surface, ice temperature and salinity at 2 cm resolution). Location and sampling time of the main stations are given in the table below. See above for the information above the 'flux chamber stations'.

Table 3.2 Location and sampling time of the main stations

Date	Coordinates	Type of station	Average ice thickness
02/06/2008	N 71°04.623 W 124°49.009	Complete	59 cm
02/25/2008	N 70°58.250 W 123°54.970	Complete	123 cm
03/08/2008	N 71°01.357 W 123°51.765	Complete	124 cm

For each station the work has been organized as follows:

1) Ice sampling: a minimum of 10 ice cores has been taken for each main station, using our non-contaminating drilling equipment. Each core is generally dedicated to the study of one variable of the variables given in the table 3.1. A short description of each core (breaks) was made on the field. Most of the ice cores will be shipped back to Winnipeg or Belgium for further analysis. Ice cores have also been taken for people from other teams.
2) In-situ data collection: using a temperature probe and a drill, the ice temperature has been measured at 5 cm resolution. The same resolution will be used for the other parameters. Once back on the ship, this temperature core is processed for bulk salinity measurement. Other general observations have also been made on the field including temperature, freeboard and snow thickness measurements. The next figure shows an example of those observations for one station.

Laboratory work

Here below is a list of the variables measured on the ship or of the samples prepared for further measurement.

Salinity and $\delta^{18}O$

Using a calibrated conductivimeter, bulk ice salinity has been measured on melted ice samples at a resolution of 5cm for the main stations and 2m for the 'flux chamber stations'. The same water was then used to fill in small $\delta^{18}O$ vials for further analysis.

Chl_a

With the help of Dr. Maria Estrada (ICM, Barcelona), the Chl_a level was measured for each main station. Considering the low Chl_a levels usually observed in the ice during this time of year (very low light input), we decided to filter melted ice for every 15 cm instead of the usual 5 cm spatial resolution. This represents a total amount of 20 measurements.

DMS, DMSP, DMSO

Using a special 'dry- extraction technique by crushing', Dr. Maurice Levasseur's "purge and trap system" and a gas chromatographer, we analysed the DMS concentration in the ice at a spatial resolution of 5 cm for the main stations for a total of 63 measurements. See Gauthier Carnat's report (leg 4B) for further details about the method.

By addition of NaOH pellets to the crushed ice, we turned DMSP into DMS and measured 63 concentrations of DMSP. Ice powder from each sample was collected in 20 ml vials for further DMSO measurements in Belgium.

In total, more than 120 samples of ice, water and brines were analyzed.

Other Variables

Additional studies (see table 3.1) will be undertaken in Brussels or Winnipeg later this year, when the ice cores will have been shipped back from the Arctic.

Example of data

As an example, we show some results and profiles obtained during the cruise.

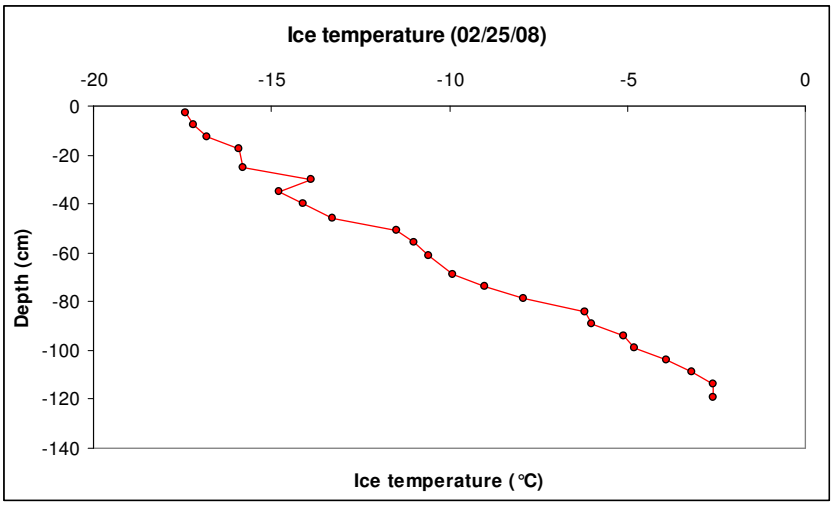


Fig. 3.1 Temperature profile for station 02/25/08

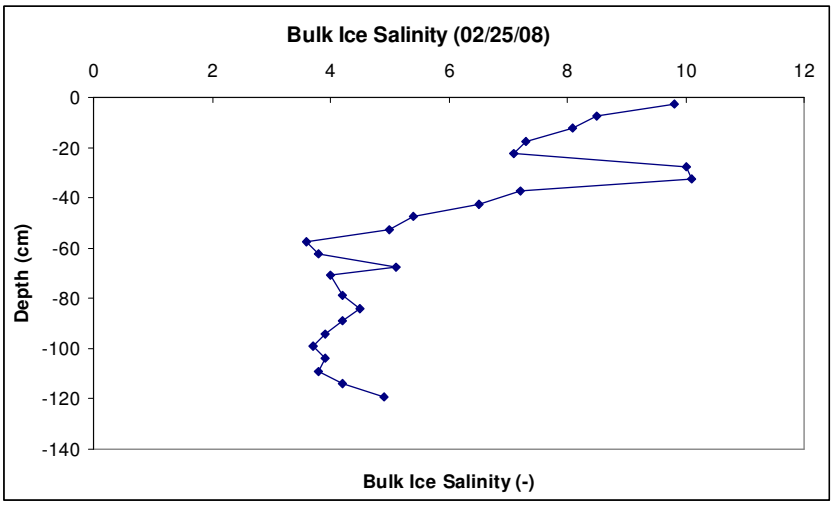


Fig. 3.2 Salinity profile for station 02/25/08

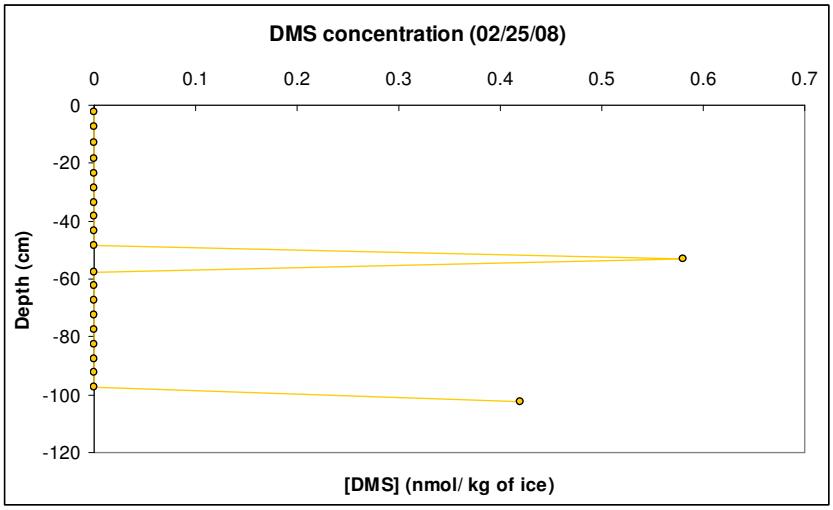


Fig. 3.3 DMS profile for station 02/25/08

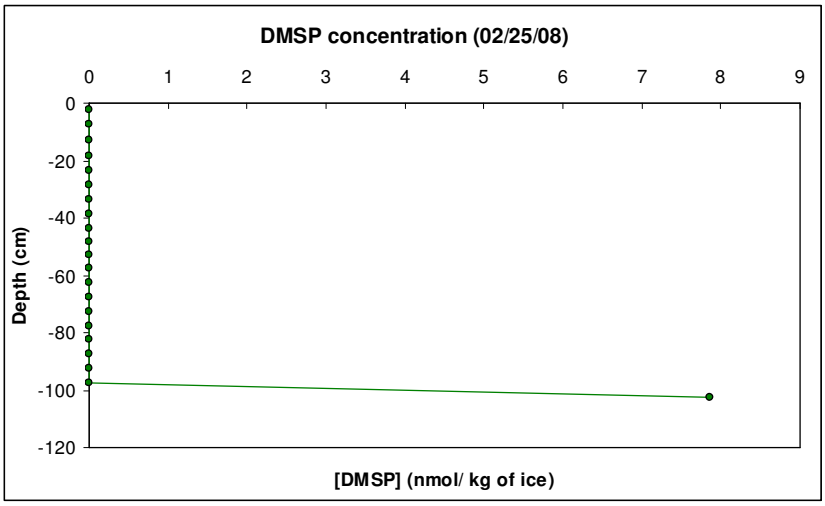


Fig. 3.4 DMS profile for station 02/25/08

Outreach

We took part in some outreach activities during this leg what giving us the opportunity to let people from general public know a bit more about the importance and the interest of the CFL experiment. We worked in collaboration with Bartley Kives and Wayne Glowacki (Winnipeg Free Press) in order to publish a popularization article as well as an interactive slideshow mainly focused on Team 6 research activities during CFL. Oportunity was also given to accompany students from the 'Schools on Board' program during fieldtrip and laboratory activities.

Dissolved Inorganic Carbon (DIC)/Alkalinity Project

Brent Else

Introduction

During this leg, DIC/TA samples were occasionally taken from ice cores and from surface water under the ice. The purpose of this study was to support flux measurements (chamber and tower) by observing the carbon dynamics within the ice and immediately below it. This also augments DIC/TA samples taken from the CTD/Rosette, since surface water cannot be sampled through the moon pool. Due to personnel constraints, no samples were taken during Leg 6a, and samples were limited during Leg 6b. However, samples of thin ice were taken in Leg 6b, which helps fill a data gap from previous legs.

Methods
Where ice was thick enough, conventional ice cores were taken. The cores were packaged in a well-sealed core sleeve, and transported in a box with cold packs frozen at -80 ^{0}C to the cold lab (-20 ^{0}C) on the ship. In the cold lab the cores were immediately sectioned and placed into gas impermeable Tedlar bags. The bags have a small valve, from which air was removed using a vacuum pump. The core samples were allowed to melt at room temperature, and were then transferred into DIC bottles, spiked with $HgCl_2$ and analyzed for DIC/TA. Over thin ice, samples were extracted by more crude methods (saws, ice chippers) and placed directly in the Tedlar bags. From that point, the same procedure as above was conducted.

For surface water samples, several methods were used for sample collection. When sampling on the ice (conventional cores) a small pump was used to collect surface water. When sampling over thin ice (i.e. in the ice cage) water was either sampled by carefully immersing the DIC bottles, or from a Niskin bottle. Whenever possible, pH samples were taken as well. Generally, surface casts using a portable CTD were made in conjunction with surface DIC/TA/pH samples.

Sample Dates/Times/Locations
Table 4.1 lists the samples taken during Leg 6.

Table 4.1: DIC/TA/pH sample locations/dates

Station	Date/Time	Notes
??	Mar 1/2200	-Sampled bulk ice, surface water and 1m water for DIC/TA in newly formed lead (ice thickness 16cm)
D29	Mar 8	-DIC/TA core, with surface water sampled by pump. pH for surface water.
D30	Mar 9/~2230	-DIC/TA at 1m, 5m, 15m and 30m from Niskin bottle in ice cage over open lead. 2 hours later sampled newly formed ice for DIC/TA (2cm thick).

2.5.2. OASIS

Team members: Jan Bottenheim[1], Ralf Staebler[1], Alexandra Steffen[1], Patrick Lee[1], Paul Shepson[2], Phil Tackett[2], Jim Whiteway[3], Jeff Seabrook[3], Vlad Popovici[3], Udo Friess[4], Leif Vogel[4], Denis Poehler[4]

[1] Air Quality Research Branch, Environment Canada
[2] Purdue University
[3] York University
[4] Universität Heidelberg

Introduction
In 1986, independent reports of surface O_3 depletion were published from the Arctic coastal Global Atmospheric Watch (GAW) stations Alert and Barrow (Bottenheim et al., 1986; Oltmans et al., 1986). This depletion appeared to occur after Polar sunrise hence suggesting that this was a photochemically driven process. Pursuit of a causal relationship in photochemical O_3 destruction led to the discovery by Barrie et al. (1988) that O_3 depletion occurred in concert with large increases in particle-phase bromine, leading the authors to hypothesize the following chain reaction:

$$Br + O_3 \rightarrow BrO + O_2 \qquad (1)$$
$$BrO + BrO \rightarrow 2Br + O_2 \qquad (2)$$

This hypothesis is now confirmed through the observation of tropospheric BrO radicals during O_3 depletion episodes (Hausmann and Platt, 1994). Observations from space show enhanced BrO columns in polar spring over areas exceeding 10 million square kilometers in sea-ice covered Polar Regions (Richter et al., 1998) but to date only limited, short term observations have been made on the ocean surface, mostly near Alert, NU (Hopper et al., 1994, 1998; Bottenheim et al, 2002; Morin et al., 2005). A major gap in understanding the depletion chemistry is the role of various oceanic surfaces in halogen activation and subsequent O_3 and Hg depletion (Simpson et al., 2005).

Since the discovery in 1995 of atmospheric mercury depletion events (MDEs) at Alert, NU, (Schroeder et al., 1998) the understanding of cycling of Hg in the polar atmosphere has dramatically changed. During the spring elemental Hg is transformed in the atmosphere to a more reactive species that appears to be deposited to snow and ice. Models suggest that up to 300 tonnes of Hg could be deposited to the Arctic environment each year from MDEs alone (Lu et al., 2001), but cause and effect are still uncertain. For instance, the location where MDEs originate is unclear, key processes involved in creating the depletion episodes are poorly identified, and the identity of the atmospheric end-products is still largely a mystery. As a result it is also unclear whether the bulk of the deposited Hg enters the ecosystem or is reemitted into the atmosphere once the snow melt starts.

The various OASIS activities on board the Amundsen under the umbrella of IPY-CFL aim to improve our understanding of the details of these ozone and mercury depletion episodes. Direct measurement of halogen oxides and halogenated VOCs by Phil Tackett & Paul Shepson (Purdue) will shed light on the ozone destruction chemistry. Measurement of BrO using one active DOAS and two passive MAX-DOAS instruments by Leif Vogel and Denis Poehler (Heidelberg) will give us information on the spatial and temporal variations of BrO. Vertical ozone profiles are obtained using an ozone LIDAR operated by Jeff Seabrook, Vlad Popovici and Jim Whiteway (York). A sodar provides wind profiles and information on the structure of the boundary layer, which will be related to the ozone profiles (Ralf Staebler, Environment Canada). An ozone eddy covariance flux system has been added to the energy & CO_2 flux system at the bow of the Amundsen (Ralf Staebler). And last but not least, a mobile measuring system constructed by the Environment Canada OASIS team, the so-called OOTI (Out-On-The-Ice) sled, is being deployed on surfaces thought to be active sites of heterogeneous chemistry to determine their relative significance, to measure ozone, mercury and energy fluxes as well as BrO and the micrometeorological conditions.

Atmospheric Halogen Chemistry

Philip Tackett, Purdue University

As part of the OASIS campaign, I investigated Arctic surface-to-atmosphere interactions through the quantitative measurement of halogen oxides and various halogenated volatile organic compounds (VOCs). With support from the National Science Foundation's Office of Polar Programs (USA), a new chemical method was developed at Purdue University for the quantitative determination of halogen oxides during 2007. This new method was first deployed aboard the CCGS *Amundsen* as part of the Circumpolar Flaw Lead System Study during IPY 2007-2008. This method operates by drawing halogen atoms and halogen oxides into a flowing chemical reaction chamber, where they undergo rapid reaction with a fluorinated alkene and nitric oxide to produce a stable ketone product that is detected by gas chromatography with electron capture detection.

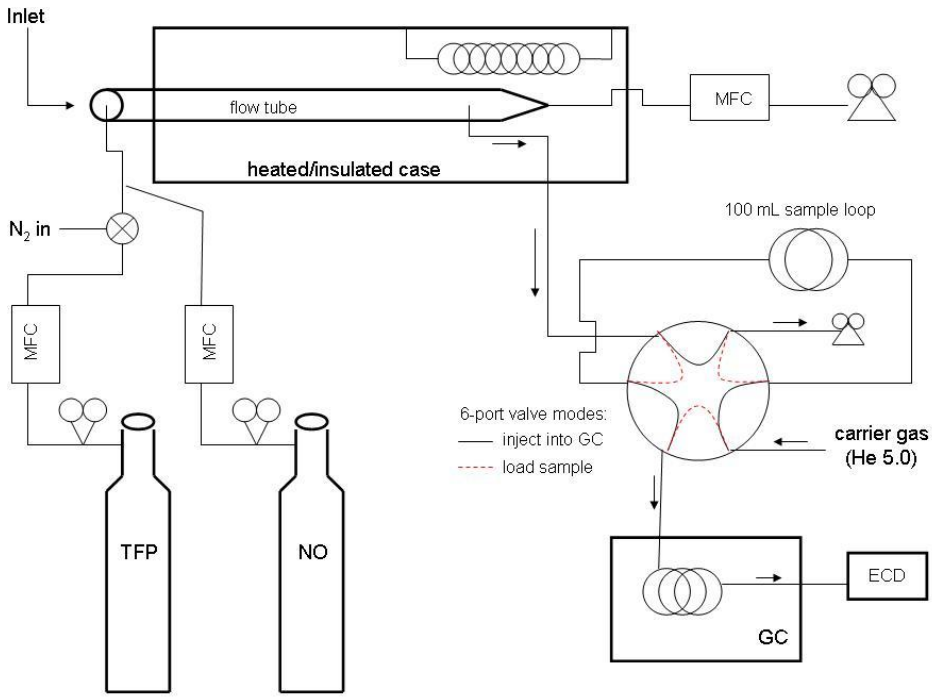


Fig 1**:** Complete flowing reaction chamber instrument schematic

The instrumentation arrived on the *Amundsen* on 2 Feb 2008, and was operational on 5 Feb 2008. Samples were collected throughout Leg 6, during various weather events and sampling locations. As expected, halogen oxides (specifically BrO) remained undetected until the local ozone concentration decreased from the typical ambient mixing ratio of approximately 40 ppb. Several halogenated VOCs, including bromoform and dibromomethane, were detected at varying mixing ratios throughout the duration of the campaign, even when halogen oxides were not detected. There were two very brief nighttime periods of ozone depletion upon which halogen oxides were detected, which is likely due to the advection of ozone-depleted and halogen-enriched air from beyond the local atmosphere. These were followed by a 48-hour period of continuous ozone depletion in early March, in which ozone dropped to a mixing ratio of less than 10 ppb. Halogen oxides were also detected during this time period, and dropped below the limit of detection upon the eventual rise of ozone concentration.

Fig 2**:** Reaction chamber mounted above instrumentation container

The instrument was deployed in a container on the uppermost deck of the vessel, with the reaction chamber mounted above the container. Special care had to be taken to ensure that the samples being collected were not affected by exhaust from the ship's stacks, located just aft of the container. The crew aboard the *Amundsen* during Leg 6 was of invaluable assistance throughout the campaign, helping to provide a well-equipped laboratory in a location ideal for the investigation of surface-to-atmosphere interactions. The data collected from this instrumentation will be combined with data from other CFL participants, including ozone, wind, and potential temperature vertical profiles, atmospheric mercury, and meteorological data, to develop a better understanding of the Arctic atmosphere and its interactions with the significantly changing sea ice conditions.

DOAS Measurements

Leif Vogel, Heidelberg University

As part of the OASIS project, the Institute of Environmental Physics (IUP), University Heidelberg, Germany is participating in the Circumpolar Flaw Lead by conducting remote sensing measurements of atmospheric trace gases in the planetary boundary layer. The applied Differential Optical Absorption Spectroscopy technique (DOAS) determines concentrations of gases of interest via their absorption structures in the measured spectral region. The main goal during Leg 6 and the first half of Leg 7 is the observation of Bromine Explosion, the sudden increase of BrO concentrations in the PBL with subsequent Ozon Depletion Events. Also other gases absorbing in the measured spectral range can be evaluated.

The measurement instruments are one passive Max-DOAS instrument and one Long Path DOAS (LP-DOAS) instrument. The Max-DOAS consists of an temperature controlled OceanOptics USB2000 spectrograph connected to an external telescope head via an optical fibre in order to measures spectra of scattered sunlight in a wavelength range between 310nm and 385nm at different elevation angles. Compared with sunlight at zenith angle, trace gases along the light paths of the respective elevation angle can be determined in the lower troposphere. The LP-DOAS instrument on the other hand uses an artificial broadband light source to send a collimated beam of light to retro-reflectors placed on the ice at 1.5km to 5km distance of the ship. The reflected light is measured at the ship with an Acton 300 spectrograph and contains absorption structures of the gases to be studied. Comparison of light which is send with the backscattered one allows the deduction of trace gas concentrations along the light path.

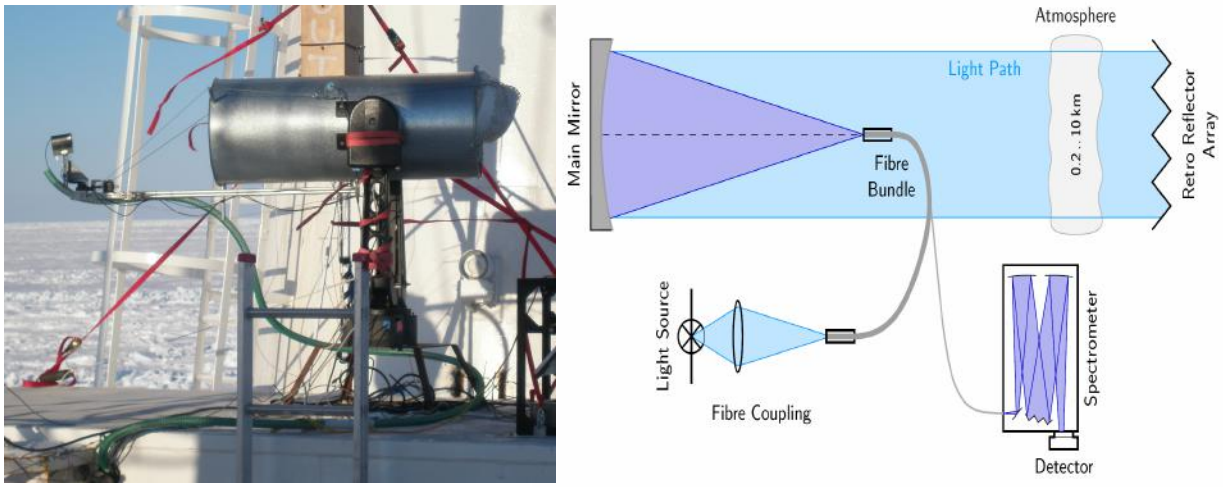


Fig. 3: (Left) LongPath DOAS set up. (Right) Telescope mounted on top of the OASIS container

Setting up the LP-DOAS was completed during the first week of leg 6. The loss of more than half of the available retro-reflectors during a snowstorm with subsequent movement of the ship was a major

setback. Unfortunately further tries of retrieval were unsuccessful due to the rapid movement and change of the ice caused by the strong winds.

Further measurement time was limited by the weather conditions and the necessity of ship movements, along with restrictions on possible light paths lengths.

The Max-DOAS instrument was installed on the 15th of Februar and is collecting data since. First data evaluations yield BrO concentrations below the detection limit until the end of February. Since the February 29th, BrO could be detected in low quantities on several days, but further data analysis and correlation with other measurements are necessary.

Ozone LIDAR Measurements

Jeff Seabrook, York University

The OASIS Tropospheric Ozone LIDAR is designed to measure back-scattered laser light in 4 separate wavelengths. By knowing the absorption characteristics of these wavelengths in regards to ozone, as well as their atmospheric scattering properties an ozone profile can be determined by directly comparing the backscatter signal of any 2 of these wavelengths. The LIDAR was installed at the beginning of LEG 6 and operated successfully for the first half of this leg.

Due to a malfunction of a critical component of the LIDAR transmitter (the laser head) that needed repair by the manufacturer, the LIDAR was non operational from Feb 20th to March 4th. The laser head was removed from the LIDAR and taken to the manufacturer in Bozeman, Montana, for repair on Feb 25th; these repairs were completed on Feb 29th.

On March 3rd we were able to return onboard with the repaired laser head and integrate it back into the LIDAR.

Since becoming operational on March 4th the LIDAR has performed well and has yielded some potentially interesting preliminary results regarding ozone concentrations during an ODE.

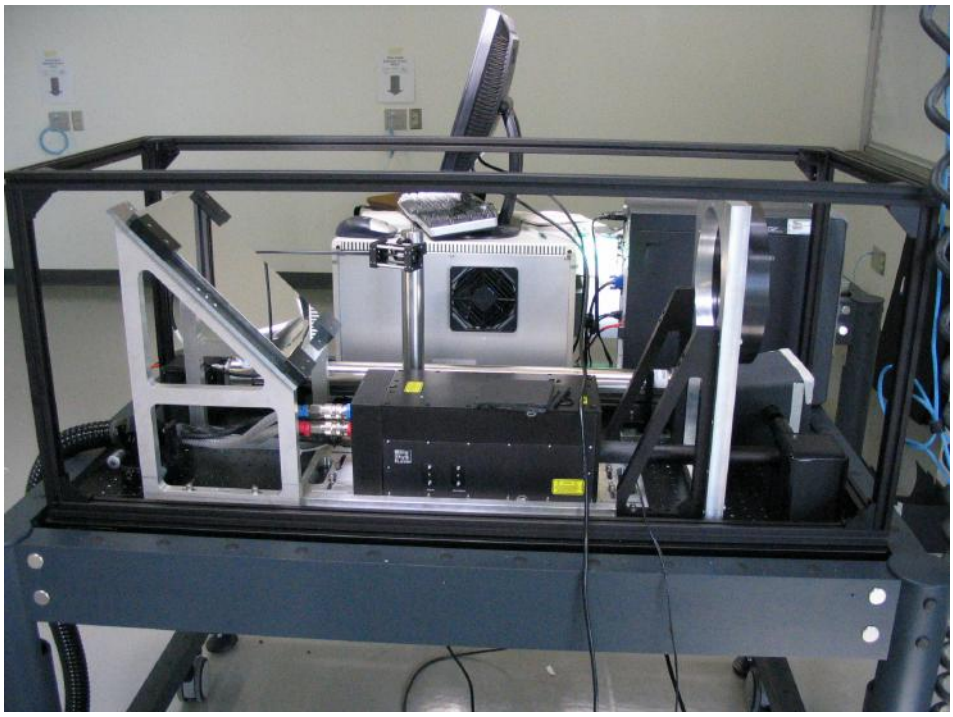


Fig. 4 Tropospheric Ozone LIDAR

OOTI Sled, Sodar and O_3 Fluxes

Ralf Staebler, Environment Canada

The OOTI (Out On The Ice) sled is a mobile measurement platform that has been developed at Environment Canada over the last 4 years, and earlier versions have been deployed at Alert as well as Barrow. The instrumentation consists of a MAX-DOAS (see 3. for details), vertical gradient systems for ozone, gaseous mercury and carbon dioxide, coupled with a sonic anemometer, a temperature profile, and basic meteorological parameters.

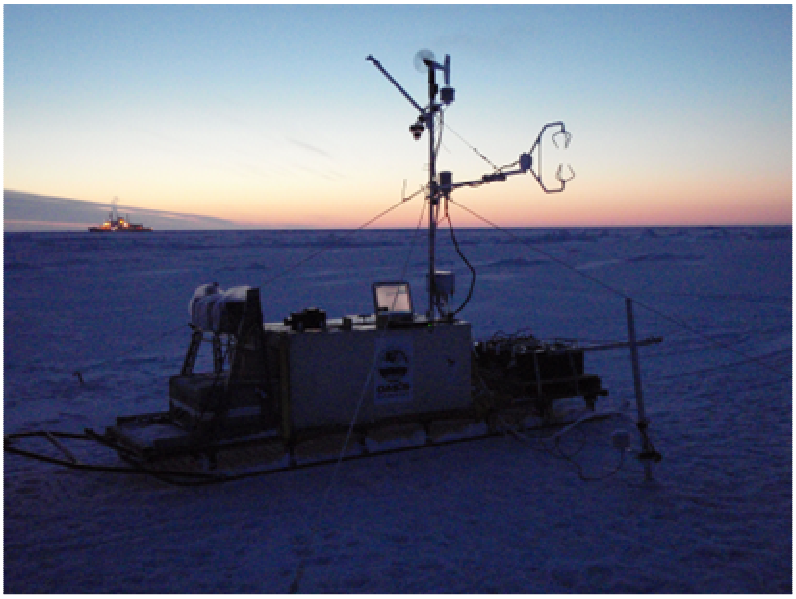


Fig. 5. The OOTI sled, about 1.2km east of the Amundsen, on 8 March 2008

This year, the OOTI Sled came off to a rough start. The computer responsible for data acquisition and instrument control inside the OOTI box was damaged beyond repair in transit from Toronto to the Amundsen, and a replacement had to be set up from scratch. It took more than 10 days to complete this job and involved a lot of improvisation, but on 5 March 08 the sled was deployed with (almost) everything working. The first site was 1.2 km west of the ship on ice about 1m thick. Late on 7 March 08 the sled was moved to relatively young ice (30cm thick) about 1 km east of the ship. We plan to deploy the sled as much as feasible over the next 3 weeks, and results will be shown in the report for Leg 7a.

The sodar (a Scintec MFAS with nominal range of 1000m) was set up for the first time on 6 March 08 about 50m east of the ship. Optimization of the operating parameters is still in progress. This instrument will let us relate the vertical profile of O3 with the thickness the stable boundary layer that develops in calm conditions and discern the relative importance of dynamics (i.e. mixing into the boundary layer from the free troposphere) and chemistry.

Fig. 6. The Scintec MFAS sodar next to the ship on 9 March 2008

The "fast ozone analyzer", an instrument based on detecting ozone by monitoring the photons produced in the chemiluminescent reaction of ozone with nitric oxide, has been operational since 2 March 08. It is set up to sample air in parallel with the CO_2 instrumentation in the Hg/CO_2 flux container on the bow of the ship, at a frequency of 10Hz, in order to calculate eddy covariance fluxes between the atmosphere and the surface. This will let us quantify the importance of surface uptake of O_3 in its overall budget in the lower atmosphere.

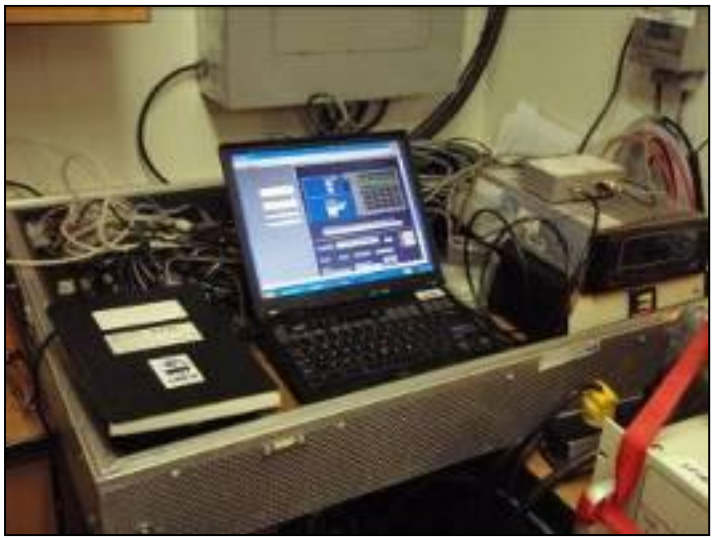


Fig. 7. The O_3 Eddy Covariance Flux Instrument

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2.5.3. Dissolved Inorganic Carbon System (CFL Teams 6 & 7)

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submitted by Helmuth Thomas
05.03.2008

The ocean's exchange of carbon dioxide with the atmosphere is governed by the biogeochemical cycling of carbon and physical processes throughout the water column, which determine the concentration of dissolved inorganic carbon (DIC) and total alkalinity (TA) in the surface waters. Out of the four measurable carbon system parameters (DIC, TA, pH and pCO_2), a minimum of two are needed to calculate the others and fully describe the inorganic carbon chemistry, over-determination of the system being beneficial. During CFL Leg 6, a total of 140 samples were analyzed for dissolved inorganic carbon and total alkalinity and to a lesser extend for pH, yielding two, and for some stations, three relevant parameters.

Water samples were collected in parallel with the weekly, or once per station nutrients rosette. Individual 250 ml bottles were used for DIC and TA, and pH was collected in a smaller plastic bottle. DIC samples were first to be taken from the Niskin bottles, and pH and TA followed immediately at individual casts and depths. If possible, DIC and TA samples were analyzed within 24 hours of sampling. The remaining samples were spiked with $HgCl_2$ and were stored in the dark at 4°C.

DIC and TA were analyzed on board using a VINDTA 3C (Versatile Instrument for the Determination of Titration Alkalinity) by Marianda. TA was determined by titrating a volumetrically accurate subsample using 0.1n HCl as titrant. For DIC analysis, a volumetrically determined subsample was acidified with 8.5% H3PO4 to convert all inorganic carbon into gaseous CO_2. The CO_2 is then stripped out of the sample using ultra-pure N2 gas, transferred into a coulometric titration cell and detected using the coulometric method (Johnson et al., 1993). Samples were analyzed for pH using a HP 8453 spectrophotometer; pH was be calculated using the absorbances measurements obtained from the coloration of water samples with Phenol Red and Cresol Purple.

In addition to water column sampling, an attempt was made to continue (to a lesser extent) the ice core work initiated by team 6 on the previous legs. To this end, ice samples were collected at drift stations. The top, middle, and bottom 10 cm of the core were cut and placed in plastic Tedlar bags – gas impermeable, with a clamp type seal and small spigot for withdrawing air or water. The ice samples were laid out to thaw then transferred to DIC bottles. These samples were analyzed for DIC, TA, and conductivity. In parallel, surface water samples were taken with a hand-held niskin bottles from below the ice and the upper meters of the water column

Table 1: Stations sampled for DIC, TA and pH during leg 6 (until March 6)

Station	LAT	°N min	LON	°E min	cast #	Date	DIC/TA	pH
D19	71	4.627	-124	48.998	0801012	04.02.08	x	
D19	71	4.614	-124	48.942	0801033	08.02.08	x	
D19	71	4.547	-124	48.127	0801053	11.02.08	x	
D22	71	19.333	-124	31.87	0801068	18.02.08	x	
D26	70	55.96	-123	56.15	0801079	25.02.08	x	x
D26	70	50.73	-123	36.78	0801100	29.02.08	x	x
D27	70	45.60	-123	27.46	0801103	01.03.08	x	x

References:

Johnson, K. M., K. D. Wills, D. B. Butler, W. K. Johnson and C. S. Wong. Coulometric total carbon dioxide analysis for marine studies: maximizing the performance of an automated gas extraction system and coulometric detector. Marine Chemistry, Vol. 44, pp. 167-187, 1993.

2.5.4. Barium (CFL Teams 6 & 7)

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submitted by Helmuth Thomas
05.03.2008

In the Canadian Arctic, barium (Ba) is mainly released from the North American continent and can therefore be used as a tracer for terrestrial freshwater input. Together with ^{18}O, a tracer for freshwater input from precipitation and ice melt, all freshwater sources to the Arctic can be quantified, thus providing complementary information to the CO2 system studies.

Samples for barium were taken from the rosette parallel to samples for ^{18}O, at approximate depths 5, 10, 25, 50, 75, 100, 150, 200 and 500 m. 15 ml nalgene bottles were rinsed three times, then filled and

spiked with 15 µl concentrated HCl. Sample bottles were sealed with parafilm and taken for later analysis using isotope dilution mass spectrometry.

Table 1: Stations sampled for Barium during leg 6 (until March 6)

station	LAT	°N min	LON	°E min	cast #	date
D19	71	4.627	-124	48.998	0801012	04.02.08
D19	71	4.547	-124	48.127	0801053	11.02.08
D22	71	19.333	-124	31.87	0801068	18.02.08
D26	70	50.73	-123	36.78	0801100	25.02.08
D27	70	45.60	-123	27.46	0801103	01.03.08

We appreciate support in sampling by Marie-Emmanuelle

2.6. Team 7

2.6.1. Carbon & nutrients fluxes

PI: Jean-Éric Tremblay (Laval University)
Samples taken by Clément Clerc and Marie-Emmanuelle Rail

Samples for nutrients and urea have been taken at the following stations:

Station	Date	Latitude	Longitude
2007-19D	04/02/08	71°04.627	124°48.998
2007-19D	08/02/08	71°04.614	124°48.942
2008-19D	11/02/08	71°04.547	124°48.127
2008-22D	18/02/08	71°19.333	124°31.870
2008-26D	25/02/08	70°55.960	123°56.158
2008-26D	29/02/08	70°50.736	123°36.779
2008-27D	02/03/08	70°45.607	123°27.461
2008-29D	08/03/08	71°00.940	123°46.478
2008-29D	11/03/08	71°00.940	123°46.478

Water was sampled at the following depths:
salinity of 33.1, 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300 and every 100 m up to the bottom.

Nutrients and urea samples are all frozen and will be analyzed on a further leg.

2.6.2. Marine Microbiology Group

Participants: Marta Estrada, Laura Alonso (Carles Pedrós-Alió team: Institut de Ciències del Mar, Barcelona, Catalonia, Spain), Beatriz Fernández (Connie Lovejoy team: Québec Ocean et Department de Biologie, Université Laval, Québec city, Québec, Canada

Introduction
Microorganisms are a heterogeneous group that include representatives of the three kingdoms of live, Archaea, Bacteria and Eukarya. Because of this heterogeneity these organisms accomplish key biogeochemical processes in the ecosystem. Autotrophic microorganisms are the base of the Arctic ocean trophic web, which comprises 7 orders of size magnitude, from the smallest cell, less than 1 µm microorganisms, to the largest mammals on the order of meters. All these organisms are strongly influenced by the lack of light during part of the year, the low temperatures and the ice cover. Comparing the species composition and activities of microbial communities in systems with diverse

chemical and physical regimes is a good way to learn more about the importance of the different forces that determine how microbes use organic and inorganic matter and how this influences other components of the food web. This knowledge is needed to better predict the consequences of natural or anthropogenic changes on these trophic dynamics. This will also help us to evaluate the system's ability to buffer these changes at short and long timescales.

Objectives
Our group had an ambitious sampling program to be completed during this leg. The different protocols done though this leg covered the work of 4 teams: Corina Brussard, Connie Lovejoy, Roxanne Maranger and Carles Pedrós-Alió. These protocols addressed different aspects of the microbial world, with the objective of giving a detailed view of the microbial diversity and processes occurring during the winter season.

Sampling
The sampling for this leg took place at the south and southwest off the coast of Banks Island. The comparison of samples gathered during the different wintering legs will allow a better understanding of the seasonal dynamic and the comparison of the different geographical areas will provide valuable information on the diversity and depth distributions of microbes.

Since the beginning of leg 6, we sampled at 5 stations (D19, D22, D26, D27, D28). The sampling dates and the localization of the stations can be found on Annex 1. Our strategy was to obtain microbiological data from specific water masses through the water column with a special focus on the nutricline, the upper mixed layer, and the deep waters. These water masses were identified during the downcast of the CTD, based on the readouts from the temperature, salinity, oxygen, nitrate, fluorescence, transmissometer and pH probes.

When possible, surface water from about 2 metres detph was collected through holes in the ice. These samples will be compared to the 12 meters surface water collected from the moon pool inside the ship.

Variables Sampled
A table summarizing the samples obtained during leg 6 can be found on Annex 2. A brief description of the protocols follows.

1. Molecular genetics

a. DNA sampling. Samples for DNA were collected on every station at 4 different depths. During DNA collection water was prefiltered through a 50 µm mesh, excluding larger organisms to be collected. Water was then filtered through a 3 µm polycarbonate filter and the same water was again filtered through a 0.2 m filter. This sampling protocol gives two different samples, one containing the DNA from 50 µm to 3 µm fraction (Large fraction) and one containing the 3 µm to 0.2 µm fraction (Small fraction). After collection samples are keeped at -80 ºC until processing in the Lovejoy laboratory in Université Laval. These samples will give valuable information on the biodiversity and distribution of microorganisms.

b. Metagenomic library

On station 2008-D26 (cast 78) we took 14 litters at 60 metres (temperature inversion) that were filtered for RNA. This specific sample will be used to construct a metagenomic library once the sample is processed in the laboratory off the ship.

2. Gene expression

Samples for RNA were collected on every station at 4 different depths. During RNA collection water was prefiltered through a 50 µm mesh, excluding larger organisms to be collected. Water was then

filtered through a 3 µm polycarbonate filter and the same water was again filtered through a 0.2 m filter. This sampling protocol gives two different samples, one containing the RNA from 50 µm to 3 µm fraction (Large fraction) and one containing the 3 µm to 0.2 µm fraction (Small fraction). After collection samples are keeped at -80 ºC until processing in the Lovejoy laboratory in Université Laval. These samples will give valuable information on the spatial expression of key genes.

3. Chlorophyll concentration

Samples for chlorophyll analysis were taken on each station at six or seven different depths. For each sample, one liter of water was filtered through a Whatman GF/F filter. This was the so-called large fraction, comprising all microorganisms larger than the nominal pore aize of 0.7 In addition, water was prefiltered through a 3 µm pore filter to obtain the small fraction, which was finally filtered through a Whatman GF/F filter. Afer filtration, the filters were stored overnight at -20ºC. Subsequently, the filters were introduced in acetone 90% and placed in a refrigerator, in the dark. After 24 hours, the fluorescence of the extracts, before and after acidification with 3 drops of 5% HCl, was determined by means of a Turner TD-700 fluorometer. As can be seen in Annex 4, the chlorophyll concentration in the CFL stations has been decreasing steadily since last fall.

4. HPLC

Samples for High Performance Liquid Chromatography (HPLC) analysis were taken on each station at six different depths. Two fractions were collected, one for the total fraction (down to 0.7 µm) and one for the small fraction (from 3 µm to 0.7 µm). Samples were stored at -80 ºC and will be analyzed at Laval University.

5. Virus

Different variables associated with viruses have been collected.

a. Viral abundance

Flow cytometry samples for six depths were collected at every station.

b. Burst Size

Transmission electronic microscopy samples were collected for six depths at two stations.

c. Viral production

Virus free seawater was added to a bacterial concentrate and incubated with mytomicine C during 12 hours. Samples without mytomicine C are compared with the mytomcine C samples in order to obtain an estimate of virus production on infected cells (lytic and lysogenic cycles). Viral production was followed taking samples for flow cytometry each 3 hours.

d. Viral diversity

2 litters of surface seawater were concentrated on 50 mL using a Vivaflow system (30 kd cartridge). This concentrate will be used to analyze the diversity of viruses present in the surface seawater.

6. Silicon – isotopes

Three different depths were sampled in order to obtain information on Si isotopes. Seawater was filtered through a 0.6 µm polycarbonate filter. The filters and the filtrate were stored to be processed on land.

7. Organic matter

Using pre-combusted GF/F filters (47 mm diameter) in a passive filtration system (by gravity) samples for dissolved organic carbon (DOC), total organic carbon (TOC), amino acids and carbohydrates were taken. Samples without filtration for total phosphorus determination were also collected.

8. Bacteria and Archaea abundance

Microscope preparations for bacterial abundance estimations were prepared by filtering a small volume of water (20ml) fixed with formaldehyde and staining with DAPI (which bounds to the DNA). Microscopy slides were prepared on all stations at 6 different depths. Slides were frozen (-20°C) until counting on a microscope.

Bacterial preparations were also obtained in some stations using glutaraldehyde instead of formaldehyde as the fixative. These slides were frozen at -20 ºC and counted onboard using the Olympus BX51 epifluorescense microscope onboard.

9. Eukaryotic microbes abundance

Microscope slides for eukaryotic abundance estimations were prepared filtering 100 mL of seawater fixed with glutaraldehyde and staining with DAPI (which bounds to the DNA). Microscopy slides were prepared on all stations at 6 different depths. These slides were frozen at -20 ºC and counted onboard using the Olympus BX51 epifluorescense microscope onboard.

10. Ciliates

Samples for ciliates abundance and diversity were collected and preserved using a Lugol acid solution. These samples will be analyzed off the ship.

11. FISH: eukaryotes

The Fluorescent In Situ Hybridization is a powerful technique to study specific groups of microorganisms. Samples for FISH were collected on all stations at 6 different depths. Samples were stored at -80 ºC until analysis off the ship.

12. CARD – FISH: bacteria and archaea

Samples for the abundance and distribution of specific groups of prokaryotic microbes were collected in all stations at 6 different depths. These samples have been frozen at -20 ºC until its analysis with different oligonucleotide probes off the ship.

13. MarFISH: bacteria and archaea

Incubations with 3H-labeled leucine and C14-labeled bicarbonate were carried out to detect active prokaryotes in the uptake of these substrates at all sampled stations at a minimum of two depths (surface and base of the nitrocline). Leucine incubations lasted for 8 hours and bicarbonate incubations lasted for 24h always in the dark. After fixation of the samples, they were filtered and the filters were stored at –80 to be analyzed off the ship. In combination with the FISH technique this can give information on the phylogenetic identity of these active microorganisms.
Beside the MarFISH incubations, samples were incubated with C14-labeled bicarbonate (at a lower concentration) to measure bulk bicarbonate uptake by bacteria and archaea in the dark. These samples were incubated for 24 hours and subsequently filtered. The filters were exposed to HCl fumes overnight, and embedded in cocktail for the scintillation counter measurement.

14. Bacterivory – FLBs grazing

In order to acquire values of ingestion rates of bacteria by heterotrophic eukaryotes, Fluorescent Labelled Bacteria (FLB) obtained from a culture of *Brevundimonas diminuta* were used on bacterial grazing experiments. Three replicates and a 0.2 µm seawater filtered control with 10^5 cells/ml added were used. Samples for flagellates and bacterial microscopy observation and for bacterial production were collected at the beginning and after 48 hours of incubation at seawater temperature (cold-room).

15. Alguivory – Micromonas grazing

Two grazing experiments with the *Micromonas* strain RCC497 were performed in order to calculate an ingestion rate of *Micromonas* cells by heterotrophic flagellates. For each experiment, two replicates of 2000 ml seawater filtered by 200 µm were incubated during 96 hours, at surface seawater temperature (-1.4 ºC). A control of 0.2 µm filtered seawater was run in the same conditions at the same time. Samples for FISH (to observe *Micromonas* ingestion) and flow cytometry (to observe *Micromonas* disappearance) were taken.

Incubations were run at the second half of the leg, as the *Micromonas* cultures brought from Barcelona had to adapt to the incubation conditions onboard. Once the exponential growth of the cultures was achieved, experiments were run.

16. Bacterial production

Bacterial production rates were measured using the leucine incorporation method (^{3}H labelled leucine) with 4 hours of incubation in coolers filled with ice-cold seawater in the radioactive lab. Samples were taken at every station at six depths, and also from surface waters below the ice. Rates of incorporation of radio labelled leucine were measured using the scintillation counter onboard.

17. Respiration

Bacterial/community respiration rates were measured using the FIBOX, which measures O_2 depletion in time using sensors glued to the bottom of 500ml Erlenmeyers. The consumption of O2 in time can be converted in CO2 production to compare carbon respiration rate to bacterial carbon production rates. Each experiment lasted for about 15 days and oxygen measurements were made every 1-2 days. The Erlenmeyer were kept in the dark inside a cooler in a cold room. An ongoing experiment from the previous leg was followed and a new experiment was started at station 26D.

18. ETS

Due to the low respiration rates in Arctic waters, a back-up method was also employed to obtain respiration rate surrogates via ETS (Electron transport system activity). This is achieved by filtering a large quantity (8L-10L) of water on GF/F filters to collect live cells and freeze them (-80°C) as quick as possible. Once off the ship, filters will be defrozen and the living cells will be subject to various enzymatic tests to measure activity.

19. N_2O

Dissolved N2O measurements were carried out using the headspace equilibration method with 1.1 L of seawater. 3 samples were taken from 3 depths and will be analyzed off the ship for N2O on an electron capture detector (GC).

Experimental program

1. BrdU incubations

Incubations with the timidine analogue bromodeoxiuridine (BrdU) were carried out during 4 weeks. On a periodic basis DNA samples were taken. Once off the ship these samples can be used to determine the identity of the active microbes on the incubations using antibodies specific for the BrdU incorporated to the DNA of the microorganisms.

2. Archaea enrichment

Laura Alonso followed with the archaeal experiments set up by Pierre Galand on leg 4. The objective of those experiments was to enrich bacteria or archaea that have a chemoautotrophic lifestyle in the Arctic, and study their rates of dark bicarbonate uptake. For that reason incubations were started at leg 4 in order to promote labile organic carbon consumption by heterotrophic bacteria through time. Two incubations were amended with ammonia and phosphate while the other two did not present any nutrient addition. At the beginning of leg 6 (about 3 months later) samples were taken from the incubations to measure dark bicarbonate uptake (using C14-bicarbonate) and we found higher rates than those found in in situ samples, what suggested the growth of chemoautotrophic organisms in the cultures after organic carbon depletion. Then, about 15 L of each incubation were filtered by 0,2 microns in order to have labil organic carbon depleted waters free of bacteria. This water was used to start new incubations (regrowth experiments) with the inoculum of fresh bacteria from in situ samples, or bacteria from the cultures set up on leg 4. Replicate seawater cultures with and without the addition of ammonium were followed every 3-4 days (Annex 3). Samples were taken for DAPI preparations, FISH, and flow cytometry. FISH and flow cytometry samples will be processed off the ship. Microscopic anaylisis of DAPI preparations was done on board in order to follow the growth of bacteria in the cultures. Towards the end of the incubations samples were taken for bicarbonate uptake, bacterial production, MarFISH with leucine and bicarbonate and DNA analysis.

3. SIP experiments

Incubations amended with C13-labeled bicarbonate were carried out during 4 weeks in the dark at the cold room. DNA samples were taken every week from replicate bottles. Once off the ship these samples will be used to try to isolate the DNA of those organisms taking up bicarbonate in the dark.

4. Microcosm experiments

Some phytoplankton culture experiments carried out during CASES 2003-3004 indicated that there could be substantial chlorophyll *a* concentration increases with little or no apparent consumption of nitrate-N, suggesting that, at a short time scale, dissolved organic nitrogen (DON) could be a major source of N for phytoplankton growth (either directly or trough remineralization). During leg 6 of CFL, a microcosm experiment was designed to test whether polar phytoplankton would utilize urea as a nitrogen source, as some studies carried out two decades ago had suggested. Water collected from 12 m depth at station 19D was distributed in eighteeen containers, which were subjected (in triplicate) to treatments combining high (30 µmol photons m^{-2} s^{-1}) or low (0.5 µmol photons m^{-2} s^{-1}) light with no nutrient amendments, addition of nitrate or addition of urea. After two weeks of incubation, and at the end of the experiment, samples were taken for determination of chlorophyll, phytoplankton, nutrient and organic carbon concentrations. MarFISH incubations with 14C urea were also carried out with subsamples from the microcosms and with surface water of several stations. An evaluation of the results of this experiment will have to wait until the measurements to be carried out on land are available.

Other activities

The whole team participated in all social activities of the ship and in the schools on board program. Laura gave a talk ("Microscopic life in the Arctic") and Marta and Bea did some lab activities with

the students. Marta also wrote a dispatch to be published on the CFL webpage. Laura and Beatriz were responsible for the maintenance of the MilliQ system. We three also helped the zooplankton team on the digging of holes in the ice and sampling. We also provided 0.2 µm filtered seawater for them. Finally Beatriz continued a Spanish course that was started by Laura Sims during the first 3 weeks.

Acknowledgements
The cruise was a success and we are grateful to our Chief Scientists (Rob McDonald and Gary Stern), Captain Stephan Julien and crew of the Amundsen for the excellent work done during leg 6. We would like to thank Clement Clerc and Marie Emmanuelle Rail for CTD Rosette operations, Steeve Gagné for technical assistance and the zooplankton team, Anaïs Aubert, Helêne Cloutier, Gerald Darnis and Louis Letourneau, for assistance in under ice surface water sampling.

Annex 1. Station localizations

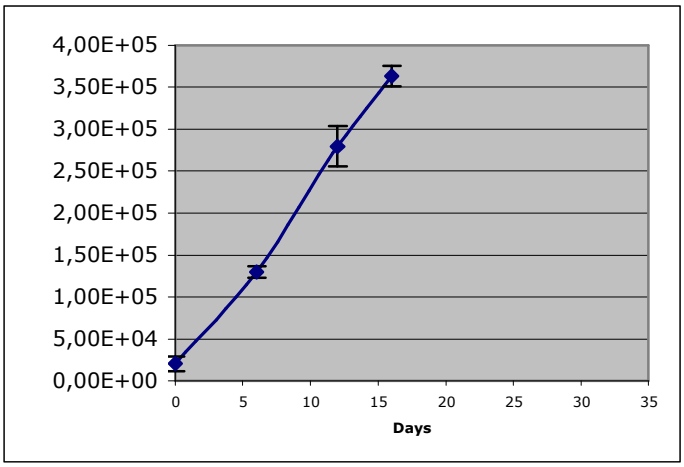
Cast #	Drift Station	Date Start	Time Start (UTC)	Latitude (north)	Longitude (west)
9	2008-D19	03.02.2008	17:40	71º 4.627'	124º 48.998'
ICE-01	2008-D19	05.02.2008	10:00	71º	124º
52	2008-D19	11.02.2008	18:05	71º 4.236'	124º 47.135'
67	2008-D22	18.02.2008	18:12	71º 18.649'	124º 29.798'
ICE-02	2008-D22	19.02.2008	17:30	71º	123º 55.357
78	2008-D26	25.02.2008	17:38	70º 56.044	125º
ICE-03	2008-D26	26.02.2008	11:00	70º	125
115	2008-D27	02.03.2008	17:51	70º 47.434	123º 4.163
OPEN WATER	2008-D28	03.03.2008	23:30	70º	123º

Annex 2. Sampling details during leg 6. Numbers indicate depths sampled.

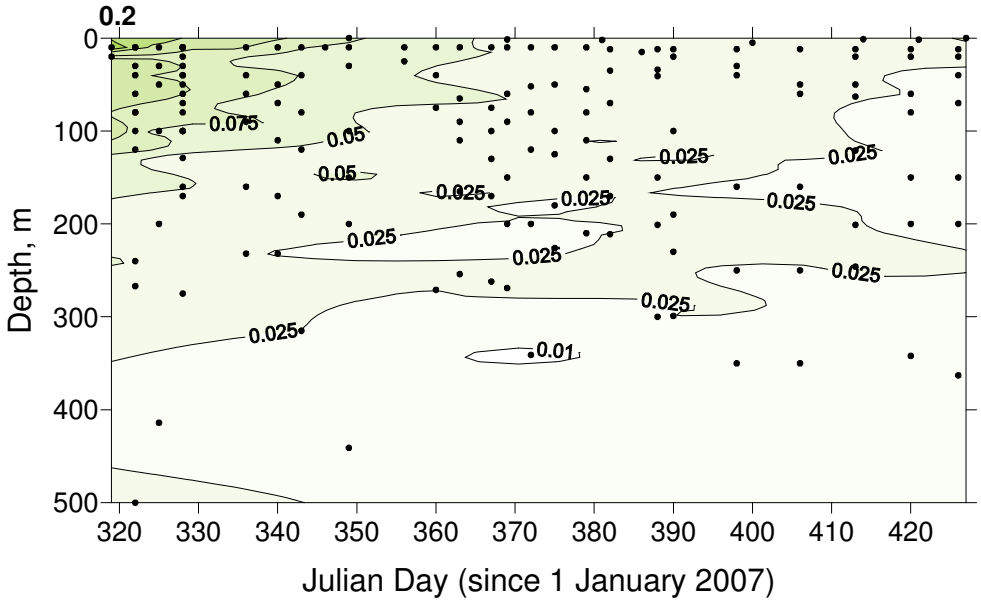
Station information	**Date**	03/02/08	05/02/08	11/02/08	18/02/08	19/02/08	25/02/08	26/02/08	02/03/08	03/03/08
	Drift station	2007-19D	2007-19D	2008-19D	2008-22D	2008-22D	2008-26D	2008-26D	2008-27D	2008-28D
	Cast number	9	ICE-01	52	67	ICE-02	78	ICE-05	115	OPEN WATER
Protocols	**Bacterial production**	6	6	6	6	1	6	1	6	1
	ETS	-	-	2	2	-	2	-	2	-
	Respiration	-	-	-	-	-	2	-	-	-
	N2O	-	-	2	-	-	2	-	-	-
	Bacteria and Archaea abundance	6	1	6	6	1	6	1	6	1
	Eukaryotic microbes abundance	6	1	6	6	1	6	1	6	1
	DNA - Large	4	1	4	4	1	4	1	4	1
	DNA - Small	4	1	4	4	1	4	1	4	1
	RNA - Large	4	1	4	4	1	4	1	4	1
	RNA - Small	4	1	4	4	1	4	1	4	1
	Chlorophyll a Total	6	1	6	6	1	6	1	6	1
	Chlorophyll a Small	6	1	6	6	1	6	1	6	1
	HPLC Total	-	2	2	2	2	2	2	2	2
	HPLC Small	-	2	2	2	2	2	2	2	2
	Virus (abundance)	6	1	6	6	1	6	1	6	1
	Organic matter and Total phosphorus	-	-	6	-	-	-	-	-	-
	Ciliates	6	1	-	6	1	-	-	6	1

	CARD-FISH (bacteria)	6	1	6	6	1	6	1	6	1
	FISH (eukaryotes)	6	1	6	6	1	6	1	6	1
	MAR FISH	3	1	3	3	-	2	-	3	-
	Bacterivory	-	-	-	1	-	-	-	1	-
	Alguivory	1	-	-	-	-	1	-	-	-
	Virus (Diversity)	-	-	-	1	-	-	-	1	-
	Virus (TEM)	-	-	-	1	-	-	-	1	-
	Viral production	-	-	-	1	-	-	-	1	-
	Silica isotopes	3	-	-	3	-	-	-	-	-
	Metagenomics	-	-	-	1	-	-	-	-	-

Annex 3. Bacterial growth in dilution cultures with aged seawater.



Annex 4. Temporal evolution of chlorophyll concentration (mg m^{-3}) in the CFL stations between 16 November 2007 and 3 March 2008.



2.7. Team 8

PI: Gary Stern (DFO, Freshwater Institute)
Participants: Joanne DeLaronde (DFO, Freshwater Institute), Alexis Burt (MSc student, University of Manitoba), Amanda Chaulk (MSc student, University of Manitoba), Jeff Latonas (MSc student, University of Manitoba), Patrick Lee (Environment Canada)

General objective
This question this project hopes to answer is how climate variability in physical forcing and the biogeochemical response to this primary forcing will affect hexachlorocyclohexane (HCH) and mercury (Hg)/methyl mercury (MeHg) contaminant cycling. Ultimately, we propose to relate changes in delivery and biogeochemical cycling of these contaminants to their levels in fish, marine mammals and the people who consume these tissues as part of their traditional diets.

2.7.1. Organic contaminants

Hexachlorocyclohexane (HCH) (DeLaronde)

Technical HCH is a mixture of several isomers, the most abundant being α-HCH (60-70%), β-HCH (5-12%) and γ-HCH (10-15%). Technical HCH and pure □-HCH (lindane, pesticide active isomer) have been used for over 50 years and are now ubiquitous in water throughout the northern hemisphere with the highest levels found in the surface water layers near pack ice in the Arctic Ocean.

Technical HCH was banned or heavily restricted by China, the former Soviet Union and India between the mid-1980s and 1990. Concentrations of α-HCH in arctic air responded quickly to these large-scale usage changes and declined by an order of magnitude from the early 1980s to mid-1990s in steps that closely matched global usage and emission estimates. As a consequence, the direction of net gas exchange in arctic waters reversed from deposition in the 1980s to air-water equilibrium or volatilization in the mid-1990s.

The α-isomer is the prominent in Arctic air, water, biota and soil, and moves northward via cold-condensation, a process whereby the contaminant evades into the atmosphere, drifts with atmospheric currents, and condenses in colder climates where at colder temperatures increasingly favours the water and extensive ice cover inhibit further evasion. Hence the contaminant accumulates disproportionately in the Arctic.

Water sampling
Water (4L) was collected from the rosette from 10m, 25m, 50m, 100m, 150m, 200m, 300m and the bottom where possible. Through a hole in the ice away from the ship, water from the water/ice interface and 5m was collected using a Niskin bottle. In the lab, water was pumped through a glass-fiber filter followed by an ENV+ solid-phase extraction (SPE) cartridge using peristaltic pumps. Filters and cartridges are frozen and brought back the Freshwater Institute for analysis. $^{18}\delta O$ were also collected at each site and depth where HCH samples were taken.

Twenty eight HCH water samples were collected during leg 6 from the following stations; D19, D23 and D26.

Air Sampling
The air sampler was set up on the bow of the ship on the starboard side along with each ice sampling. Samples are collected on a glass fiber filter and polyurethane foam (PUF) for analysis of organic contaminants. Air samples collection time ranged between 4 and 10 hours. Filters and PUFs were frozen at -20°C and shipped frozen back to the FWI for HCH contaminant analysis.

Air samples were collected at stations D22, D23 and D26.

Ice sampling
Ice samples for HCHs concentration and enantiomeric composition were collected. The samples for oxygen isotope composition ($\delta^{18}O$) and salinity were taken along with all ice samples. The ice samples were collected in collaboration with team 2 and the ice microstructure and physical analysis was made on all of them (see team 2 cruise report). Ice cores were cut according to ice microstructure into 8-30cm layers, melted (4-8L of water) and pumped through a glass-fiber filter followed by an ENV+ solid-phase extraction (SPE) cartridge using peristaltic pumps. Surface water (4L) was sampled along with every ice sampling using a Niskin bottle. The cartridges and GFFs were stored in -80 °C and brought to the DFO (Winnipeg) for analysis.

Ice cores were sampled for HCHs from stations D22, D23 and D26.

2.7.2. Mercury

Ice sampling
Snow, frost flowers and ice samples were taken to follow the movement of mercury and its forms through the snow/ice interface and the ice/brine interface. Both new (nilas) and old ice were sampled. All ice was characterized with microstructure, temperature and salinity measurements. All coring activities coincided with Team 2. At Station D19 where a mercury depletion event was observed, surface snow was collected in triplicate 3 to 4 times daily to generate a time series of mercury deposition and revolatilization. New Ice was sampled when the opportunity presented itself. Sampling was facilitated both from the ship being lowered in the cage, and being harnessed at the ice edge of an open lead. Team 8's ice sampling efforts were also featured on the front page of the Winnipeg Free Press ☺.


Alexis Burt and Amanda Chaulk collecting snow


Amanda Chaulk and Joanne DeLaronde in the cage sampling ice

Snow Collection: D19, D26, D29
Frost Flower Collection: D19, D26, D27
Ice Collection: D27, D29

Water (Hg)
During leg 6 the Portable In-Situ Laboratory for Mercury Speciation (P.I.L.M.S.) became operational after many challenges. Broken glassware, contaminated tubing, and interference from helicopter flights and ship transit were some of the challenges that had to be overcome. Both the total mercury analysis system and dissolved gaseous mercury analysis system are operational and samples are being run as much as possible. Preparations are underway to begin operation of the methyl mercury analysis system during leg 7.

Water was collected from the moonpool via rosette for Hg profiles (15 depths) along with corresponding ^{18}O and salinity samples. To complete the Hg profile, water from the water/ice interface and from 5 m was collected out on the ice either at the zooplankton sampling hole or at an auger hole. These depths cannot be accurately sampled through the moonpool due to contamination from the moonpool itself. We have found that water collected by the moonpool rosette down to a depth of 12 m is contaminated for mercury sampling purposes. At least 50 ml of water is collected in duplicate from each depth into Falcon Tubes. The samples are returned to PILMS and analyzed as soon as possible (preferably within one day) by CVAAS (cold vapor atomic absorption spectroscopy).

Water depth profiles from the rosette were sampled at stations D19, D22, D27 and D29(x2).

Water from the water/ice interface and from 5 m was sampled at; D26, D28(x2), D29(x4). The sampling at these stations coincided with mercury depletion events.

Algae Cores (Hg)
Cores were collected for bottom ice algae with a trace metal clean core barrel.
The bottom ice will be stored frozen and freeze dried to collect the algae. The algae will be processed for THg, MeHg, stable isotopes and fatty acids at the Freshwater Institute (DFO Winnipeg).
Ice coring for algae Hg analyses

Ice coring for Hg analyses in under ice algae.

Atmospheric Mercury Measurements
Among the parameters being measured are Gaseous Elemental Mercury (GEM), Particulate Mercury (Hg_p), Reactive Gaseous Mercury (RGM), and Total Mercury (Hg_t). GEM measurements began in Leg 5, RGM and Hg_p measurements began on February 8th 2008, and Hg_t measurements began on February 11th. These parameters have been measured continuously from their respective start dates with some down time due to routine maintenance on the instruments, ship movements, and adjustments made to the configuration.

Figure 6: Tekran 1130/1135 speciation unit with 1105 pyrolysis unit

There were some issues installing an intake manifold originally designed for the system due to problems with the original measurements and sample dilution from zero air generated by the 1130 system. The intake manifold was designed to sample air 3 feet off the starboard side of the ship to avoid deck circulated air however could not be successfully installed. The original intakes have been used. We have not seen any issues so far with ship borne contamination.

Figure 7: Tekran 2537 ambient mercury vapor analyzers with pump unit

The first major atmospheric mercury depletion event recorded occurred on February 29th and preliminary data suggests that the reaction may be taking place on particulate surfaces; this may be due to the fact that this is where the BrO is absorbed, and thus the particle surface is used as a reaction site in which the GEM is converted to RGM. It is also possible that the RGM is photoreduced back to GEM directly from the particle surface without ever being deposited. The following graphs show the initial data; Figure 3 shows GEM measured from the 1130/1135 speciation unit, ambient air with a

2537, as well as the Hg_t with the pyrolysis unit. Figure 4 and Figure 5 show the two initial depletion events in detail including calculated values for coarse particulate mercury (Hg_t – GEM) showing the role of atmospheric particles during the events.

GEM measurements are done with a resolution of 1 every 5 minutes on two separate Tekran 2537 instruments. Due to the lesser concentrations of RGM and Hg_p the measurements for these parameters are thermally desorbed and analyzed by one of the 2537 units every 2 hours. Hg_t measurements are also conducted at a resolution of 1 every 5 minutes on a separate 2537 unit.

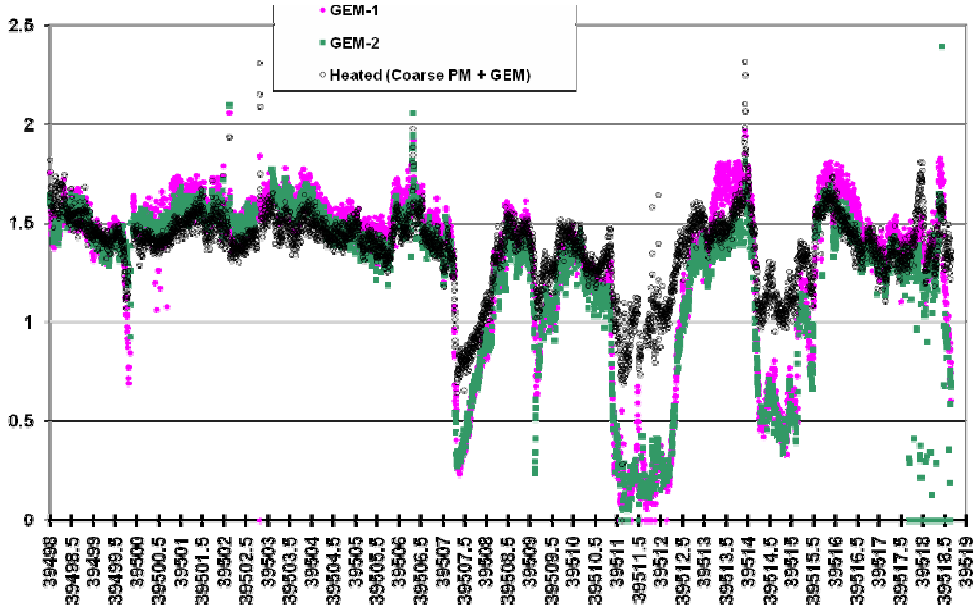


Figure 8: Gaseous Elemental Mercury

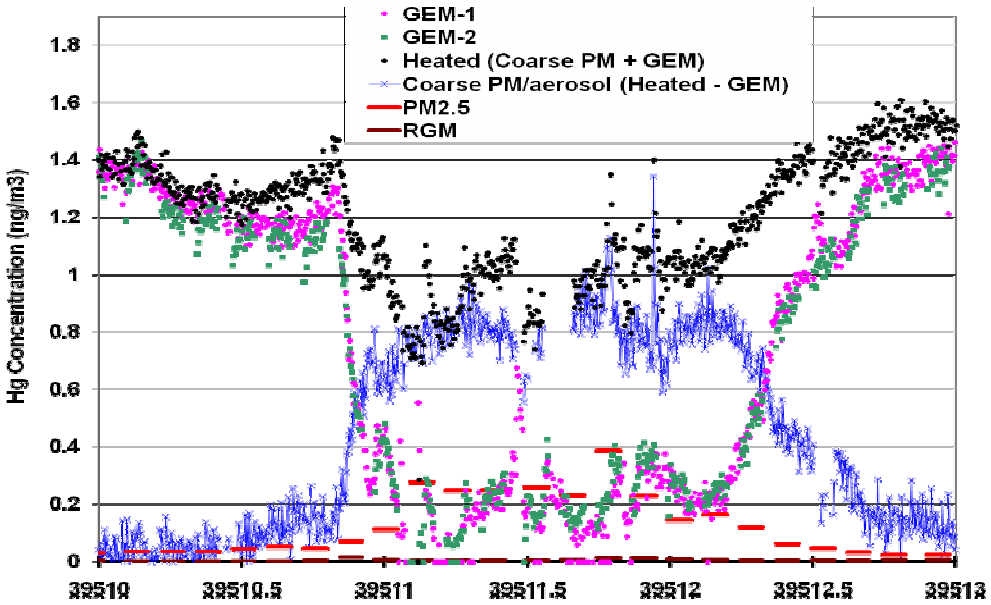


Figure 9: Depletion Event 1

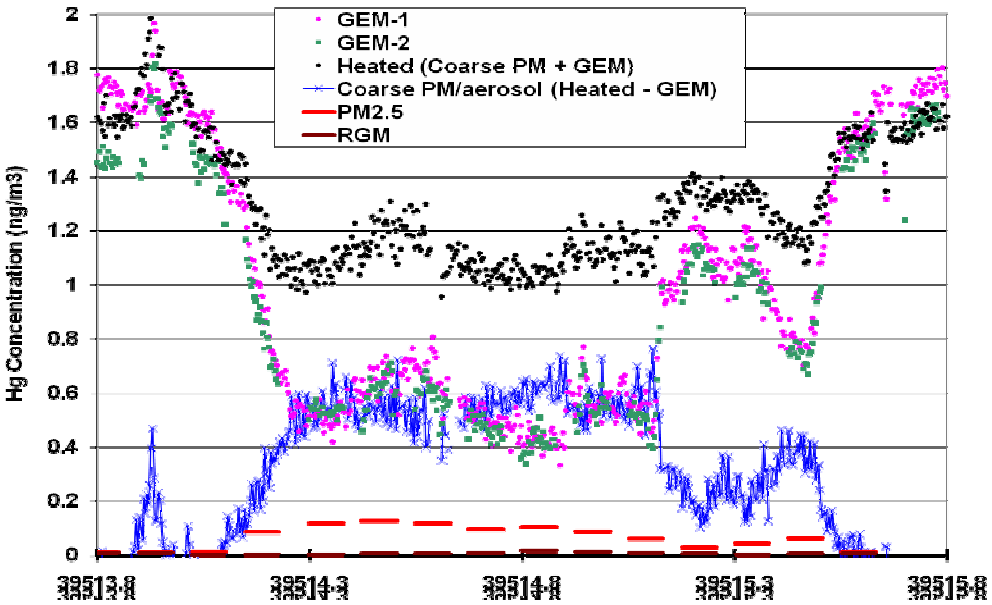


Figure 10: Depletion Event 2

Dissolved Gaseous Mercury

A system has been developed to measure dissolved gaseous mercury (DGM) in surface waters collected from either a niskin or the sea water sample line which has been installed directly into the PILMS laboratory. The system uses a specially designed vessel in which mercury free air generated by a zero air generator is bubbled through the sample and then measured by a Tekran 2537B unit. The zero air is purged through the vessel for 50 minutes in order to recover a high portion of the DGM in the 1 liter of sample water.

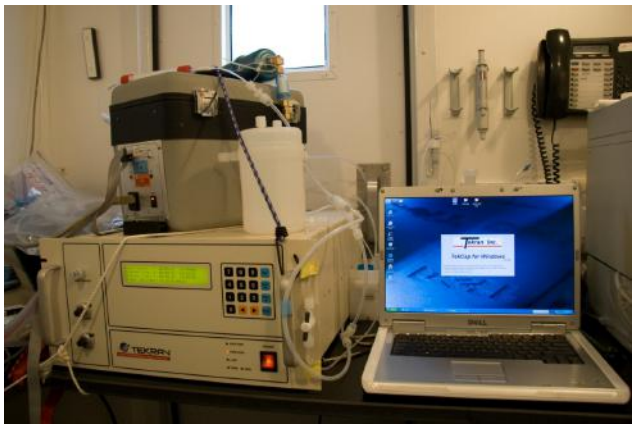


Figure 11: DGM measurement system in the PILMS laboratory

The initial data shows results typically between 150 and 40 ng/m^3 of water. Samples have been taken from open water, at station under thicker ice as well as at depth. Collection comes primarily from the sea water intake line in the lab, however samples collected from the niskin and rosette have also been analyzed as comparison and show no significant differences.

Sample	Date	Wind speed (kt)	Conditions	Result (ng/m^3)
SW 8	3/1/2008	2	In lead, sample line	107.500
SW 9	3/1/2008	3	In lead, niskin	99.651
SW 10	3/2/2008	17	Near lead, under ice	67.095
SW 11	3/2/2008	18	Near lead, under ice	89.658

SW 12	3/2/2008	18	Thick ice, lead frozen over	158.757
SW 13	3/3/2008	10	Open lead, very thin ice, AMDE, sample line	88.878
SW 14	3/3/2008	10	Open lead, very thin ice, AMDE, Niskin	99.529
SW 15	3/3/2008	12	Open water, Niskin	105.986
SW 16	3/5/2008	18	Under thick ice, no visible open water	95.484
SW 17	3/7/2008	12	Open leads ~ 1km, AMDE, Sample line	38.075
SW 18	3/7/2008	6	Open leads ~ 1km, AMDE, Sample line	58.411
SW 19	3/8/2008	22	Open leads ~1km from ship, sample line	58.188
SW 20	3/8/2008	3	Open leads ~1km from ship, sample line	89.819
SW 21	3/9/2008	15	Open water, from niskin	72.3450
SW 22	3/10/2008	0	Under thick ice, no open water visible	86.615

Biotic Sampling (HCH, mercury, stable isotopes) (Burt, DeLaronde)
The main purpose of this study is to link physical and biological processes to mercury levels in the food web and to target the pelagic food web biomagnification and bioaccumulation of HCH and mercury with stable isotopes and fatty acids. Thus, all biological samples collected will be measured for HCHs, total mercury and MeHg along with stable isotopes to place organisms into their associated trophic levels.
Biological samples were collected every 1-3 days. Various zooplankton families were collected using the vertically towed Tucker net (mesh size 500 µm) from the moonpool. Zooplankton was sorted by species where feasible, by genus or family otherwise and placed into plastic vials and Whirlpak bags and frozen until they can be shipped to Winnipeg where they will be analyzed for HCH, THg, MeHg, stable isotopes and fatty acids. Common species found were *Calanus* sp., *Euchaeta* sp., *Sagitta* sp., *Themisto* sp., *Ostracoda* sp., Cnidarians, Ctenophores, and Polychaetes. Some less common species found were *Cleone limacina*, *Hyperoche* sp., Euphasiids, *Pandalus* sp., and a couple of lucky arctic cod juveniles.
Algal samples were taken in conjunction with zooplankton hauls and preserved with lugol's. Alga was also collected from the surface water and filtered onto pre-combusted and weighed glass fibre filters (GF/F), in series. Surface water was also filtered for chlorophyll a and dry mass. These were also frozen, and will be shipped to Winnipeg for further analysis.

Stations D19(x8), D20, D22, D23, D25(x2), D26(x5), D27(open water) and D29(x5) were sampled for a total of 24 zooplankton hauls.

Monitoring and Speciation of Mercury (Hg) in the Arctic Atmosphere during the Mercury Depletion Event (Lee)

Introduction
Mercury (Hg) in the air is an interesting and important chemical species. It is one of the toxic metals exist in the atmosphere that we breath. When deposit into the ocean water, it can eventually bioaccumulation all the way up to the top of food chain - Human. The initiate for this work is to collect as more scientific data as possible in order to understand the nature of Arctic atmospheric chemistry. Speciation of Gaseous, Particulate and Reactive Mercury can provide us more detail of the chemistry picture. Therefore, it is important to understand the chemical processes influencing the concentrations of mercury in the Arctic atmosphere.

In this paper, we present results from the monitoring the airborne mercury in the Arctic atmosphere during the spring-time Mercury Depletion Event (MDE). Different instrumentations were set up for analyzing the various Hg species at the Arctic atmosphere. The purpose for this study work is to find out the Hg balance at the well know phenomena of MDE exist in the Arctic atmosphere.

Equipment and Methodology

1. Ambient air for Total Gaseous Elemental Mercury (GEM) determination was collected using a real time Hg analyzer (Tekran 2537) operating at 1.5 L/min flow rate for a 5 min average reading. A Teflon filter (47mm Sartorius PTFE, 0.2µm pore size) was used for separated the particulated and aerosol from the ambient air for the total GEM measurement in the Arctic atmosphere. This filter was placed on the back of the instrument sampling inlet line. An Arctic pyrolyser (Tekran 1105-P) sampling unit was installed on the outside next to the edge of the ship. Figure 1 illustrates the unit contains a sampling inlet head with two sampling lines running through the system: (a) Ambient air without any heating for the measurement of the total GEM; (b) Pass through a furnace that was heated up to 900^{o}C by the quartz bead for converting most of the coarse particulated/aerosol into gaseous Hg. We do not know the exactly size cut from the sampling inlet of the pyrolyser. Based on the design of the inlet head and only draw 3 lpm of flow, it is close to coarse airborne size. Figure 2 provides a close up image of the sampling inlet head. We assumed the pyrolyser heated at 900^{o}C converted and measured the total of the GEM + Hg bounded into the coarse PM or aerosol.

Figure 1. Sampling head for the Arctic Pyrolyser (right side) and for the Mercury speciation system (left side)

Figure 2. Pyrolyser sampling inlet head

2. Another Mercury speciation sampling system (Tekran 1130/1135) was installed for the speciation of Gaseous, Reactive and Particulate Hg. The sample inlet contains an impactor which provide a particle size cut of 2.5µm (PM2.5) at 10 L/min flow rate (Figure 1). It collects ambient air at 2 hrs sampling mode for GEM measurement, and then followed by one hour desorbing mode for reactive gaseous and particulate Hg determination. Figure 3 presents the whole sampling system of both the Arctic Pyrolyser (bottom) and the Mercury speciation system (top).

Figure 3. Sampling systems for the Arctic Pyrolyser (bottom) and the Mercury Speciation system (top).

3. Sampling were collected every 5 minute average from Feb 02 to Mar 11, 2008. The measurement site was on the front starboard side of the Amundsen icebreaker. The ship was moving around between the ice of the Beaufort Sea and Amundsen Gulf. An intensive quality control program was implemented to maintain the accuracy and precision throughout this project. This included periodically using standard Hg vapor calibration (Tekran 2505), internal permeation Hg source calibrations at regular intervals, standard addition every 73 cycles, and baseline monitoring.

Results and Discussion

Figure 4 displays the different of Hg species concentration throughout the study period. GEM-1 is the measurement of ambient air without heating from the pyrolyser, while GEM-2 is the sample collected from the mercury speciation system. Result for the two different GEM instrument were matching with each other very closely. The pyrolyser heated coarse PM/aerosol concentration was following both GEM value during non-MDE. Three major MDEs were identified between the period Feb 29 and Mar 08, 2008.

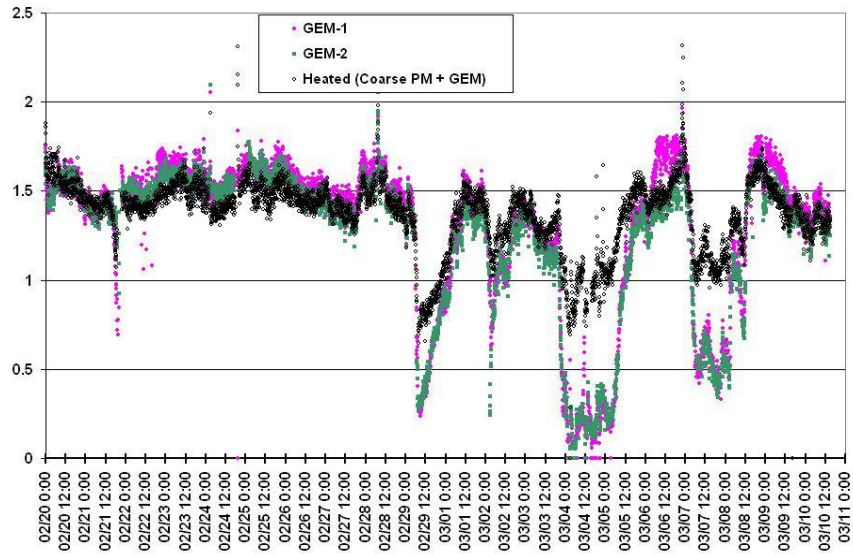


Figure 4. Hg concentration from Feb 02 to Mar 11, 2008

Figure 5 is a plot of the 3 days MDE from Mar 03 to Mar 06 2008. Three parameters were added on this plot (a) the pyrolyser heated value minus the GEM-1 value which is equal to the Hg bounded into the coarse PM or aerosol; (b) Hg in PM2.5 from the Hg speciation unit; and (c) gaseous reactive Hg from Hg speciation unit. The Hg bounded onto the coarse PM/aerosol indicated a very good mirror image of the gaseous Hg depletion throughout the whole MDE period. The beginning and ending stage of the MDE demonstrates a very quick partition reaction rate between Hg bounded coarse PM and the GEM. The chemistry between two phase partitioning is so rapid indicate once MDE finished the GEM will be shift back to the gaseous atmosphere. The Hg in PM2.5 follow the coarse PM/aerosol pattern rise up during MDE further proves the partitioning between gaseous and the fine aerosol phase. Figure 6 shows another MDE from Mar 7 to Mar 8 2008 reveal the same pattern with a small scale of Hg depletion. The Hg concentration bounded onto the coarse PM did not rise up to the level before the depletion occur mean there is some GEM still need to be account for. The reminder of the GEM most likely is partition into ocean sea, ice and snow surface.

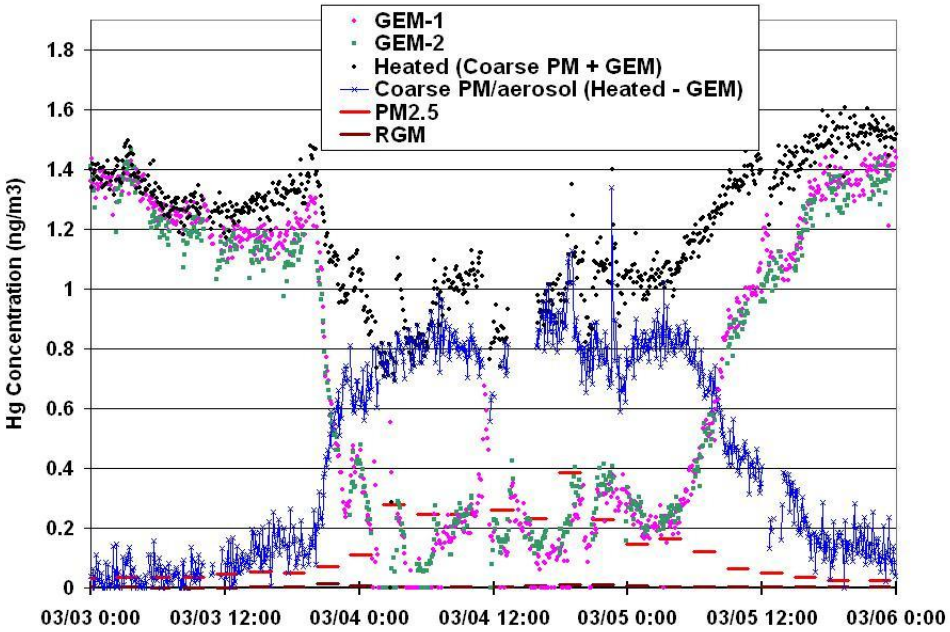


Figure 5. MDE from Mar 03 to Mar 06, 2008

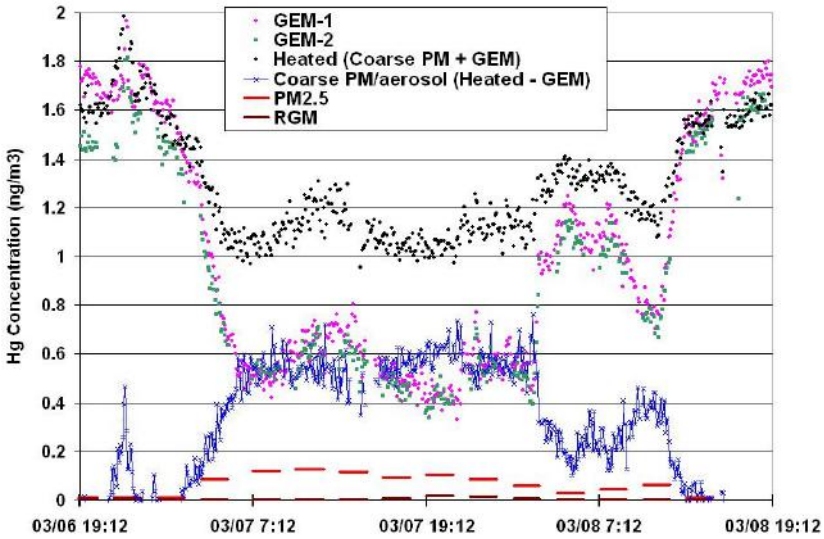


Figure 6. MDE from Mar 7 to Mar 8, 2008

In summary, during the MDE gaseous Hg was partition into the coarse PM/aerosol phase at a very fast reaction rate. More than 50% of the GEM was involved in the partition reaction. The chemistry reaction could be appears at the surface of the aerosol. As the MDE end the Hg that absorbed onto the surface of the aerosol immediately release back into the gaseous atmosphere. Further study of the Hg content in the sea, ice and snow at the time before, during and after the MDE may provides more detail picture of the total Hg balance system in Arctic atmosphere.

3. 2008 International Schools on Board - Field Program #1

March 2-15th, 2008 – Onboard Leg 6B

submitted by: Lucette Barber, Program Coordinator

Schools on Board is an outreach program of ArcticNet and the IPY-CFL study, used to promote Arctic sciences in high schools across Canada and abroad. The field program takes high school students and teachers on-board the CCGS Amundsen where they are integrated into the activities of the various science teams conducting research in the Arctic. It blends adventure, curiosity and exposure to create an energized learning environment and provides opportunities for scientists to share their passion for science and research with students – both on the ship and in classrooms. The multidisciplinary nature of the field program demonstrates the breadth of opportunities that are available to aspiring young researchers and technicians. Face-to-face interactions with scientists of all levels (masters, PhD's, researchers, CRC chairs) and access to state-of-the-art scientific instrumentation onboard the Canadian research icebreaker are the focus of the on-board field program. To extend the outreach beyond the field program, experiences of those chosen to participate, are shared with fellow classmates, family members and communities through a series of presentations that are delivered by the participant upon their return home.

The first of 2008 Schools on Board Field Program experienced a very successful year on-board Leg 6B of the Circumpolar Flaw Lead system study. As part of our commitment to education and outreach for IPY, this year's field programs include collaboration with international research partners and schools. Our 14 spaces for this first of three field programs, were filled by 7 students; 5 teachers; and 2 program leaders from the following schools and agencies:

USA - Ocean Research College Academy **-** University of Washington - (1 student; 1 teacher);
CHINA - Qingdao Middle School #39 - Ocean University of China - (1student; 1 teacher);
UK - West Kirby Grammar School - Proudman Oceanographic Laboratory - (1 student; 1 teacher);
SPAIN - Fredric Mistral/Tecnic Eulalia, Instituto de Ciencias Del Mar - (1 student; 1 teacher);
CANADA - Inuksuit School, Nunavut, (1 teacher and 1 student)
CANADA - Sisler High School, Canada (1 student)
CANADA - Nellie McClung Collegiate, Canada (1 student)
Schools on Board – 2 program leaders; University of Manitoba

Participating schools were selected by collaborating research agencies. Individual participants were selected by their schools to represent their community and region on-board this very unique Arctic research experience. Participants met in Winnipeg where they proceeded to Inuvik. Prior to boarding the ship, participants engaged in cultural and community activities in both Inuvik and Tuktoyaktuk. These included: a visit to the Visitor Centre; activities at Samuel Hearne Secondary School; dogsledding, cultural tour in Tuktoyaktuk, and interactions with youth and community leaders in each community.

The group boarded the ship at 5:00pm on March 6, 2008 and immediately became integrated in the activities of the CFL science teams. The program included science lectures, lab activities and fieldwork. Details of the on-board program are posted on the IPY-CFL website (www.ipy-cfl.ca). Daily dispatches including a report, photos and ship location were sent to both, IPY-CFL, and ArcticNet central to be posted on their websites. This two-week adventure into Arctic research exposed students and teachers to the research objectives and methods of numerous science teams representing a number of research disciplines from institutions across Canada and abroad. See attached table.

In addition to hands-on research activities the program included information and sessions on various aspects of climate change in Canada's North, including local knowledge, art, culture, history, and politics.

Outreach
Based on participant and scientist evaluations, activities of the Schools on Board program were successful in raising the awareness of the program on two levels:

1. Increasing awareness of the Schools on Board program and its educational objectives
2. Increasing awareness of the IPY-CFL program and its scientific objectives

Website & dispatches
The primary communication tool for the program was the webpage hosted on the CFL and ArcticNet websites. These sites were used to deliver program details and relevant application information. The site was a very effective tool, as it also contained all of the necessary science information relevant to the science project and the Amundsen. During the field program, participants submitted daily dispatches (March 5-13th, 2008) to the CFL website and the ArcticNet Expedition logbook. These sites included text and pictures describing daily activities and interactions between scientists and participants. They allowed schools, teachers, friends, and families, to share the experience, as well as provided visitors to the website (general public and other scientists) with detailed information of this outreach initiative.

Live from IPY event:
On March 12, we went Live from the Amundsen to participate in an international conference call organized by PolarTrec (University of Fairbanks) in conjunction with International Polar Day – Changing Earth. This web-based conference call included presentations Live from the Beaufort Sea aboard the CCGS Amundsen, Live from McMurdo Dry Valleys in Antartica, and Live from a North America test site for a Russian drilling project. Participants from various schools and universities from across North America and abroad listened to the presentations and asked questions of the presenters. Participation on board the Amundsen included the captain Stephane Julien, Gary Stern (chief scientist), Mathew Asplin and Dustin Isleifson (University of Manitoba), all Schools on Board students, teachers, and program leaders.

Presentations
One of the required outputs from the participants is the preparation and delivery of presentations to their schools and communities. Students prepared their presentation prior to leaving the ship. Teachers will be expected to share their new knowledge with teachers in their region, as well as assist S/B with the development of educational resources. Information on presentations delivered by participants will be collected in a School Evaluation at the end of the school year.

Media
Media continues to show an interest in the program. Our media activities will be recorded in the Schools Evaluation at the end of June. They include (but are not limited to):

1. Various newspaper articles and radio interviews prior to departure in each respective community
2. Interviews and ongoing media coverage onboard the Amundsen with Emily Chung, CBC
3. Interviews with NewsNorth – Inuvik
4. Interview with
5. Interview – CTV – TV – regional and national news
6. Daily dispatches appearing on school website in Spain
7. Article featuring student and the IPY-CFL study in one of Spain's national newspapers
8. Daily blogs on Everett Community College website (Washington, USA) file:///Schools%20on%20Board/Field%20Program/FieldProgram_2008/IPY%20-%20International_1/Outputs/ORCA_blogs.html
9. Radio interview – CBC – Radio – Morning Show with Terry McLeod

In conclusion, this first 2008 International Schools on Board Field Program was a great success. The international perspective fulfilled our mandate to broaden our outreach activities on an international scale during IPY. The overwhelming positive feedback received from all stakeholders (students, teachers, schools and scientists) indicates that this program is welcomed in both the science and education communities.


SCHOOLS on BOARD
Exploring Arctic Sciences


March 10 AM
20-25cm

Participating Scientist and CCGS Crew
2008 International Field Program #1

Date	Session	Name	Affiliation
Mar.6	Logistics and Safety tour	Olivier Tremblay	CCGS
Mar.7	Lecture: The Physical Process in the Arctic Ocean	Marie-Emmanuelle Rail	INRS - Quebec
Mar.7	Salinity and Temperature profiles	Marie-Emmanuelle Rail Clement Clerc	INRS - Quebec
Mar.7	Rosette demo and water sampling	Marie-Emmanuelle Rail Clement Clerc	INRS - Quebec
Mar.7	Lecture: Carbon Fluxes in the Arctic	Brent Else	University of Manitoba
Mar.7	Design project – build a pyranometer	Brent Else	University of Manitoba
Mar.8	Deployment of nets in moonpool	Gerald Darnis Louis Letourneau	Université Laval Université Laval
Mar.8	Fieldwork – check on instrument sled	Ralph Stabler Phil Tackett	Environment Canada (OASIS) Purdue University (OASIS)
Mar.8	Lab activity – sorting zooplankton	Joanne Delaronde	DFO-Freshwater Institute
Mar.8 Mar.10 Mar.11 Mar.12	Fieldwork – snow sampling; ice cores	Pascale Collin Mathew Asplin Dustin Isleifson Lauren Candish	University of Manitoba - CEOS
Mar.8 Mar.10 Mar.12	Radiosonde – set up and demo	Mathew Asplin Lauren Candish	Unversity of Manitoba - CEOS
Mar.9	Helicopter safety tour Helicopter tour of Banks Island	Helicopter pilots	DFO
Mar.9	Lecture: Microscopic Life in the Arctic	Laura Alonso	Institut de Ciències del Mar, Barcelona
Mar.9 Mar.11 Mar.12	Fieldwork & labwork – ice cores & ice chemistry	Frederic Brabant Brent Else	University of Brussels University of Manitoba
Mar.9	Labwork: Working with epifluorescent microscope	Marta Estrada	Institut de Ciències del Mar, Barcelona
Mar.9	Labwork with microbial team – water filtration	Beatriz Fernandez	Institut de Ciències del Mar, Barcelona
	Lab – mercury in the atmosphere	Patrick Lee	Environment Canada
Mar.10 Mar.11	Fieldwork with OASIS team	Ralf Staebler Jeff Seabrook Leif Vogel Phil Tackett	Environment Canada (OASIS) York University (OASIS) University of Heidelberg (OASIS) Purdue University (OASIS)
Mar. 10	Labwork – sorting zooplankton; respiration experiemnts	Gerald Darnis	Universite Laval
Mar. 10	Labwork – ice microstructures	Dustin Isleifson	University of Manitoba - CEOS
Mar. 10	Lecture: Air Quality research & contaminants in the Arctic	Ralf Staebler Jeff Seabrook Leif Vogel Phil Tackett	Environment Canada (OASIS) York University (OASIS) University of Heidelberg (OASIS) Purdue University (OASIS)
Mar. 10	Lecture: Climatology and Sea Ice	Mathew Asplin	University of Manitoba - CEOS
Mar.10	Labwork: DNA	Beatriz Fernandez	Universite Laval
Mar. 10	Lecture: Contaminants in the Arctic & the CFL study	Gary Stern	DFO – Freshwater Institute University of Manitoba - CEOS
Mar.10	Lecture: The Amundsen: Scientific modifications and plans for IPY	Capitaine Stéphane Julien	CCGS
Mar. 11	Tour of the bridge	Capitaine Stéphane	CCGS

		Julien	
Mar. 11	Ongoing tours of labs & clean lab	Amanda Chaulk	University of Manitoba
Mar.11	Communicating Science	Emilie Chung	CBC
Mar. 11	Labwork – processing ice cores	Pascale Collin	University of Manitoba - CEOS
Mar.10	Fieldwork – water sampling on the	Beatriz Fernande,	Institut de Ciències del
Mar.11	ice	Marta Estrada	Mar, Barcelona
Mar.12		Laura Alonso	Universite Laval
		Gerard Darnis	Universite Laval
		Louis Letourneau	
Mar.11	Lecture: Arctic Marine Foodweb	Gerald Darnis	Universite Laval
Mar.12	Live from IPY	Capt. Stephane Julien	CCGS
	-international web-based conference	Gary Stern	DFO/UofM
	call	Dustin Isleifson	UofM – CEOS
		Mathew Asplin	UofM - CEOS
		Schools on Board team	

Leg 7

13 March – 24 April 2008

edited and compiled by Tim Papakyriakou and David Barber (Chief Scientists)

1. General overview

1.1. Introduction

Leg 7 of the CFL project was succefully completed on April 24. The science plan allowed for several drift sites over the 6 week leg. In the first half of the leg (7A) the science teams conducted some drift site sampling and then secured the ship into thick FY ice south of DeSallis Bay. The mid leg crew change was done at this location. The ice here remained stable for about 1 week then broke loose and began to drift towards Banks Island. The Amundsen extacted from this situation and went to a location SW of Banks Island. We had a successful visit by team 10 to the ship at this location. The meeting was part of the CircumArctic climate change workshop. The one day visit to the tour was highlighted by a crack separating most of the visitors and science crews from the ship. We continued with draft sampling over the next week and finally settled into a large older FY floe in the middle of Amundsen Gulf. The second International Schools on Board program joined the ship at this location. The helicopter was delayed by about 10 days getting to the ship but was operational immediately after it arrived. Crew change to leg 8 went without a hitch.

1.2. Cruise maps and station identifiers

Yves Gratton acted as a 'keeper of station ID's on this leg. He produced a map showing the drift stations identifiers and has in his records a more complete description of the lats and longs of each drift station. Note that box coring may not be co-located exactly with other sampling as quite often we had to move the ship to do a box core; we did however keep the same station identifier.

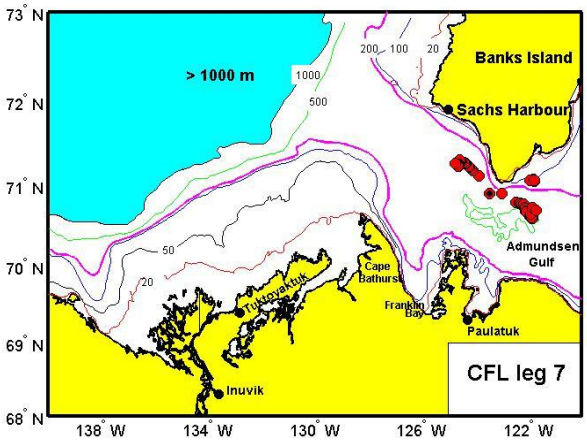
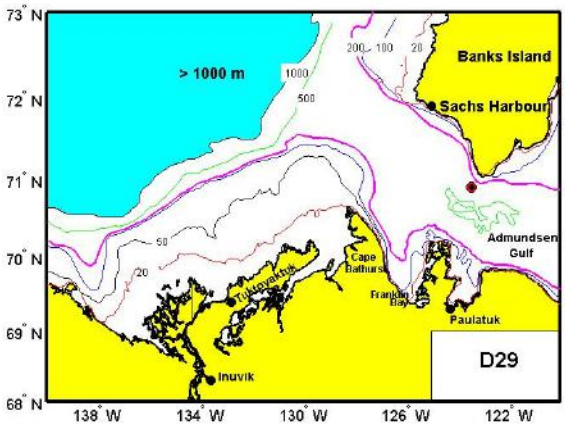


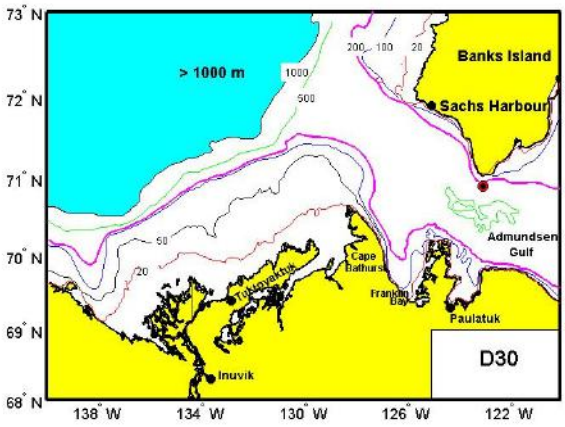
Figure 1. Drift stations completed during leg 7. Individual maps of these stations and their ID's are located in the Appendix of this report. Drift stations 29, 30 31, 33, 34, 35, 36, 37, 38, 40, 41 and 42 were successful completed on this leg. More details are available from Yves Gratton and in the appendices of this report.

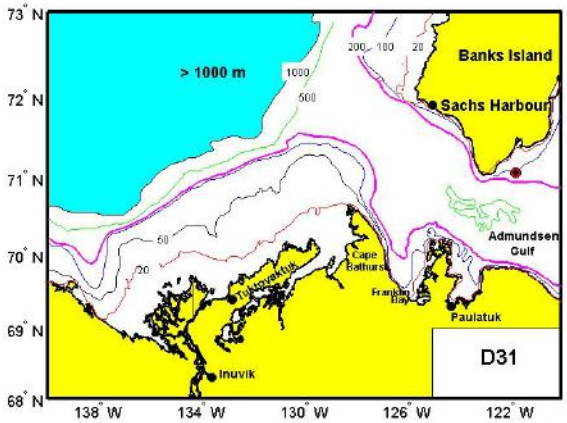
1.3. Cruise schedule

Science operations on this leg consisted of on ice sampling, sampling through the moonpool and sensors which collected data while underway. The ships log should be consulted for specifics of what sampling occurred when, where and at what time. Note also that we were in the drift mode of the CFL project at this time so position locations at the beginning of a station stop are not necessarily and same as those in the middle or end of that same station.

1.4. Sampling location maps



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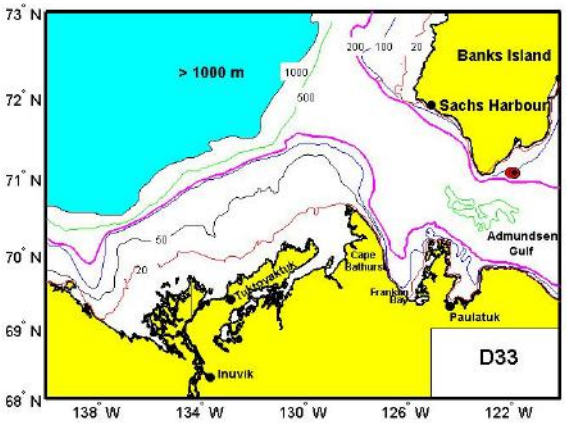
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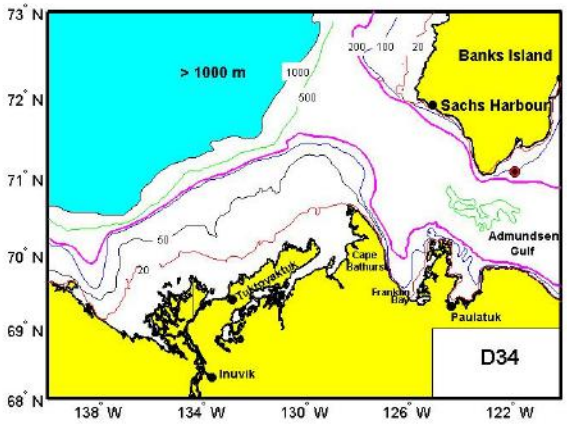
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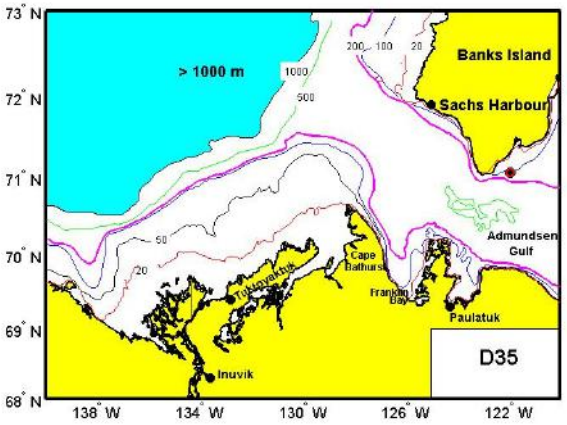
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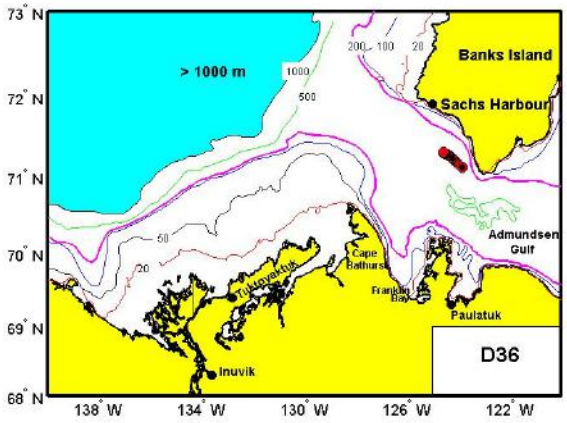
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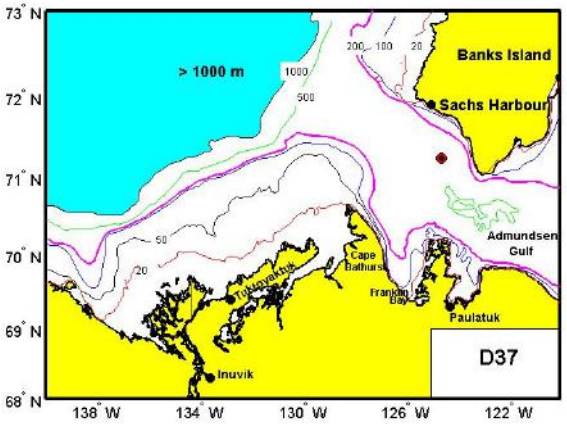
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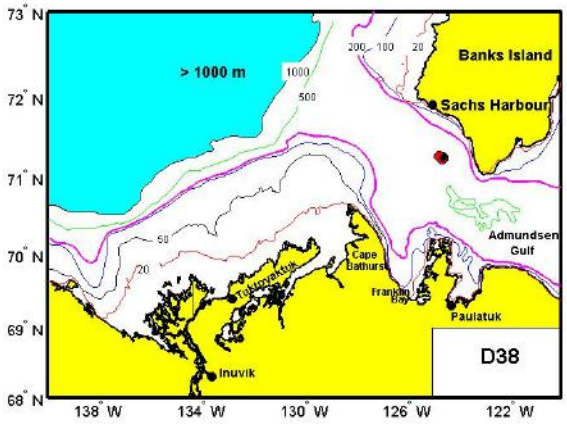
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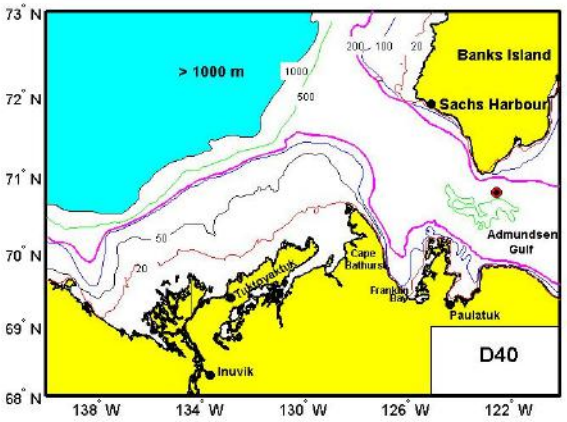
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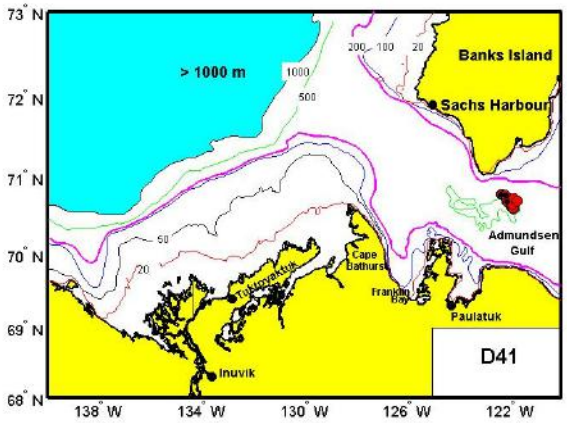
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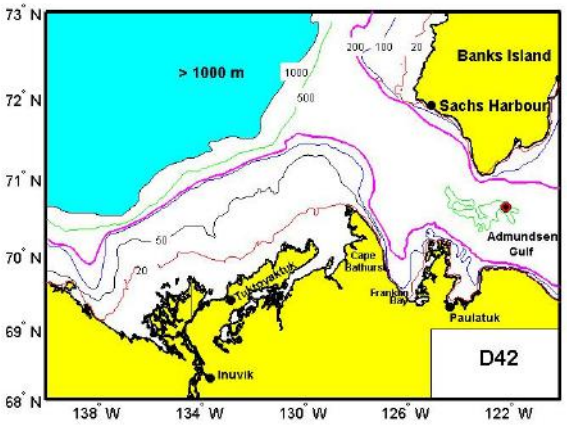
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1.5. Rosette casts

Cast	Station	Date	Time	Lat. (N)	Lon. (W)	Bot.	cast depth
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004	2008D29	16 03 08	17 09	70°54.47	123°28.61	401	390
005	2008D29	16 03 08	21 28	70°54.47	123°28.62	401	390
006	2008D29	17 03 08	00 58	70°54.47	123°28.61	401	390
007	2008D29	17 03 08	13 01	70°54.47	123°28.62	401	390
008	2008D29	17 03 08	18 03	70°54.47	123°28.62	402	391
009	2008D29	18 03 08	01 11	70°54.47	123°28.61	401	390
010	2008D29	18 03 08	13 10	70°54.47	123°28.61	401	390
011	2008D29	18 03 08	17 12	70°54.47	123°28.61	401	390
012	2008D29	18 03 08	21 40	70°54.47	123°28.61	401	390
013	2008D29	19 03 08	01 22	70°54.47	123°28.61	401	390
014	2008D29	19 03 08	13 04	70°54.47	123°28.61	401	390
015	2008D30	20 03 08	01 02	70°54.73	123°1.189	444	437
016	2008D31	23 03 08	22 56	71°3.846	121°47.22	187	179
017	2008D31	24 03 08	14 59	71°3.846	121°47.22	188	178
018	2008D34	24 03 08	21 20	71°4.630	121°48.69	181	172
019	2008D33	25 03 08	03 12	71°3.848	121°47.22	188	180
020	2008D33	25 03 08	14 49	71°3.846	121°47.22	188	178
021	2008D33	25 03 08	15 58	71°3.845	121°47.22	188	179
022	2008D33	25 03 08	16 53	71°3.846	121°47.22	188	178
023	2008D33	25 03 08	18 05	71°3.846	121°47.22	188	181
024	2008D33	25 03 08	19 01	71°3.845	121°47.22	188	180
025	2008D33	25 03 08	19 58	71°3.846	121°47.22	188	180
026	2008D33	25 03 08	20 59	71°3.846	121°47.27	188	179
027	2008D33	25 03 08	22 09	71°3.846	121°47.27	187	177
028	2008D33	25 03 08	22 59	71°3.846	121°47.21	187	179
029	2008D33	26 03 08	00 08	71°3.846	121°47.21	187	177
030	2008D33	26 03 08	01 03	71°3.846	121°47.21	188	181
031	2008D33	26 03 08	02 08	71°3.846	121°47.21	188	181
032	2008D33	26 03 08	03 00	71°3.846	121°47.21	188	178
033	2008D33	26 03 08	04 01	71°3.486	121°47.21	188	178
034	2008D33	26 03 08	13 06	71°3.848	121°47.20	188	179
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084 2008D36 07 04 08 13 02 71°16.11 124°21.53 274 263
085 2008D36 07 04 08 17 00 71°16.42 124°23.04 274 265
086 2008D36 07 04 08 21 34 71°16.87 124°25.03 262 250
087 2008D36 08 04 08 00 59 71°16.97 124°25.59 258 251
088 2008D36 08 04 08 13 03 71°17.61 124°30.40 260 250
089 2008D36 08 04 08 17 05 71°17.66 124°31.15 259 248
090 2008D36 08 04 08 21 32 71°17.96 124°32.61 255 245
091 2008D36 09 04 08 01 02 71°17.95 124°32.77 253 245
092 2008D36 09 04 08 13 06 71°18.11 124°34.65 234 224
093 2008D36 09 04 08 17 00 71°18.43 124°34.22 245 235
094 2008D36 09 04 08 21 39 71°18.96 124°35.04 255 245
095 2008D37 10 04 08 22 33 71°15.04 124°36.82 278 270
096 2008D37 11 04 08 02 02 71°15.00 124°37.02 276 265
097 2008D37 11 04 08 13 08 71°15.06 124°37.81 270 263
098 2008D38 11 04 08 22 46 71°15.51 124°37.23 259 250
099 2008D38 12 04 08 02 31 71°15.29 124°37.00 269 260
100 2008D38 12 04 08 12 39 71°14.77 124°36.66 287 276
101 2008D38 12 04 08 17 13 71°14.48 124°36.30 292 280
102 2008D38 13 04 08 02 48 71°14.58 124°39.40 283 271
103 2008D38 13 04 08 14 34 71°16.45 124°45.57 271 265
104 2008D40 15 04 08 22 58 70°47.89 122°27.95 471 460
105 2008D40 16 04 08 00 57 70°47.62 122°28.32 477 467
106 2008D41 16 04 08 13 40 70°47.37 122°20.45 502 494

107	2008D41	16 04 08 17 09	70°47.12	122°18.16	516	506
108	2008D41	16 04 08 21 43	70°46.82	122°13.95	526	506
109	2008D41	17 04 08 01 06	70°46.64	122°10.66	528	515
110	2008D41	17 04 08 13 09	70°44.34	122°8.342	541	530
111	2008D41	17 04 08 17 02	70°43.45	122°7.614	556	547
112	2008D41	17 04 08 21 38	70°41.72	122°6.760	589	568
113	2008D41	18 04 08 01 05	70°40.74	122°5.165	530	520
114	2008D41	18 04 08 13 33	70°37.66	121°56.66	500	490
115	2008D41	18 04 08 17 15	70°37.06	121°54.86	503	485
116	2008D41	18 04 08 21 38	70°36.31	121°52.76	508	320
117	2008D41	19 04 08 01 04	70°35.97	121°51.24	517	500
118	2008D41	19 04 08 14 11	70°35.94	121°51.00	515	504
119	2008D41	19 04 08 17 01	70°35.95	121°51.00	519	505
120	2008D41	19 04 08 17 31	70°35.95	121°51.01	519	025
121	2008D41	19 04 08 21 31	70°36.05	121°51.29	517	500
122	2008D41	20 04 08 00 56	70°36.52	121°52.31	508	490
123	2008D41	20 04 08 13 35	70°39.66	121°54.75	534	525
124	2008D41	21 04 08 01 33	70°43,94	121°50,53	517	500
125	2008D41	21 04 08 15 03	70°42.11	121°43.24	477	470
126	2008D41	21 04 08 17 06	70°41.67	121°42.59	486	470
127	2008D41	22 04 08 02 15	70°39.37	121°43.00	543	526
128	2008D41	22 04 08 14 19	70°36.39	121°47.48	521	520
129	2008D41	22 04 08 17 11	70°36.43	121°48.81	540	525
130	2008D41	22 04 08 21 43	70°35.78	121°51.64	512	496
131	2008D42	23 04 08 13 00	70°38.25	121°97.74	497	
132	2008D42	23 04 08 17 00	70°38.25	121°97.74	497	

2. Team reports

2.1. Team 1

PI: Yves Gratton (INRS-ETE, 490, Rue de la Couronne, Québec)
Participants: Louis Prieur, Shannon Nudds, Richard Marsden and Maria Sharatunova

2.1.1. CTD/Rosette

Objectives
Description of water masses and general circulation over a year in Beaufort Sea and Amundsen Gulf.

Materials
Physical parameters were recorded using a ship mounted RDInstruments Ocean Surveyor ADCP (150 kHz), and a rosette equipped with 24 bottles of 12 L each and the following sensors.

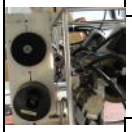
Photo	Item	Manufacturer	Type & Properties	Serial Number
	CTD	SeaBird	SBE-911 Sampling rate : 24 Hz	
	Temperature	SeaBird	SBE 3plus Range: -5°C to + 35°C Accuracy: 0.001	4204
	Pressure	SeaBird	Accuracy: 0.015% of full range	90584
	Conductivity	SeaBird	SBE 4C Range: 0 to 7 S/m Accuracy: 0.0003	2696
	Oxygen	SeaBird	SBE-43 Range: 120% of saturation Accuracy: 2% of saturation	0420
	pH	SeaBird	SBE-18 Range: pH from 0 to 14 Accuracy: pH 0.01	0444
	Nitrates	Satlantic	MBARI ISUS Range: 0.5 to 200 µM Accuracy: ± 2 µM	134
	PAR	Biospherical		4664
	SPAR	Biospherical		20147
	Fluorometer	Sea Point		2465
	Transmissometer	WetLab	Path length: 25 cm	CST-558DR
	Altimeter	Benthos		1061

Table 1: Sensors used on the Rosette

Method

For the whole leg, because of heavy ice conditions, the rosette was deployed from the Moonpool. CTD or Rosette casts were usually performed four times a day at 07h00, 11h00, 15h30 and 19h00. Twice (March 25 and April 1), we did a 13 hour non-stop CTD sampling. Water samples were collected on request. Here are a few typical examples of water sampling depths.

- *Nutrients* (Team 7; PI: Jean-Éric Tremblay): salinity of 33.1, 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300 and every 100 m up to the bottom.
- *DIC* (Team 6; PI: Lisa Miller): salinity of 33.1, 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300 and every 100 m up to the bottom.
- *Contaminants* (Team 8; PI: Gary Stern): 10, 25, 50, 100, 200 m and bottom.
- *Microbes* (Team 7; PIs: Carlos Pedros and Roxanne Maranger): "interesting" features in the O_2, NO_3, fluorescence, temperature and salinity profiles.
- *pH/alkanilitys* (Team 6; PI: Alfonso Mucci): salinity of 33.1, 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300 and every 100 m up to the bottom.

Sampling region

We focused on the northern Amundsen Gulf, south of Banks Island.

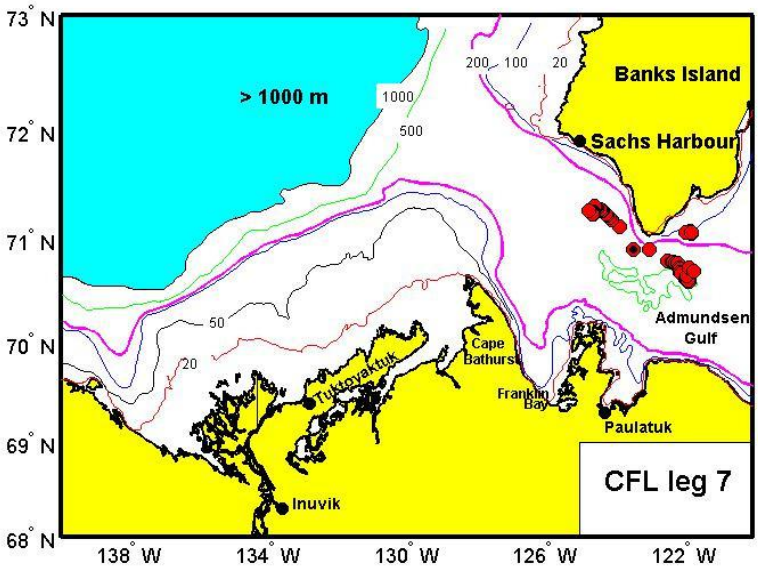


Figure 1: Location of all the rosette and CTD.

Probes calibration

Salinity: Samples were taken on many casts with small bottles of 200 mL. They were analysed with an autosal GuildLine, model 8400B. Its range goes from 0.005 to 42 and its accuracy is <0.002. The results were satisfying. The difference in between the salinity probe recordings and the samples was around 0.033.

pH: Tests were done using two buffers. The sensor is quite stable. Results are as follow:
Buffer 4.01 gave 4.09
Buffer 7.00 gave 7.45
Sea water is usually around pH=8, we can expect pH data to be a little over estimated.

Oxygen: Oxygen sensor calibration was performed using Winkler's method and a Mettler Toledo titration machine. Reagent Blanks were performed once, results show that chemicals are still good (m<4). We sampled oxygen on eight casts. Each time, we choose five depths of different oxygen concentration and sampled it three times. Results were really goods, the probe recordings and the samples were always pretty similar.

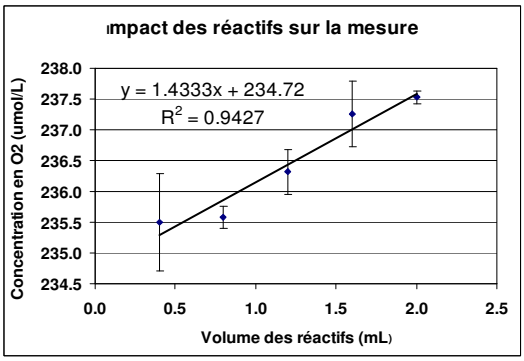


Figure 2: Reagents Blanks (m=1.4333).

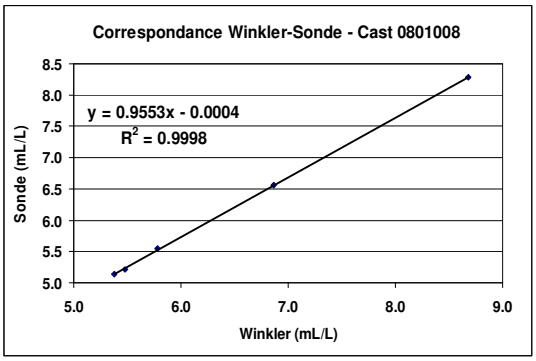


Figure 3: Relation between samples and probe recordings during cast #008 (m=0.955).

Problems

- **Sensors**
  We had pH problems between casts 036 and 055. We don't have nitrates data for casts 65, 66 and 67. We tried an ISUS filter on the nitrates sensor to try to remove the noise on casts 98 and 99: disaster. We changed the fluorometer settings from 0-150 µg/l to 0-50 µg/l. We had problems with the next four profiles (casts 109, 110,111 and 112), but everything came back to normal. We also had problems with the dissolved oxygen sensor and then the salinity. The pump was changed with no amelioration after cast 115. The connecting cable was the changed after cast 122° and everything went back to normal. Oxygen below 250 m from casts 116 to 122° should be ignored and salinity from casts 118 to 122° will have to be checked thoroughly. Thanks to Pascal Massot for fixing all the previous problems.
- **Bottles**
  Some bottles are leaking once in a while, which is a problem that had persisted for a few legs. Bottles number 4 and 5 were not closing all the time at the beginning of the leg. Sylvain Blondeau has repaired them.
- **ADCP:** It's something difficult to get data on the whole water column. This is most probably due to a lack of reflectors at depth. We were really careful and we removed the ice from under ship each time we sarrived on station.

Available data

All information concerning the Rosette casts are summarized in the CTD Logbook. It includes cast and station numbers, date and time of sampling in UTC, latitude and longitude, bottom and cast depth, comments concerning the cast and its name. An electronic Rosette sheet was also created for every single cast. It includes the same information than the CTD Logbook plus the sampling history of the cast. The weather information is written in every Rosette Log as well as in a meteorological logbook. For every cast, data recorded at the moment of bottle closure were averaged and recorded in the so-called 'bottle files'. Averaged data are those recorded between 3 seconds before bottle closure and 7 seconds after it. It includes the bottle position, time and date, pressure, temperature, salinity, light transmission, chlorophyll, oxygen, irradiance and pH measurements. All those files are available on the 'Shares'.

- Rosette sheets and the CTD logbook : Shares\Leg7\Rosette\logs
- Bottles files : Shares\Leg7\Rosette\btl
- Plots of every cast including salinity, temperature, oxygen, transmissivity, nutrients, fluorescence and irradiance : Shares\Leg7\Rosette\plots

A total of 132 CTD-rosette casts were obtained between March 14 and April 23, 2008. More information may be found in the files "Log_Book_0802.xls". Annex 1, below, gives the position of all the CTD casts.

Preliminary Results

We observed a mid-depth eddy between March 29 and April 1 (between casts 46 and 66). The eddy was centered at 80 m and possesses a recognizable dome salinity and velocity structure (Figure 5).

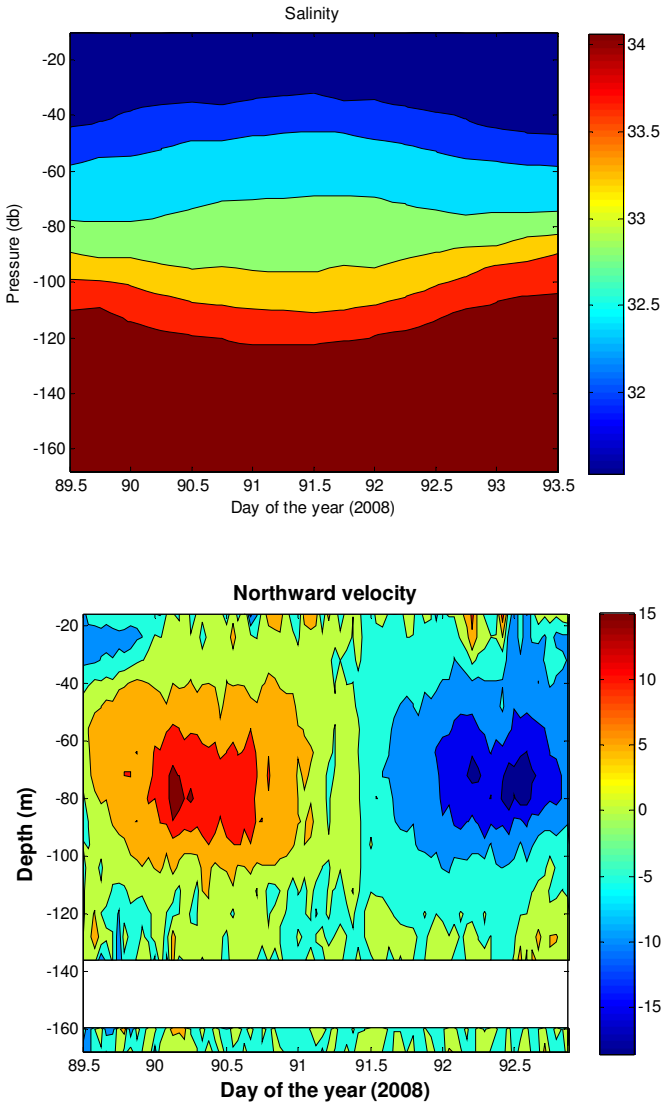


Figure 5: Salinity and velocity contours for the eddy observed between March 29 and April 1, 2008.

2.1.2. Self Contained Autonomous MicroProfiler (SCAMP)

Objectives

The SCAMP is a CTD type profiler (see figure 6). It samples at a frequency of 100 Hz (i.e. 100 times per second). It free falls at approximately 10 cm s^{-1}, resulting in a vertical resolution of approximately one (1) millimetre, down to a maximum depth of 100 m. The instrument measures the temperature and salinity fluctuations at the micro-scale in order to estimate the turbulent mixing occurring in the water column. To properly measure (as opposed to "estimate") turbulence we should also be measuring the velocity fluctuations. Unfortunately, we do not have velocity sensors (too expensive for

now). The current sensors on the SCAMP include temperature (three sensors), salinity (i.e. conductivity; two sensors) and fluorescence.

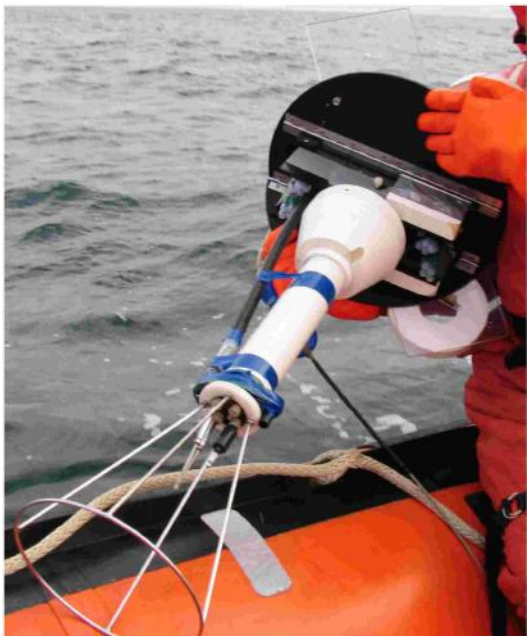


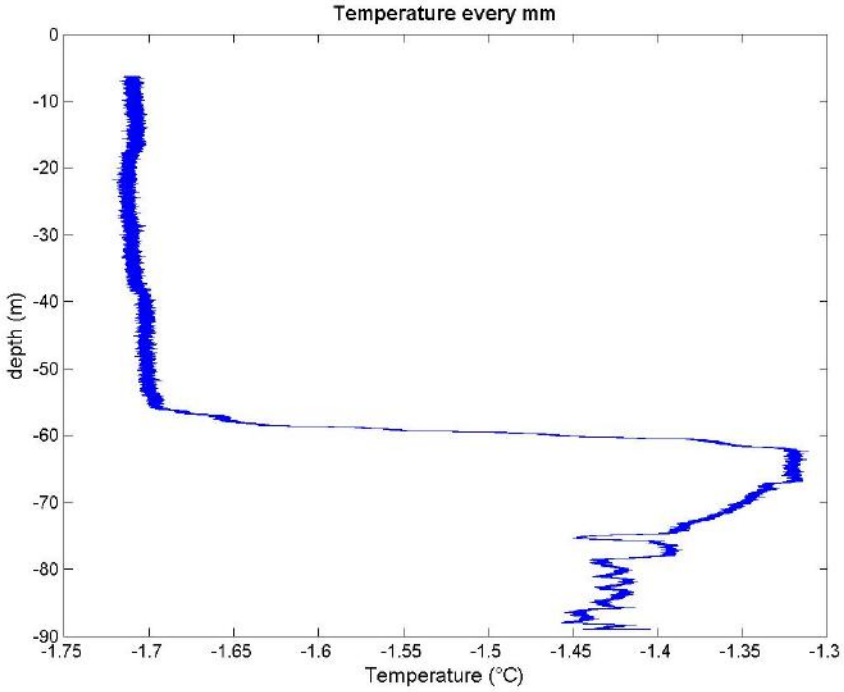
Figure 6: SCAMP in its summer quarters.

Turbulent transports and mixing are among the most important processes in natural systems. They are much more efficient and act much faster than purely diffusive (i.e. molecular) processes. By analogy with the molecular diffusive processes, turbulent mixing is often called “eddy diffusion”. The mixing energy is introduced at large scales, often by the wind at the sea surface and tides at the bottom. Turbulent mixing is called “eddy diffusion” because energy can be thought as being transferred from larger scales to smaller scales, i.e. cascading from larger eddies to smaller and smaller eddies until it reaches the molecular scale where it will be ultimately dissipated into heat. Studying turbulent processes will help us understand how the Mixed Layer (ML) if formed and how it evolves over daily, seasonally and yearly time scales. A better knowledge of the ML properties will help determine how the biological production is affected by the physical processes in the surface layer. A better understanding of the dynamics of the ML will improve our climatic forecasting abilities. Indeed, the mixed layer is the main buffer between the atmosphere and the ocean and it controls most of the heat exchange between the two. One of the major problems is that the ML is evolving hourly, making it very difficult to parameterize in larger numerical circulation models. A better understanding of the ML dynamics will improve the forecasting capacities of both oceanic and atmospheric models.

We encountered a lot of communication problems with the probe. The table, below, summarizes the basic information about the SCAMP profiles obtained during Cruise 0802, i.e. in CFL leg 7. More information may be found in the file “scamp_log_0802.xls”.

Station	Date (UT)	Time (UT)	# profiles	Profiling depth
2008 D38	2008/04/12	17:30:00	3	90 m
2008 D41	2008/04/22	17:00:00	1	90 m

Figure 7. High resolution temperature profile at station D41 on April 22.



2.1.3. Ice Camp

Team 1 planned study the boundary layer between the ice and the top of the ocean mixed layer. The mixing processes in this region have a big impact on the exchanges not only between the ocean and the ice but also on the phytoplankton living in the ice.

The instrumentation for the boundary layer turbulence system consists of three principal components as follows:

- 2 X 614 kHz RDI Acoustic Doppler Current Profilers (ADCPs)
- 2 X 10 MHz Sontek Acoustic Doppler Velocimeters (ADV).
- 2 X PME fast sample thermistor and conductivity probes (SC).

The ADCPs function separately while the ADVs and SCs are integrated into 2 boundary layer heat and salinity flux monitors (BLM). Data collection for the BLM is controlled through a Campbell 3000 data logger. The two ADCPs and the bound BLMs are mounted on aluminium frames and lowered through the ice so the instruments intrude the water column to just below the ice-water interface. The overall sampling set-up is shown in figure 8.

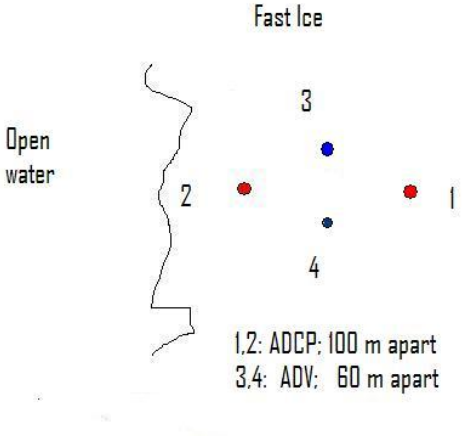


Figure 8: Ice camp ADCP and ADV set-up

ADCP System
The ADCP system consists of two instruments. The objectives are twofold:

1. one ADCP will be set to high resolution mode - mode 11 with a depth resolution of 25 cm sampling at 1 Hz the data will be analysed to determine the turbulence properties as a function of depth. Typically the instrument will sample to 7 m below the ice-water interface.
2. the second ADCP will be used to monitor the larger scale water properties (i.e. internal waves and solitons. The instrument will be set to mode 1 with a one minute sampling interval with 2.0 m depth bins. Typically the instrument will be able to sample to 25 m below the ice-water interface

Boundary Layer Conductivity and Temperature Monitor (BLM)
The purpose of the BLM is to obtain eddy correlation estimates of turbulent salinity and temperature flux at the ice-water interface. There are two BLM consisting of three distinct systems:

1. A Sontek point velocimeter (2 units)
2. A PME conductivity and Temperature probe (2 units)
3. A Campbell 3000 Data logger that will log data from all four sub-systems simultaneously.

All the equipment was put together for the first time (a lot of new instruments) and tested successfully in the outside rosette control room. Unfortunately, the ice conditions prevented us from mooring them at the proposed Ice Camp location.

2.1.4. List of Moonpool operations

This section contains a simple list of moonpool operations in CFL0802 (leg 7).

Moonpool operations: times are local (UT-6)

March 15	11h30	CTD	
	19h00	CTD	
March 16	07h00	CTD	
	08h30	Hydrobios	
	11h00	CTD	
	15h00	rosette	traps
	19h00	CTD	
March 17	07h00	rosette	DNA
	08h30	hydrobios	nets
	11h30	rosette	CO2
	15h30	rosette	cancelled
	19h00	rosette	contaminants
March 18	07h00	CTD	
	11h00	rosette	CO2
	13h00	Tuckers	
	15h30	rosette	nut + Hg
	19h00	rosette	traps
March 19	07h00	CTD	
	08h00	Hydrobios	3 Tuckers
	transit		
	late p.m.	rosette	PP + Rod
March 20	transit	struck	

March 21	transit		
March 22	transit		
March 23	13h00	hydrobios	
	15h30	rosette	PTP
	19h00	CTD	
March 24	06h30	Tuckers (3)	
D33	08h00	hydrobios	
	08h30	CTD	
D34	15h00	basic (lead)	PP + O2 + CO2
	21h00	CTD	Hg
March 25	06h30	nets	
	07h30	hydrobios	Spring tides
	09h00	CTD	
	10h00	CTD	
	11h00	CTD	
	12h00	CTD	
	13h00	CTD	
	14h00	CTD	
	15h00	CTD	
	16h00	CTD	
	17h00	CTD	
	18h00	CTD	
	19h00	CTD	
	20h00	CTD	
	21h00	CTD	
	22h00	CTD	
March 26	07h00	rosette	microbes
	11h00	CTD	
	12h00	Gérald	nets
	15h30	CTD	
	19h00	CTD	
March 27	07h00	CTD	
	11h00	CTD	
	13h00	Gérld	nets
	15h30	rosette	nutrients
	19h00	CTD	
March 28	07h:00	CTD	PP
	08h:00	Gérald	nets+hydro
	11h30	CTD	PP
	15h30	CTD	
	19h00	CTD	
March 29	07h00	CTD	
	11h00	CTD	
	15h30	CTD	

	16h00	Light profile	
	19h00	CTD	
March 30	07h00	CTD	
	08h00	nets	
	11h00	CTD	
	19h00	CTD	
March 31	07h00	CTD	PP
	11h00	CTD	
	15h30	CTD	contaminants
	19h00	CTD	
April 1	06h30	nets	Neap tides
	07h30	hydrobios	
	08h30	CTD	
	09h30	CTD	
	10h30	rosette	
	11h30	CTD	
	12h30	CTD	
	13h30	CTD	
	14h30	CTD	
	15h30	CTD	
	16h30	CTD	
	17h30	CTD	
	18h30	CTD	
	19h30	CTD	
	20h30	rosette	contaminants
	21h30	rosette	traps
April 2	07h00	CTD	
		Lead	
	10h30	hydrobios	
	12h30	light profile	
	13h30	rosette	
	19h30	rosette	PP + zoo
April 3	07h00	rosette	PP
	11h00	CTD	
	15h30	CTD	
	16h00	light profile	
	19h00	CTD	
April 4	07h:00	CTD	
	08h:00	Gérald	nets+hydro
	11h30	CTD	
	15h30	CTD	
	19h00	CTD	
April 5	transit		
	19h30	rosette	PP
April 6	07h00	rosette	microbes + PP
	09h30	nets	

	11h00	CTD	
	15h30	rosette	Hg
	19h00	CTD	
April 7	07h00	CTD	
	11h00	rosette	Nut+Hg+DIC+DOC
	13h00	nets	
	15h30	rosette	traps + PTP
	16h00	nets	
	19h00	rosette	contaminants
April 8	07h00	CTD	
	08h00	nets	
	11h00	rosette	PP
	13h00	light profile	
	15h30	CTD	
	19h00	CTD	
April 9	07h00	rosette	PP
	08h00	nets	
	11h00	rosette	DNA + DO
	13h00	light profile	
	15h30	rosette	traps
April 10	16h30	rosette	nut+Hg+DIC+DOC+O
	20h00	CTD	
April 11	06h00	nets	
	07h00	CTD	
	16h30	CTD	PTP+ PP + traps
	20h30	CTD	
April 12	06h30	rosette	microbes
	09h30	nets	
	11h00	rosette	PP
	11h30	SCAMP	
	14h00	ROV	
	20h30	CTD	
April 13	08h30	rosette	contaminants
April 14	transit	Box Core	Station D39
April 15	14h30	nets	hydrobios
	17h00	rosette	contaminants + PP
	18h00	light profile	
	19h00	rosette	nut+Hg+DIC+DOC+O
April 15	14h30	nets	hydrobios
	17h00	rosette	contaminants + PP
	18h00	light profile	
	19h00	rosette	nut+Hg+DIC+DOC+O

April 16	06h00	hydrobios	
	07h30	rosette	microbes + DNA
	11h00	rosette	
	12h00	hydrobios	nets
	15h30	CTD	
	16h30	SCAMP	
	19h00	CTD	
April 17	07h00	rosette	PTP
	08h00	hydrobios	
	11h00	CTD	
	15h30	CTD	
	19h00	CTD	
April 18	06h00	hydrobios	
	07h30	CTD	
	10h00	hydrobios	
	11h00	rosette	nut+Hg+DOC+DIC
	14h00	hydrobios	
	15h30	CTD	
	18h00	hydrobios	
	19h30	CTD	
	22h00	hydrobios	
April 19	02h00	hydrobios	
	06h00	hydrobios	
	07h30	CTD	
	11h00	rosette	PP
	15h30	CTD	
	19h00	rosette	PP
April 20	07h30	rosette	PTP
	08h30	ROV	
	19h30	rosette	contaminants
April 21	07h00	rosette	microbes
	11h00	rosette	nut+Hg+DOC+DIC
	13h00	ROV	
	19h00	rosette	
April 22	08h00	rosette	zooplankton
	09h30	light profile	
	11h00	CTD	
	13h00	SCAMP	
	15h30	CTD	
	19h00	CTD	
April 23	07h00	CTD	
	11h00	rosette	nutrients

2.2. Team 2

2.2.1. Ice Dynamics

PI: David Barber (CEOS, University of Manitoba)
Participants: Klaus Hochheim (Research Associate, CEOS, University of Manitoba),
Andrea Rossnagel (MSc Student, CEOS, University of Manitoba),
Monika Pucko (PhD student, DFO and CEOS, University of Manitoba)

General Ice Conditions

Leg 7a started with the ship stationed in a "fast ice" location SSW of De Salis Bay, Station D33, within medium first-year ice (FYI) where the ice thicknesses were approx. 120-150 cm with a band of younger ice adjacent (30-70cm thick). This site remained in a fixed location until April 3, when the site had to be evacuated. The first half of leg 7 was dominated by a high pressure system, clear skies, and relatively calm winds. The stations after April 3 were all mobile as ice was being flushed out of Amundsen Gulf. A ice bridge (Figure 1b) remained in intact till the morning of April 14.

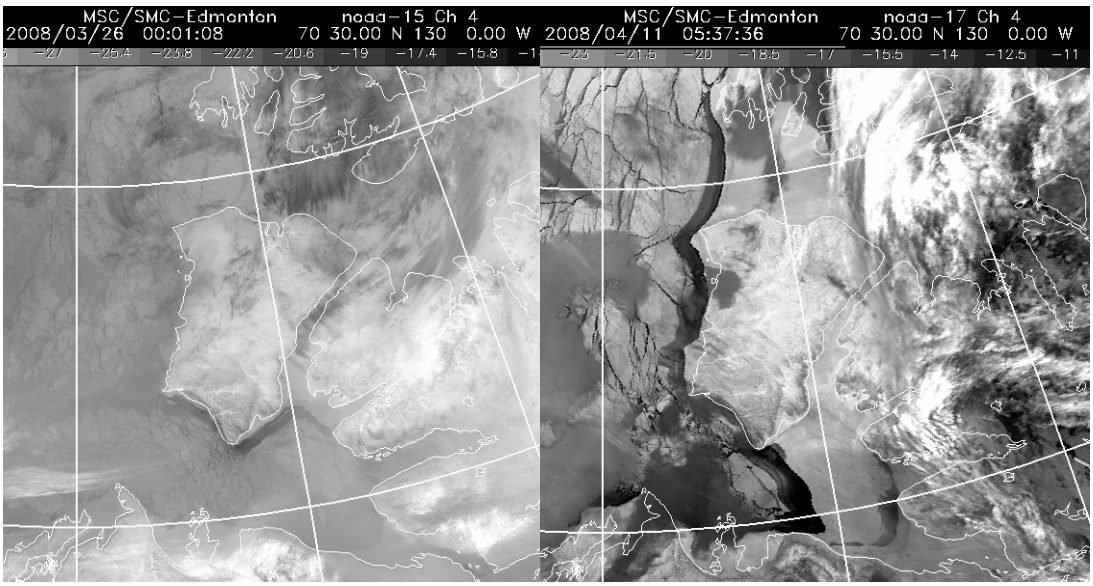


Figure 1. A) AVHRR image from March 26, 2008; B) April 11

Physical Sampling

The Team 2 CFL ice raid program continued throughout Leg 7a following the protocol that was previously established in Leg 5. We have termed this sampling "Drift Mode Sampling." The goal is to obtain physical and microstructure measurements of the snow and sea ice, and for twice-daily sampling to occur at the same time as the passage of a train of arctic monitoring satellites at 9:30 and 3:30pm. We continued the drift mode sampling protocol, protecting our EM scanning site with a fence, and performing twice-daily sampling in areas indicative of the area being scanned. There were chances to visit the flaw lead and consequently examine thin and newly forming ice and therefore samples were taken on an opportunistic basis to optimize our data collection

The ice surface condition was recorded and site photos were taken. The nature of ice coring and snow pit work depended on how many days we had been at that site, but in general we followed the sampling protocol outlined in Table 1.

Table 1. Drift Station Physical Sampling Protocol.

DAY	ICE (AM)	SNOW (AM)	ICE (PM, TOP 40 CM ONLY)	SNOW (PM)
Day 1	T, Sal, VMS, D	T, Cap, SGA, D, depth, Sal	T, Sal	T, Cap, SGA, D, depth, Sal
Day 2	T, Sal	T, Cap, SGA, D, depth, Sal	T, Sal	T, Cap, SGA, D, depth, Sal
Day 3	T, Sal, D	T, Cap, SGA, D, depth, Sal	T, Sal	T, Cap, SGA, D, depth, Sal
Day 4	T, Sal	T, Cap, SGA, D, depth, Sal	T, Sal	T, Cap, SGA, D, depth, Sal
Day 5	T, Sal	T, Cap, SGA, D, depth, Sal	T, Sal	T, Cap, SGA, D, depth, Sal
Day 6	T, Sal	T, Cap, SGA, D, depth, Sal	T, Sal	T, Cap, SGA, D, depth, Sal
Day 7	T, Sal	T, Cap, SGA, D, depth, Sal	T, Sal	T, Cap, SGA, D, depth, Sal
Week 2 at site	Repeat from day 1	Repeat from day 1	Repeat from day 1	Repeat from day 1

Ice: T = temperature profile (T = core temperature profile, Sal = core for Salinity, VMS = core for vertical microstructure, D = core for density.
Snow Pits: T = temperature profile, Cap = capacitance plate, SGA = snow grain analysis, D = densit, Sal

In summary, we took ice cores twice per day for salinity and temperature profiles, with the 3:30 pm ice cores limited to the top 40 cm. A core was taken for vertical microstructure on day 1 as well as density. We also performed a twice-daily snow pit measurement according to our standard procedure. This includes temperature profiles, salinity profiles, capacitance plate measurements, and snow grain photos.

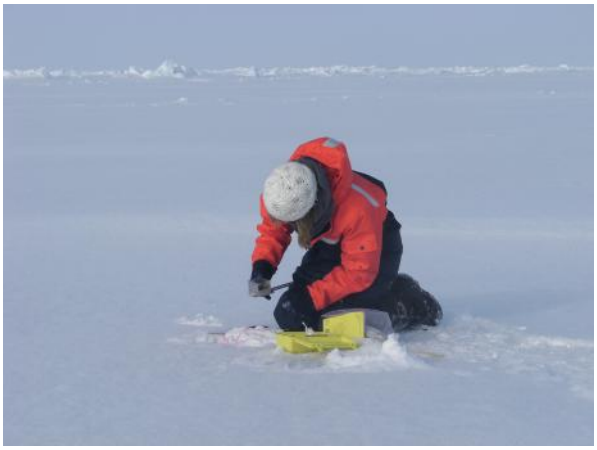


Figure 2. Typical snow pit measurement procedure.

Table 2. Ice Sampling Summary

DATE	STATION	SNOW	ICE TYPE	ICE MICRO
17-Mar-08 to 18-Mar-08	2008D29	Variable (5 – 14 cm)	First year ice (110-135 cm)	Vertical
19-Mar-08	2008D31	Frost Flower Collection	First year ice (28-55 cm)	Vertical

25-Mar-08 to 03-Apr-08	2008D33	Variable (5 – 38cm)	First year ice (135 – 153 cm)	Vertical
6-Apr-08 to 9-Apr-08	2008D36	Variable (2 - 13cm)	First year ice (70 – 160 cm)	Vertical
16-Apr-08 to 23-Apr-08	2008D41	Variable (4.5 - 72cm)	First year ice (128-140 cm)	Vertical

Ice sampling was not as regular (twice a day) in 7b due to fewer team members on board as well as flooding of EM sites during repositioning of the ship. Snow sampling carried on regularly with more sites being done.

Ship Based EM Measurements

EM measurements were conducted throughout Leg 7a in order to observe the interaction of electromagnetic radiation with various ice conditions. The collected data will be used in electromagnetic modeling studies and for calibration of satellite remote sensing data. The results of this study will allow for us to improve our knowledge of the temporal evolution of sea ice physical, thermodynamic, and electrical properties during the winter ice growth period.

Scatterometer

A fully polarimetric scatterometer system was operated at each station stop. The height of the instrument above the surface has been regularly measured and maintained in the operations log. Measurements from the ship were conducted with a sweep from -30° to 30° in the azimuth, requiring the 0° reference at a perpendicular line to the ship side. The variation in elevation was measured with sweeps in the elevation at 5° increments on the range 20° to 60°. Table 3 summarizes the scatterometer data collected during Leg 7. An infrared transducer (Everest, 4000L) was mounted on a rail near the scatterometer.

At the beginning of Leg 5B, we had noticed that sometimes the noise floor of the system would rise and therefore some of the radar returns would be lost in the noise and corrupted. This problem was not evident in Leg 7a, towards the end of 7b noise was evident, cables were cleaned and dry resulting in a clean signal. Operators of the instrument need to continue monitoring noise levels to ensure high quality data.

Table 3. Summary of scatterometer data acquired.

Site	Date (DMY)	Local START	UTC Start UTC	Local END	UTC end UTC	Duration	Comments
D29	17/3/2008	08:43:00	14:43:00	11:24:00	17:24:00	02:41:00	station
D29	17/3/2008	15:14:00	21:14:00	17:51:00	23:51:00	02:37:00	station
D29	18/3/2008	08:49:00	14:49:00	11:06:00	17:06:00	02:17:00	station
D31	19/3/2008	15:32:00	21:32:00	18:45:00	00:45:00	03:13:00	thin ice location during transit
transit	20/3/2008						ice cam computer crash, config file missing or corupt.
D33							arrived at new location, were stuck numerous times (3), days lost due to positioning
D34	24/03/08	18:21:00	00:21:00	19:03:00	01:03:00	00:42:00	young ice (30 cm), note:several initial scans aborted
D33	25/03/08	08:48:00	14:48:00	12:39:00	18:39:00	03:51:00	D33 longer term station on old ice, scans restricted to 0-30 deg (left) 20-60 elv
D33	25/03/08	15:08:00	21:08:00	17:28:00	23:28:00	02:20:00	
D33	26/03/08	09:00:00	15:00:00	10:30:00	16:30:00	01:30:00	
D33	26/03/08	15:25:00	21:25:00	17:30:00	23:30:00	02:05:00	
D33	27/03/08	09:14:00	15:14:00	11:40:00	17:40:00	02:26:00	
D33	29/03/08	08:21:00	14:21:00	10:52:00	16:52:00	02:31:00	

D33	29/03/08	15:31:00	21:31:00	18:16:00	00:16:00	02:45:00	
D33	30/03/08						Positioner stopped working, initpos "alarm" and cannot set chirp card into idle.
D33	02/04/08						positioner fixed
D33	03/04/08	08:40:00	14:40:00	10:55:00	16:55:00	02:15:00	
D33	03/04/08	15:08:00	21:08:00	17:25:00	23:25:00	02:17:00	
D33	04/04/08		06:00:00		06:00:00	00:00:00	evacuated site D33, ice in Admundsen Gulf started to flush out. remaining locations flooded

Ship-Based Radiometer (SBR)

Dual polarized radiometers operating at 37 GHz and 89 GHz with a 6° beamwidth were mounted about 12 m above the sea surface on the port side of the ship. The SBR conducted twice daily scans to correspond with our physical sampling program. The system was operated in a scan mode, changing the incident angle from 30° to 150° using 5° steps. During transit, the radiometers were kept at an incident angle of 55°. A network camera was used to monitor the surface conditions at a sampling rate of 10 s while in transit. The settings have not been changed otherwise. In addition, a hand-held camera is used at each site to provide more information on the surface conditions. A summary of SBR data collected is provided in Table 4.

Table 4. Summary of scatterometer data acquired

Site	Date (DMY)	Local START	UTC Start UTC	Local END	UTC end UTC	Duration	Comments
D29	17/3/2008	08:39:00	14:39:00	11:27:00	17:27:00	02:48:00	
	17/3/2008	15:19:00	21:19:00	17:54:00	23:54:00		
D29	18/3/2008	08:51:00	14:51:00	11:08:00	17:08:00		
transit	19/3/2008	15:12:00	21:12:00	18:45:00	00:45:00	03:33:00	thin ice location during transit (pancake) 30 cm, 18:00 stoped ship for Moon pool
transit	19/3/2009	18:51:00	00:51:00	21:31:00	03:31:00		
D33	20/3/2008	08:45:00	14:45:00	11:01:00	17:01:00		stuck for last .5 hrarrived at new location, were stuck numerous times (3), days lost due to positioning
D33	20/3/2008	11:29:00	17:29:00	13:59:00	19:59:00		lake for last hour
			06:00:00		06:00:00		
D34	24/03/08	18:13:00	00:13:00	19:01:00	01:01:00	00:48:00	young ice (30 cm), note:several initial scans aborted
D33	25/03/08	08:51:00	14:51:00	12:41:00	18:41:00	03:50:00	D33 longer term station on old ice, scans restricted to 0-30 deg (left) 20-60 elv
D33	25/03/08	15:13:00	21:13:00	17:26:00	23:26:00	02:13:00	
D33	25/03/08	17:35:00	23:35:00	19:10:00	01:10:00		
D33	26/03/08	09:02:00	15:02:00	11:11:00	17:11:00	02:09:00	
D33	26/03/08	15:15:00	21:15:00	17:35:00	23:35:00	02:20:00	
D33	27/03/08	09:16:00	15:16:00	11:40:00	17:40:00	02:24:00	
D33	29/03/08	08:29:00	14:29:00	10:51:00	16:51:00	02:22:00	angles off, do not use
D33	29/03/08	15:32:00	21:32:00	18:18:00	00:18:00	02:46:00	angles off, do not use
D33	30/03/08						corrected angles, positioner was off as of last date, program showing 45 deg, actual was 28 deg.
	31/03/08	08:25:00	14:25:00	14:47:00	20:47:00	06:22:00	
	01/04/08	15:47:00	21:47:00	17:09:00	23:09:00		
Transit	02/04/08	09:08:00	15:08:00	13:34:00	19:34:00		
D33	03/04/08	08:59:00	14:59:00	10:58:00	16:58:00	01:59:00	

D33	03/04/08	15:08:00	21:08:00	17:27:00	23:27:00	02:19:00	
D33/trans	04/04/08	11:25:00	17:25:00	18:55:00	00:55:00	07:30:00	evacuated site D33, ice in Admundsen Gulf started to flush out. Stuck for 2 hours

Laser Profiler

The laser profiler was disassembled and put in storage during Leg 5, and thus was not operated during Leg 7.

Skippy Boat

The purpose of the skippyboat is to allow us to investigate several sites using the optical equipment on board, and still return to the sites to perform additional measurements and physical sampling. The skippyboat was de-winterized at the beginning of Leg 7b, and was used throughout the duration of Leg 7b.

Figure 3. Skippy boat in lead allowing scientists to sample water and do PAR and CTD measurements.

Coloured Dissolved Organic Matter (CDOM), Fluorescence of Dissolved Organic Matter (FDOM), Salinity and Oxygen Isotope ($\delta^{18}O$)

Dissolved organic matter (DOM) plays a major role in the ocean as carbon and energy sources for the microbial food web, and for consumers at higher trophic levels that feed on microbes or on DOM directly. The coloured fraction of this dissolved organic matter is a complex pool of autochthonous materials, derived from in situ photosynthetic activity and processed microbially, and allochthonous materials, that are rich in humic substances and largely derived from terrestrial environments.

This coloured dissolved organic matter (CDOM) is photochemically active and also influences the spectral underwater regime that in turn affects primary production. The composition and reactivity of CDOM in aquatic ecosystems are still poorly understood. The sources and dynamics of DOM are of special interest in the coastal Arctic Ocean. These environments receive inputs of freshwater from large rivers that drain arctic tundra and peatlands as well as subarctic boreal forest. To increase the understanding of this tracer we are coupling the sampling with $\delta^{18}O$ which is a conservative tracer of freshwater masses. It has been estimated that more than 25% of the world's soil carbon lies in these catchments, and there is concern about how ongoing climate change may mobilize these stocks and transport them to arctic seas. The carbon derived from arctic rivers appears to be a major source of terrigenous DOM to the deep ocean, and changes in the magnitude and composition of this material therefore have broader oceanographic implications.

Global circulation models predict that the arctic basin will experience greater and more rapid warming than elsewhere over the course of this century, and there is increasing evidence that global climate change has already begun to have significant impacts on permafrost degradation and terrestrial vegetation dynamics at high northern latitudes.

Water was collected onboard using the rosette from the moonpool. The ice was collected at stations D38. The water was collected at 10 m, 25 m, 50 m, 100 m and 180 m on contaminant (THg) casts.

Due to problems with the spectrophotometer Cary 50, the CDOM samples has been store at 4°C and measurements of CDOM will be completed at University of Manitoba.

Preliminary Results:
CDOM and FDOM analysis will be performed after the cruise in laboratories at the University of Manitoba. Stable isotope analysis of water and ice samples will be analyze outside of the university.

Table 5. CDOM and FDOM sample locations.

Date (mm-dd-yyyy)	Station (#)	Cast (#)
02-04-2008	2008D35	72

Atmospheric Sampling Program
The purpose of the atmospheric sampling program is to monitor cloud cover and cloud properties, upper level and boundary layer winds, temperature, and humidity.

All-Sky Camera
The all-sky camera system is used to take pictures of sky in order that percentage and type of cloud cover may be determined throughout the cruise. The Camera system did not function for the majority of the trip, due to power issues, those were resolved. The camera takes pictures every 10 minutes.

Ceilometer
The ceilometer is used to measure the height of the cloud layers above the ship. The ceilometer was fully functional for most of Leg 7, with the exception of about a week, were water from the ceiling destroyed the computer. New software was obtained and installed in a new computer. Backups wwere performed at regular intervals.

Atmospheric Profiling Radiometer
The profiling radiometer is used to continuously measure the temperature, relative humidity, and pressure within the atmosphere to a 10 km altitude . The profiling radiometer has been running smoothly, with only occasional crashing of the interface software on the laptop due to a memory leak. Data collection was not affected.

Radiosondes (weather balloons)
There were 6 balloon launches during Leg 7, most were launched towards the latter part of Leg 7 as the first half of the Leg Was dominated by a high pressure system. Balloon launches were conducted to correspond mainly with low-pressure depressions and cyclones, one was released in support of OASIS (ozone event).

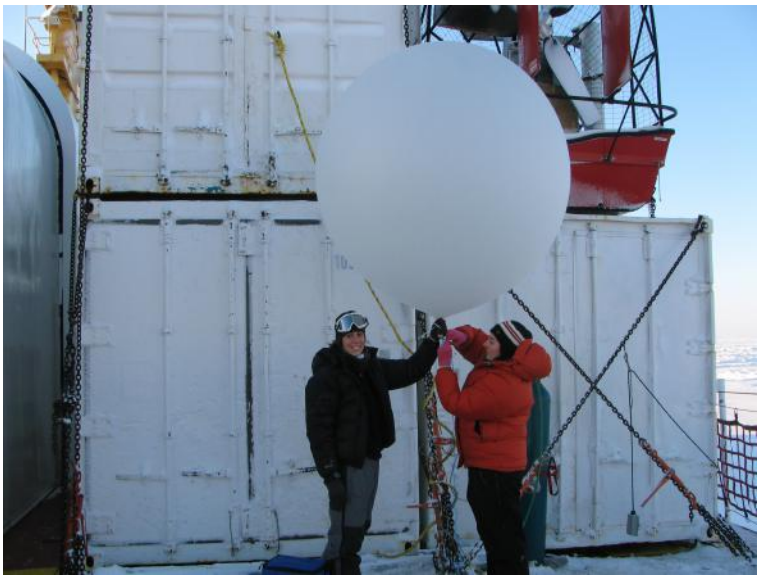


Figure 4. Attaching a radiosonde to a balloon for an atmospheric profile.

Table 6. Stations and dates of balloon launches.

Station	Date
2008D31	23/03/08
2008D33	02/04/08
2008D41	16/04/08
2008D41	16/04/08
2008D41	17/04/08

Laser Precipitation Gauge

This instrument was not fully functional throughout Leg 7 but was for the second half of the leg. The instrument continues to run as per normal, and all data has been downloaded and archived.

Ice Motion Beacons

We deployed three ice motion beacons and will deploy a couple more before melt begins.

Table 7: Ice motion beacon deployments.

Beacon ID	Date Deployed	Location Deployed	Status
n/a	*/03/08	n/a	Active
19310	24/03/08	D33 Oasis reflector	Active
15000	5/04/08	n/a	Active
25590	17/04/08	2008D41	Active

Figure 5. Ice motion beacon installed in a first-year ice floe.

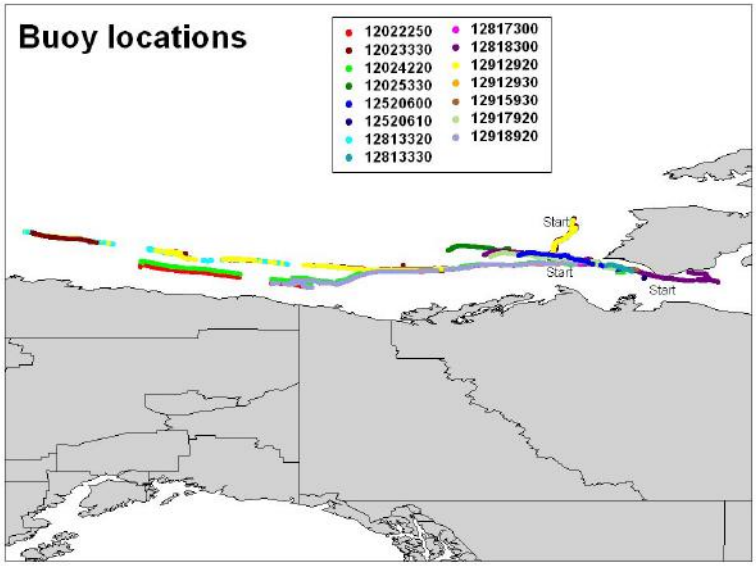


Figure 6. Ice motion buoy locations as of February 25, 2008.

Met-ocean MOBS Buoys
Two improved MOBS buoys were received, but have not been operated. The buoys are presently stored near and inside the benthic lab.
Met-ocean POPS Buoy

No POPS buoys were on the ship until the last week of Leg 7. There is also no fast ice camp so no POPS buoy has been deployed.

AVOS (Environment Canada MetObs System)
This system was operating normally, with the exception of a few glitches in data transmission that were worked out by the ship's electronics officer.

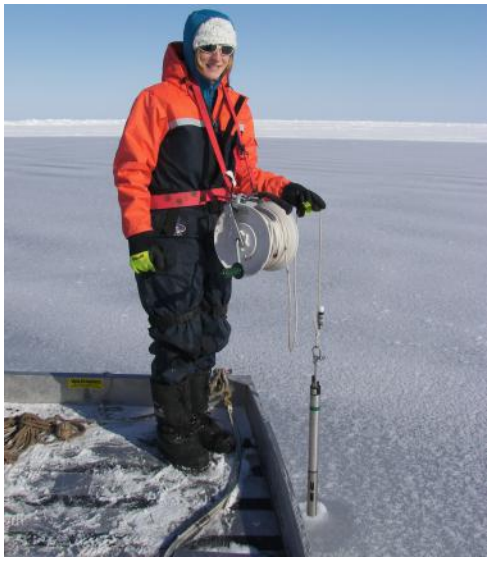
Light and Optical Measurements
The objectives of this experiment are to examine potential impact of sea ice (and related environmental parameters) on light intensity under various sea ice, snow and solar zenith angle regimes during the spring transition period (Legs 7, 8b and 9a). To address this objective we will be

measuring light fields (PAR) above and under the ice down to 60 m, albedo, snow properties (temperature, grain size, salinity) and upper ocean properties (conductivity and temperature) along with other relevant surface validation data. These measurements will be done in fast ice floes as well as in leads and the marginal ice zone. The ultimate intent is to extrapolate these observations/results to regional scales.

Figure 7. A CTD and PAR profile through the snow and ice

CTD (Conductivity, Temperature, and Depth) and PAR (Photosynthetically Active Radiation) profiles were done opportunistically with a focus on different snow and ice conditions as well as different times of the day. This is to see the affect of different snow and ice regimes on PAR in the water column below the ice. Profiles were also done through thin ice as well as open water between floes from the skippy boat and from the ice edge. Sampling was done at different times of the day to see the effect of solar zenith angle.

Snow pits including a vertical pit photo, and snow grain photos, density and salinity were done for the top, middle and bottom of each snow pack.



STATION	DATE	Licor PAR	Alec PAR	SNOW	ICE DEPTH	CTD
D29	22/03/08	Yes	No	Dep	Yes	Yes
D33_1	25/03/08	Yes	No	Dep	Yes	Yes
D33_2	28/03/08	Yes	Yes	Dep	Yes	Yes
D33_1a	29/03/08	No	Yes	Dep	Yes	Yes
D33_1b	29/03/08	No	Yes	Dep	Yes	Yes

D33_1c	29/03/08	No	Yes	Dep	Yes	Yes
D33_d	29/03/08	No	Yes	Dep	Yes	Yes
D33_e	29/03/08	No	Yes	Dep	Yes	Yes
D33_3	31/03/08	Yes	Yes	Dep	Yes	Yes
D33_4	3/04/08	Yes	Yes	Dep	Yes	Yes
D36_1	6/04/08	Yes	Yes	Dep	Yes	Yes
D36_2	6/04/08	Yes	Yes	Dep	Yes	Yes
D36_3	6/04/08	No	Yes	Dep	Yes	Yes
D36_4	6/04/08	No	Yes	n/a	Lead / Open Water	Yes
D36_5	6/04/08	No	Yes	n/a	Lead / Open Water	Yes
D36_6	6/04/08	No	Yes	n/a	Lead / Open Water	Yes
D36_7	6/04/08	No	Yes	No snow	Yes	Yes
D36_8	7/04/08	No	Yes	No snow	Yes	Yes
D36_8b	7/04/08	No	Yes	No snow	Yes	Yes
D36_9	8/04/08	Yes	Yes	SGA, D, Den	Yes	Yes
D36_10	8/04/08	No	Yes	No snow	Yes	Yes
D36_11	9/04/08	Yes	No	Dep	Yes	Yes
D36_12	9/04/08	No	No	Dep, SGA,D,S	Yes	Yes
D36_13	9/04/08	No	No	Dep, SGA,D,S	Yes	Yes
D36_14	9/04/08	No	No	Dep	Yes	Yes
D38_1	10/04/08	No	Yes	No	Lead / Thin ice/ open water	Yes
D38_2	10/04/08	No	Yes	Dep, SGA,D,S	Yes	Yes
D38_3	10/04/08	No	Yes	Dep, SGA,D,S	Yes	Yes
D38_4	10/04/08	No	Yes	Dep, SGA,D,S	Yes	Yes
D38_5	10/04/08	No	Yes	n/a	Lead / Thin ice/ open water	Yes
D38_6	11/04/08	No	Yes	Dep, SGA,D,S	Yes	Yes
D38_7	11/04/08	Yes	Yes	Dep, SGA,D,S	Yes	Yes
D38_8	11/04/08	No	Yes	Dep	Yes	Yes
D38_9	11/04/08	No	Yes	Frost Flowers	Lead / Thin ice	Yes
D38_10	12/04/08 to 13/04/08	No	Yes	Dep	Lead / Thin ice	Yes
D38_11	12/04/08 to 13/04/08	No	Yes	Frost Flowers	Lead / Thin ice	No
D38_12	12/04/08 to 13/04/08	No	Yes	Frost Flowers	Lead / Thin ice	No
D38_11a	13/04/08	No	Yes	Frost Flowes	Lead / Thin ice	Yes
D38_10a	13/04/08	No	Yes	Dep	Lead / Thin ice	Yes
D41_1	16/04/08 to 22/04/08	No	Yes	Frost Flowers, Dep	Lead / Thin ice	No
D41_2	16/04/08 to 22/04/08	No	Yes	Dep, SGA,D,S, Cap	Yes	No

D41_3	16/04/08 to 22/04/08	No	Yes	Dep, SGA,D,S, Cap	Yes	No
D41_5	16/04/08 to 22/04/08	No	Yes	Frost Flowers, Dep	Yes	No
D41_5b	19/04/08	No	Yes	Frost Flowers, Dep	Yes	Yes
D41_6	17/04/08	No	Yes	Frost Flowers, Dep	Yes	Yes
D41_7	17/04/08	No	Yes	Frost Flowers, Dep	Yes	Yes
D41_8	19/04/08	No	Yes	Frost Flowers, Dep	Yes	Yes
D41_9	20/04/08	No	Yes	Dep, SGA,D,S, Cap	Yes	Yes
D41_10	20/04/08	No	Yes	n/a	Lead / open water	Yes

Snow Pits: T = temperature profile, Cap = capacitance plate, SGA = snow grain analysis, D = density, Dep = Depth

Moorings of PAR sensors were made and installed two times during the leg. One series was installed for a period of 24 hours and the second one for 5 days. In thick ice the strings of sensors went down to 30 m and along the ice edge and in the thin ice they went down to 50 m.

Downwelling and upwelling irradiance as well as under ice transmitted irradiance measurements were done every three days with a Licor quantum PAR sensor under low, medium and high snow depths in conjunction with Team 3. A table of sampling dates can be found in the Team 3 section of the cruise report.

Dive Program

Team 2 was involved in the dive program starting April 7, 2008. A Satlantic HyperOCR hyperspectral profiler was used for measurements directly under the ice, at 15 and 40 cm below, and for vertical 50 m profiles under the ice. The measurements were done under thin ice, 5 cm, to thick ice at 160 cm. After the measurements were completed for these sites, the snow was cleared and a second series of measurements were made without snow.

Figure 8. Hyper OCR about to be deployed at dive location

Table 8. HyperOCR data summary

Date	Type	Profile
April 7, 2008	Ice, thick (70 cm) and thin (5cm)	Profile to 50 m
April 8, 2008	Ice, thick (150 cm) and thin	Profile to 50 m
April 12, 2008	Ice, thick (130 cm) and thin	Profile to 50 m
April 18, 2008	Ice, thick (130 cm) with and without snow	Profile to 50 m
April 21, 2008	Ice, thick (130 cm) with and without snow	Profile to 50 m

2.2.2. EM ice survey

Participants: Scott Holladay (Geosensors ltd, Toronto, Ontario,
scottholladay@geosensors.com, April 3 – 17, 2008)
Simon Prinsenberg (Bedford Institute of Oceanography, Dartmouth Nova Scotia,
prinsenbergs@mar.dfo-mpo.gc.ca, April 3 -24, 2008)

Thursday, April 3 to April 16, 2008
EM sled work around the ship while stationed in the ice.
Waiting for the BO105 helicopter to arrive.
Ship moving towards Henson Point on southern tip of Banks Island (April 4-5)

Sunday, April 6, 2008
Testing sled over thick floe 165cm near ship and thin floe forward of ship 70cm.
Ice thickness transects to-from thin floe to ship.

Monday April 7, 2008.
Calibration line over thick floe, the line runs South to North, with the bag and lead (divers) on the south side where the ship was. Bags every 10m, snow every 2.5m.

	Snow (cm)	Ice (cm)	Snow+ice (cm)	Sled EM (cm)
S - #1	6	166	172	---
	3 - 3 - 1			
#2	1	171	172	170
	3 - 2 - 2			
#3	3	172	175	171

	4 - 21 - 26			
#4	5	156	161	164
	3 - 3 - 5			
#5	4	165	170	167
	3 - 4 - 3			
#6	2	169	171	168
	4 - 4 - 10			
#7	8	160	168	166
	5 - 3 - 2			
#8	4	167	171	165
	3 - 2 - 2			
#9	2	163	165	166
	2 - 2 - 3			
#10	3	165	168	163
	5 - 3 - 3			
#11	3	162	165	162
	3 - 11 - 10			
#12	12	147	159	165
	10 - 10- 5			
#13	6	160	166	164

Accuracy of snow depths is +/- 1cm

Tuesday and Wednesday April 8-9, 2008

Several lines along thick calibration floes (SIS 125) and then the thin floe north of the ship (SIS 126). Drilled holes along the thin floe calibration line. Line ended at lead used for second dive. Ice thickness in lead 10-15cm. Thin layer of snow had covered frost flowers and made a salty slush layer of 38ppt. Depth increased from ½ cm at North (location #1) to 1cm at location 15 and towards the lead. They are in small4-6cm mounts of up the 2cm. Sled rails flatten some of the flush so snow depth for Sled EM system is estimated to be ½ - 1cm.

Table below shows the thin floe ice thickness, first 15 done on Tuesday afternoon, then last 11 (7-18) redone on Wednesday morning. Total length of line to edge of lead is 174.8m. SIS File 128

Table with thin floe thicknesses line running N to S and holes at 10m intervals.

Hole #	Distance (m)	Ice (auger)	Snow*	Sled	Snow+ice
1	0	75	½	77	76
2	10	73	½	76	74
3	20	72	½	74	73
4	30	73	½	75	74
5	40	74	½	76	75
6	50	74	½	76	75
7	60	73	1	73	74
8	70	71	1	73	72
9	80	71	1	74	72
10	90	71	1	75	72
11	100	71	1	74	72
12	110	72	1	74	73
13	120	71	1	73	72
14	130	72	1	74	73
15	140	72	1	72	73
16	150	70	1		71
17	160	73	1		74
18	170	70	1		71
Edge (4.8m)	174.8	71	4 slush ice		72

Files sled numbers SIS 129 and 130 along calibration line plus two and from thin floe to ship.

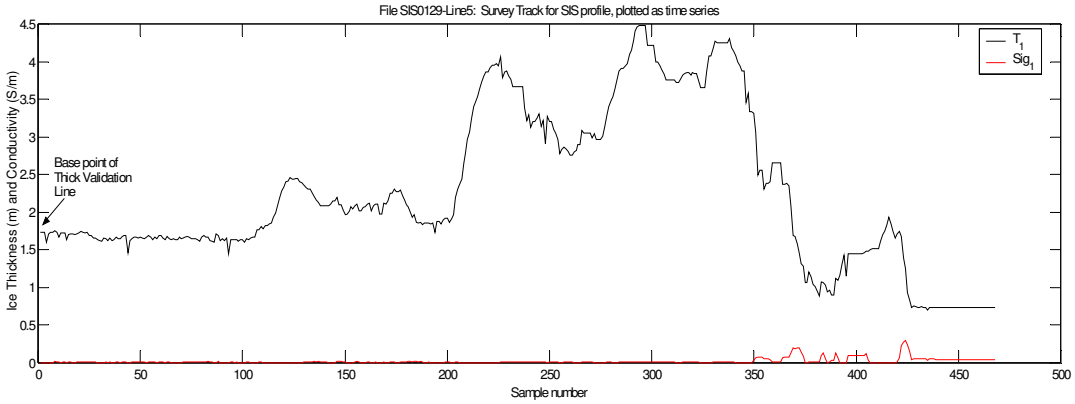


Figure above shows the ice thickness collected by the EM sled from thick floe (left) where ship was stationed to thinner flat floe area (right) where dive #2 was done. Ridge area between thick and thin floe sections follows the skido track (plotted below) used by others going from ship to thin floe section.

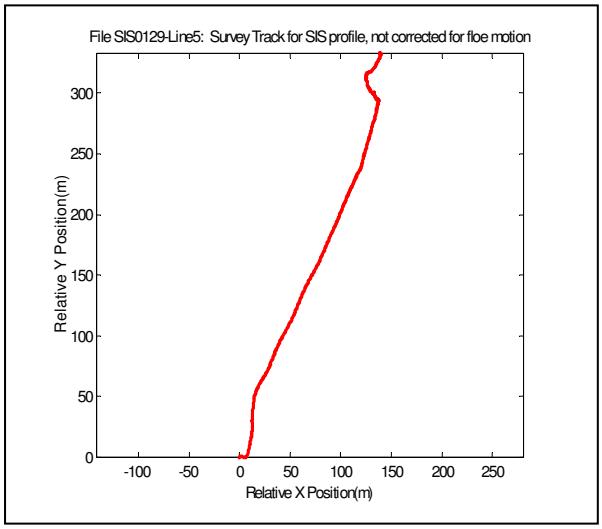


Figure on left shows the track along with the EM sled data was collected. Bottom of track is location where ship was located and top where thin floe section was located; total length of track around 350 meters.

Friday and Saturday April 11-12, 2008

Ship has moved to another floe and is staying here until Monday as thickness is fine to land both types of planes near the ship. Did the star auger check 125-127cm with 2-3 cm. Sled had 129cm. Collecting now general long lines with sled and returning to starting point to eliminate floe drift from GPS to geographical plots on floe. SIS 131 and SIS 132. Ship had moved to other end of floe. Afternoon to/from new to old ship location files SIS 133 and SIS 134.

Sampled thickness lines to the landing strip SIS135, the landing strip SIS 136 very homogeneous ice NW to SE, with NW end stopping into a small rubble area where thicknesses of runway increase to 150cm. Rest of the thicknesses ranged from 120 – 130 cm. Back to ship SIS 137. Went out on the ice in afternoon to sample several times the bare strip of ice used for light penetration and fluxes and diver's hole SIS 139. There appears to be a small affect from the wires at lead side and snow plow at the opposite side. Four out of six transects seem very clean of metal affects. Sample 75-115 (into floe 1.275m), 150- 180 (to lead 1.28m), 190-245 (into floe 1.256m), 310-345 (into floe 1.274m). SIS 141 and 142 are ice edge test files.

Sunday April 13-15, 2008 .

April 13 - Arctic Council visit and on-the ice affair when the floe split in two.
April 14 - Ship moving east, while helicopter is flying from Inuvik
April 15 - Helicopter here Pilot Michel Dube and technician Michel Gionet

- Captain Lise Marchaud and Dave Barber out in morning to find a better place to locate ship where another runway can be build. Paper work being done.
- Installed all the gear on the helicopter; an Radar altimeter plug was available for the EM system.

Helicopter EM survey (April 16-April 23)

Wednesday-Thursday April 16-17, 2009 - calibrations

Calibration line set out south of new ship position (two bags) (morning 16)
PIC#1 was flown and calibrated on April16 afternoon, with final flight Thursday morning. PIC #2 installed and tested over line and new constants inserted.
Two holes #1 near helicopter down wind from inside bag 128+5-6snow for 133-134cm and second hole along inside bag 126+5-6snow for 132-133cm. Sled sample up wind and down wind 134.5 and 135.1cm.
Second flight to SE then stopped at snow shower line; turned to East for 50km then back to ship into wind. Back by 17:00 and packed it in. Video 010-014 and GPR 715-719.
PIC File 109: ship at 122.11, 70.69 then line to SE 121.68, 70.42 then directly east to 120.55, 70.43 and back NW to 121.55, 70.62.

Friday and Saturday April 18-19, 2008 -survey

PIC file 110. To NWest for 50km and ended south of Banks Island, very windy and open water wind parallel to coast from NW. 123.8, 70.887. Turned 90deg to SW for 45km to 123.9 and 70.5 then turned towards the ship west to east line for 50km. Ship at 121.92 and 70.62 total line about 145km of alternating EM thickness and Video data.

PIC file 111. Out towards the north just east of Banks Island. First to NNW (121.99 and 70.754), then NNE to 121.63 and 70.953 and finally into Banks Island along North track121.59 and 71.18, very gusty wind and flat light caused to fly a bit higher than what we wanted. Open water along Banks Island and old flaw lead of 60cm thick turned into very rough ice along Banks Island and is now part of the land-fast ice. Total track north about 60km. Along Banks Island for 15km saw old runway on ice at 122.15 and 71.166. Criss-crossed rafted flaw lead with expected 60cm thick blocks to 122.26 and 71.19, then turned directly WSW to ship 50km. Total track length 140km.

Saturday -PIC file 112. Start at ship ~ 70.60, 122.80, due east to 70.44 121.1 then turn to south 70.07 120.77 and back to ship for about 140km track. Passing mostly over thick ice until on the return leg where thin ice is present all the way into the ship (from WSE for 60km).

PIC file 113. With two school-on-board teachers from Germany. From ship SSW to 70.14 and 122.55 then NW to 70.64 and 123.68 and back east to ship, 150km track.
Did four lines over small pack ice floe and thin lead SW of ship. Back ground between lines while doing video. Video on also over lead at 5-6m height.

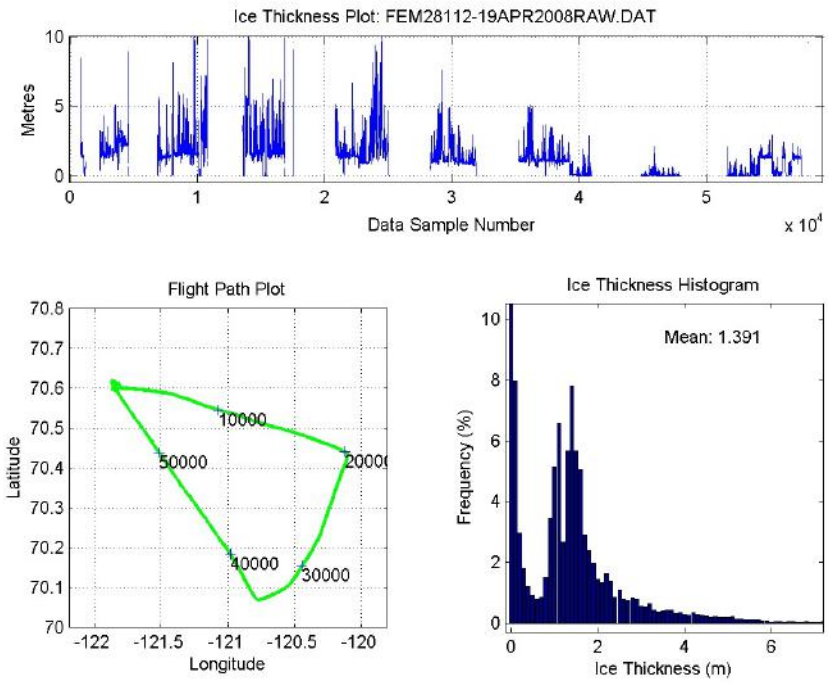
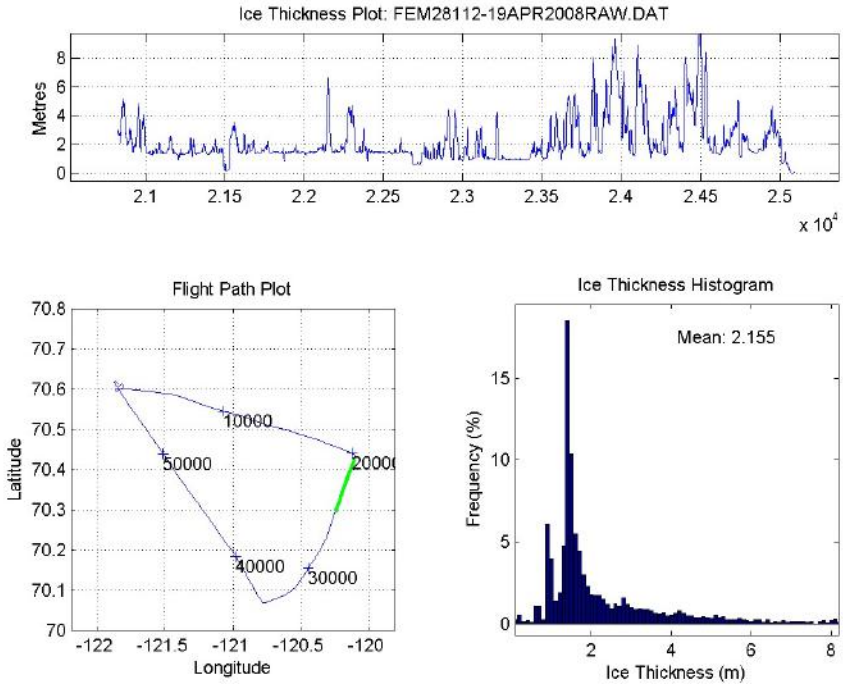


Figure above shows the thickness line plot along the 150km triangle flown morning of April 19 with the ship in the upper-left corner (70.6 N latitude) at about 5-6m above the ice. Video data was sampled at line sections at a height of 130m where no ice data was collected, At this height the video frame width is 150m wide.



An 12km section of line track (112) shown in previous figure that shows ridges up to 8m, mean flat ice thickness of 1.4m, old lead (at 2.27) 63cm thick and thin ice section of 95cm (at 2.33).

The video frames were collected with an AXIS 210 Network Camera using an 4mm lens for 250 pixcels across the camera's frame width providing a resolution of 1/2m at the 130m flying height. It is housed in a "Pod" along with a laser (Optec Sentinel 3100 laser) that is strapped to the helicopter skid gear. The computer program reads the flying height and helicopter speed to collect camera frames

with an 50% overlap. This means every 60m along the track an frame is collected or 16/km (or 1000frames per triangle).

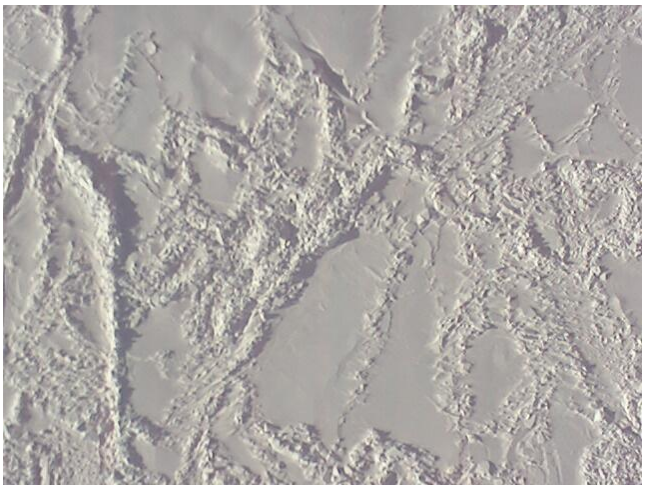
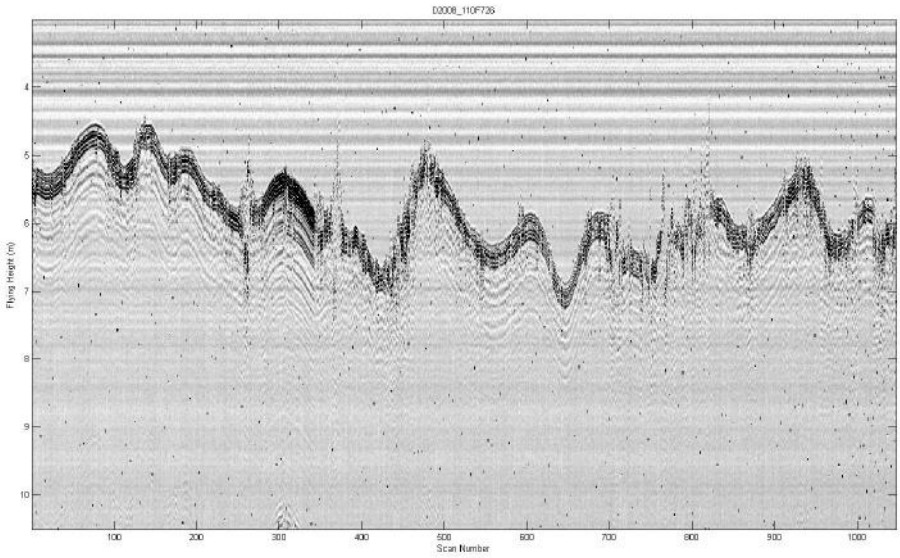


Figure above shows a video picture from the April morning flight 122 showing the rough rubble fields with ice thickness up to 8meters as shown in the line plots shown above. Frame width is approximately 1.2height of 400ft or 150m. The shadows created with the sun in the SE indicates that the helicopter was flying to the NW on its way back to the ship. Sun's shadows in the morning and evening provide additional 3-d information to the picture in addition to the orientation of the picture.

A ground-penetrating-radar (GPR) is used to determine if snow depths can be monitored. The GPR used is a Noggin-plus 1000 by Sensors & Software Inc. It has a frequency of 1000MKz and is used to measure freshwater ice thicknesses of ice roads behind truck. The GPR is housed in a second "pod" strapped to the helicopter skid gear. It operation functions along with those of the video camera are controlled through cables by a laptop inside the helicopter. The GPR as an helicopter-borne sensor has provided freshwater ice thicknesses for a test lake on Prince Edward island before being brought up here on the CFP-IPY program to evaluate if it can also measure thick snow depths.

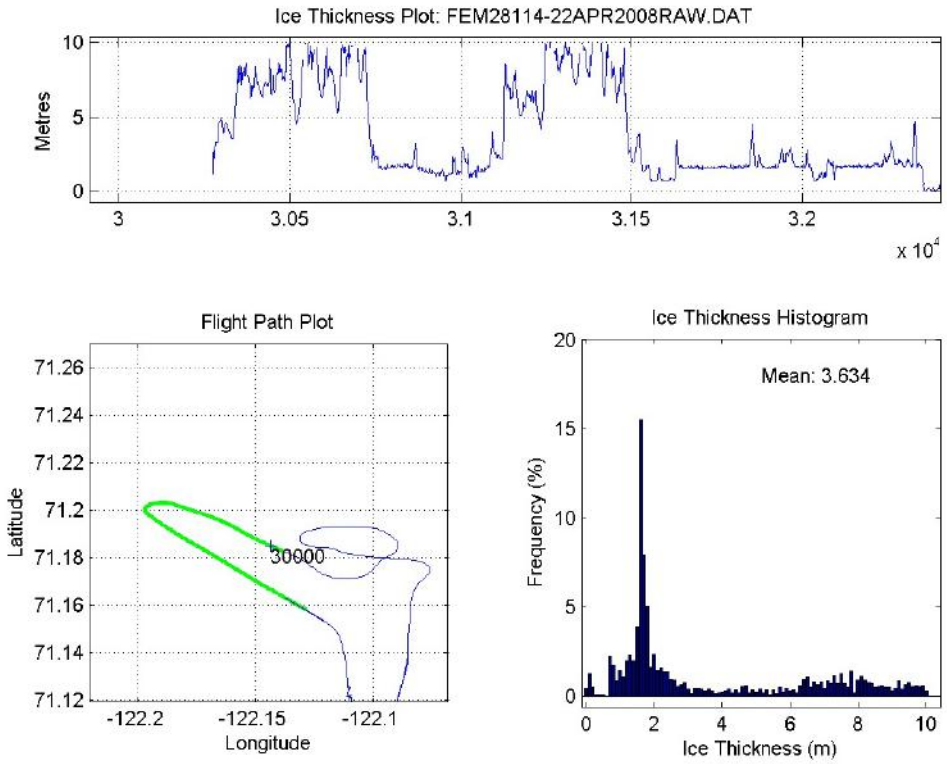


Plot of GPR file 726 which at 10scans per sec and speed of 30m/sec means the total length of the record is 3km and covers an area of rough ice where snow dunes of 40cm can be found. Hard ego is from the ice surface and its oscillation shows the flying height variability of the helicopter 6-7m. It is assumed the greyer ego areas indicate snow areas and the hard ice ego is reduced due to energy absorption in the snow. This needs to be verified by a snow dune test.

Table of helicopter and sled EM data files

date	EM File	other sensors	survey/test	area	data length
April 8-9	*125-128*	sled	calibration	Thick –thin ice	500m
April 8-9	*127-130*	sled	ship floe 1	To/from thin ice	1000m
April 11	*131-134*	sled	ship floe 2	Old to new location	500m
April 12	*135-138*	sled	ship floe 2	Landing strip	2000m
April 12	*138-139*	sled	ship floe 2	to Andrea no snow	400m
April 12	*140-142*	sled	ship floe 2	ice edge test	200m
April 13	*143-145*	sled	ship floe 2	Cleared ice area	300m
April 16-21	*146-147*	sled	ship floe 3	EM cal. lines	400m
April 16	101-104	----------	EM test	ship	-------
April 17	108	----------	EM test	ship	-------
April 17	109	Video-GPR	Survey	SE flat triangle	90km
April 18	110	Video-GPR	Survey	W to NW triangle	145km
April 18	111	Video-GPR	Survey	N to NE triangle	140km
April 19	112	Video-GPR	Survey	W to SW triangle	140km
April 19	113	Video-GPR	Survey	E to SE triangle	150km
April 22	114	-------	Reco	North to Banks Isl.	-------
April 22	115	Video-GPR	Survey	Near the Ship	55km
April 23	116	Video-GPR	Survey	S to SE triangle	120km

On April 22, a reco flight to find a new runway just north of our site and to Banks Island to check on the old runway as another possible fall-back position. Below is a picture of the old flaw lead of 60cm ridge to up to 10m , or reduced to 1/15 of its width. The ridged area near the old runway was passed over twice, the inshore land-fast ice against it crunched it 1.7m to 1.0m thick (sample section 3.1. there is still a small area left of the old flaw lead (sample section 3.16 now showing a thickness of 73cm, the thick floe the ship was anchored can be seen between 3.16 to 3.24 and was at this location 1.6m thick.



Tuesday and Wednesday April 22-23, 2008 -survey
A small survey was done on April 22 (115) around the ship while others removed the equipment from the ice; total track flight length of 55km. On Wednesday afternoon a triangle was flown to the SE and E PIC file 114. Most of the ice seen there was very thin mostly old frost flower ice covered with snow 15-20cm. Three GPR passes were done over the measured snow line before returning to the ship

Summary CFL-EM survey

- Ice thickness and roughness data set were collected over the middle of the Amunsden Gulf during April 17-23, 2008 with helicopter-born sensors. An estimated profile length of over 400km was collected in 5minute subsections by the EM-Laser system from 5-7 altitude along with 400km flight subsections of video data from 120m altitude.
- Ice thickness profiles were successfully collected with an EM sled while the ship was stationed in the pack ice. Total linear length covered by foot pulling the sled is approximately 5.5km mostly done prior to April 16.
- Ground-Penetrating-Radar data was collected during ¼ of the EM flights to estimate snow depths. Only data was collected over thick ice where visually deep snow areas were seen. Video and GPR data to April 22 archived on two CDs.

2.3. Team 3

2.3.1. Primary Production

PI: Michel Gosselin

Introduction
Primary producers fuel nearly all of the Earth's ecosystems by converting the sun's energy to an available food source through a process called photosynthesis. During photosynthesis, primary producers fix carbon dioxide, an important greenhouse gas, into food molecules connecting them, albeit indirectly, to our global climate. In this project we have focused our efforts to better understand physical (e.g., light) and chemical (e.g., nutrients) factors affecting primary production within the circumpolar flaw lead within the Amundsen Gulf.

In seasonally ice-covered seas, primary producers can be found in two generalized environments (habitats): (1) associated with sea ice (ice algae) and (2) suspended in the upper water column (phytoplankton). The timing, intensity and duration of primary production in these two environments are different. Both habitats play a very important and integrated role within the ecosystem. In a typical Arctic marine ecosystem, the relative importance of sea ice algae and phytoplankton follow a seasonal progression, with sea ice algae providing an initial food source for heterotrophs in early spring when the region is ice-covered, followed by a shift to phytoplankton production as the ice melts away during summer months. However, in the flaw lead system where open water can exist even in winter, the general location of primary producers is understandably much more complex. Contrasting the environments of primary producers in the flaw lead with the surrounding ice cover is a driving goal of our research. Furthermore, we have not had the opportunity to examine this dynamic region throughout the entire year, until now with the Circumpolar Flaw Lead System Study.

The Sea Ice Community
A very unique community exists within the inter-connected brine channels and brine pockets found between the larger ice crystals of the sea ice matrix. Therefore, within the sea ice, our group has focused not only on the primary producers, but on the entire community from bacteria through to

meiofauna. In this section we describe the sea ice community dataset collected during leg 7 of CFL (March 14 – April 24, 2008).

Ice samples were mainly obtained via ice core extraction using 9 cm core barrels (Kovacs© Mark II Coring System). Ice core sampling was conducted every 3 days or on the first sampling day after arriving at a new ice floe. Depending upon the analysis needed and the snow depth available, cores were collected under low (< 5 cm), medium (8 – 15 cm) and high (> 15 cm) snow covers. General measurements taken at each core hole included snow depth, ice thickness and freeboard. Our group also worked closely in the field with teams 2, 6 and 7 to collect data on PAR albedo, transmitted PAR, vertical profiles of temperature, salinity and concentrations of various gases in the sea ice (e.g., CO_2, CO, N_2O and DMSP) and nutrients of the sea ice. Another method to obtain material from the ice involved collection of samples by SCUBA divers. The following sections are separated into sea ice algae and sea ice meiofauna.

Sea Ice Algae

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State Variables

If available, 3 snow depths were targeted at every sampling station. The bottom 0 – 3 cm and 3 – 10 cm sections of the ice cores were collected from each snow depth. Depending on the amount of material needed for analysis and the amount of algae visible in the sea ice, 4 to 7 cores were collected from each snow depth site. One of the medium site ice cores extracted was also used for a full vertical profile. Ice cores were pooled in cooler jugs and 0.2 µm filtered seawater (FSW) was added at a dilution of 100 ml FSW per 1 cm of core prior to melting. The samples were then left to melt overnight in the cooler jugs. Once melted, nutrient (Nut) samples were taken, followed by a measurement of the salinity and total volume of the samples. It is noted that nutrient samples for FSW were collected as well as nutrient samples for additional core sections (i.e., no FSW added) which were stored in whirl-pack bags and placed in darkness to melt.

The dive program also allowed for collection of bottom ice samples via slurp guns (Fig. 3.1). This method of sample collection is quantitative and minimizes stresses such as osmotic shock on organisms during collection. Slurp gun samples were analysed identically to ice core extraction samples, except the addition of FSW was not required.

Samples were filtered for determination of size fractionated chlorophyll *a* (chl *a*), particulate organic carbon and nitrogen (POC/N), spectral absorption of particulate matter (Ap), high performance liquid chromatography pigment analysis (HPLC), general cell identification (Cells; fixed in Lugol Acid and Formalin and to be counted via inverted microscopy), cell identification of autotrophs and heterotrophs via epifluorescence microscopy (Epi), abundance and size class of pico/nanoalgae and bacteria via flow cytometry (Cyto) and DNA fingerprinting of ice samples (DNA) (Table 3.1). Table 3.2 lists the same analysis, except for slurp gun samples. Furthermore, at every medium snow depth site listed in Table 3.1, a vertical profile core was collected for determination of Chl *a*, Cells, Ap and HPLC.

Figure 3.1. Image of one of the SCUBA divers collecting a bottom ice slurp gun sample.

Table 3.1. Data collection timeline for ice core extraction samples. L, M and H stand for low, medium and high snow depths and thin represents ice less than 70 cm thick with a 3 – 4 cm snow cover.

Station	Date	PAR/ CTD	Nut	Chl a	POC/N	Ap	HPLC	Cells	Epi	Cyto	DNA
D29	17/03/08		LMH	LMH	LMH	LMH	LMH	LMH	LMH	LMH	
D31	19/03/08		thin	thin				thin			
D32	22/03/08	LMH	LMH	LMH	LMH	LMH	LMH	LMH	LMH	LMH	LMH
D33	25/03/08	LMH	LMH	LMH	LMH	LMH	LMH	LMH	LMH	LMH	
D33-2	28/03/08	LMH	LMH	LMH	LMH	LMH	LMH	LMH	LMH	LMH	
D33-3	31/03/08		thin	thin	thin	thin		thin		thin	
D33-3	31/03/08	LMH	LMH	LMH	LMH	LMH	LMH	LMH	LMH	LMH	
D33-4	03/04/08	LMH	LMH	LMH	LMH	LMH	LMH	LMH	LMH	LMH	
D36	06/04/08	LMH	LMH	LMH	LMH	LMH	LMH	LMH	LMH	LMH	
D36-1	09/04/08	thin	thin	thin	thin	thin	thin	thin	thin	thin	
D38	11/04/08	LH	LH	LH	LH	LH	LH	LH	LH	LH	
D41	16/04/08		LH	LH	LH	LH	LH	LH	LH	LH	
D41-1	19/04/08	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH
D41-SonB	21/04/08			√							

Table 3.2. Data collection timeline for slurp gun samples. L, M and H stand for low, medium and high snow depths and thin represents ice less than 70 cm thick with a 3 – 4 cm snow cover.

Station	Date	Nut	Chl a	POC/N	Ap	HPLC	Cells	Epi	Cyto	DNA
D36	09/04/08	thin	thin	thin	thin	thin	thin	thin	thin	
D38	11/04/08	thin	thin	thin	thin	thin	thin	thin	thin	
D41	16/04/08	LH	LH	LH	LH	LH	LH	LH	LH	
D41-1	19/04/08	LH	LH	LH	LH	LH	LH	LH	LH	LH

Rate Variables

During leg 7, samples were collected to measure carbon uptake by algae under varying light conditions via ^{14}C labeling. Increasing light intensity is plotted against carbon uptake per unit chl *a* to create Photosynthesis-Irradiance (PI) curves. These curves are used to determine parameters such as the algal photoacclimation and maximum carbon uptake per chl *a* biomass. Two separate methods were used to collect the samples. The first method involved scraping the bottom of an extracted ice

core into a known volume of FSW in the field. This method minimizes osmotic stress on the algae. The second method was to collect samples via the slurp gun (Fig. 3.1).

The samples were also analyzed using two separate methods. The first method was an under ice incubation array deployed by either an under ice arm or by divers (Fig. 3.2). Samples were placed into 60 ml culture flasks and covered with a range of neutral density filters used to block a known percentage of light per flask. A Licor© PAR sensor was positioned in the center of the incubation array to log incoming light during the incubation. When deployed by divers, the under ice surface was scraped to remove existing algae and the incubation array was placed under the scraped portion of ice. The second technique was a small volume, short time incubation method as described by Lewis and Smith (1983). The incubation set-up, referred to as a photosynthetron, was connected to a cooling bath and incubations were run at -1.5 °C. Light intensity experienced by the individual vials during an incubation run was measured using a Biospherical Instruments QSL-100 scalar PAR sensor.

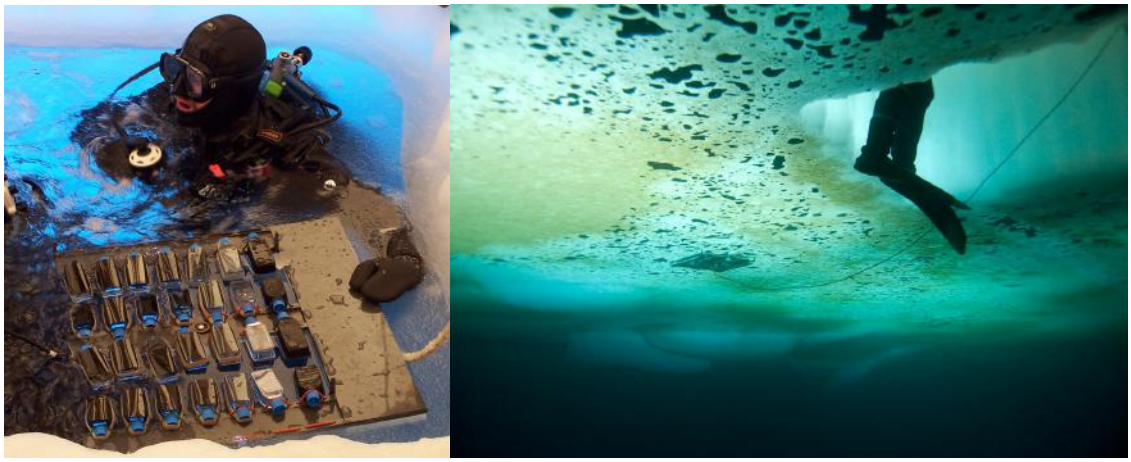

Figure 3.2. Image of the under ice incubation array (left) and the array deployed under the ice attached to a PAR sensor cable leading to the surface through the dive hole (right).

Table 3.3. Data collection timeline for PI curves. L, M and H stand for low, medium and high snow depths and thin represents ice less than 70 cm thick. Slurp and scrape represent samples collected by a slurp gun and bottom ice scraping of extracted core samples into FSW, respectively.

Station	Date	Under Ice Incubation	Photosynthetron
D33-4	04/04/08	L	
D36	09/04/08	LMH	thin (slurp)
D38	11/04/08		LH (slurp)
D41	16/04/08		LH (slurp)
			LH (scrape)
D41-1	19/04/08	LH	LH (slurp)
			LH (scrape)

Fatty acids and Particulate Phosphorus

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Our group has collaborated closely with teams 3 and 4. The aim of our work is to study the effect of light on the food quality of ice algae and the transfer of energy from algae via *Calanus* copepods and ice amphipods in Arctic ecosystems in ice covered waters. We will use this to compare and contrast key ecosystem component between the Canadian Arctic and Svalbard waters, Norway. The samples

collected during Leg 7 will be used by Post doc Eva Leu (ice algae), Post doc Janne Soereide (zooplankton) and PhD student Henrik Nygaard (Ice amphipods). Sampling of ice amphipods will be continued by Haaakon Hop on Leg 9a.

The aim of the ice algae sampling is to study the effect of light on nutritional quality of ice algaes in terms of fatty acids and elemental stoichiometry. Samples were taken from different types of ice floes, different snow depths (high and low) one - two times a week. In total we sampled 7 times during the 5 weeks (Table 1). Three ice cores were collected at each site (high and low snow cover). The bottom 3 or 5 cm of the cores (depending on the amount of ice algae) were cut off and kept in the dark. The cores were melted in filtered sea water; 100ml sea water was added per 1 cm core. At station D36, D38 and D41 samples were also collected from the interface between the ice and the sea water. These samples were collected by the divers using a slurp gun. The samples were filtered on pre-burned (450°C) GF/F 25 mm filters and frozen at -80°C. The samples will be analyzed for fatty acid composition and particulate phosphorus. Three pseudo-replicates were taken for each parameter for each core, if there was enough material. All sampling were done at the same time and location as the other ice core sampling.

Table 3.4. Ice algae samples for fatty acid and particulate phosphorus.

Sample	Date	Time	Station	Longitude (W)	Latitude (N)	Snow thick. (cm)	Ice thick. (cm)	Freebord (cm)	Fatty acid samples	P-particulate samples
L1	18.03.2008	17:00	2008D29	123 28.606	70 54.471	4	133	10	1	1
L2	18.03.2008	17:00	2008D29	123 28.606	70 54.471	4	136	13	1	1
L3	18.03.2008	17:00	2008D29	123 28.606	70 54.471	4	143	13	1	1
H1	18.03.2008	18:00	2008D29	123 28.606	70 54.471	19	130	18	1	1
H2	18.03.2008	18:00	2008D29	123 28.606	70 54.471	19	130	17	1	1
H3	18.03.2008	18:00	2008D29	123 28.606	70 54.471	19	130	18	1	1
L1	22.03.2008	18:00	2008D32	121 46.766	71 02.741	3	135	2	3	3
L2	22.03.2008	18:00	2008D32	121 46.766	71 02.741	3	145	5	3	3
L3	22.03.2008	18:00	2008D32	121 46.766	71 02.741	3	135	7	3	3
H1	22.03.2008	18:00	2008D32	121 46.766	71 02.741	25	142	12	3	3
H2	22.03.2008	18:00	2008D32	121 46.766	71 02.741	34	139	12	3	3
H3	22.03.2008	18:00	2008D32	121 46.766	71 02.741	38	148	13	3	3
L1	31.03.2008	14:00	2008D33	121 47.2	71 03.9	3	156	14	3	3
L2	31.03.2008	14:00	2008D33	121 47.2	71 03.9	2	155	14	3	3
L3	31.03.2008	14:00	2008D33	121 47.2	71 03.9	2	155	14	3	3
H1	31.03.2008	13:00	2008D33	121 47.2	71 03.9	27	142	12	3	3
H2	31.03.2008	13:00	2008D33	121 47.2	71 03.9	28	142	12	3	3
H3	31.03.2008	13:00	2008D33	121 47.2	71 03.9	28	143	11	3	3
L1	06.04.2008	11:00	2008D36	124 09.00	71 12.5	3	158	13	3	3
L2	06.04.2008	11:00	2008D36	124 09.00	71 12.5	3	159	13	3	3
L3	06.04.2008	11:00	2008D36	124 09.00	71 12.5	3	159	13	3	3
H1	06.04.2008	11:00	2008D36	124 09.00	71 12.5	17	151	12	3	3
H2	06.04.2008	11:00	2008D36	124 09.00	71 12.5	18	152	10	3	3
H3	06.04.2008	11:00	2008D36	124 09.00	71 12.5	19	154	12	3	3
L1	09.04.2008	11:00	2008D36	124 34.3	71 18.4	1	71	7	3	3
L2	09.04.2008	11:00	2008D36	124 34.3	71 18.4	1	71	6	3	3
L3	09.04.2008	11:00	2008D36	124 34.3	71 18.4	1	71	7	3	3
interface	09.04.2008	11:00	2008D36	124 34.3	71 18.4				3	3
interface	09.04.2008	11:00	2008D36	124 34.3	71 18.4				3	3
interface	09.04.2008	11:00	2008D36	124 34.3	71 18.4				3	3
L1	11.04.2008	11:00	2008D38	124 37.8	71 15.0	2	124	12	3	3
L2	11.04.2008	11:00	2008D38	124 37.8	71 15.0	2	124	12	3	3
L3	11.04.2008	11:00	2008D38	124 37.8	71 15.0	2	124	12	3	3
H1	11.04.2008	11:00	2008D38	124 37.8	71 15.0	19	109	11	3	3
H2	11.04.2008	11:00	2008D38	124 37.8	71 15.0	20	109	9	3	3
H3	11.04.2008	11:00	2008D38	124 37.8	71 15.0	18	109	8	3	3
interface	11.04.2008	11:00	2008D38	124 37.8	71 15.0				3	3
interface	11.04.2008	11:00	2008D38	124 37.8	71 15.0				3	3
interface	11.04.2008	11:00	2008D38	124 37.8	71 15.0				3	3
L1	16.04.2008	11:00	2008D41	122 21.54	70 47.1	5	131	11	3	3
L2	16.04.2008	11:00	2008D41	122 21.54	70 47.1	5	132	11	3	3
L3	16.04.2008	11:00	2008D41	122 21.54	70 47.1	5	132	11	3	3
H1	16.04.2008	11:00	2008D41	122 21.54	70 47.1	10	130	9	3	3
H2	16.04.2008	11:00	2008D41	122 21.54	70 47.1	11	129	10	3	3
H3	16.04.2008	11:00	2008D41	122 21.54	70 47.1	12	131	10	3	3
interface									3	3
interface									3	3
interface									3	3

Ice Algae Biomarkers

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Objective:
An investigation into the use of compound specific biomarkers from sea ice diatoms to determine the presence of past Arctic sea ice.

Background:
Previously, the Plymouth team (Guillaume Masse, Simon Belt, Lindsay Vare and Thomas Brown) have demonstrated that an unusual chemical biomarker, derived from sea ice diatoms, can be detected in sediments below sea ice, thus providing a proxy measure for sea ice cover in the past. Analysis of sediment material collected with the help of Dr. A Rochon (UQAR) and his colleagues during the 2005 ArcticNet cruise revealed the presence of this biomarker across the entire Canadian Arctic Archipelago from the NOW region through to the Beaufort Sea. Notably, analysis of extracted sediments showed significant temporal and spatial variations in the concentration of the sea ice biomarker, indicating variations in sea ice cover in the past and between different locations. The aim of the current fieldwork was to obtain a series of sea ice cores encompassing various physical, temporal and spatial variations in order to investigate factors effecting biomarker concentration. These data would then be calibrated against satellite records of sea ice over the region.

A further aim of the current fieldwork was to collect sufficient amounts of representative species of the Arctic ecosystem in order to be able to perform analyses of their lipid contents and study the transfer of sea ice biomarkers across food chains. planktonic specimens were to be collected using nets. Box core sediments were also obtained from stations relating to ice covered regions.

Sampling:
Box core sediments were collected from a range of locations in the Amundsen gulf. Sampling consisted of bulk homogenised surface sediment. Stations sampled were D34, D35, D37 and D39.

Plankton net tows were collected at every opportunity throughout the cruise and samples from both vertical tows (50m water column – 50um) and horizontal tows (~100m tow – 50um) were pooled separately and frozen (-20^{o}C) for later analysis of biomarker content in the UK.

Sea ice cores were collected regularly in an attempt to capture the spring sea ice algal bloom. Cores were sampled in triplicate to determine local variability in algal and biomarker production as well as from areas of low snow (~2cm) and high snow (~30cm) to determine irradiance effects. Opportunistic cores were also sampled in interesting features such as pressure ridges, frozen cracks, lead edges, new ice (~10cm) and thin ice (~50 - 70cm). Cores were melted (bottom 10cm) and filtered (0.7 GF/F). Samples were frozen (-20^{o}C) and taken back to the UK for analysis. Selected triplicate cores were sectioned at 1cm over the bottom 10cm and filtered. Thin section cores will be used for isotope analysis. Stations sampled were D29, D31, D32, D33, D36, D38 and D40.

Dive samples were obtained from the onboard dive team. A scraping device was manufactured on board to remove and collect the bottom 2~3 cm. Slurp guns were also used to sample the under ice community. Samples were filtered (0.7 GF/F) and frozen (-20^{o}C).

Our analysis, briefly, consists of solvent extraction, open column chromatography and Gas Chromatography - Mass Spectrometry.

Meiofauna

Chantal Lacoste and Maike Kramer

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Ice samples were taken for studies on diversity, abundance and feeding ecology of sympagic meiofauna (metazoans between 40 µm and 500 µm living within the ice). Most dsamples were collected by extracting ice cores. Every three days, three ice-core bottom sections (3 cm length) were taken on a site of non-deformed ice with low snow cover (< 5 cm), and three with high snow cover (> 20 cm) for analyses of meiofauna diversity, abundance and biomass. Also every six days 3 additional ice-core bottom sections (3 cm length) were taken from each site for stable isotopes analyses on animals and particulate organic matter (POM). Additional samples were taken by SCUBA divers using the slurp gun and ice scraper (20 µm mesh) for sub/bottom ice samples.

Bottom sections of ice-cores were melted in 500 ml of FSW (0.2 µm) in the dark at 4 °C. Samples obtained from the scraper were also melted in FSW however slurp gun samples did not require addition of FSW. Once melted, 4 ml of the samples were pre-filtered on a 40 µm nylon mesh and placed in a 5 ml cryovial stored at -80 °C for bacterial counts via flow cytometry. The volume of the remaining melted samples was measured and then sieved on a column of 500 µm followed by a 40 µm mesh. The material obtained from the 40 µm sieve was fixed with NBF formaldehyde 4% in 20 ml plastic vials and stored at room temperature for future counting. The six extra cores obtained for stable isotopes analyses and part of the samples obtained from the SCUBA divers (scraper and slurp) were sieved as previously described. The animals obtained on the 40 µm sieve were separated per group, counted and rinsed with milli-Q water on a Whatman GF/F fiberglass filter and stored in petri dishes at -80 °C. The water obtained from the sieving was then filtered on a Whatman GF/F fiberglass filter and stored in petri dishes at -80 °C.

Table 3.5 Data collection of meiofauna community structure and stable isotopes.

Station	Date (yymmdd)	Site	Ice cores	Slurp	Sraper	Bact count	SC	SI	SI POM
D33	080325	L	3			3	3		1
D33	080328	L	3			3	3		
D33	080328	H	3			3	3		
D33	080331	L	6			3	3	3	3
D33	080331	H	6			3	3	3	3
D33	080403	L	3			3	3		
D33	080403	H	3			3	3		
D36	080406	L	6	1	1	5	5	5	5
D36	080406	H	6	1	1	5	5	5	5
D41	080416	L	3	1	1	5	5		
D41	080416	M	3	1	1	5	5		
D41	080419	L	6	1	1	5	5	5	5
D41	080419	H	6	1	1	5	5	5	5

SC – community structure (qualitative and quantitative samples)
Bact – bacterial count
SI – Stable isotopes
POM – Particulate organic matter

L – low snow site
M – medium snow site
H – high snow site
Numbers are numbers of replicates.

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Ice samples were taken for studies on diversity, abundance and feeding ecology of sympagic meiofauna (metazoans > 20 µm living within the ice). Every three days, five ice-core bottom sections (5 cm length) were taken on a site of non-deformed ice with medium snow cover (4-18 cm), nearby the PAR measurement area, for measurement of algal pigments (bottom section 1) and for analyses of meiofauna diversity, abundance and biomass on fixed (bottom section 2) and fresh samples (bottom sections 3-5). Once per floe, one full ice core, cut in sections of 2-10 cm, was taken instead of bottom section 2 for analyses of meiofauna abundance and biomass on fixed samples with respect for vertical distribution. On the same sampling day, further three ice-core bottom sections (3-5 cm length; bottom sections 6-8) for analyses of meiofauna *in situ* gut contents were taken at sites with high, medium and low snow cover. Further ice samples, including ice-core bottom sections (3-10 cm length), ice underside (2-5 cm thick layer) scraped from blocks of ice and pieces of ice picked up from the water next to the ship using the ice cage, were taken in order to gain meiofauna organisms and sympagic ciliates for fatty acid analyses and feeding experiments.

Bottom section 1 was melted in the dark at 4 °C and filtred on a Whatman GF/F glasfibre filtre; algal pigments were extracted in acetone in the dark at 4 °C, and chlorophyll a and phaeopigment a were measured fluorometrically. Bottom sections 6-8 were immediately placed in 50 ml of 0.2 µm filtred sea water (FSW) and shaken gently for one minute to flush out meiofauna organisms. The liquid was sieved on a 20 µm gauze, and the samples were fixed in picric acid formaldehyde (PAF) and stored at 4 °C. In the home laboratory, meiofauna will be sorted from these samples and cut in half, and the gut content will be analysed using a scanning electron microscope. All other ice samples, as well as the remains of bottom sections 6-8, were melted in an excess of FSW (200 ml per 1 cm of ice core) at 4 °C and sieved on a 20 µm gauze. Bottom section 2 / sections from the full ice core were then fixed in borax-buffered formaldehyde (37 % formaldehyde added to the sample, final concentration 2 %). Bottom sections 3-5 were sorted onboard at 4 °C within two days after melting, and bulk abundances of meiofauna and ciliates were determined. All other ice samples were sorted onboard at 4 °C within a few days after melting.

Part of the organisms sorted from the samples onboard were preserved in formaldehyde (2-4 %) or PAF for later taxonomical and morphological studies. For fatty acid analyses, alive animals were rinsed by transferring them into fresh FSW several times, were then transferred onto a pre-combusted Whatman GF/F filtre, rinsed with MilliQ water, and stored at -80 °C. In the home laboratory, the samples will be extracted in dichloromethane:methanole (2:1 v:v), transesterificated and analysed in a gas chromatograph. The fatty acid composition will provide information on in *situ diets* (e.g. the degree of carnivory). For feeding experiments during Leg 8 and in our home laboratory, cultures of sympagic meiofauna have been established.

Table 3.6. Algal pigments and diversity, abundance, biomass and gut contents of meiofauna

Station	Date (yymmdd)	Site	Chl	D	A	AB	ABvp	G
D29	080317	L	1	+	3	1		
D29	080317	H		+				
D30	080319	T/IC		+	1	1		
D32	080322	L		+				
D32	080322	M	1	+	2	1		
D33	080325	M	1	+	3	1		

D33	080328	L		+				1
D33	080328	M	1	+	2	1		1
D33	080328	H		+				1
D33	080329	L		+				
D33	080329	M		+				
D33	080330			+				
D33	080331	M	1	+	3	1		
D33	080403	L		+				1
D33	080403	M	1	+	3		1	1
D33	080403	H		+				1
D34	080324	IC		+				
D35	080402	IC		+				
D36	080406	L						1
D36	080406	M	1	+	3		1	1
D36	080406	H		+				1
D36	080409	T		+				
D38	080411	L	1	+	3	1		1
D38	080411	H		+				1
D41	080416	L		+				
D41	080416	M	1	+	3	1		
D41	080419	L		+				1
D41	080419	M	1	+	3		1	1
D41	080419	H		+				1

Chl – chlorophyll a and phaeopigment a in 5 cm bottom sections of ice cores
D – meiofauna diversity in the ice (qualitative)
A – meiofauna abundance in fresh 5 cm bottom sections of ice cores
AB – meiofauna abundance and biomass in fixed 5 cm bottom sections of ice cores
ABvp – vertical profiles of meiofauna abundance and biomass from full ice cores
G – gut contents of sympagic meiofauna
L – low snow site
M – medium snow site
H – high snow site
T – thin ice
IC – ice cage
Numbers are numbers of replicates.

Table 3.7. Fatty acid data collection.

Taxon	**D29**	**D33**	**D36**	**D38**
Nauplii				
Harpacticoida indet.	1	7	2	3
Harpacticoida indet.			1	2
Nematoda indet.		1		

Water Column

Remote Sensing

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Introduction

To understand and to monitor biophysical processes in complex coastal waters it is necessary to use remote sensing methods. CASES measurements showed that optical properties of the Beaufort Sea and

the Amundsen Gulf region are dominated by the freshwater outflow from the Mackenzie river leading to a bias in the estimation of phytoplankton biomass using remote sensing data. There is thus a need to develop specific methods to make more effective use of remote sensing data. The building of a database of inherent optical properties relating a wide variety of physical and biological conditions is a crucial step towards this goal.

The general objective of our team is to study the relationship between the spatial and temporal distribution of the phytoplankton and the physical environment in the canadian Arctic with an emphasis on the Beaufort Sea and the Baffin Sea using remote sensing data.

Specific objectives for the CFL 2007-08 cruise are:
The estimation of the ability of current bio-optical algorithms to measure chlorophyll-a concentration and species discrimination;
The development of specific algorithms for a variety of ocean color sensors which will in turn provide a better understanding of the Beaufort Sea and the Baffin Sea physical and biological processes;
The analysis of light absorption properties of arctic phytoplankton.

To reach these objectives, we will measure throughout the program the following parameters whenever possible:
the transparency of the water with a Secchi disk;
vertical profiles of inherent optical properties (light absorption and transmission, backscatter light, volume scattering function, particle size spectra, phytoplancton fluorescence, CDOM fluorescence, temperature ans salinity using a custom built optical profiler system;
the pigment composition of phytoplankton with the high performance liquid chromatography method (HPLC);
the algal pigments light absorption;
the total suspended matter and its partition into organic and inorganic matter;
the chromophoric dissolved organic matter concentration.

Methods
Water samples were taken from March 24 until April 5 under the thinner ice of a refreezing flaw lead close to the southeast coast of Banks Island at station D33. Another time series was made at station D41 at the edge of the floe where the ship was parked using the skippy boat. Samples were taken using a pump and a hose lowered through a small hole perforated in the thin ice with a handheld ice auger. Samples were taken at depths of two and five meters from the surface water level. Ice thickness during the experiment slowly increased from 50 to 65 cm. Two other samples were also taken using the rosette system at depths of 10 and 25 metres. Measurements were also made at other locations throughout the area while the ship was moving.
Filtrations were performed for chlorophyll determination (HPLC techniques), a_{ph}, total suspended matter (TSM) and chromophoric dissolved organic materiel (CDOM). For chlorophyll-a, and algal pigments, water samples (up to 2.5 litres) were filtered through 25 mm GF/F filters, flash freezed and stored in liquid nitrogen on the ship. Samples will be transported south for analysis at the end of the leg. CDOM samples were filtered using 0.2 µm Anotop® syringe filters (Whatman) and collected into 60 ml acid-cleaned amber glass bottles. The bottles were stored frozen (-20 ˚C) in the dark on the ship. Samples will be transported south for analysis at the end of the leg. Total suspended matter was measured by filtering up to 2 litres of water using pre-weighted 25 mm GF/F filters. The filters were stored on the ship at –80 ˚C, to arrest pigment degradation (Sosik, 1999), and will be transported south at the end of the leg to complete the analysis. Some vertical profiles of inherent optical properties were made from April 5 to April 22 from the moonpool. However, a defective AC9 greatly limited the use of the profiler. Detailed sampling activities up to April 22 are summarized in Appendix.

Conclusions
The CFL LEG7 operations were successfully completed between March 13 and April 24. This was a good leg that allowed to measure optical properties before the phytoplankton bloom started. The chiefs

scientists were comprehensive of the particular needs of the optics team. We are particularly indebted to the crew members and Schools on Board students who helped with some operations.

Phytoplankton

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The upper water column underneath the sea ice was sampled regularly with the ice core collection. Samples at the ice-water interface (sfc) and at 2 and 5 m depths were obtained via a small battery powered PVC pump (Cyclone Products ©) equipped with a 450 µm nitex mesh. The sfc sample was collected with the assistance of an under ice arm. Depths at 10 m or greater were collected by the rosette through the moonpool. The samples collected and the analysis to be accomplished on these samples are provided in table 3.X.

Table 3.8. Water samples collected during regular ice coring stations.

Station	Date	Nut	Chl a	Cells (Lugol)
D29	17/03/08	2, 5, 10, 50	2, 5, 10, 50	2, 5, 10, 50
D31	19/03/08	sfc, 10, 25	sfc, 10, 25	sfc, 10, 25
D32	22/03/08	2, 5, 8	2, 5	2, 5
D33	25/03/08	sfc, 2, 5, 10, 25	sfc, 2, 5, 10, 25	sfc, 2, 5, 10, 25
D33-2	28/03/08	sfc, 2, 10, 20	sfc, 2, 10, 20	sfc, 2, 10, 20
D33-3	31/03/08	sfc, 2, 5, 10, 25	sfc, 2, 5, 10, 25	sfc, 2, 5, 10, 25
D33-4	03/04/08	sfc, 2, 5, 10, 25	sfc, 2, 5, 10, 25	sfc, 2, 5, 10, 25
D36	06/04/08	sfc, 2, 5, 10, 25	sfc, 2, 5, 10, 25	sfc, 2, 5, 10, 25
D36-1	09/04/08	sfc, 2, 5, 10, 25	sfc, 2, 5, 10, 25	sfc, 2, 5, 10, 25
D38	11/04/08	sfc, 2, 5, 10, 25	sfc, 2, 5, 10, 25	sfc, 2, 5, 10, 25
D41	16/04/08	sfc, 2, 5, 10, 25	sfc, 2, 5, 10, 25	sfc, 2, 5, 10, 25
D41-1	19/04/08	sfc, 2, 5, 10, 25	sfc, 2, 5, 10, 25	sfc, 2, 5, 10, 25

A full water column station was also sampled at station D40 on April 15, 2004. At this station we sampled at the surface (100 % light), 9 m (50 %), 15 m (30 %), 25 m (15 %), 37 m (5 %), 60 m (1 %), 78 m (0.2 %) and 100 m for: Chl *a*, POC/N, DOC/N, HPLC, cells (Lugol and Formolin) and flow cytometry (pico/nano algae and heterotrophic bacteria).

Literature Cited

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Appendix: Sampling information: Number of depths sampled for each variable. Latitude, logitude and time refers to the ice sampling station location. Refer to the CTD-Rosette logs for the location and timing of the rosette sampling.

Station	Date	Time (UT)	Latitude	Longitude	Chl-a (HPLC)	Algal pigments	TSM	CDOM	OPTICAL PROFILER	ROSETTE
D34	2008-03-24	21h30	71°04.630	-121°48.696	4	4	4	4		0802018
D33	2008-03-26	20h00	71°04.314	-121°49.839	4	4	4	4		0802036
D33	2008-03-28	16h45	71°04.048	-121°48.322	4	4	4	4		0802043
D33	2008-03-30	15h20	71°04.048	-121°48.322	3	4	4	4		0802047
D33	2008-04-01	16h00	71°04.048	-121°48.322	4	4	4	4		0802059
D35	2008-04-02	16h30	71°04.010	-121°56.321	4	4	4	4	X	0802072
D33	2008-04-03	15h25	71°04.048	-121°48.322	4	4	4	4		0802075
D36	2008-04-06	17h45	71°12.691	-124°09.547	4	4	4	4		0802081
D36	2008-04-08	15h40	71°17.833	-124°30.563	4	3	4	4	X	0802089
D36	2008-04-09	19h15	71°18.5	-124°34.3					X	
D38	2008-04-11	21h15	71°15.5	-124°37.82	4	4	4	4		0802098
D38	2008-04-12	15h15	71°14.564	-124°36.463	3	3	3	3		0802101
D39	2008-04-15	02h00	70°49.509	-122°21.163	1	1	1	1		
D40	2008-04-15	21h15	70°47.92	-122°27.83	6	6	6	6		0802104
D41	2008-04-17	22h15	70°41.728	-122°06.760	4	4	4	4		0802112
D41	2008-04-19	16h15	70°35.807	-121°51.837	4	4	4	4		0802119
D41	2008-04-21	18h00	70°41.478	-121°42.312	4	4	4	4		0802126
D41	2008-04-22	15h45	70°36.6	-121°48.2					X	

2.4. Team 4

2.4.1. Zooplankton and fish Acoustic

PI: Louis Fortier
Participants: Gérald Darnis (U. Laval), Catherine Lalande (U. Laval), Luc Michaud (U. Laval), Brigitte Robineau (U. Laval), and Pascal Massot (electronic technician from U Laval), with the contribution of Stig Falk-Petersen and Anette Wold from the Norwegian Polar Institute.
Written by: Gérald Darnis, Brigitte Robineau, Anette Wold, Stig Falk-Petersen, Catherine Lalande, and Luc Michaud

Introduction
The fragmented, thin, and often absent ice cover in the flaw lead allows solar radiation to reach the surface layer of the ocean where it triggers photosynthesis by microscopic algae. Team 4, Pelagic and Benthic Food Web, will investigate how and to what extent the microalgae growing in the flaw lead are exploited by animals living in the plankton (the zooplankton) and on the sea floor (the benthos). Our simple hypothesis is that, relative to adjacent ice-covered regions, enhanced algal production in the flaw lead translates into biological hot spots where higher zooplankton and benthos abundances prevail. We will also investigate how the Arctic cod, a central species in the Arctic food web, uses the flaw lead for feeding, overwintering, reproduction, and as a nursery ground for their young stages (http://www.ipy-cfl.ca/page1/page1.html).

General objectives
The objectives of the team on leg 7 were in part to continue the work made during the previous legs and also to install the under ice towing system that permits to sample efficiently the surface layer and under ice habitat for Arctic cod larvae. Our sampling program was designed in the continuity of the overarching goal of ArcticNet project 1.4 led by Dr. J.-É. Tremblay (U. Laval) 'Marine productivity and sustained exploitation of emerging fisheries' which is to assess the impact of sea-ice cover reduction and increasing sea temperatures on biological productivity, fisheries resources and marine mammal populations of the coastal Canadian Arctic. Since October 18th, date the CFL program started, we focus on how the physical processes moderate biogeochemical processes within the changing northern flaw lead ecosystem nearby Banks Island (Beaufort Sea). Our multidisciplinary ArcticNet-CFL team is strongly linked with Team 7 (Carbon Fluxes – Tremblay) of the CFL program. For this leg-7 of CFL, sampling efforts were concentrated on the pelagic secondary producers.

The primary objectives of our team during CFL-7 were:
1- To assess zooplankton / fish abundance and diversity by using various plankton nets.
2- To track zooplankton / fish biomass and distribution with the EK60 Echo sounder.

Our secondary field objectives were to collect and use the zooplankton sample for:

- The cycling of contaminants in zooplankton (G. Stern, U. Manitoba)
- Identification of the sources and pathways of omega-3 in the arctic marine food chain (J. Michaud, E. Dewaily and L. Fortier, U. Laval). This project linked to the CFL-URSUK program and the ArcticNet theme 1.5, focusing on the importance of omega-3 fatty acid in the traditional diet of Inuit communities.
- Assessment of the biomass and respiration rates of the zooplankton community by the Electron Transfer System (ETS) activity at chosen stations (G. Darnis and L. Fortier).
- Stable isotope analysis on the food web structure and carbon fluxes; this is a joint project between Team 4 and 7 of CFL (A. Forest, L. Fortier, J-E. Tremblay)
- Copepod *in-situ* egg production (EPr) and gonad maturation of *Calanus* glacialis, *C. hyperboreus* and *Metridia longa* (M. Ringuette, G. Darnis, L. Fortier).

A team from the Norwegian Polar Institute joined the team 4 on this leg and participated actively to the sampling. They have a project of their own that is in part related to the study of the energy transfer from algae to *Calanus glacialis*. The section of their report that focuses on zooplankton work is incorporated at the end of the present report.

Sampling program

The first part of Leg-7 sampling program was oriented towards ice work, when the ship was stationary on an ice floe for periods of time varying from 1 day to a week. On the second week of the leg, the decision was made to the installation of the under ice towing system. We started to look for a flat surface of ice free of cracks and large enough to bear a hauling system with its two ice holes 1000 m apart. Unfortunately no such floe was available in the vicinity of the ship and we had to reduce our ambition to a 450 m long installation at station 2008D33. It took the team four days of strenuous effort to achieve this work. Without the precious help of the ship's crew this would have most probably not been possible. The system was used on three occasions for oblique and under ice sampling (Table 5). The capture of our first arctic cod larva was promising. However right after the mid-leg crew change, unfavourable winds suddenly pushed the ship in the direction of the Bank's Island. The threat of having the ship crushed between the coast and thick and solid ice pushed for the decision to abandon the site. We hastily removed the rope under the ice and the frames covering the ice holes before fleeing toward better ice conditions. This event was a serious drawback to our cod sampling program. We never found again the opportunity to install another system during the remainder of the leg, which we could bequeath to the next zooplankton team. As an alternative we tried to haul the ring net in leads completely free of ice, using the Skippy boat. This proved to work well but these leads were elusive and the Skippy boat was heavily used for the needs of other teams. As a consequence, this experience occurred only once during our painful wanderings in heavy ice in search of ice floes large enough to be used for all the teams involved in sampling on the ice. Vertical sampling of the water column from the ice, initiated during the previous legs, was continued as well as the usual moon pool zooplankton sampling activities. However a reduced team and the many times the ship got stuck during our displacements had the effect to decrease the sampling frequency of this leg compared to the two previous ones.

1) Sampling gear and events

a) 1-m^2 Square net. Frame rigged with a 1 m^2 mouth opening net (1 x 200, µm mesh), out-rigged with a 10 cm diameter net (50 µm) and equipped with a TSK flowmeter (Figure 1a). This net is used for integrated water column sampling that is summarized in table 1. When deploying, downward winch speed was <40 m/min to avoid mixing of the nets, and upward winch speed was 30m/min. To obtain quantitative tow (i.e. for taxonomy and abundance estimates), the content of the 200 µm (TSK) and the 50 µm mesh-net were preserved in formaldehyde (Fortier). Qualitative tows (i.e. 'live tows') were also performed to obtain animals for contaminants, lipids, EPr and/or ETS studies.

b) Hydrobios. Multi-depth plankton sampler (Figure 2b) equipped with nine 200 µm-mesh nets (opening 0.5 m^2). This was allowing for depth specific sampling of the water column. The *Hydrobios* is also equipped with a CTD to record water column properties while collecting biological samples. When deploying, downward winch speeds was 40m/min and the speed up was 30m/min. At most casts, the net collection was preserved in formaldehyde for taxonomic analysis but for some casts, the content of each net was divided: 50% for taxonomy (4% buffered formaldehyde) 25% for biomass estimates and 25% for ETS analysis (Table 2). The Hydrobios flowmeters appeared again to be functioning perfectly after the troubles of leg 3 and 4. A 24-hour Hydrobios sampling involving 4-hour intervals deployments was made during the leg. The targeted date for this sampling event was close to mid-leg but continual repositioning of the ship due to heavy drifting postponed this to the end of the second last week of the leg.

c) Ring net. A 1m diameter ring net equipped with a 200 µm mesh net and out-rigged with 10 cm diameter net (50 µm) and a GO flowmeter. This net was deployed at least three times per cast from a hole in the ice at proximity of the ship but at a site not influenced by its presence. On a few occasions

the net was deployed from the ice edge of the floes sampled (Figure 2c). Ice zooplankton sampling activities are summarized in table 3. A RBR CTD was added to the net frame. At each station cast, the first haul was from 10 m to the surface and the second haul from a maximum of 270 m to the surface. A third haul from 60 m to surface was carried out to augment the sampling effort to collect Arctic cod larvae and juveniles. The net was lowered manually to the desired depth and pulled manually for the 10 m haul and using a motorised engine for the deeper hauls during the first cast. One visited ice floe was too small and unstable to bear motorised vehicles and thus the nets had to be pulled by hands. The consequence was that the deep hauls were cancelled at that site. Sampling from the ice edge proved difficult at times when thin ice was pushed by the current against thicker ice, forming ridges that prevent normal sampling. Again, the deep net tow was cancelled under these conditions.

d) Double net
Frame rigged with two 1 m^2 mouth opening net (2 x 500 µm mesh), out-rigged with a 10 cm diameter net (64 µm) and equipped with a GO flowmeter (Figure 2d). The gear is deployed from one hole of the hauling system on the ice and towed to the other hole by the half track (BR). Added to the operator of the BR, people at both ends of the system are required to verify that the rope is unwinding correctly through the pulleys. Two floats are fixed on the frame for under ice casts and removed for oblique hauls from one ice hole to the other.

e) Gill net
A 40 m long net deployed vertically from the bottom to 40 m above (Figure 2e). One of the ice holes was used for 24h00 deployments. This sampling is used to collect adult fish.

f) Rosette
Nine depths are sampled for water using the bottles of the rosette in the moonpool. Two bottles per depth are taken and their content sieved through a 50 µm sieve. The particles retained are preserved in formaldehyde. This method is used to study the vertical distribution of the zooplankton size fraction under 200 µm that is not retained by the nets of the Hydrobios.

Overall, 122 sampling events occurred and 77 of the samples obtained were preserved for taxonomy, and the remainder, the 'live tows', were used for further analysis and laboratory experiments as described above. Samples for lipid and stable isotope analysis were placed in cryovials and stored at -80˚C. During the course of the leg, requests were made for samples preserved as a bulk at -80˚C for later gut fluorescence measurements. These samples will be sorted and analysed at Laval University. Samples of ice algae were also collected upon request for lipid analysis. Samples for contaminants were sorted and preserved by Gary Stern's team. On a few occasions, usually corresponding to box core deployments, Dieter Piepenburg requested splits of zooplankton to verify the emergence of meroplankton larvae (Table 1).

a)

b)

c)

d)

e)

Figure 2. Zooplankton sampling gear used during CFL-Leg 7: a) 1-m^2 Square net and b) Hydrobios, both deployed from the moonpool, c) ring net, d) double net and e) gill net deployed from the ice.

Table 1: CFL-Leg 7 summary sampling activities using the 1m^2 -net

Date (UTC)	Station	LAT	LONG	Sampling depth	Contami - nants	Taxo- nomy	Lipids	Stable Isotope	Gut content	EPR	Biomass and ETS
15/03/2008	2008D29-18	70,545	123,286	385		X					
15/03/2008	2008D29-19	70,545	123,286	385							X
15/03/2008	2008D29-20	70,545	123,286	385	X						
16/03/2008	2008D29-21	70,545	123,286	385							X
17/03/2008	2008D29-22	70,545	123,286	385		X					
17/03/2008	2008D29-23	70,545	123,286	385	X						
17/03/2008	2008D29-24	70,545	123,286	385			X	X			X
18/03/2008	2008D29-25	70,545	123,286	385		X				X	
18/03/2008	2008D29-26	70,545	123,286	385			X				
19/03/2008	2008D29-27	70,545	123,286	385		X				X	
19/03/2008	2008D29-28	70,545	123,286	385	X						X
24/03/2008	2008D33-1	71,385	121,472	177							X
24/03/2008	2008D33-2	71,385	121,472	177			X	X			
24/03/2008	2008D33-3	71,385	121,472	177	X						
24/03/2008	2008D33-4	71,385	121,472	177			X				
25/03/2008	2008D33-5	71,39	121,472	177							
25/03/2008	2008D33-6	71,39	121,472	177			X				
26/03/2008	2008D33-7	71,39	121,472	177		X					
26/03/2008	2008D33-8	71,39	121,472	177						X	X
26/03/2008	2008D33-9	71,39	121,472	177	X						
27/03/2008	2008D33-10	71,39	121,472	177	X						
28/03/2008	2008D33-11	71,39	121,472	177		X					
28/03/2008	2008D33-12	71,39	121,472	177	X						
30/03/2008	2008D33-13	71,39	121,472	177		X					
30/03/2008	2008D33-14	71,39	121,472	177							X
30/03/2008	2008D33-15	71,39	121,472	177	X						
01/04/2008	2008D33-16	71,39	121,472	180		X					
01/04/2008	2008D33-17	71,39	121,472	180			X	X			X
01/04/2008	2008D33-18	71,39	121,472	180	X						
01/04/2008	2008D33-19	71,39	121,472	60			X				

04/04/2008	2008D33-20	71,39	121,472	180		**X**					
04/04/2008	2008D33-21	71,39	121,472	180			**X**	**X**			**X**
04/04/2008	2008D33-22	71,39	121,472	180	**X**						
04/04/2008	2008D33-D	71,39	121,472	180		**X**					
05/04/2008	2008D36-1	71,8	123,566	198		**X**					
06/04/2008	2008D36-2	71,124	124,85	291		**X**					
06/04/2008	2008D36-3	71,136	124,121	281	**X**	**X**					
07/04/2008	2008D36-4	71,167	124,243	244		**X PIE**	**X**	**X**			
07/04/2008	2008D36-5	71,167	124,245	244					**X**		
07/04/2008	2008D36-6	71,168	124,247	244	**X**						
07/04/2008	2008D36-7	71,168	124,7	244	**X**			**X**	**X**		
08/04/2008	2008D36-8	71,176	124,306	250		**X**					
08/04/2008	2008D36-9	71,182	124,346	221		**X**					
09/04/2008	2008D36-10	71,182	124,346	221							
09/04/2008	2008D36-11	71,182	124,343	233	**X**						
11/04/2008	2008D38-1	71,151	134,376	255		**X**					
11/04/2008	2008D38-2	71,151	134,379	255		**X**					
12/04/2008	2008D38-3	71,146	124,365	280		**X PIE**					
12/04/2008	2008D38-4	71,155	124,364	278	**X**						
12/04/2008	2008D38-5	72,145	124,364	278		**X**	**X**				
15/04/2008	2008D40-1	70,479	122,278	460		**X**		**X**			
15/04/2008	2008D40-2	70,479	122,274	460	**X**						
16/04/2008	2008D41-1	70,474	122,215	450			**X**				**X**
16/04/2008	2008D41-2	70,47	122,173	500		**X**					
16/04/2008	2008D41-3	70,47	122,166	500	**X**						
16/04/2008	2008D41-4	70,469	122,158	521		**X**					
21/04/2008	2008D41-5	70,425	121,45	475		**X**					
21/04/2008	2008D41-6	70,425	121,45	470			**X**	**X**			**X**
21/04/2008	2008D41-7	70,425	121,45	470	**X**			**X**	**X**		**X**
21/04/2008	2008D41-8	70,425	121,45	475				**X**	**X**		**X**

Table 2: **CFL-Leg 7 summary sampling activities using the Hydrobios.**

Date (UTC)	Station	LAT	LONG	Sampling depth	Taxonomy	Lipids	Stable Isotope	Gut content	Biomass and ETS
16/03/2008	2008D29-J			384	X				
17/03/2008	2008D29-L			392	X				
19/03/2008	2008D29-M	70,545	123,286	385	X				X
24/03/2008	2008D33-A	71,385	121,472	177	X				
25/03/2008	2008D33-B	71,39	121,472	177	X	X			
28/03/2008	2008D33-C	71,39	121,472	177	X				X
01/04/2008	2008D33-D	7139	121,472	180.4	X	X			
02/04/2008	2008D35-A	71,4	121,563	203	X				X
02/04/2008	2008D35-B	71,4014	121,563		X				X
04/04/2008	2008D33-E				X				
06/04/2008	2008D36-B				X				
08/04/2008	2008D36-C	71,176	124,307	250	X				X
15/04/2008	2008D40-A	70,48	122,276	455	X				
16/04/2008	2008D41-A	70,474	122,21	450		X			
16/04/2008	2008D41-B	70469	122,153	510	X	X			
17/04/2008	2008D41-C	70,442	122,81	525	X				
18/04/2008	2008D41-D	70,379	121,579	493	X		X	X	
18/04/2008	2008D41-E	70,373	121,554	485	X				
18/04/2008	2008D41-F	70,365	121,533	485	X				
19/04/2008	2008D41-G	70,36	121,516	500	X				
19/04/2008	2008D41-H	70,359	121,51	500	X				
19/04/2008	2008D41-I	70,359	121,51	504	X				
19/04/2008	2008D41-J	70,359	121,51	505	X				

Table 3: CLF-Leg 7 summary sampling activities using the 1 m diameter ring net on the ice.

Date (UTC)	Station	LAT	LONG	Sampling depth	Contaminants	Taxonomy	Lipids	Stable Isotope	Gut content	Biomass and ETS
18/03/2008	2008D29-ice1	70,545	123,286	10		X				
18/03/2008	2008D29-ice2	70,545	123,286	250		X				
18/03/2008	2008D29-ice3	70,545	123,286	60			X			
18/03/2008	2008D29-ice3	70,545	123,286	60			X			
29/03/2008	2008D33-ice1	71,039	121,472	10		X				
29/03/2008	2008D33-ice2	71,039	121,472	150		X				
31/03/2008	2008D33-ice3	71,039	121,472	180		X				
31/03/2008	2008D33-ice4	71,039	121,472	10		X				
02/04/2008	2008D33-ice7	71,039	121,563			X				
07/04/2008	2008D33-ice8	71,169	124,251	10		X				
07/04/2008	2008D33-ice9	71,169	124,251	20		X				
07/04/2008	2008D33-ice12	71,169	124,251	20			X			
08/04/2008	2008D36-ice1	71,18	124,326	10		X				
08/04/2008	2008D36-ice2	71,18	124,326	20		X				
08/04/2008	2008D36-ice3	71,18	124,326	50		X				
09/04/2008	2008D36-Ice4	71,19	124,35	10		X				
09/04/2008	2008D36-Ice5	71,19	124,35	50		X				
09/04/2008	2008D36-Ice6	71,19	124,35	50		X				
10/04/2008	2008D36-Skippy1	71,19	124,35	50		X				
12/04/2008	2008D38-Ice1	71,145	124,369	50		X				
12/04/2008	2008D38-Ice2	71,145	124,369	50		X				
12/04/2008	2008D38-Ice3	71,146	124,369	50		X				
12/04/2008	2008D38-Ice4	71,146	124,369	70			X			
12/04/2008	2008D38-Ice5	71,145	124,369	70					X	
17/04/2008	2008D41-Ice1	70,434	122,78	250		X				
17/04/2008	2008D41-Ice2	70,434	122,78	50		X				
17/04/2008	2008D41-Ice3	70,434	122,78	60	X					
17/04/2008	2008D41-Ice4	70,434	122,78	10		X				
19/04/2008	2008D38-Ice5	70,361	121,512	10		X				
19/04/2008	2008D38-Ice6	70,361	121,512	250		X				
19/04/2008	2008D38-Ice7	70,361	121,512	60	X					
19/04/2008	2008D38-Ice8	70,361	121,512	60		X				
19/04/2008	2008D38-Ice9	70,361	121,512	60				X		

Table 4: CFL-Leg 7 summary sampling activities using the 2 x 1 m^2 horizontal nets under the ice (sampling depths are estimated).

Date (UTC)	Station	LAT	LONG	Sampling depth	Contaminants	Taxonomy	Lipids	Stable Isotope	Gut content	Biomass and ETS
29/03/2008	2008D33-H1	71,039	121,472	2		X				
31/03/2008	2008D33-H2	71,039	121,472	2		X				
31/03/2008	2008D33-O3	71,039	121,472	100		X				
02/04/2008	2008D33-H4	71,04	121,563	2		X				
02/04/2008	2008D33-O5	71,04	121,563	100		X				

Table 5: CFL-Leg 7 summary sampling activities using the rosette

Date (UTC)	Station	LAT	LONG	Sampling depth	Contaminants	Taxonomy	Lipids	Stable Isotops	Gut content	Biomass and ETS
22/04/2008	2008D41-128	70,345	121,476	520		X				

Laboratory analysis

1) Egg production rate experiments
Copepod *in-situ* egg production and gonad maturation (after Niehoff 1998) were monitored by incubating large calanoid species females at 0°C, thus at a similar temperature that they experience at depth. *Calanus glacialis*, *C. hyperboreus* and *Metridia longa* egg production was assessed approximately every 5 or 6 days.

At the start of April, egg production rate of *C. hyperboreus* was still high (60 eggs fem^{-1} day^{-1}) but decreased drastically (6 eggs fem^{-1} day^{-1}). At the end of the leg, most of the females *C. hyperboreus* were spent, indicating the end of their reproduction season. Eggs were sampled for dry weight measurements. Approximately 200 eggs were put to dry on a pre weighed GF/F filter that will be weighed again on a microbalance at Laval University. Harsh winter conditions always provide difficulties in studying winter Arctic organisms. Because of this constraint, the metrics on the reproduction of *C. hyperboreus* is currently poorly documented. In order to measure the total production of *C. hyperboreus,* 50 immature females have been placed in filtered sea water during leg 5 and their egg production monitored daily. Eggs produced were then used to measure the hatching rates for different eggs buoyancies (sinking vs. floating). By the end of April we hope to get total reproductive output and the fate of this production. To this date, 20 females have spawned more than 1000 eggs. The record is presently held by female number 47 with a total of 1949 eggs spawned. However most of the females are spent and their lipid reserves are for many of them completely consumed. The egg production rate decreased greatly compared to the measurement of leg 6.

A large proportion of the females *Metridia longa* were in a mature stage of gonad maturation. Spawning was recorded on three experiments out of six but the rate of production remains low (1.66-6.3 eggs fem^{-1} day^{-1}).

The experiment initiated on leg 5 to test the hypothesis arguing that *Metridia longa* can feed on *C. hyperboreus* eggs. (Conover & Huntley 1991) was finally terminated. There was a high rate of mortality among the females after a few days even when they were fed eggs of *C. hyperboreus*.

An experiment carried out on females *Calanus glacialis* collected in the 60-0 m layer gave a fairly high egg production (25 eggs fem^{-1} day^{-1}) for the population of this species occupying the surface layer. Furthermore their guts were green with chlorophyll, most probably ice algae. We found no sign of egg production in other experiments for which females collected over the entire water column were incubated.

2) Biomass and Transfer System (ETS) activity
On five occasions, corresponding to five stations (Table 1 and 2), samples were sorted for biomass and ETS activity essay. At these stations, each Hydrobios net was subdivided: 50% for taxonomy (i.e. preserved in formol), 25% for population biomass estimates and 25% for ETS activity. For biomass estimate, the sub-sample (i.e. 25% of total sample) was fractionated with sieves in > 1000 □m and < 1000 □m size classes; these fractions were preserved at -20˚C. Sub-samples for zooplankton population ETS activity essays (i.e. 25% of total sample) were also sieved into the same two size fractions. As no Sanyo incubator was available for the ETS experiments, samples were incubated in a Pyrex plate filled with water and heated to 40˚C on a hot plate. Temperature of this 'hot tub' proved to remain constant during the required incubation time. ETS experiments were also performed on individual copepods, females and copepodite stage 5, of *Calanus glacialis*, *C. hyperboreus* and *Metridia longa.*

3) Respiration experiments
To derive respiration from the activity of the Electron transfer system a ratio of respiration on ETS activity is required. Thus incubations were carried out to measure oxygen consumption of copepods in sealed chambers. The handheld oxygen meter that we started to use on leg 6 proved to be very easy and practical to use for the respiration measurements.

4) Taxonomic analysis of the zooplankton small size fraction

Every 2-4 days (depending on the net sampling possibilities), one 50µm tucker net sample was prepared for small fraction taxonomy. For each sample, 300 copepods specimens were identified under the stereomicroscope. For each sample preserved, one other 50 µm tucker net sample was preserved for biomass measurement. The codend content was filtered through a 1000µm sieve (in order to eliminate the large organisms) then filtered through a 50µm sieve. The zooplankton was then placed on a preweighed GF/F filter that will be weighed back in Québec. Moreover, for every 50 µm sample analysed, the females *Calanus hyperboreus* and *Paraeuchaeta glacialis* were counted in one 200 µm Tucker net sample of the same cast. This counting will permit to estimate, related to the egg production rate experiments, the expected number of eggs in the 50 µm sample.

Acoustic monitoring

The Simrad EK-60 Echosounder of the Amundsen allowed our group to continuously monitor the spatial and vertical distribution of zooplankton and fish, the later mostly represented by Arctic cod (*Boreogadus saida*). The hull-mounted transducers are in operation 24h a day and will provide an extensive mapping of where the fishes are within the region of interest over a yearly cycle.

General Recommendations:

We will keep the same recommendations given on the past zooplankton team reports:

As the drift of the ship while in an ice floe can be important, we recommend sampling as often as possible with the Hydrobios and the 1-m^2 square net in the moon pool and with the ring net from the ice. Unfortunately sampling in the morning in the moon pool and from the ice in the afternoon as it was done before was not an option this leg because of the reduced team.

Low temperature is the essence of all the measurements done with live animals. The very warm temperature in our laboratory may pose problems even to the environment chamber which shows difficulties to maintain the required 0°C. The air conditioner system set at 22°C remedied to the problem. From now on, the AC should stay on and the laboratory door must remain closed. Also, the opening of the incubator should be kept to a minimum.

When the ship is in transit, and that may last a few days, and then stops in a flow, particular attention should be given to the EK-60 sounder and the ADCP in order to make sure all sensors cleared of ice before the shutting down of the engines. Otherwise the data recorded are simply unusable.

More importantly, enjoy this amazing experience in this harsh but beautiful environment, have fun and KEEP THE SPIRIT!!!

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2.4.2. Ice algae, Zooplankton, Ice Amphipods (CFL 3 & 4)

Participants: Stig Falk-Petersen, Anette Wold - Norwegian Polar Institute

The aim of our work is to study the effect of light on the food quality of ice algae and the transfer of energy from algae via *Calanus* copepods and ice amphipods in Arctic ecosystems in ice covered waters. We will use this to compare and contrast key ecosystem component between the Canadian Arctic and Svalbard waters, Norway. The samples collected during Leg 7 will be used by Post doc Eva Leu (ice algaes), Post doc Janne Soereide (zooplankton) and PhD student Henrik Nygaard (Ice amphipods). Sampling of ice amphipods will be continued by Haaakon Hop on Leg 9a.

Ice algae
The aim of the ice algae sampling is to study the effect of light on nutritional quality of ice algaes in terms of fatty acids and elemental stoichiometry. Samples were taken from different types of ice flows, different snow depth (high and low snow depth) one - two times a week. In total we sampled 7 times during the 5 weeks (Table 1). Three ice cores were collected at each site (high and low snow cover). The bottom 3 or 5 cm of the cores (depending on the amount of ice algaes) were cut of and kept in the dark. The cores were melted in filtered sea water; 100ml sea water was added per 1 cm core. At station D36, D38 and D41 samples were also collected from the interface between the ice and the sea water. These samples were collected by the divers using a "slurp-gun". The samples were filtered on pre-burned (450°C) GF/F 25 mm filters and frozen at -80°C. The samples will be analyzed for fatty acid composition and particulate phosphorus. Three pseudoreplicates were taken for each parameter for each core, if there was enough material. All sampling were done at the same time and location as the other ice core sampling. For details concerning the ice coring see the Ice algae report (team 3).

Zooplankton
The aim of the project is to investigate how *Calanus* spp. (focusing on *C. glacialis*) adapts to the environment in different ice conditions (Rijpfjorden, Spitsbergen pack ice vs. Canadian polynya). The following sets of samples have been taken in order to get information about the distribution of *C. glacialis* as well as the nutritional state of and their recent diet:

Vertical distribution of *Calanus* spp.
Egg production of *C. glacialis* females
Dry weight, lipid content, lipid classes, fatty acid/fatty alcohol composition, C and N stable isotope composition of *C. glacialis* and *C. hyperboreus*
Genetics

Vertical distribution of *Calanus* spp.:
Samples were taken at distinct depth using a Hydrobios. This was done by the Fortier team by Gérald Darnis. See the Zooplankton report (team 4) for more details.

Egg production:
C. glacialis females were collected from the upper 50 m by use of a ring net (from the ice edge or whole in the ice) or by use of the Tucker or Hydrobios from the moon pool. 20 healthy *C. glacialis* females were incubated in egg production chambers with *in situ* filtered sea water at 0°C temperature for3 days. The egg production chambers are equipped with mesh (1000 µm) false bottoms to separate females from eggs. After 24 hours, 48 h and 72 h we counted the eggs, measured the egg diameter, and counted the number of fecal pellets. The females were preserved in 4% formaldehyde in order to determine their gonad status. Four experiments were conducted in total.

Lipid and stable isotope compositions:
C. glacialis and *C. hyperboreus* were sampled by the Hydrobios at two distinct depths (bottom layer, below 150 m and surface layer, 50-0m). The animals were kept in the dark at *in situ* temperature and

sorted as soon as possibly after sampling. The dominant stages of *C. glacialis* and *C. hyperboreus* were selected by use of a stereomicroscope (Leica MZ6), and frozen immediately at -80° C. Samples were taken for the following parameters:
a) Dry weight
b) Lipid content
c) C and N stable isotope composition
d) Lipid class composition
e) Fatty acid and fatty alcohol composition

Genetics
Samples were collected for genetic analysis at the beginning and the end of the leg. Samples were taken with the Tucker net (200 µm) from the bottom to the surface and preserved in 90 % alcohol.

Table 1: Ice algae samples for fatty acid and particulate phosphorus

Sample	Date	Time	Station	Longitude (W)	Latitude (N)	Snow thick. (cm)	Ice thick. (cm)	Freebord (cm)	Fatty acid samples	P-particulate samples
L1	18.03.2008	17:00	2008D29	123 28.606	70 54.471	4	133	10	1	1
L2	18.03.2008	17:00	2008D29	123 28.606	70 54.471	4	136	13	1	1
L3	18.03.2008	17:00	2008D29	123 28.606	70 54.471	4	143	13	1	1
H1	18.03.2008	18:00	2008D29	123 28.606	70 54.471	19	130	18	1	1
H2	18.03.2008	18:00	2008D29	123 28.606	70 54.471	19	130	17	1	1
H3	18.03.2008	18:00	2008D29	123 28.606	70 54.471	19	130	18	1	1
L1	22.03.2008	18:00	2008D32	121 46.766	71 02.741	3	135	2	3	3
L2	22.03.2008	18:00	2008D32	121 46.766	71 02.741	3	145	5	3	3
L3	22.03.2008	18:00	2008D32	121 46.766	71 02.741	3	135	7	3	3
H1	22.03.2008	18:00	2008D32	121 46.766	71 02.741	25	142	12	3	3
H2	22.03.2008	18:00	2008D32	121 46.766	71 02.741	34	139	12	3	3
H3	22.03.2008	18:00	2008D32	121 46.766	71 02.741	38	148	13	3	3
L1	31.03.2008	14:00	2008D33	121 47.2	71 03.9	3	156	14	3	3
L2	31.03.2008	14:00	2008D33	121 47.2	71 03.9	2	155	14	3	3
L3	31.03.2008	14:00	2008D33	121 47.2	71 03.9	2	155	14	3	3
H1	31.03.2008	13:00	2008D33	121 47.2	71 03.9	27	142	12	3	3
H2	31.03.2008	13:00	2008D33	121 47.2	71 03.9	28	142	12	3	3
H3	31.03.2008	13:00	2008D33	121 47.2	71 03.9	28	143	11	3	3
L1	06.04.2008	11:00	2008D36	124 09.00	71 12.5	3	158	13	3	3
L2	06.04.2008	11:00	2008D36	124 09.00	71 12.5	3	159	13	3	3
L3	06.04.2008	11:00	2008D36	124 09.00	71 12.5	3	159	13	3	3
H1	06.04.2008	11:00	2008D36	124 09.00	71 12.5	17	151	12	3	3
H2	06.04.2008	11:00	2008D36	124 09.00	71 12.5	18	152	10	3	3
H3	06.04.2008	11:00	2008D36	124 09.00	71 12.5	19	154	12	3	3
L1	09.04.2008	11:00	2008D36	124 34.3	71 18.4	1	71	7	3	3
L2	09.04.2008	11:00	2008D36	124 34.3	71 18.4	1	71	6	3	3
L3	09.04.2008	11:00	2008D36	124 34.3	71 18.4	1	71	7	3	3
interface	09.04.2008	11:00	2008D36	124 34.3	71 18.4				3	3
interface	09.04.2008	11:00	2008D36	124 34.3	71 18.4				3	3
interface	09.04.2008	11:00	2008D36	124 34.3	71 18.4				3	3
L1	11.04.2008	11:00	2008D38	124 37.8	71 15.0	2	124	12	3	3
L2	11.04.2008	11:00	2008D38	124 37.8	71 15.0	2	124	12	3	3
L3	11.04.2008	11:00	2008D38	124 37.8	71 15.0	2	124	12	3	3
H1	11.04.2008	11:00	2008D38	124 37.8	71 15.0	19	109	11	3	3
H2	11.04.2008	11:00	2008D38	124 37.8	71 15.0	20	109	9	3	3
H3	11.04.2008	11:00	2008D38	124 37.8	71 15.0	18	109	8	3	3
interface	11.04.2008	11:00	2008D38	124 37.8	71 15.0				3	3
interface	11.04.2008	11:00	2008D38	124 37.8	71 15.0				3	3
interface	11.04.2008	11:00	2008D38	124 37.8	71 15.0				3	3
L1	16.04.2008	11:00	2008D41	122 21.54	70 47.1	5	131	11	3	3
L2	16.04.2008	11:00	2008D41	122 21.54	70 47.1	5	132	11	3	3
L3	16.04.2008	11:00	2008D41	122 21.54	70 47.1	5	132	11	3	3
H1	16.04.2008	11:00	2008D41	122 21.54	70 47.1	10	130	9	3	3
H2	16.04.2008	11:00	2008D41	122 21.54	70 47.1	11	129	10	3	3
H3	16.04.2008	11:00	2008D41	122 21.54	70 47.1	12	131	10	3	3
interface									3	3
interface									3	3
interface									3	3

Table 3. Number of individuals per dry mass /stable isotope and per lipid sample

Species	Stage	Dry mass / stable isotope	Lipid class / fatty acid
C. glacialis	female	15	15
	CV	20	15
	CIV	25	25
	CIII	30	30
C. hyperboreus	female	5	5
	CV	10	10
	CIV	15	15
	CIII	20	20

Three replicate of each species and stage was sampled at each station if there were sufficient animals.

Table 4. Zooplankton sampling

Date	Time (local)	Station	Latitude (N)	Longitude (W)	B. depth (m)	Net	Mesh (µm)	Sampling depth (m)	Sample type
16.03.2008	08:51	2008D29	70 54.471	123 28.606	401	Hydrobios	200	380-360-340-320-233-146-60-40-20-0	Abundance*
16.03.2008	08:51	2008D29	70 54.471	123 28.606	401	Hydrobios	50	380-0	Abundance*
16.03.2008	09:55	2008D29	70 54.471	123 28.606	401	Hydrobios	200	380-300	Lipids; Stable isotopes; Dry mass
18.03.2008	10:00	2008D29	70 54.471	123 28.606	401	WP2	200	50-0	Lipids; Stable isotopes; Dry mass
18.03.2008	12:15	2008D29	70 54.471	123 28.606	401	Tucker	200	50-0	Egg experiment; Lipids
24.03.2008	07:23	2008D33	71 03.851	121 47.238	401	Tucker	200	380-0	Genetic
24.03.2008	07:40	2008D29	71 03.851	121 47.238	401	Hydrobios	200	50-0	Lipids; Stable isotopes; Dry mass
24.03.2008	08:15	2008D33	71 03.851	121 47.238	187	Hydrobios	200	180-160-140-120-100-80-60-40-20-0	Abundance*
24.03.2008	08:15	2008D33	71 03.851	121 47.238	187	Hydrobios	50	180-0	Abundance*
25.03.2008	07:05	2008D33	71 03.851	121 47.238	187	Tucker	200	50-0	Lipids; Stable isotopes; Dry mass
25.03.2008	07:39	2008D33	71 03.851	121 47.238	187	Hydrobios	200	170-100	Lipids; Stable isotopes; Dry mass
01.04.2008	07:37	2008D33	71 03.851	121 47.238	188	Tucker	200	60-0	Egg experiment; Lipids
01.04.2008	08:05	2008D33	71 03.851	121 47.238	188	Hydrobios	200	180-160-140-120-100-80-60-40-20-0	Abundance*
01.04.2008	08:05	2008D33	71 03.851	121 47.238	188	Hydrobios	50	180-0	Abundance*
02.04.2008	10:30	2008D35	71 04.014	121 56.330	213	Hydrobios	200	203-183-163-143-116-88-60-40-20-0	Abundance*
02.04.2008	10:30	2008D35	71 04.014	121 56.330	213	Hydrobios	50	203-0	Abundance*
02.04.2008	11:15	2008D35	71 04.014	121 56.330	213	Hydrobios	200	200-120	Lipids; Stable isotopes; Dry mass
02.04.2008	11:15	2008D35	71 04.014	121 56.330	213	Hydrobios	200	50-0	Lipids; Stable isotopes; Dry mass
06.04.2008	09:42	2008D36	71 12.263	124 07.500	302	Hydrobios	200	270-200	Lipids; Stable isotopes; Dry mass
06.04.2008	09:42	2008D36	71 12.263	124 07.500	302	Hydrobios	200	50-0	Lipids; Stable isotopes; Dry mass
06.04.2008	13:37	2008D36	71 13.263	124 11.523	304	Hydrobios	200	285-265-245-225-170-115-60-40-20-0	Abundance*
06.04.2008	13:37	2008D36	71 13.263	124 11.523	304	Hydrobios	50	285-0	Abundance*
08.04.2008	15:00	2008D36	71 17.263	124 32.781	304	WP2	200	50-0	Egg experiment; Lipids;Stable isotopes
12.04.2008	15:00	2008D38	71 14.478	124 36.335		WP2	200	50-0	Egg experiment
16.04.2008	12:40	2008D41	70 47.1	122 21.54	503	Tucker	200	450-0	Genetics
16.04.2008	12:53	2008D41	70 47.1	122 21.54	503	Hydrobios	200	450-200	Lipids; Stable isotopes; Dry mass
16.04.2008	12:53	2008D41	70 47.1	122 21.54	503	Hydrobios	200	50-0	Lipids; Stable isotopes; Dry mass

* see Zooplankton report (team 4) for more details

Ice amphipods
The aim of the study is to understand the ecology of ice associated amphipods in relation to variations in the sea ice cover and to compare and contrast the ecology and life history of ice amphipods between the Canadian Arctic and Svalbard waters.

Baited traps were deployed on ice floes either trough holes or at the ice edge of the floes. Chicken and scampi were used as bate. The divers also tried to collect amphipods with a hand net, but no amphipods were seen on any of the diving locations. The animals collected were length measured and sexed, and then frozen at -80°C. The Five individuals were pooled for each species, size group.
Samples will be analyzed for the following parameters:
population biology
genetics
lipid analyses,
stable isotope analyses

The search for amphipods were not very successful, and in total we only got 21 individuals, of which 20 was collected from one trap the first day of deployment.

Table 5. Amphipod traps

Station	Date	Longitude (W)	Latitude (N)	Bate	Trap location	N° traps	Time	N° ind.	Species	Comment
2008D33	26.03.2008	121 47.238	71 03.851	chicken	close to ship 1	2	24h	20	Anonyx sp.	all amphipods in one trap
2008D33	26.03.2008	121 47.238	71 03.851	chicken	thin ice	4	24h	0		
2008D33	28.03.2008	121 47.238	71 03.851	chicken	close to ship	4	24h	0		
2008D33	28.03.2008	121 47.238	71 03.851	chicken	thin ice	4	24h	0		
2008D33	29.03.2008	121 47.238	71 03.851	chicken	close to ship	4	24h	1	Onisimus spp.	
2008D33	29.03.2008	121 47.238	71 03.851	chicken	thin ice	4	24h	0		
2008D33	30.03.2008	121 47.238	71 03.851	chicken	close to ship	6	18h	0		
2008D33	31.03.2008	121 47.238	71 03.851	chicken	thin ice	4	24h	0		
2008D33	31.03.2008	121 47.238	71 03.851	scampi	close to ship	6	24h	0		
2008D33	01.04.2008	122 47.238	72 03.851	scampi	close to ship	6	24h	0		retrieved all traps
2008D36	08.04.2008	124 32.781	71 17.263	scampi	crack in front of ship	5	24h	0		
2008D36	09.04.2008	124 32.781	71 17.263	scampi	ridged crack in front of ship	5	24h	0		lost 4 traps, the crack closed up
2008D36	11.04.2008				divers using a hand net			0		
2008D38	12.04.2008	124 36.335	71 14.478		divers using a hand net			0		
2008D41	16.04.2008	122 21.54	70 47.1		divers using a hand net			3	G.wilkitzkii, Onisimus spp.	

The collection of ice amphipods will be continued by Haakon Hop on Leg 9a

2.4.3. Benthos (CFL 4 & 7)

Participants: Dieter Piepenburg (University of Kiel, Germany, Team 4 Food webs),
Paul Renaud, Akvaplan-niva Norway, Team 7 Carbon and Nutrient Fluxes) and
Tobias Tamelander (University of Tromsø, Norway, Team 7 Carbon and Nutrient Fluxes)

Scribe: Tobias Tamelander

Background
Benthic work on leg 7 was carried out as part of activities of Team 4 (Food webs) and Team 7 (Carbon and nutrient fluxes). This included deployments of the box corer for retrieving sediments and a Remotely Operated Vehicle (ROV) for surveys of the surface of the seafloor and epibenthos. The objectives were to determine the carbon utilisation by the benthic community as community respiration and sediment properties. This work will be continued during proceeding legs to form a time-series of the seasonal patterns of benthic metabolism.

Sampling and incubations
Sediment was collected with a box corer at four stations (Table 1) in water depths ranging from 183-469 m. Sub-cores for incubations, Chlorophyll, and CN were collected from the same box (one successful cast per station). Sub-cores for Chlorophyll *a* were sliced in 1 cm sections to 10 cm depth.

For CN, the top 2 cm were collected. These samples were frozen and transported off the ship for analyses in the home-lab.

Incubations were performed in a temperature controlled room (ca 1° C) in the zooplankton container (front deck, port side). The decrease in oxygen volume in the water overlying the sediment was measured periodically (8 h intervals) over 2-3 days. Cores containing water only acted as controls. At the end of the incubations, the sediment sieved on 0.5 mm mesh sieve and the fauna collected for analyses of species composition, abundance and biomass. SOD was also measured in cores to which algae from the sub-ice layer had been artificially introduced. Experiments with algal additions were only performed at two stations.

The ROV was deployed 3 times (Table 2). During dives #4 and #6 it was possible to survey the benthic habitat and the epifauna in transects and obtain video-recorded material for quantitative determinations of the epifauna. Strong ship-drift during dive #4 caused heavy resuspension of the sediment, precluding detailed photography of the epifauna and transect for spatial coverage of epifauna.

Preliminary results
The sediment generally consisted of a brown top layer, ca 5 cm deep, and a deeper layer consisting of grey clay. Small stones were abundant at Stns D34 and D35. At Stn D37 and D39 the sediment and the clay was softer and contained less stones. Some fauna was visible in all cores (polychaete tubes, clam siphons protruding from the sediment).

The raw values of oxygen consumption (sediment and water) ranged from 1.4 to 2 mmol O_2 $m^{-2}d^{-1}$ at the stations assessed. Oxygen consumption was increased after algal additions at least at one of the stations.

Table 1. Box coring stations during leg 7, with number of cores collected for Sediment Oxygen Demand (SOD), Chlorophyll (Chl) CN and samples for other groups.

Date	Pos N	Pos W	Depth	CTDNr	StnNr	core#	SOD	Chl	CN	Other samples
24.03 2008	71 04.5680	121 48.6319	183	802018	D34	2	5	3	3	Biomarkers (TB)
02.04 2008	71 04.1562	121 56.6672	214	802070	D35	1	5	3	3	Biomarkers (TB), Hg (DA)
09.04 2008	71 18.7139	124 36.1849	243	802094	D37	1	5	3	3	Biomarkers (TB)
14.04.2008	70 49.4996	122 21.2445	469		D39	1	5	3	3	Biomarkers (TB), Hg (DA)

TB – Thomas Brown, DA – Debbie Armstrong

Table 2. ROV deployments on leg 7.

Dive#	Date	Pos N	Pos W	Surveys	Comments
4				Seafloor	Transect
5	20.04.2008	70 40.57	121 54.49	Seafloor and ice under-side	Strong drift, no transect, poor visibility
6	21.04.2008	70 41.1284	121 42.1510	Seafloor and ice under-side	Strong current. Seafloor transects.

2.5. Team 6

PIs: Tim Papakyriakou (U of M), Lisa Miller (IOS) and Jean-Louis Tison (Ulb – Belgium)

Participants: Tim Papakyriakou (U of M), Bruno Delille (Ulg – Belgium), Melissa Chierici (Göteborg University – Sweden), Agneta Fransson (Göteborg University – Sweden), Gauthier Carnat (U of M) and Doris Leong (Dalhousie)

Introduction
The main goal of Team 6 is to investigate the sea-ice-atmosphere exchanges of climatically active gases (such as carbon dioxide and dimethyl sulfide). Gas concentrations and near-surface fluxes are measured from installations on the ship and from the sea ice. In order to better understand the driving

factors regulating those exchanges, we are looking at ice and water biogeochemistry, selecting a set of variables that describes the best ice and water column conditions in terms of physical, biological and chemical properties. Meteorological and surface climatological data are also collected to relate the observed fluxes and ice/ocean properties to near-surface microenvironment. Collectively this information should provide a good description of the gas cycles and their dynamics in the arctic environment of the flaw lead system over the annual cycle.

Sampling and deployments were undertaken as part of CFL Drift Mode – where the ship would associate itself with an ice floe for a period of time ranging from 4 d to 17 d. Our sampling, monitoring and the associated data set is described in the following sections.

2.5.1. Surface Meteorology and Flux Project

Introduction

The surface meteorology and flux program (CFL Team 6) is designed to record basic meteorological conditions and to study exchanges of momentum, heat and mass across the atmosphere-sea ice-ocean interface. The main value of this program to the overarching objectives of Team 6 is the direct measurement of CO_2 fluxes and measures of the basic terms of the heat budget (sensible and latent heat, radiation fields).

Turbulent fluxes (CO_2, heat and momentum) are measured by the eddy covariance technique, which is dependent only on atmospheric measurements. To realize the potential of the data set the measurements of the CO_2 flux, in particular, require ancillary information on processes (physical, biological and chemical) that drive gas exchange. In an open-ocean situation this context is largely provided by measurement of sea-surface pCO_2, but the situation becomes much more complex when a sea ice cover is included in the equation. Surface flux monitoring facilities are deployed on the ship`s foredeck, and when possible, on the sea ice.

This section of the CFL Team 6 cruise report reviews the atmospheric and sea surface pCO_2 measurements that were made during Leg 7. Other sections of the report will deal with the sea ice measurements that were made in support of the CO_2 flux measurements.

Ship-Based Micrometeorology and Eddy Covariance Flux Tower

Methods

The micrometeorological tower located on the front deck of the Amundsen (Figure 1.1) provided continuous monitoring of meteorological variables and eddy covariance parameters. The tower consists of slow response sensors that record bulk meteorological conditions (air temperature, humidity, wind speed/direction, surface temperature) and fast response sensors that record the eddy covariance parameters (CO_2/H_2O concentration, 3D wind velocity, 3D ship motion, air temperature) (Table 1.1). In addition, radiation sensors (Figure 1.1, Table 1.1) were installed on the roof of the wheelhouse to provide information on incoming radiation fields, including: long-wave, short-wave, photosynethetically active, and ultra-violet radiation (UVA and UVB). All data was logged to Campbell Scientific dataloggers; a model CR5000 logger was used for the eddy covariance data, a CR1000 logger for general meteorological elements (e.g., temperature, relative humidity, etc.), and a CR23X for the radiation data. All loggers were synchronized to UTC time using the ship's GPS system as a reference.

The eddy covariance system on the tower makes use of two separate gas analyzers and a single 3D sonic anemometer. The dual gas analyzers system allows us to make use of both closed path and open path eddy covariance systems. The open path gas analyzer has the benefit of making measurements concurrently with the sonic anemometer, but the closed path gas analyzer is not as easily disturbed by adverse weather conditions.

In order to make sure that the two systems are comparable, careful calibrations were performed on both instruments. The closed path system is based on a LI-7000 gas analyzer which employs two optical cells, one of which was used to monitor the drift of the instrument by constantly passing a stream of ultra-high purity N_2. In addition, the sample cell of the instrument was calibrated daily using the ultra-high purity N_2 to zero the CO_2 and H_2O measurements, and a reference gas of known CO_2 to span the instrument. Occasionally, a span calibration of the H_2O sensor was performed using a dew point generator (model LI-610). The open path gas analyzer (LI-7500) could not be calibrated as conveniently, and so it was calibrated approximately every three weeks. In general, we find that this is effective for this particular instrument, which does not drift significantly over time.

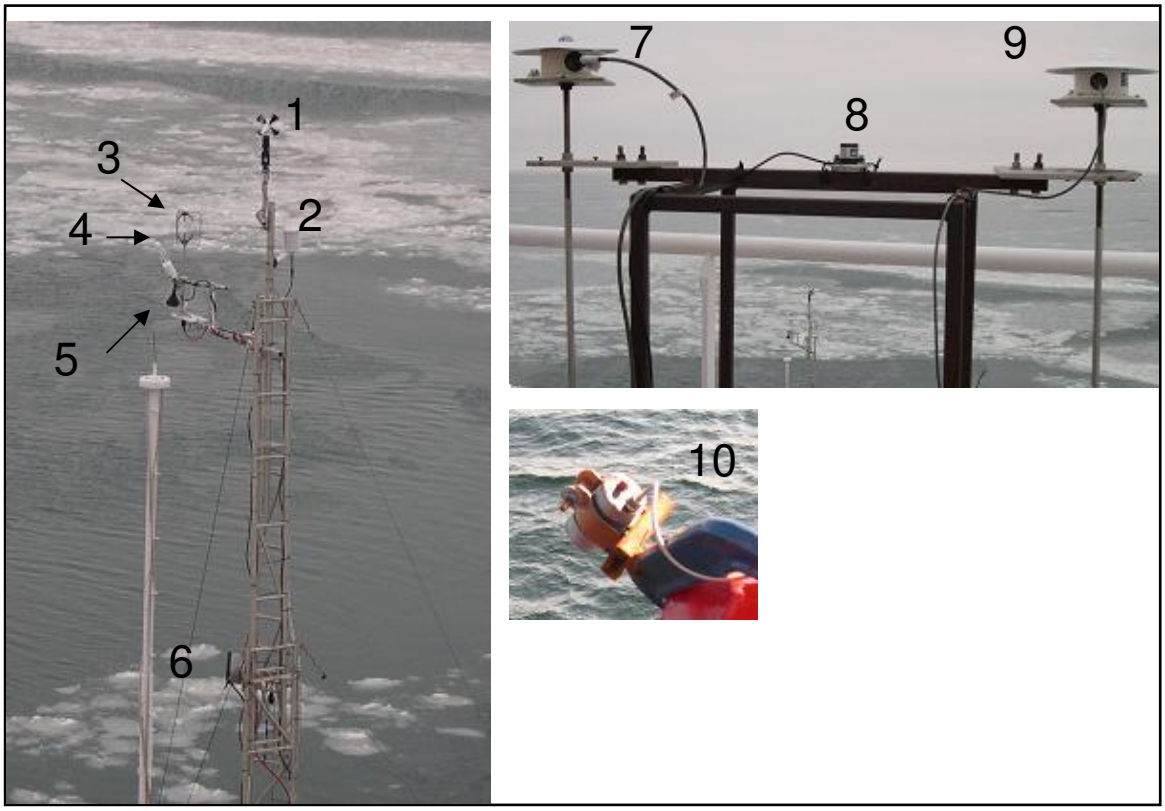

Figure 1.1: Meteorology and flux program instrument setup. See Table 1 for description of instruments based on the numbers. Note that on Nov. 18 the Motion Pak (6) was moved to the rear face of the tower to facilitate easier motion correction, and the UV sensor is not shown.

Table 1.1: Description of instruments shown in Fig. 1.1.

Fig 1	Sensor	Variables	Units	Ht from deck (m)	Scan (s) /Ave (min)	Specs
1	wind monitor (RMYoung 05103)	wind speed/direction	m/s; °	8.45	2/1	±0.6 m/s ±3° deg
2	temperature/relative humidity probe (Vasailla HMP45C212)	T and RH	ºC; %	7.53	2/1	Humidity ±2% 0-90% @ 20ºC ±3% 90-100% @ 20ºC 0.05% RH/ºC Temperature ± 0.1 ºC
3	3D wind velocity (Gill R3 ultra-sonic anemometer)	u,v,w, speed of sound (SOS)	m/s	7.1	10 Hz	RMS noise <1% offset <0.01 m/s SOS < 0.5% accuracy
4	LI7500 open path gas analyzer	CO_2/H_2O	µmol/ m^3 mmol/	7.1	10 Hz	RMS noise ±0.1 µmol/mol zero drift 0.1

			m^3			µmol/mol/ºC gain drift 0.1%/ºC
5 (inlet, analyzer not shown)	LI7000 closed path gas analyzer	CO_2/H_2O	µmol/ m^3 mmol/ m	inlet at 7.1	10 Hz	RMS noise ±0.1 µmol/mol zero drift 0.3 µmol/mol/ºC gain drift 0.2%/ºC
6	multi-axis inertial sensor (MotionPak, Systron Donner)	rate x,y,z accel x,y,z	º/s; g	6.48	10 Hz	rate <0.004º/s acc <10 µg
7	pyranometer (Eppley, model PSP)	SW_in	W/m^2	1.5	2/1	~±5%
8	quantum sensor (Kipp & Zonen, PARLite)	PAR	µmol/ m^2/s^1	1.5	2/1	~±5%
9	pyrgeometer (Eppley, model PIR)	LW_in	W/m^2	1.5	2/1	~±10%
10	surface temperature (Everest infrared transducer, model 4000.44ZL)	Tsrfc	ºC	1.6 m	3/1	±0.5 ºC accuracy
not shown	pressure transducer (RM Young, 61205V)	Patm	kPa	1.6	2/1	~±2%
not shown	UV Radiometer (Kipp & Zonen, UV-S-AB-T)	UVA, UVB	W/m^2	1.5	2/1	~±5%

Sample data

As an example of the slow response meteorological data, Figure 1.2 shows the evolution of air temperature and wind speed over one day at Station D7 (a first year sea ice floe, ~70cm depth). An example of the rapid response flux data is shown in Figure 1.3, which shows 10 minutes of vertical wind speed and CO_2 concentration. A great deal of processing will be required to calculate actual fluxes of CO_2, and to filter out erroneous data.

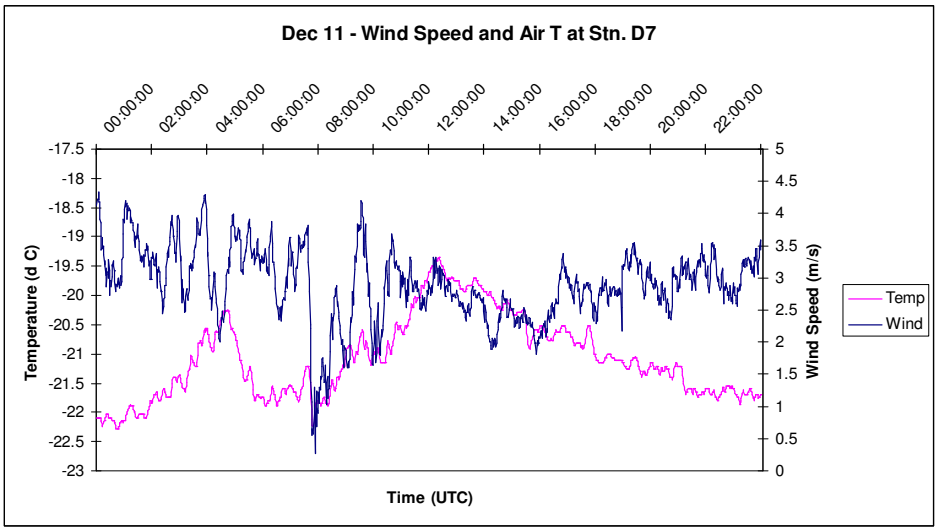

Figure 1.2: Slow response meteorological data example; wind speed and air temperature (24 hrs).

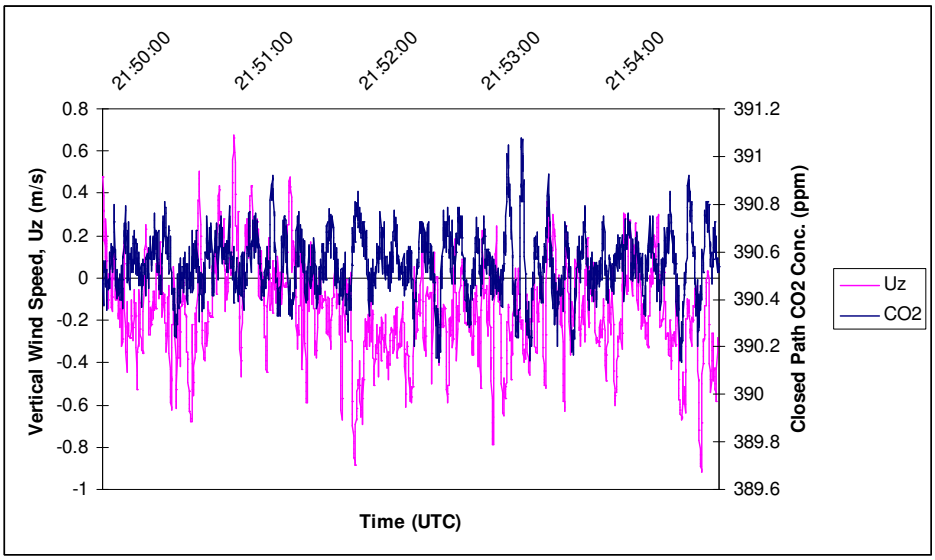

Figure 1.3: Fast response flux data example; vertical wind speed and closed path $_{CO2}$ concentration (10 min).

Notes

The meteorological tower ran consistently for the duration of the leg with the exception of brief periods when the tower was taken down for maintenance. Occasional periods occurred when the LI-7500 and sonic were inoperable because of ice and frost. This problem most seriously affected the LI-7500, which was very difficult to keep clean. The problem also affected the sonic anemometer, but to a much lesser degree. The extent of data lost due to atmospheric conditions cannot be estimated at this time, and will only be known once post processing is complete.

Ice-Based Micrometeorology and Eddy Covariance Flux Tower

Methods

An ice-installation (Figs. 1.4 a and b) was installed on April 16. A list of variables that were monitored appear as Table 1.2.

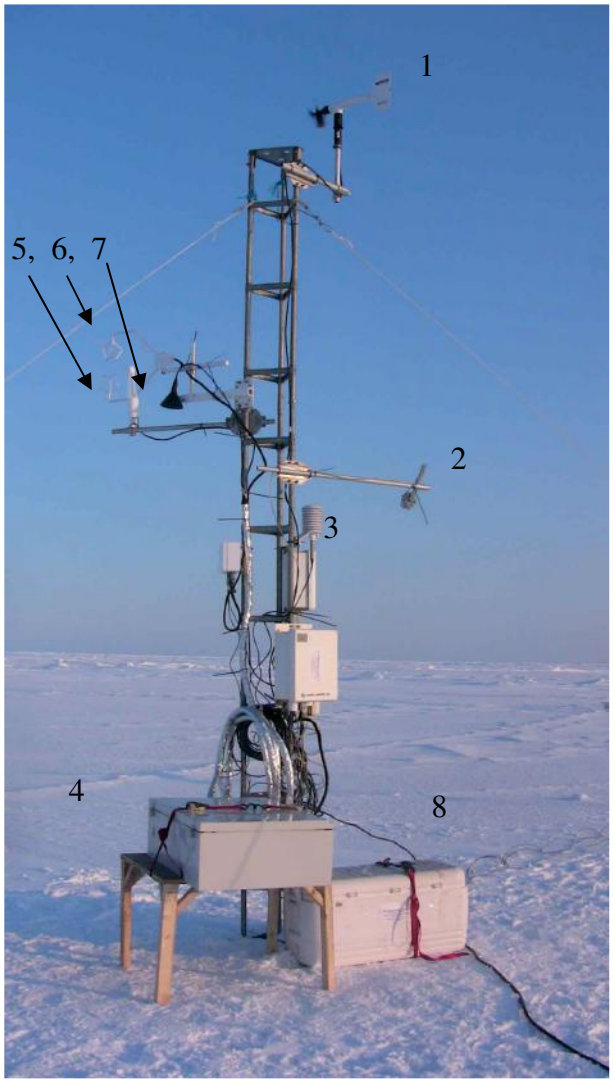

Figure 1.4a: Meteorology and flux instrument setup on sea ice. See Table 1.2 for description of instruments based on the numbers. Item 8 is the 12VDC power supply.

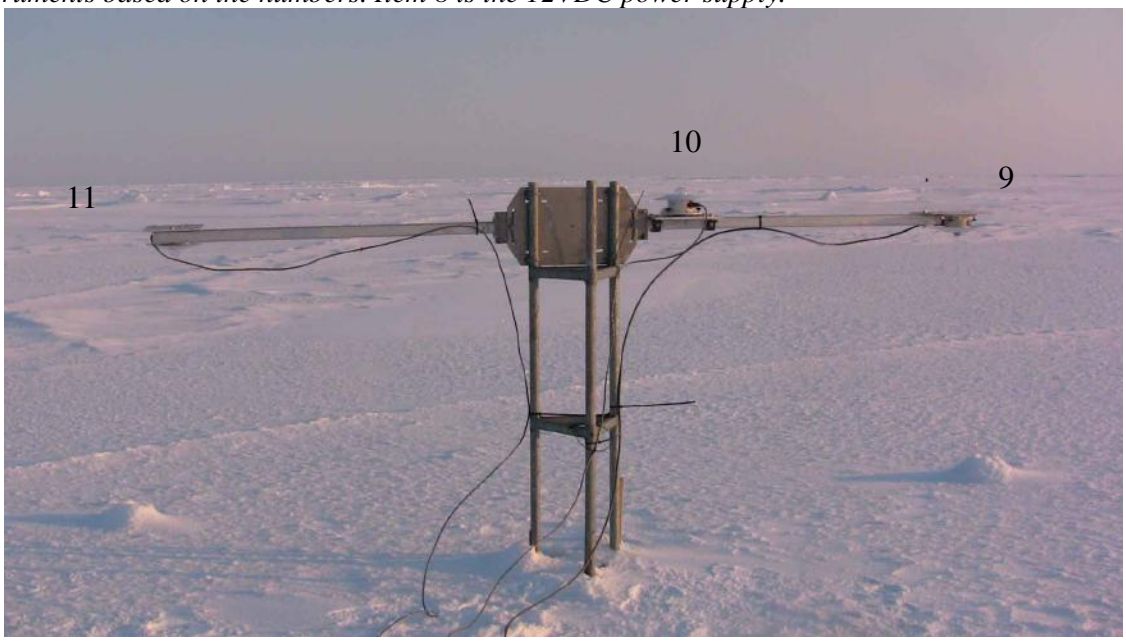

Figure 1.4b: Radiation sensors on sea ice. See Table 1.2 for description of instruments based on the numbers.

The installation was located approximately 500 m to the east of the ship on a uniform pan of sea ice that was 1.32 m thick at the time of installation. The set-up consisted of two short TV antenna-style tower sections: i) for surface fluxes and meteorology (Fig. 1.4a), and radiation (Fig. 1.4b). Snow thickness was on average 5 cm, until a snow event on April 21, increasing the snow depth around the tower to approximately 10 cm. The installation was powered by lead-acid batteries (12 VDC), which themselves were trickle charged by a battery charger which required AC power to the site. A 10kW diesel generator was located 200 m to the north of the tower. The vertical structure of ice temperature was monitored by thermocouples arranged in profile within a shield (Fig. 1.5) composed of concentric pvc tubing (OD nominal 3 cm). Signals associated with the set-up logged by a Campbell Scientific loggers: model CR1000 for basic meteorology and temperature, and model CR3000 for the components of the eddy covariance system. Raw data from the flux sensors were sampled at 20Hz and immediately transferred to flash card.

Notes

The towers, complete with meteorological and radiation sensors were deployed on April 16, except for incoming solar radiation (April 18). The sonic anemometer and open-path flux components were installed on April 19, and the closed sensor was installed on April 22. The LI-7500 was factory calibrated prior to deployment. The zero and span of the LI-7000 was checked prior to deployment, then again on April 21. There are several notes related to this sensor. First, the enclosure temperature rose to nearly 50C with full insulation. Insulation was removed on April 21 and temperature subsequently dropped to 17C (nominal). Second, it is difficult to field calibrate the sensor. Alternatively, span and zero gas were passed through cell B at ~ 0.4 L/min. Cell pressure increased to slightly greater than ambient atmosphere.

Figure 1.5: Temperature sensor prior to installation. Sensor levels are provided in Table 1.2.

Table 1.2: Description of instruments shown in Fig. 1.4a and b.

Fig 1	Sensor	Variables	Units	Ht from srfc (m)	Scan (s) /Ave (min)	Specs
1	wind monitor (RMYoung 05103)	wind speed/direction	m/s; °	5.00	1/1	±0.6 m/s ±3° deg
2	surface temperature (Everest infrared transducer, model 4000.44ZL)	Tsrfc	ºC	1.6 m	3/1	±0.5 ºC accuracy
3	temperature/relative humidity probe (Vasailla HMP45C212)	T and RH	ºC; %	2.00	1/1	Humidity ±2% 0-90% @ 20ºC ±3% 90-100% @ 20ºC 0.05% RH/ºC Temperature ± 0.1 ºC

4,7 (analyzer and inlet, respectively)	LI7000 closed path gas analyzer	CO_2/H_2O	µmol/mol mmol/m	inlet at 3.05	20 Hz	RMS noise ±0.1 µmol/mol zero drift 0.3 µmol/mol/ºC gain drift 0.2%/ºC
5	LI7500 open path gas analyzer	CO_2/H_2O	µmol/m^3 mmol/m^3	3.2	20 Hz	RMS noise ±0.1 µmol/mol zero drift 0.1 µmol/mol/ºC gain drift 0.1%/ºC
6	3D wind velocity (CSAT3 ultra-sonic anemometer)	u,v,w, sonic temperature	m/s (ºC)	3.25	20 Hz	RMS noise <1% offset <0.01 m/s SOS < 0.5% accuracy
9	pyrgeometer (Eppley, model PIR)	LW_out	W/m^2	1.5	2/1	~±10%
10	pyranometer (Eppley, model PSP)	SW_in	W/m^2	1.5	2/1	~±5%
11	pyranometer (Eppley, model PSP)	SW_out	W/m^2	1.5	2/1	~±5%
Fig. 1.5	Type T thermocouples (note depths are presented from the snow/ice interface)			1.8, 1.7, 1.6, 1.5, 1.4, 1.3, 1.0, 0.9, 0.7, 0.5, 0.35, 0.2, 0.01		~±2 ºC

On-track *p*CO_2 System

Methods

A custom-built *p*CO_2 system was utilized on this leg to measure dissolved $_{CO2}$ at the sea surface in near real time. The system (Figure 1.6) is located in the engine room of the Amundsen, and draws sample water from the ship's clean water intake. The water is passed into a sealed container through a shower head, maintaining a constant headspace. This set up allows the air in the headspace to come into equilibrium with the CO_2 concentration of the seawater, and the air is then cycled from the container into the LI-7000 gas analyzer in a closed loop. Thermocouples are used to measure water temperature immediately before entering the equilibration chamber, and to measure the temperature of the air in the chamber. All data is logged to a Campbell Scientific CR1000 datalogger.

The LI-7000 gas analyzer was calibrated daily using ultra-high purity N_2 as a zero gas, and a gas with known CO_2 concentration as a span gas. Spanning of the H_2O sensor was not necessary because a desiccant column removes H_2O from the air stream before passing into the sample cell. As with the closed path system, a stream of N_2 is constantly cycled through the reference cell of the LI-7000 to monitor and correct for drift of the instrument.

Figure 1.6: The on-track pCO_2 system located in the engine room of the Amundsen. The equilibration chamber is the clear cylinder (left bottom) and the gas analyzer is the box with the digital display.

Sample Data
Figure 1.7 shows an example of a single day of CO_2 data recorded by the on-track system, along with water temperature. Further processing must still be undertaken to correct the values for changes in temperature that occur due to the length of the sample line, and to properly calculate pCO_2.

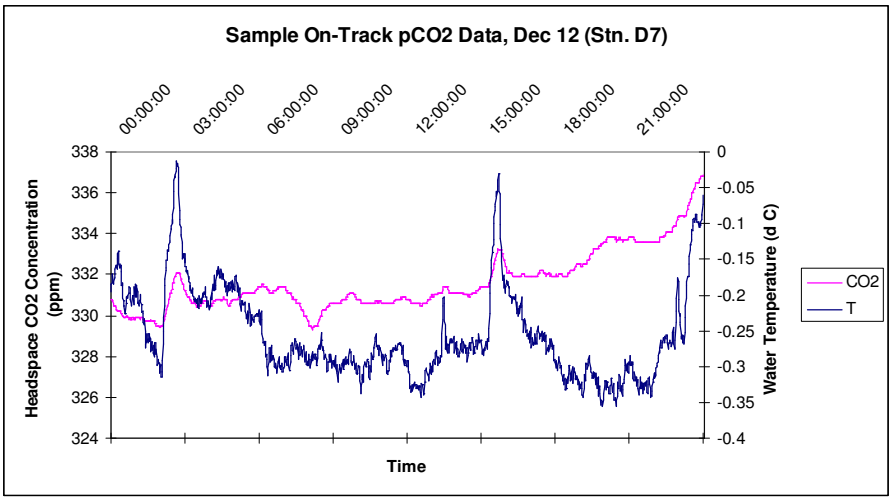

Figure 1.7: Sample on-track pCO_2 data (CO_2 and water temperature)

Notes
The on-track pCO_2 system was active for the duration of the leg, with some minor interruptions for maintenance. Major interruptions in data collection were experienced when the ship was breaking ice, which either reduced the flow of water into the equilibration tank, or completely blocked it. In the case of blocked flow, the data is lost, but tests will have to be conducted to determine if data obtained with low water flow is useful. Also note that the air outlet from the closed loop clogged, increasing cell pressure to ~ 139 kPa, and causing the water in the reservoir to rise to dangerously high levels. The symptoms are: i) reduced air flow rate in the closed loop; ii) high cell pressure and water level. To remedy the situation the reservoir must be removed from the system so that the outlet can be removed and cleaned. Note, the reservoir need not be dismantled. A temperature sensor was installed into the reservoir to monitor water temperature. Temperatures are generally similar to the temperature that is measured at the tank inflow.

2.5.2. CO_2 In Sea Ice

Bulk sea ice CO_2 contents

Sea ice CO_2 contents were measured by two ways :
-Ice core collections for further gas chromatography analysis
-Peepers

Gas chromatography measurement
Ice cores were collected from further measurements of pCO_2 of bulk sea ice at high vertical resolution. pCO_2 will be measured with a 5 cm vertical resolution using a new method developed by Verbeke (2005). The backbone idea of this method is that the ice samples are equilibrated at *in situ* temperature in an enclosure filled with a standard atmosphere of known concentration in CO_2. After equilibration, CO_2 concentration in the enclosure is analysed by gas chromatography.

Peepers
Material and methods

A peeper is a 20 cm length closed tube formed by a silicone membrane permeable to CO_2 exchanges (Fig. 2.1). The top part and the bottom part of the tube are impermeable (aluminium sheets). Stainless steel tubings with Swagelock fittings are used to pump and inject air inside of the tube.

The idea is to install the peeper in the ice structure by drilling a hole with a small auger and to leave it there for a couple of days (the top part of the hole is closed by a wooden plate to avoid air exchanges with the atmosphere). After 24 h, the pCO_2 of the air in the inside volume of the peeper is supposed to be in equilibrium with the pCO_2 of the medium surrounding the peeper. The air volume of the peeper is then pumped in the field and analyzed with a LICOR.

Deployment strategy

There are two ways to install the peepers in the ice. The first one is to drill a sac hole at the desired depth. The second one is to drill through the seawater. The mediums surrounding the peepers are thus considerably different: frozen brines in the first case, frozen seawater in the other case.

We deployed seven peepers in total at one station. Three in the same « through seawater hole » at respectively 20 – 40 and 60 cm depths (for a total ice thickness of 160 cm). The four other ones were put into sac hole at 20 (2 peepers) -40 and 60 cm depth as well for comparison purposes. The peepers were sampled every four days.

Fig. 2.1 Peeper and installation

Preliminary Results

The pCO_2 levels measured with the peepers at 20 cm depth in sac holes.

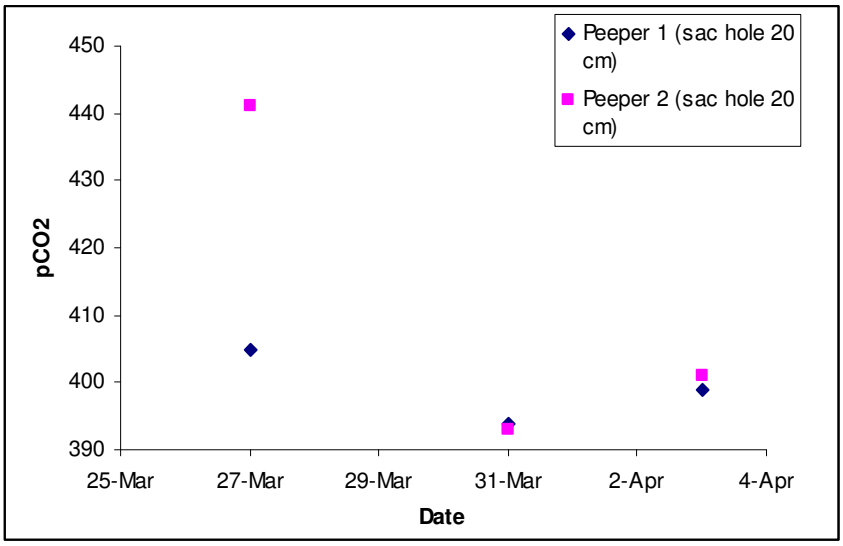

Fig. 2.2 Changes in peeper pCO_2 with time after deployment.

pCO_2 in Brines and Surface (under-ice) Water

SIES System

Material and methods

Sampling of ice brines was conducted by drilling shallow sackholes (ranging from 15 cm down to almost full ice thickness) through the surface of the ice sheet. The brine from adjacent brine channel and pockets was allowed to seep into the sackhole for 15-60 min, with the hole covered with a plastic lid (Gleitz et al., 1995), reportedly the best current method to sample brines for chemical studies (Papadimitriou et al., 2004). Water was pumped from the hole using a peristaltic pump (Masterflex® - Environmental Sampler) and supplied to the sea ice equilibrator system (SIES), a device for measurements of pCO2 and air-ice CO2 fluxes. This device allows measurement of pCO2 using a membrane contractor equilibrator (Membrana® Liqui-cell) coupled to an infrared gas analyzer (IRGA, Li-Cor® 6262). Seawater flowed into the equilibrator at a rate of 1 L min-1 and a closed air loop ensured circulation through the equilibrator and the IRGA at a rate of 3 L min-1. Temperature was measured simultaneously in situ and at the outlet of the equilibrator using Li-Cor® sensors. Temperature correction of pCO2 was applied assuming that the relation from Copin-Montégut (1988) is valid at low temperature and high salinity. The IRGA was calibrated soon after returning to the ship while the analyser was still cold using CO2-in-air standards with mixing rations of 0 ppm and 369.4 ppm of CO2 supplied by Air Liquide Belgium®. Stable field pCO2 readings usually occurred within 5 min of flowing gas into the IRGA. The equilibration system ran 10 min before averaging the values given by the IRGA and temperature sensors over 30s and recording the averaged values with a data logger (Li-Cor® Li-1400). All the devices were enclosed in an insulated box that contained a 12V power source and was warmed to keep the inside temperature just above 0°C.

Preliminary results

During leg 7b, pCO_2 within sea ice brines were always oversaturated compared to the atmosphere. pCO_2 within brines ranged from 480 to 1880 ppmV. The upper end of this range corresponds to the highest pCO_2 values ever measured within sea ice (by a direct method). Previous largest value of pCO_2 observed within warmer sea ice (i.e. -9°C) was around 900 ppmV. This confirms that decrease of temperature acts to increase pCO_2. Higher pCO_2 was observed in the upper, saltier and colder part of the ice cover. We observed a high spatial and temporal variability, that is not related to sea ice temperature.

Comparison of the last two stations (16/04/08 and 19/04/08) gives some insights on short term variability. pCO_2 dropped from 1130 to 480 ppmV in the lower 40 cm of the ice (Fig. 2.3). Similar salinity and temperature together with the occurrence of platelet in the skeletal layer, suggest that the ice was in a "steady" of " growing" state. Thus, this drawdown should be ascribed to the algae bloom (chl a µg increased from 12 to 256 µg L^{-1}), underlying the role of the primary production on CO_2 dynamics within sea ice.

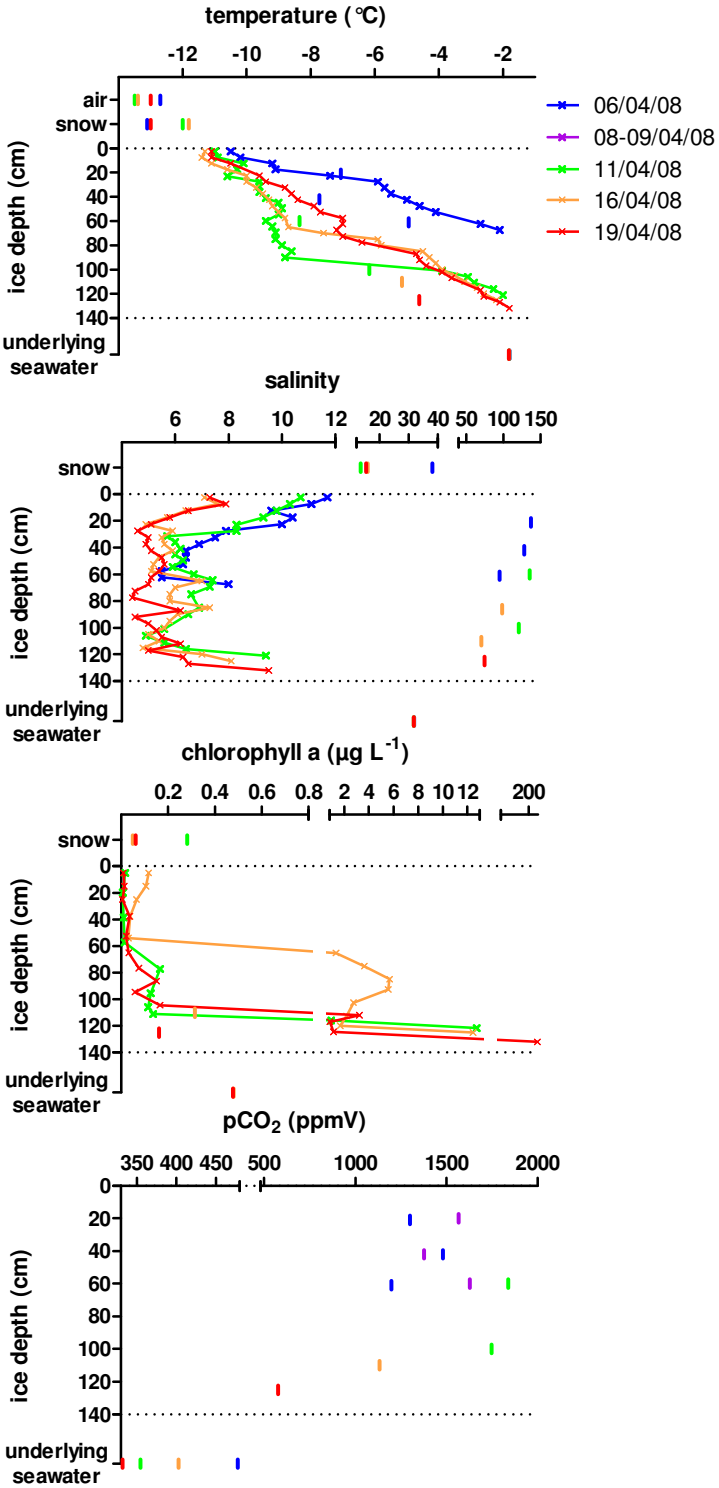

Figure 2.3 . Temperature, salinity, shlorophyll a and pCO_2 , within snow (vertical bars), ice (line with crosses), brines (vertical bars), and underlying water (vertical bars) during leg 7b

Gas chamber measurements

Material and methods

A chamber (Fig. 2.4) coupled to the SIES was used to measure air-ice CO_2 fluxes. The accumulation chamber (West system®) is a metal cylinder closed at the top (internal diameter 20 cm; internal height 9.7 cm). A rubber seal surrounded by a serrated-edge iron ring ensured an air-tight connection

between the base of the chamber and the ice. For measurement over snow, an iron tube was mounted at the base of the chamber to enclose snow down to the ice and prevent lateral advection of air through the snow. The chamber was connected in a closed loop between the air pump (3 L min^{-1}) and the IRGA of the SIES. The measurement of pCO_2 in the chamber was recorded every 30 sec for at least 10 min. The flux was computed from the slope of the linear regression of pCO_2 against time ($r^2 \geq$~ 0.99) according to Frankignoulle (1988). The uncertainty of the flux computation due to the standard error on the regression slope is on average ±3%. CO_2 fluxes values correspond to the average of three measurements. The idea is to look at the changes in the pCO_2 between the beginning and the end of the gas chamber deployment. Any increase in this pCO_2 can then be understood as a positive flux from the ice – any decrease as a negative flux. The gas chamber is usually left on the ice for a period of time of 10 minutes.

We did several gas chamber measurements during the main coring stations but also during small punctual stations. In order to investigate the influence of the ice properties on the fluxes, we put the chamber on different ice types and thicknesses.

Fig. 2.4 Gas chamber on top of 70 cm thin ice with frost flowers on top

Preliminary results

One of our interests is to look at the impact of the snow cover on the gas exchanges measurement. The next two charts (in Fig. 2.5) show the pCO_2 changes in two gas chamber experiments on the same spot. The first one was put on top of the snow, the second one on the ice with the snow cover removed.

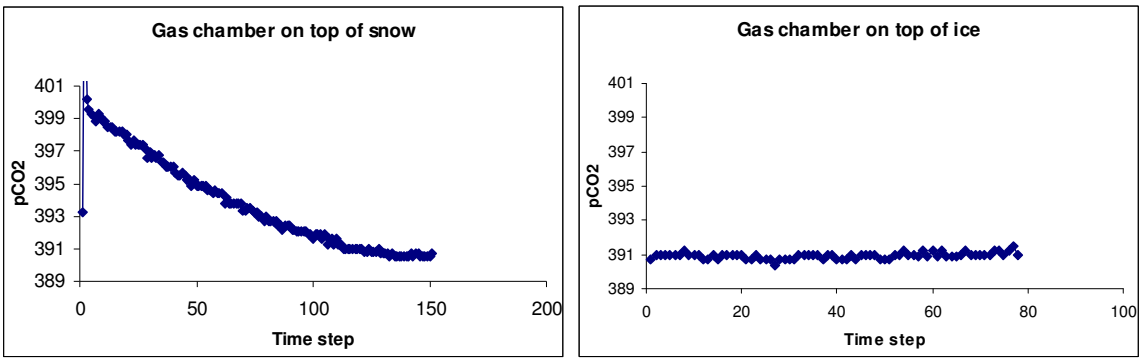

Fig. 2.5 Rate of gas concentration change in surface chambers.

Air-ice CO_2 fluxes were close to zero or around the detection limit during the leg 7b. This is not surprising since the snow-ice interface temperature ranged from -12.7 to -10.5°C, likely below the temperature threshold of permeability for gases within sea ice. However, we observed some fluxes between the snow and the atmosphere that indicate that specific processes could affect CO_2 concentration within the air trapped among snow crystals. Indeed, the salinity of the snow was significantly higher than the salinity of the upper part of the ice cover as a probable consequence of previous formation of frost flowers. This high salinity could provide a CO_2 buffer capacity to the snow

that supports interaction between snow and CO_2. In addition, algae biomass of the snow is also significantly higher than the upper part of the sea ice cover. This biomass may also play a role in these snow processes.

2.5.3. DMS/P/O In Sea Ice

DMS/P/O contents in sea ice, brines and water

Material and methods
The purpose of the DMS/P/O project is to measure the DMS/P/O contents in sea ice, brines and water during leg 7 in order to determine the dynamics of those compounds in the ice and between the mediums. Another point of interest is to follow the evolution of those concentrations over time and to look at the potential interactions and influences of the biogeochemistry of sea ice on DMS/P/O. The work is undertaken in collaboration with Dr. Maurice Levasseur (U.Laval).

Basically, we took ice cores, brines and water samples at different locations representing different ice types and thicknesses. Ice samples were taken using a electropolished stainless steel corer and liquid samples were put into air tight vials with the help of a peristaltic pump or syringes. The vials stayed in the dark at 4 degrees before analysis to avoid biological activity. The ice cores were immediately cut in the freezer room on the ship into 5 cm length sections. Each section was then crushed in a stainless steel air tight container using an ice crusher. After that, the container was connected to a « Purge and Trap » system. This system uses helium as a carrier gas to remove all the DMS from the container and to accumulate it into a teflon loop immerged into liquid nitrogen in order to capture the DMS. When all the DMS is trapped (10 minutes are needed to extract all the DMS from the container), the loop is put into hot water and all the gas is released into a gas chromatography system (GC Varian with a six way valve, a column specific for sulfur and a PFPD detector) – Fig. 3.1. The crushed ice is then put into vials for DMSP and DMSO further analysis. In order to measure the DMSP levels of the ice, we added two pellets of NaOH in order to transform the DMSP into DMS. The ice was then stored at 4 degres in the dark for 12 hours to melt and mix the ice with the NaOH.

Liquid samples (DMSP and water/brines samples) are also analyzed with the Purge and Trap system and the GC. The only difference is that the sample is injected with a syringe into a glass tube instead of in the stainless steel container. DMSO vials were not analyzed on the ship, and instead will be shipped to Belgium for processing.

Fig. 3.1 Purge and trap system and ice crusher

Preliminary results
Leg 7 was a very interesting leg in terms of DMS/P/O measurements because of the phytoplanctonic bloom that occurred at the beginning of the leg. The two next charts (Fig. 3.2) show the DMSP profiles in ice for one station before the bloom and one station after the bloom.

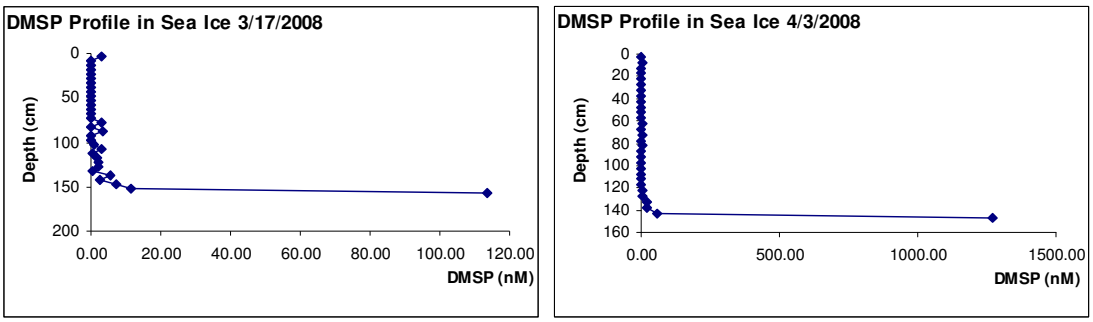

Fig. 3.2 DMSP profiles in sea ice.

Cell lysis during a dilution experiment and related DMSP release

Material and methods

In collaboration with Dr. C.J. Mundy and the dive program we collected underice water and brines at different locations. The brines or underice waters were then distributed in different quantities (starting from 100 ml to 2 ml) into whirlpack bags. The next step was to add different quantities of milliQ water into those bags in order to create a dilution gradient in terms of salinity. We used two techniques for that. The first one was a fast mixing technique : the milliQ water was just added to the bag. The second one was a slow mixing technique : a frozen block of milliQ water was slowly melted into the brines or water samples. Both techniques required 12 h of mixing in the dark to avoid biological activity.

The purposes of this experiment are to show how cell lysis provoked by an osmotic choc can affect different compounds and to look at the rate this osmotic choc and those cell lysis are occuring. To investigate that, we did nutrients, chla, DMSP and salinity measurements on the samples. As a intracellular compound and osmoregulator DMSP is supposed to react strongly to any change in the salinity of the medium.

Preliminary results

Most of the results aren't available yet but we were already able to show that the amount of DMSP in a diluted sample was approximately two times longer than in a normal sample.

2.5.4. Ice Permeability

Bail test

Material and methods

The bail test has been often used in soils studies and a few times successfully used in sea ice studies. The purpose of this test is to derivate the permeability of the ice from the rate of penetration of sea water into a sac hole. After drilling a hole in the ice close to the bottom (usually between 2 and 10 cm of ice are left at the bottom), a tube is inserted into the hole and a floater is inserted into the tube. A laser, mounted on the top of the tube is measuring the distance between the floater (indicating the water level in the hole) and the top of the tube. The water level is increasing into the hole by addition of sea water coming through the ice. The difference between the water level at equilibrium and the water level at any time is then put on a chart and the exponent of the exponential curve obtained gives the permeability.

Miscellaneous

Even if the bail test was working perfectly during the tests and the calibrations we did on the ship, we had some difficulties during the experiments in the field. We undertook four unsuccessful tries in total and we were not able to get a stable and reliable curve during one of those tries. Considering the

results obtained, the test seems to work for a short time but then something that we were not able to find is disturbing the signal. Fig 4.1 illustrates such an example.

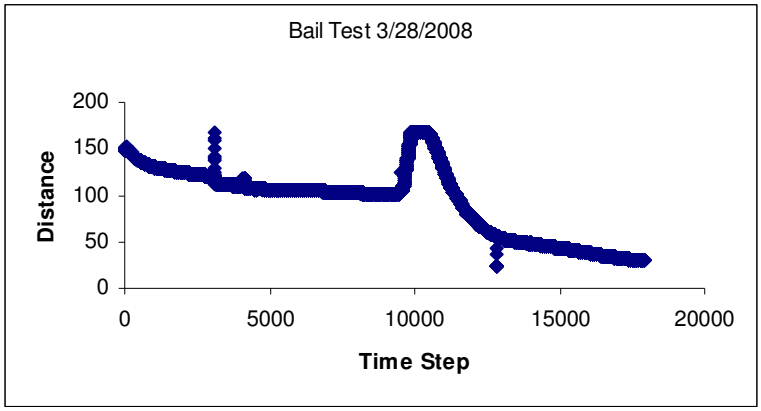

Figure 4.1 Sample bail test results.

Another problem relates to a contribution of brine to the test hole. To avoid that, we unsuccessfully tried to build a rubber jacket around the basis of the tube. But the salinity levels measured into the hole remained still higher than a normal water signal.

2.5.5. Sea Ice Biogeochemistry

In-Situ measurements and Ice Core Collection

In order to get a set of biogeochemical variables that will help us to understand the dynamics of the processes happening in sea ice, we collected ice cores for further analysis in both Winnipeg, Brussels and Liege labs. Basically, we took between 10 and 12 cores at each station. A major concern throughout the whole sampling procedure has been to prevent contamination in trace metals, especially iron. We followed the trace metal clean procedures proposed by Lannuzel et al. 2007. Nitrile gloves were used for handling the iron dedicated samples, and items used for sample collection and storage were acid-cleaned and sealed in plastic bags. The electropolished stainless steel core barrel (Lichtert Industries, Brussels, Belgium) has been specially designed and tested to be non-contaminant for iron. Seawater was pumped up with a portable peristaltic pump (Cole-Parmer, Masterflex E/P). Finally, the sea ice cores dedicated to iron determination were immediately packed in cleaned plastic bags and stored at minus 25 degrees Celsius.

In addition to that, we measured a couple of standard variables in the field (e.g. : freeboard, snow thickness, snow temperature...).

A complete list of the variables that will be accessible for the leg 7a is presented in Table 5.1.

Table 5.1 Biogeochemical parameters measured during leg 7.

		temporal survey				temporal survey	
		6/04/08	8/04/08	9/04/08	11/04/08	16/04/08	19/04/08
	air-ice CO2 fluxes	DM	DM	DM	DM	DM	DM
Brines & underlying water sampling	direct pCO2	DM	DM	DM	DM	DM	DM
	TA & DIC (VINDTA)	AO			AO	AO	AO
	pCO2 & DIC (Stenton Method)	UoM			UoM	UoM	UoM
	T°/salinity	AO		AO	AO	AO	AO
	□^{18}O	ULB			ULB	ULB	ULB
	DMS	AO			ULB	ULB	ULB
Snow	T°/salinity/chl a			AO	AO	AO	AO
	δ^{18}O			ULB	ULB	ULB	ULB
Ice cores	Temperature, salinity	AO		AO	AO	AO	AO
	δ^{18}O	ULB			ULB	ULB	ULB
	Chl a			OG	AO	AO	AO
	Fabrics	UoM			UoM	UoM	UoM
	nutrients			OG	OG	ULB/Ulg	ULB/Ulg
	DMS,P,O	ULB			ULB	ULB	ULB
	Total gas content, O2, N2, CH4, Ar, CO2	ULB			ULB	ULB	ULB
	pCO2 of bulk ice	ULB			ULB	ULB	ULB
	TA & DIC (centrifugation)	Ulg			Ulg	Ulg	Ulg
	Iron	ULB			ULB	ULB	ULB
	Other trace metal	ULB			ULB	ULB	ULB

DM Direct measurement
AO Analyzed onboard
UoM Ice cores /liquid phase sampled for subsequent analysis at the University of Manitoba
ULB Ice cores / liquid phase sampled for subsequent analysis at the Université Libre de Bruxelles
Ulg Ice cores sampled for subsequent analysis at the Universite de Liège
OG measurements carried by other groups

2.5.6. Dissolved Inorganic Carbon (DIC)/Alkalinity Project

DIC and TA in sea ice, brines and under-ice water
Brines were collected for onboard measurements of dissolved inorganic carbon (DIC) and total alkalinity (TA). Sackholes were drilled at several depths, depending on ice thickness and temperature. Samples were collected for DIC/AT as well as C-13. In some cases where brine formation was limited, the sampling priority was DIC, AT, then C-13, from highest to lowest. Temperature was measured in-situ, and salinity later measured in the lab. During Leg 7a, pH was also measured.

Analysis for DIC and TA was performed using the VINDTA 3C (Versatile Instrument for the Determination of Titration Alkalinity) developed by Marianda, (Fig. 6.1).

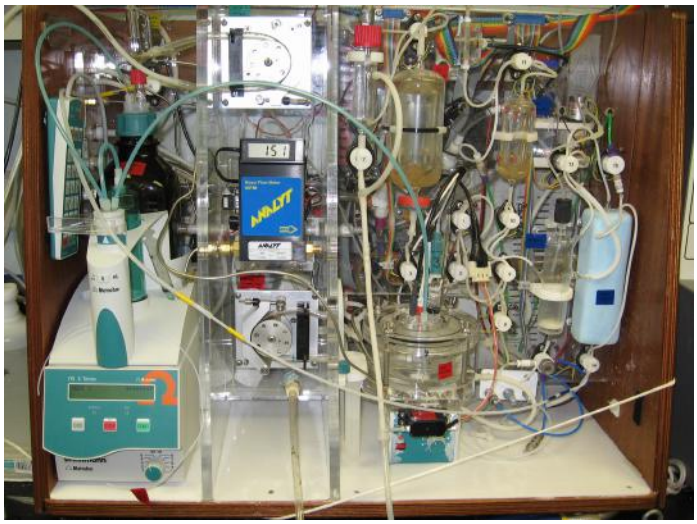

Figure 6.1 VINTA System.

TA was determined by titrating a volumetrically accurate subsample using HCl as the titrant, and a set of three electrodes - a Ross pH electrode, a reference AgCl electrode and an auxiliary platinum electrode. For measuring DIC, a volumetrically determined subsample was acidified with 8.5% H3PO4 to convert all inorganic carbon into gaseous CO2. The CO2 was stripped out of the sample using ultra-pure N2 gas, transferred into a coulometric titration cell and detected using the coulometric method.

DIC and TA in the water column
DIC/AT was sampled coincident with nutrient sampling, at the same depths/bottles. These nutrient casts occurred approximately every 6th day during Leg 7a and every 3rd day during Leg 7b. For Leg 7a, additional samples were also taken for time series measurements. In particular, around the 27-28th of March, biological production was initiated according to Chl a and fluorescence measurements. Samples were then taken in order to observe corresponding changes in DIC.

Water for DIC/AT measurements were sampled in 500mL bottles, then spiked with 500uL HgCl2 in the lab in order to avoid contamination of the Rosette area. The samples were stored in the dark at 4C until analysis. Surface water samples were also collected at the ice-water interface. These complement rosette sampling since the CTD is deployed through the moon pool of the ship and cannot sample the upper part of the water column.

High vertical resolution of DIC, TA and calcium carbonate content of brines
Ice cores were collected from further measurements of DIC, TA and calcium carbonate content of brines at high vertical resolution. The cores were sectioned into 10cm pieces and placed into gas impermeable Tedlar bags. These bags have a small valve from which air is removed using a vacuum

pump and the ice melts overnight at room temperature. From all melted ice cores, we measured DIC, AT, pH and salinity, and for the gas in the Tedlar bags (after melting of ice) we measured pCO2.

Brines will be extracted by centrifugation from the ice cores with a 10 cm vertical resolution. DIC and TA will be analyzed accordingly to the methods described above.

7.4 Sampling Dates/Stations

Station	Date	Notes
D29	March 17	rosette(bottom depth 312m)
D31	March 21	cage sampling of thin ice(30cm); surface water
D32	?	ice core sampling while stuck in ice: 150-157cm(thick ice)- 5 cores 50-55cm(thin ice)-7 sampling occasions w/8 cores
D33	March 24, 27, April 1	rosette time series(bottom depth 188m); ice cores: 50 cm and 145 cm
D35	April 2	rosette(bottom depth 213m)
D36	April 6,7	rosette(bottom depth 274m); surface water; 3-levels of brine
D37	April 10	rosette(bottom depth 278m)
D38	April 11,13	surface water; 2-levels of brine(60, 100cm)
D40	April 15	rosette(bottom depth 477m)
D41	April 16,18, 19, 21	2 rosettes(bottom depth 486m); 3 levels of brine(120, 100, 50cm) + surface water; 3 levels of brine(120, 90, 50cm) + surface water

*Note that during Leg 7a, station numbering differed between ice core stations and rosette stations.

**The following Leg 7a activities have yet to be logged by station and date (to be completed by Chierici & Fransson):
Brine from thick and thin ice (20, 30, 40, 80cm)
Frost flowers: 4 samples
Surface water (0, 2, 5m): 4 sampling occasions with pump
Under-ice water: used with pump and arm. 2 sampling occasions
C13 sampling 1 ice core (thick), 1 ice core (thin), brine (40cm)
Syringe sampling for DIC and pCO2 on GC: brine (10, 20, 30, 40, 80cm)

2.6. Team 7

2.6.1. Carbon & nutrient fluxes

PI: Jean-Éric Tremblay (Department of Biology, Laval University)
Participant: Jonathan Gagnon (Department of Biology, Laval University)

Rationale. The Arctic climate displays high inter-annual variability and decadal oscillations that modulate growth conditions for marine primary producers. Much deeper perturbations recently became evident in conjunction with globally rising CO_2 levels and temperatures (ACIA 2004; Comiso

2003). The thickness and extent of Arctic sea-ice decrease rapidly (Johannessen et al. 1999; Rothrock et al. 1999) and the ice-free season is extending both in the Arctic (Laxon et al. 2003) and subarctic (Stabeno & Overland 2001). Models predict further reductions in ice cover (ACIA 2004). These changes entail a greater penetration of light into surface waters, which is expected to bolster phytoplankton production (Rysgaard et al. 1999), food web productivity and CO_2 drawdown by the ocean. At present, phytoplankton production varies by two orders of magnitude across the Canadian Arctic, but the forcing mechanisms are poorly understood and quantified. In the Canadian Archipelago, the productivity of phytoplankton is likely to be limited by light or the supply of allochtonous nitrogen, depending on ice conditions. The supply of allochtonous nitrogen is influenced by climate-driven processes, mainly the large-scale circulation, river discharge, upwelling and regional mixing processes. Over most of the western Arctic, and especially the Beaufort Sea, the concentrations of inorganic nitrogen (i.e. nitrate, nitrite and ammonia) at surface remain low throughout the year and the phytoplankton possibly depend on local recycling and the dissolved organic nitrogen (DON; e.g. urea, amino acids and primary amines) supplied by rivers. A large portion of the phytoplankton biomass is typically located within subsurface chlorophyll maxima (SCM). SCM productivity is possibly in balance with the episodic supply of nitrate across the halocline and/or the supply of ammonium and nitrate by local recycling and nitrification, respectively. Despite the importance of SCM for the food web and CO_2 fluxes, little is known about their structure, turnover and susceptibility to environmental variability and change.

Objectives. The main goals of our team for leg 7 of ArcticNet 2007&CFL were to **(1)** establish the horizontal and vertical distributions of phytoplankton nutrients and the influence of different processes (e.g. mixing, upwelling and biological processes) on these distributions, **(2)** characterize the detailed vertical structure of chlorophyll-*a* with respect to irradiance, nutrient supply and physical structure and **(3)** experimentally assess causal relationships between phytoplankton productivity and the availability of light.

Methods. Samples for inorganic nutrients (ammonium, nitrite, nitrate, orthophosphate and orthosilicic acid) and urea were taken at all rosette stations (see Table 1) to establish detailed vertical profiles. Ammonium was determined immediately after collection using modifications of the manual fluorometric method (e.g. Holmes et al. 1999). Urea samples were either frozen or analyzed fresh using the method of Mulveena & Savidge 1992. The concentrations of nitrate, nitrite, orthophosphate and orthosilicic acid were determined on fresh samples using an Autoanalyzer 3 (Bran+Luebbe) with colorimetric methods adapted from Grasshof (1999).

Samples for the natural abundance of ^{15}N and ^{13}C in particulate organic matter were taken from the ice-water interface, at 5 m and at 30 m (this last depth was chosen because there were no apparent maxima). Volumes ranging from 12 to 20 liters were filtered onto 47 mm pre-combusted GF/F filters with a peristaltic pump and the filters were desiccated at 60°C in a drying oven. These data will be used for nitrogen uptake calculations and to assess the nitrogen status of phytoplankton communities.

Nutrients and natural abundance samples were also taken from the bottom of the ice cores collected by C.J. Mundy and Benoit Philippe using the same techniques described above except that the volume filtered for natural abundance was 25 mL of ice core diltuted (100 mL of filtered seawater from 10 m was added for each centimeter of ice core to avoid osmotic shock during thawing).

Photosynthetic characteristics of phytoplankton taken from 3 depths (ice-water interface, 5 m and 30m) were assessed by Pulse Amplitude Modulated fluorometry (PAM; Heinz-Walz).

The Phytoflash system, powered by a CTD (SBE-19), was deployed in self-contained mode from the front deck at one station to obtain a baseline of the fluorescence quality in the water column. It was also deployed under ice during the dive program. The first one consisted in a vertical profile of 12 m and then the divers put the phytoflash against the bottom the ice. After uploading and verifying the data, the method was changed to try to obtain usable data. The phytoflash was then passed into a mist of floating ice algae created by one of the divers scraping the bottom of the ice with his hand.

Table 1. List of sampling stations and measurements during leg 7 of ArcticNet 2007&CFL.

Station	Cast	Date	Nuts Water Column	Nuts Ice Core	PAM	Natural Abundance	Phytoflash
D36	85	07/04/2008	X		X	X	
D36-1	-	10/04/2008		X	X		
D37	95	11/04/2008	X		X		X
D38	-	11/04/2008				X	
D40	105	15/04/2008	X		X		X
D41	115	18/04/2008	X	X	X	X	X
D41-1	-	19/04/2008		X	X	X	X
D41-2	126	20/04/2008	X		X	X	

Preliminary Results. No preliminary results are available because post-runs corrections aren't done at this time.

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2.6.2. Marine Microbiology Group

Participants: Dan Nguyen, Maranger team- Université de Montréal, Lisa Delaney, Lovejoy team - Université Laval

Introduction

Microorganisms are a heterogeneous group that include representatives of the three kingdoms of live, Archaea, Bacteria and Eukarya. Because of this heterogeneity these organisms accomplish key biogeochemical processes in the ecosystem. Autotrophic microorganisms are the base of the Arctic ocean trophic web, which comprises 7 orders of size magnitude, from the smallest cell, less than 1 µm microorganisms, to the largest mammals on the order of meters. All these organisms are strongly influenced by the lack of light during part of the year, the low temperatures and the ice cover. Comparing the species composition and activities of microbial communities in systems with diverse chemical and physical regimes is a good way to learn more about the importance of the different forces that determine how microbes use organic and inorganic matter and how this influences other components of the food web. This knowledge is needed to better predict the consequences of natural or anthropogenic changes on these trophic dynamics. This will also help us to evaluate the system's ability to buffer these changes at short and long timescales.

Objectives

Our group had an ambitious sampling program to be completed during this leg. The different protocols done though this leg covered the work of 4 teams: Corina Brussard, Connie Lovejoy, Roxane Maranger and Carles Pedrós-Alió. These protocols addressed different aspects of the microbial world, with the objective of giving a detailed view of the microbial diversity and processes occurring during the winter season.

During leg 7, we intensified measures of microbial respiration and began carbon consumption measurement in sea-ice. Our focus was to see how snow cover could affect these processes. For these measures, we used fiber optic O2 sensing (FIBOX) and regrowth experiment to determine consumption and lability of C.

We also wanted to monitor interannual variability and microbial diversity and relative abundance throughout the water column in the Amundsen Gulf. In order to do this, DNA and RNA was collected at various sites across the Amundsen Gulf and analyzed in Quebec City. A subset of this was to observe the variations in gene expression over seasonal time scales. Bacteria and archaea was the focus of this work. To compliment this data, pigments were recorded at the same depths as DNA and RNA.

The data recorded in this region will be compared similar data from previous years across the Canadian arctic.

Sampling

The sampling for this leg took place at the south and southwest off the coast of Banks Island. The comparison of samples gathered during the different wintering legs will allow a better understanding of the seasonal dynamic and the comparison of the different geographical areas will provide valuable information on the diversity and depth distributions of microbes.

Since the beginning of leg 7, we sampled at 6 stations (D29, D33, D35, D36, D38, D41). The sampling dates and the localization of the stations can be found on Annex 1. Our strategy was to obtain microbiological data from specific water masses through the water column with a special focus on the nutricline, the upper mixed layer, and the deep waters. These water masses were identified during the downcast of the CTD, based on the readouts from the temperature, salinity, oxygen, nitrate, fluorescence, transmissometer and pH probes.

When possible, surface water from about 2 metres depth was collected through holes in the ice. These samples will be compared to the 12 meters surface water collected from the moon pool inside the ship.

Variables Sampled

A table summarizing the samples obtained during leg 7 can be found on Annex 2 and 3. A brief description of the protocols follows.

1. Molecular genetics

a. DNA sampling. Samples for DNA were collected on every station at 4 different depths. During DNA collection water was prefiltered through a 50 µm mesh, excluding larger organisms to be collected. Water was then filtered through a 3 µm polycarbonate filter and the same water was again filtered through a 0.2 m filter. This sampling protocol gives two different samples, one containing the DNA from 50 µm to 3 µm fraction (Large fraction) and one containing the 3 µm to 0.2 µm fraction (Small fraction). After collection samples are keeped at -80 ºC until processing in the Lovejoy laboratory in Université Laval. These samples will give valuable information on the biodiversity and distribution of microorganisms.

2. Gene expression

Samples for RNA were collected on every station at 4 different depths. During RNA collection water was prefiltered through a 50 µm mesh, excluding larger organisms to be collected. Water was then filtered through a 3 µm polycarbonate filter and the same water was again filtered through a 0.2 m filter. This sampling protocol gives two different samples, one containing the RNA from 50 µm to 3 µm fraction (Large fraction) and one containing the 3 µm to 0.2 µm fraction (Small fraction). After

collection samples are keeped at -80 ºC until processing in the Lovejoy laboratory in Université Laval. These samples will give valuable information on the spatial expression of key genes.

3. Chlorophyll concentration

Samples for chlorophyll analysis were taken on each station at six or seven different depths. For each sample, one liter of water was filtered through a Whatman GF/F filter. This was the so-called large fraction, comprising all microorganisms larger than the nominal pore aize of 0.7 In addition, water was prefiltered through a 3 µm pore filter to obtain the small fraction, which was finally filtered through a Whatman GF/F filter. Afer filtration, the filters were stored overnight at -20ºC. Subsequently, the filters were introduced in acetone 90% and placed in a refrigerator, in the dark. After 24 hours, the fluorescence of the extracts, before and after acidification with 3 drops of 5% HCl, was determined by means of a Turner TD-700 fluorometer.

4. HPLC

Samples for High Performance Liquid Chromatography (HPLC) analysis were taken on each station at six different depths. Two fractions were collected, one for the total fraction (down to 0.7 µm) and one for the small fraction (from 3 µm to 0.7 µm). Samples were stored at -80 ºC and will be analyzed at Laval University.

5. Virus

Different variables associated with viruses have been collected.

a. Viral abundance.

b. Viral diversity

2 litters of surface seawater were concentrated on 50 mL using a Vivaflow system (30 kd cartridge). This concentrate will be used to analyze the diversity of viruses present in the surface seawater.

6. Organic matter

Using pre-combusted GF/F filters (47 mm diameter) in a passive filtration system (by gravity) samples for dissolved organic carbon (DOC), total organic carbon (TOC), amino acids and carbohydrates were taken. Samples without filtration for total phosphorus determination were also collected.

7. Bacteria and Archaea abundance

Microscope preparations for bacterial abundance estimations were prepared by filtering a small volume of water (20ml) fixed with formaldehyde and staining with DAPI (which bounds to the DNA). Microscopy slides were prepared on all stations at 6 different depths. Slides were frozen (-20°C) until counting on a microscope.

Bacterial preparations were also obtained in some stations using glutaraldehyde instead of formaldehyde as the fixative. These slides were frozen at -20 ºC until counting.

8. Ciliates

Samples for ciliates abundance and diversity were collected and preserved using a Lugol acid solution. These samples will be analyzed off the ship.

9. FISH: eukaryotes

The Fluorescent In Situ Hybridization is a powerful technique to study specific groups of microorganisms. Samples for FISH were collected on all stations at 6 different depths. Samples were stored at -80 ºC until analysis off the ship.

10. CARD – FISH: bacteria and archaea

Samples for the abundance and distribution of specific groups of prokaryotic microbes were collected in all stations at 6 different depths. These samples have been frozen at -20 ºC until its analysis with different oligonucleotide probes off the ship.

11. MarFISH: bacteria and archaea

Incubations with 3H-labeled leucine and C14-labeled bicarbonate were carried out to detect active prokaryotes in the uptake of these substrates at all sampled stations at a minimum of two depths (surface and base of the nitrocline). Leucine incubations lasted for 8 hours and bicarbonate incubations lasted for 24h always in the dark. After fixation of the samples, they were filtered and the filters were stored at –80 to be analyzed off the ship. In combination with the FISH technique this can give information on the phylogenetic identity of these active microorganisms.

Beside the MarFISH incubations, samples were incubated with C14-labeled bicarbonate (at a lower concentration) to measure bulk bicarbonate uptake by bacteria and archaea in the dark. These samples were incubated for 24 hours and subsequently filtered. The filters were exposed to HCl fumes overnight, and embedded in cocktail for the scintillation counter measurement.

12. Bacterivory – FLBs grazing

In order to acquire values of ingestion rates of bacteria by heterotrophic eukaryotes, Fluorescent Labelled Bacteria (FLB) obtained from a culture of *Brevundimonas diminuta* were used on bacterial grazing experiments. Three replicates and a 0.2 µm seawater filtered control with 10^5 cells/ml added were used. Samples for flagellates and bacterial microscopy observation and for bacterial production were collected at the beginning and after 48 hours of incubation at seawater temperature (cold-room). This experiment was conducted twice during the leg.

13. Alguivory – Micromonas grazing

Two grazing experiments with the *Micromonas* strain RCC497 were performed in order to calculate an ingestion rate of *Micromonas* cells by heterotrophic flagellates. For each experiment, two replicates of 2000 ml seawater filtered by 200 µm were incubated during 96 hours, at surface seawater temperature (-1.4 ºC). A control of 0.2 µm filtered seawater was run in the same conditions at the same time. Samples for FISH (to observe *Micromonas* ingestion) and flow cytometry (to observe *Micromonas* disappearance) were taken.

14. Bacterial production

Bacterial production rates were measured at six depths for each station using the leucine incorporation method (^{3}H labelled leucine) with 4 hours of incubation in coolers filled with ice-cold seawater in the radioactive lab. Samples were taken at every station at six depths, and also from surface waters below the ice. Rates of incorporation of radio labelled leucine were measured using the scintillation counter onboard.

17. Respiration

Bacterial/community respiration rates were measured using the FIBOX, which measures O_2 depletion in time using sensors glued to the bottom of 500ml Erlenmeyers. The consumption of O2 in time can

be converted in CO2 production to compare carbon respiration rate to bacterial carbon production rates. Each experiment lasted for about 15 days and oxygen measurements were made every 1-2 days. The Erlenmeyer were kept in the dark inside a cooler in a cold room. We intensified the number of experiment during leg 7, started measurements in melted ice and were running respiration measurements at full capacity (36 erlenmeyers simultaneously). We were able to measure respiration rates in melted sea ice and during the regrowth experiment.

18. ETS

Due to the low respiration rates in Arctic waters, a back-up method was also employed to obtain respiration rate surrogates via ETS (Electron transport system activity). This is achieved by filtering a large quantity (8L-10L) of water on GF/F filters to collect live cells and freeze them (-80°C) as quick as possible. Once off the ship, filters will be defrozen and the living cells will be subject to various enzymatic tests to measure activity.

19. N2O in the upper water column

N_2O Dissolved N2O measurements were carried out using the headspace equilibration method with 1.1 L of seawater. 3 samples were taken from 3 depths and will be analyzed off the ship for N2O on an electron capture detector (GC).

20. Carbon lability and consumption

To measure these variables we carried out two regrowth experiments. One of them will be passed to the leg 8 team. These experiment work on the principle of re-inoculation of a natural bacterial community (ice-water interface) in filter sterilized (0,2um) water or melted ice samples. To make sure that bacteria would only be limited by C, we added NaNO3 and NaPO4 to insure a minimal growth medium. Each 48h, we took samples for DOC analyses in Montreal, and each 4 day samples for flow cytometry to determine bacterial abundance. We hope that the DOC sample will gives more information on the lability of the carbon contained in the ice. Bacterial production was measured at the beginning and end of the experiments. These incubation were joined to respiration measurements using the same samples to see if DOC could sustain bacterial processes over a period of time (15-20 days).

Other activities

The team participated in all social activities of the ship. Lisa gave a few interviews to media members. Dan wrote a dispatch to be published on the CFL webpage. We helped other teams on the digging of holes in the ice and ice core sampling. We also provided 0.7 µm filtered seawater for the zooplancton team.

Note:

Lisa Delaney had to leave for the last week of the leg to help schools on board actually getting on board. We were still able to complete normal sampling activities without major compromises.

Acknowledgements

We would like to thank our Chief Scientists (Tim Paparyakou and Dave Barber), Captain Louise Marchand and crew of the Amundsen for the excellent work done during leg 7. Thanks to CJ Mundy, Benoit Philippe, Chantal Lacoste, Maike Kramer, Tom Brown and Rodd Laing for there help collecting the ice cores on those cold arctic days and to Yves Gratton for his help and advice on the rosette.

Annex 1. Station localizations

Cast #	Drift Station	Date Start	Time Start (UTC)	Latitude (north)	Longitude (west)
007	2008-D29	17.03.2008	13:00	70º 54.478'	123º 28.62'
ICE-01	2008-D33	25.03.2008	14:00	71° 03,9	121° 47,2
034	2008-D33	26.03.2008	13:00	71º03.84’	121º47.20’
ICE-02	2008-D33	31.03.2008	14:30	71° 03,9	121° 47,2
072	2008-D35	2.04.2008	15:00	71°04.010’	121°56.321’
080	2008-D36	6.04.2008	12:30	71º11,37’	124º 05,20
ICE-03	2008-D36	9.04.2008	16:00	71 18,5	124 34,3
100	2008-D38	12.04.2008	13:00	71°14,7’	124°36,7’
106	2008-D41	16.04.2008	13:00	70º 47.4’	122º 20.4’
ICE-04	2008-D41	19.04.2008	15:00	70°35.9’	121°51.0
125	2008-D41	21.04.2008	14:30	70º42.118	121º43,242’

Annex 2. Sampling details during leg 6. Numbers indicate depths/snow covers sampled. (DNA/RNA/HPLC/Chla in next table)

Station information	**Date**	17/03/08	25/03/08	26/03/08	31/03/08	6/04/08	9/04/08	12/04/08	16/04/08	19/04/08	21/04/08
	Drift station	2008-29D	2007-33D	2008-33D	2008-33D	2008-36D	2008-36D	2008-38D	2008-41D	2008-41D	2008-41D
	Cast number	007	ICE-01	34	ICE-2	80	ICE-03	100	106	ICE-4	125
Protocols	**Bacterial production**	6	2	5	2	6	1	6	6	2	6
	ETS	2		2	-	2	-	2	2	-	2
	Respiration	3	2	3	2	2	2	3	2	2	-
	N2O	3	-	3	-	3	-	3	3		3
	Bacteria and Archaea abundance	6	2	5	2	6	1	6	6	2	6
	Virus (abundance)	6	-	5	-	6	-	6	6	-	6
	Organic matter and Total phosphorus	-	-	-	-	3	-	-	-	-	-
	Ciliates		-	6	-	-	-	6	1		
	CARD-FISH (bacteria)	6	1	6	-	6	1	6	1		6
	FISH (eukaryotes)	6	1	6	-	6	1	6	1		6
	MAR FISH	-	-	3	-		-	3	-		
	Bacterivory	-	-	1	-	-	-	1	-		
	Alguivory	-	-	-	-	1	-	-	1		
	Virus diversity			1				1			
	Regrowth Experiment				2					2	

Annex 3: DNA/RNA/HPLC/Chla metadata

Station	Date	Time (UTC)	Cast	Latitude	Longitude	Depths (m)	Protocols
D29 rosette	17-mars-08	13h10	7	123°28.620W	74°54.478N	10	DNA/RNA/nutr
						50	DNA/RNA/nutr
						75	DNA/RNA/nutr
						390	DNA/RNA/nutr
						10	chla/HPLC
						50	chla/HPLC
D29 ice	19-mars-08	17h00	-	123°28.620W	74°54.478N	3	DNA/RNA/nutr
						3	chla/HPLC
D33 rosette	26-mars-08	13h06	34	121°47.200W	71°03.848N	10	DNA/RNA
						30	DNA/RNA
						60	DNA/RNA
						179	DNA/RNA
						10	chla/HPLC
						30	chla/HPLC
						60	chla/HPLC
						160	chla/HPLC
						179	chla/HPLC
D33 ice	25-mars-08	13h00	-	121°47.200W	71°03.848N	2	DNA/RNA
						2	chla/HPLC
D35 rosette	2-avr.-08	19h21	72	121°56.321W	71°04.010N	10	DNA/RNA
						50	DNA/RNA
						75	DNA/RNA
						203	DNA/RNA

Station	Date	Time (UTC)	Cast	Latitude	Longitude	Depths (m)	Protocols
						10	chla/HPLC
						50	chla/HPLC
						75	chla/HPLC
						203	chla/HPLC
D36 rosette	9-avr.-08	17h00	93	124°34.225W	71°16.434N	10	DNA/RNA
						50	DNA/RNA
						75	DNA/RNA
						235	DNA/RNA
						10	chla/HPLC
						50	chla/HPLC
						75	chla/HPLC
						200	chla/HPLC
						235	chla/HPLC
D36 ice	8-avr.-08	20h15	-	121°31.157W	71°17.664N	3	DNA/RNA/nutr
						3	chla/HPLC
D41 rosette	16-avr.-08	13h40	106	122°2.459W	70°47.371N	10	DNA/RNA/nutr
						50	DNA/RNA/nutr
						75	DNA/RNA/nutr
						120	DNA/RNA/nutr
						494	chla/HPLC
						50	chla/HPLC
						75	chla/HPLC
						120	chla/HPLC
						494	chla/HPLC

2.7. Team 8

PI: Gary Stern (DFO, Freshwater Institute)
Participants: Debbie Armstrong (University of Manitoba), Alexis Burt (MSc student, University of Manitoba), Alex Hare (PhD student, University of Manitoba), Monika Pucko (PhD student, University of Manitoba), Sandy Steffen (Environment Canada, Toronto), Crispin Halsall (Lancaster University, UK), Sabino del Vento (Lancaster University, UK)

General objective
This question this project hopes to answer is how climate variability in physical forcing and the biogeochemical response to this primary forcing will affect organic contaminants and mercury (Hg)/methyl mercury (MeHg) contaminant cycling. Ultimately, we propose to relate changes in delivery and biogeochemical cycling of these contaminants to their levels in fish, marine mammals and the people who consume these tissues as part of their traditional diets.

An additional sampling campaign was undertaken during CFL 2007-2008. The program is designed to obtain a detailed picture of PFOA (perfluorooctanoic acid) and PFOS (perfluorooctane sulfonic acid) concentrations in near shore and open ocean sites in the Canadian arctic.

2.7.1. Organic contaminants

Hexachlorocyclohexane (HCH) (Pucko)

Technical HCH is a mixture of several isomers, the most abundant being □-HCH (60-70%), □-HCH (5-12%) and □-HCH (10-15%). Technical HCH and pure □-HCH (lindane, pesticide active isomer) have been used for over 50 years and are now ubiquitous in water throughout the northern hemisphere with the highest levels found in the surface water layers near pack ice in the Arctic Ocean.

Technical HCH was banned or heavily restricted by China, the former Soviet Union and India between the mid-1980s and 1990. Concentrations of □-HCH in arctic air responded quickly to these large-scale usage changes and declined by an order of magnitude from the early 1980s to mid-1990s in steps that closely matched global usage and emission estimates. As a consequence, the direction of net gas exchange in arctic waters reversed from deposition in the 1980s to air-water equilibrium or volatilization in the mid-1990s.

The □-isomer is the prominent in Arctic air, water, biota and soil, and moves northward via cold-condensation, a process whereby the contaminant evades into the atmosphere, drifts with atmospheric currents, and condenses in colder climates where at colder temperatures increasingly favours the water and extensive ice cover inhibit further evasion. Hence the contaminant accumulates disproportionately in the Arctic.

HCH water sampling
Water (4L) was collected from the rosette every 4-6 days. Where feasible, transects across water bodies were collected. In the lab, water was pumped through a glass-fiber filter followed by an ENV+ solid-phase extraction (SPE) cartridge using peristaltic pumps. Filters and cartridges are frozen and brought back the Freshwater Institute for analysis. $^{18}\delta O$ were also collected at each site and depth where HCH samples were taken.

Table I List of water samples collected during leg 7

Date	Station	Depth (m)
17-Mar-08	D29	10

		25 50 100 150 200 300 350 391 (bottom)
23-Mar-08	D33	10 25 50 100 160 bottom (188)
01-Apr-08	D33	10 25 50 100 150 bottom (180)
07-Apr-08	D36	10 25 50 100 150 200 250
13-Apr-08	D38	10 25 50 100 150 200 bottom (263)
15-Apr-08	D40	10 25 50 100 150 200 250 300 350 400 bottom (460) surface water 5
20-Apr-08	D41	10 25

	50
	100
	150
	200
	250
	300
	350
	400
	450
	bottom (500)

HCH air sampling

The air sampler was set up on the bow of the ship on the starboard side along with each ice sampling. Samples are collected on a glass fiber filter and polyurethane foam (PUF) for analysis of organic contaminants. Air samples collection time ranged between 4 and 10 hours. Filters and PUFs were frozen at -20°C and shipped frozen back to the FWI for HCH contaminant analysis.

Table II List of air samples collected during leg 7

Date	Station
17-Mar-08	D29
19-Mar-08	D31
24/25-Mar-08	D34
25-Mar-08	D33
29-Mar-08	D33
01-Apr-08	D33
02-Apr-08	D35
04-Apr-08	D33a
07-Apr-08	D36
08-Apr-08	D36
10-Apr-08	D38
12-Apr-08	D38
15-Apr-08	D40
19-Apr-08	D41

HCH ice sampling

Ice samples for HCHs concentration and enantiomeric composition were collected. The samples for oxygen isotope composition ($\delta^{18}O$) and salinity were taken along with all ice samples. The ice samples were collected in collaboration with team 2 and the ice microstructure and physical analysis was made on all of them (see team 2 cruise report). Ice cores were cut according to ice microstructure into 15-40cm layers or the whole core was taken, melted (4-8L of water) and pumped through a glass-fiber filter followed by an ENV+ solid-phase extraction (SPE) cartridge using peristaltic pumps. Surface water (4L) and 5m water were sampled along with almost every ice sampling using a Niskin bottle. The cartridges and GFFs were stored in -80 □C and brought to the DFO (Winnipeg) for further chemical analysis.

Table III Ice samples and surface water samples collected during leg 7

Date	Station	Sample	HCH sample ID
16-Mar-08	D29	surface water	surface water
		frazil + transitional (0-20cm)	ice 1
		columnar (20-50cm)	ice 2
		columnar (50-80cm)	ice 3
		columnar + 5 cm of frazil intrusion (80-105cm)	ice 4
		columnar (105-130cm)	ice 5

19-Mar-08	D31	surface water	surface water
		columnar (0-30cm)	ice
24-Mar-08	D34	surface water	surface water
		5m water	5
		columnar with some frazil intrusions on the top (0-44cm)	ice
25-Mar-08	D33	surface water	surface water
		5m water	5
		frazil + transitional (0-16cm)	ice 1
		columnar (16-40cm)	ice 2
		columnar (40-70cm)	ice 3
		columnar (70-100 cm)	ice 4
		columnar (100-138cm)	ice 5
		whole core	ice
28-Mar-08	Ice camp - former	surface water	surface water
		5m water	5
		frazil + columnar (0-50cm)	ice 1
		columnar (50-100cm)	ice 2
		columnar (100-150cm)	ice 3
		columnar (150-189cm)	ice 4
04-Apr-08	D33a	surface water	surface water
		5m water	5
		columnar (0-15cm)	ice 1
		columnar (15-30cm)	ice 2
		columnar (30-45cm)	ice 3
		columnar (45-64cm)	ice 4
07-Apr-08	D36a	surface water	surface water
		5m water	5m
		new ice	ice
08-Apr-08	D36b	surface water	surface water
		5m water	5m
		frazil (0-15cm)	ice 1
		columnar (15-30cm)	ice 2
		columnar (30-45cm)	ice 3
		columnar (45-60cm)	ice 4
		columnar (60-71cm)	ice 5
08-Apr-08	D36c	surface water	surface water
		5m water	5m
		small frazil (0-23cm)	ice 1
		big frazil (23-54cm)	ice 2
		transitional (54-84cm)	ice 3
		columnar (84-128cm)	ice 4
		columnar + frazil (128-164cm)	ice 5
10-Apr-08	D38a	~1m water	surface water
		new ice	ice

12-Apr-08	D38b	surface water	surface water
		5m water	5m
		frazil + coulmnar (0-15cm)	ice 1
		columnar + frazil (15-32.5cm)	ice 2
		columnar (32.5-65cm)	ice 3
		frazil + columnar with frazil intrusions (65-93.5cm)	ice 4
		columnar (93.5-121cm)	ice 5
20-Apr-08	D41	surface water	surface water
		5m water	5m
		to be determined	ice 1
		to be determined	ice 2
		to be determined	ice 3
		to be determined	ice 4
		to be determined	ice 5
		whole core	ice

HCH snow/frost flowers sampling

At some sites snow/frost flowers were sampled for HCH analysis. Air was always sampled along with the snow/frost flowers sampling. Where possible, snow was sampled in layers. Snow/frost flowers sampling for HCH analysis was mostly done in collaboration with team 2 snow pit sampling (snow density, salinity, temperature and grain characteristics were measured). Snow/frost flowers samples were taken with a metal pan into plastic bags. After melting, 8L of melt water was pumped through a glass-fiber filter followed by an ENV+ solid-phase extraction (SPE) cartridge using peristaltic pumps. The cartridges and GFFs were stored in -80 □C and brought to the DFO (Winnipeg) for further chemical analysis.

Table IV Snow/frost flowers samples collected during leg 7

Date	Station	Sample	HCH sample ID
17-Mar-08	D29	snow (0-5cm – whole)	snow
29-Mar-08	D33	snow 1 (0-5cm), 0-snow surface	snow 1
		snow 2 (5-10cm)	snow 2
		snow 3 (10-15cm)	snow 3
		snow 4 (15-20cm)	snow 4
01-Apr-08	D33	snow 1 (0-7cm), 0-snow surface	snow 1
		snow 2 (7-14(17)cm)	snow 2
04-Apr-08	D33a	frost flowers (old, mushy)	frost flowers
08-Apr-08	D36b	frost flowers (old, mushy)	frost flowers
10-Apr-08	D38a	frost flowers (fresh)	frost flowers
12-Apr-08	D38b	snow (0-5cm – whole)	snow
19-Apr-08	D41	snow 1 (0-10cm, 0-snow surface)	snow 1
	70cm	snow 2 (10-20cm)	snow 2
	snow	snow 3 (20-30cm)	snow 3
	pit	snow 4 (30-40cm)	snow 4
		snow 5 (40-50cm)	snow 5
		snow 6 (50-60cm)	snow 6

	snow 7 (60-70cm)	snow 7
D41 10cm snow pit	snow 1 (0-5cm, 0-snow surface) snow 2 (5-10cm)	snow 1 snow 2
D41 9cm snow pit	snow 1 (0-4.5cm, 0-snow surface) snow 2 (4.5-9cm)	snow 1 snow 2

Bacterial experiment
Bacterial cultures from 9 different depths in the water column cultured by Marcela Ewert (Jody Deming's team) during leg 5 were maintained throughout leg 7 and will be taken back to Winnipeg for HCH EF degradation experiments.

The role of the Arctic in the global cycling of Persistent Organic Pollutants – ARCPOP
(Halsall, del Vento)

Overview
The purpose of the Halsall group's work is to examine the transfer of persistent organic pollutants (POPs) between the key Arctic compartments of air, snow, sea-ice and seawater during the period following polar sunrise (leg 7) to early summer (leg 8). Organic contaminants of interest include the 'legacy' POPs, such as the organochorine pesticides and polychlorinated biphenyls, as well as 'emerging' contaminants such as the perfluorinated alkylated substances (PFAS) and select current-use pesticides. The transfer and fate of these chemicals in the Arctic marine environment is poorly understood and yet their 'cycling' between air-seawater is likely to be strongly controlled by seasonal fluctuations in sea-ice cover. In addition, the role of snow in transferring airborne contaminants to marine surfaces with subsequent uptake to the marine foodweb is also an area for investigation.

Sampling strategy
Integrated sampling was conducted whenever possible; combining air, snow and seawater sampling at various CFL stations during leg 7. Due to the diversity of target analytes, separate sampling equipment and strategies where adopted. These were roughly distributed between 'large volume' techniques for legacy POPs, and 'low volume' sampling methods/techniques for PFAS.

Air samples
Leg 7a (Halsall) involved laboratory set-up (Benthic Laboratory – 400 deck) and the deployment of a high-volume (Hi-Vol) air sampler at CFL station 30. Initial 48 h samples were taken for 'legacy' POPs, with the sampler deployed on the ice, approximately 50 m both downwind of the ship, followed by sampling upwind of the ship. The dark colouration of the filters for the first two samples, (downwind of the ship) indicates that these were probably compromised by the ship's exhaust.

Hi-Vol air samples were subsequently collected throughout leg 7b to establish POP air concentrations, with samples collected both on the ice, upwind of the ship and on the roof of the top bridge. In addition, air samples using a modified Hi-Vol sample train comprising of a PUF/XAD vapour trap were taken for PFAS.

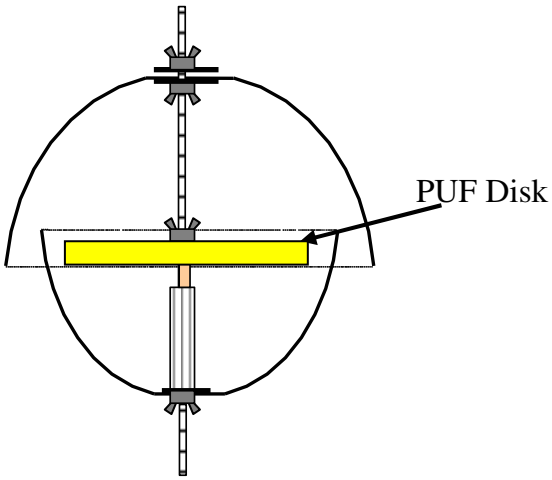
Figure 1. Hi-vol air sampler deployed on the ice at CFL station 31

Table V List of water samples collected during leg 7

ON	OFF	Station
25-Mar-08	27-Mar-08	D33
27-Mar-08	29-Mar-08	D33
29-Mar-08	01-Apr-08	D33
10-Apr-08	13-Apr-08	D38
13-Apr-08	15-Apr-08	D40
15-Apr-08	17-Apr-08	D41
19-Apr-08	20-Apr-08	D41
22-Apr-08	24-Apr-08	D42
23-Apr-08	24-Apr-08	D42

Passive air samplers (PUF-disk samplers) (2) were deployed at the stern of the ship, close to the aft labs, as well as within the benthic laboratory (1) to assess ship-based contamination, particularly for polychlorinated biphenyls (PCBs) and polybrominated diphenyl ethers (PBDEs - flame retardants). Elevated levels of these compounds are typical of many marine research vessels and deployment of PUF-disk samplers will serve as a useful quality control for the contaminant group as a whole.

PUF-disk samplers were also deployed (3) on the meteorological mast at the bow of the ship at different heights and these may reflect true contaminant levels in the Arctic marine boundary layer, and will be compared to the aft samplers. One sampler fell off the tower due to strong wind gusts presumably on 5th April. It was replaced on 18th when the meteorological mast was down for some maintenance. Two PUF-disk samplers were placed on the top of bridge in proximity of the Hi-vol position on 22nd April.



Schematic of PUF Disk passive sampler

Seawater samples

The onboard (teflon-lined) seawater line was used to collect large volume seawater samples for POPs. Seawater was sampled from the well-mixed surface layer (~7 m depth) and passed through an in-line filter and XAD-cartridge system, which operationally collects the respective particle-bound and dissolved fractions of POPs Problems were encountered with the seawater-line; notably rust-like deposits present in the water as well as erratic flow rates from the pump/tap. This resulted in clogged filters and low sample volumes. Nonetheless, seawater samples comprising of volumes of <500L were collected and will be analysed fro OC pesticides and PBDEs, although these samples may be compromised due to the rust deposits.

Figure 2. Onboard seawater sampling line in the Benthic lab

Low-volume samples (2-4L) were collected from beneath the sea-ice at CFL stations 29-32-33-38-40-41 for PFAS, these will related to the Hi-Vol air samples to examine the transfer and chemistry of this class of contaminants between the air and marine surfaces.

Snow & ice samples

Three 50L gas-tight snow sampling cans were deployed at CFL station 31 (leg 7a) and 33 (leg 7b) and used to collect sea-ice snow samples

Figure 3. Snow-can meltwater extraction

Figure 4. Snow-cans deployed on the ice

Contaminant concentrations in snow will be related to snow physical properties as well as concentrations observed in air and underlying seawater. Snow-cans were also used to collect and melt sea-ice cores to examine contaminant levels in ice. Low volume (2-4 L) snowmelt and ice-core samples (36-38-40-41) were also taken for PFAS.

2.7.2. Mercury

Rationale

Mercury (Hg) levels in marine mammals and fish are an ongoing concern in Arctic regions because of their inclusion in traditional subsistence diets among indigenous peoples in northern regions. Successful strategies to mitigate health impacts related to Hg in human diets require an understanding of both the social and cultural perspective of northern communities, as well as the natural environmental processes that lead to Hg in food resources. Our research on Hg in the Arctic is focused on determining the environmental processes responsible for the distribution and speciation of Hg in Arctic marine ecosystems, for the purpose of supporting the development of strategies to lessen the impact of Hg on human and ecosystem health.

Water Column Sampling

During Leg 7 of the CFL Study, the Team 8: Contaminants group collected samples from the marine water column in Amundsen Gulf from eight locations along its northwestern border with Banks Island (Table 1). Samples from the 10 m depth to the seafloor were collected with the ship-based Rosette sampling equipment in PVC 'Niskin-style' sample bottles remotely operated from onboard the ship. Supplementary 'Surface' samples from 0 to 10 m in depth were collected by a PVC Niskin water sampling bottle (General Oceanics, Miami, Florida) from a hole or open lead within a few hundred meters of the ship and within three hours of the Rosette collection (Table 1). Within each profile, 11 to 20 different depths were sampled (including Niskin sampling), producing high resolution profiles for 'total Hg' (Hg_T). At each depth sampled for Hg_T, water was also collected for $\delta^{18}O$ analysis in tightly sealed glass scintillation vials. After collection of $\delta\ ^{18}O$ samples, bottles were further sealed with parafilm and stored at 4°C.

Sample Analysis

After collection of marine water for Hg_T analysis, samples were spiked with ultra-pure 0.5% HCl (JT Baker, Phillipsburg NJ) and 0.5% BrCl and stored at 4°C. Hg_T samples were subsequently analyzed by cold vapour atomic fluorescence spectrophotometry (CVAFS) within 48 hours of collection in the

Portable In Situ Laboratory for Mercury Speciation (PILMS) onboard the CCGS Amundsen. Analysis followed the guidelines of the US EPA Method 1631.

Preliminary Results

Hg_T levels in the Amundsen Gulf measured during Leg 7 were very low, averaging roughly 1 pM (0.2 ng/L) throughout the water column. These values are comparable with the lowest concentrations of Hg_T observed in the global oceans (e.g., the Pacific and North Atlantic Oceans), and somewhat lower than those observed in coastal oceans and regional seas (e.g., the Baltic and the Celtic Seas, Hudson Bay).

Table 9. Sampling Location and Date for Marine Water HgT Measurements During CFL Leg 7

Station	Date	Latitude	Longitude	Bottom Depth (m)	Number of Sample Depths
D33	March 24	71° 3.848	-121° 47.227	188	11
D33	March 27	71° 3.846	-121° 47.202	188	17
D33	April 1	71° 3.885	-121° 47.224	188	17
D36	April 6	71° 13.885	-124° 12.989	303	6
D36	April 7	71° 16.428	-121° 23.05	274	21
D38	April 10	71° 15.024	-124° 36.715	278	16
D40	April 14	71° 16.428	-124° 23.045	467.8	22
D41	April 18	70° 37.06	-121° 54.782	485	23

Atmospheric Mercury

Speciation System on the Ship:

This instrument has been working well for the time I have been on the ship. The data is shown in Figure 1. Table 1 indicates days when data was collected. Table 2 indicates dates when atmospheric mercury depletion events were recorded.

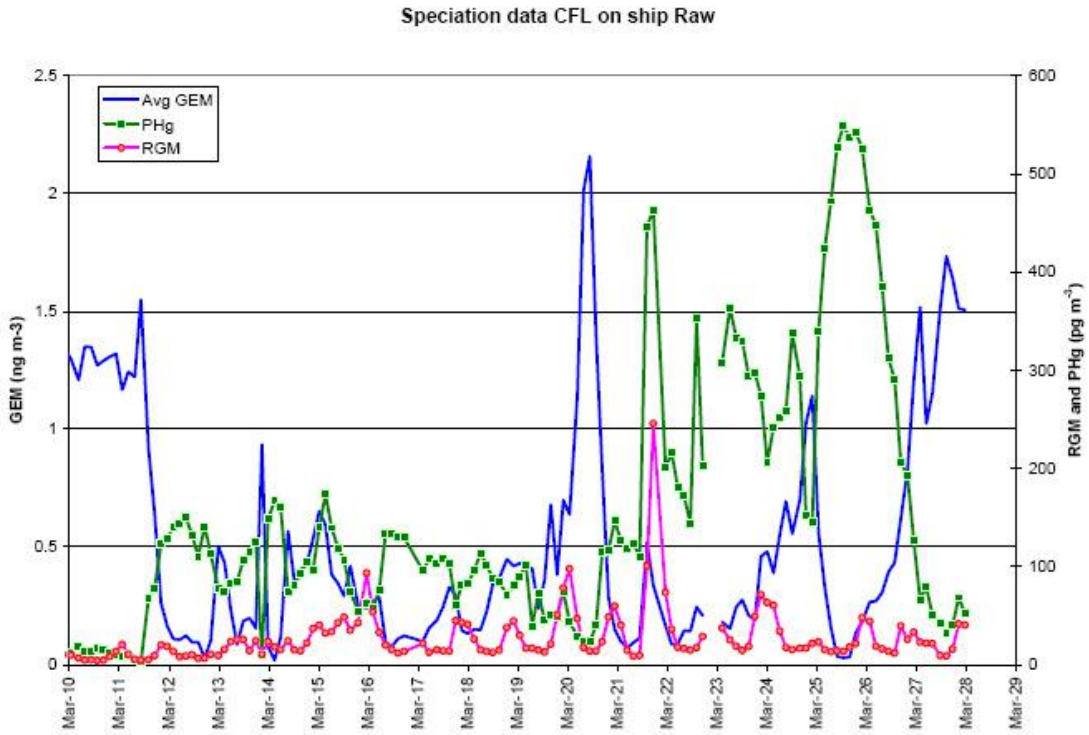
1. Glassware was changed on March 22 and April 16.
2. Injections were done on SN 323 on April 16 – nothing was changed they all looked reasonable.
3. I did not see that any standard additions were made on this instrument before I got here. Once a week I have been manually hooking up the SAU (standard addition unit) to the speciation system to run standard additions to check how well the cartridges and the instrument are working. For the most part they are ~130% recovery but that high recovery may be a reflection of the pressure from the setup when taking the sample. The SAUs have been consistent throughout my stay here so that is considered good. These weekly SAUs on the system should be kept up on the next leg in order to maintain track of the quality of the data set. Without these SAUs we lose ability to really QC the data well.
4. The flow of the speciation system is set to 9 lpm. When I arrived, the flow was about 8.6 and the pump was working hard. After a glassware change the pump worsened and so I took out some of the quartz wool from the RPF. Debbie and I adjusted the back pressure regulator so that a flow of 9 lpm was recorded. However, as time went on the flow went back to approximately 8.6. This is an issue for 2 reasons 1) the particle cutoff for the instrument (0.25□m) occurs with the impactor when the total flow is 10 lpm (9 from the pump and 1 from the Tekran 2537. If the flow is not 10 then we are getting differently sized particles than what we expect in the system; 2) the concentration is calculated from the instrument as if the flow was 10 lpm but if its not, then the concentration that is reported from the instrument is not correct. Over 2 hours with a total flow of 9.6 lpm we have a difference of 48 litres of air going through the system. This thus must be recorded in the daily log as to the average flow of the pump unit so that we can make a decision on how to deal with the data at a later date. Note: after glassware was changed on April 16 the flow went to ~9.2 lpm.

5. There seem to be denuders missing. Debbie and I can only account for 4 denuders in total between the 2 speciation system. Of those 4 denuders 1 is broken in Winnipeg and 1 is cracked at the threading at the top. Patrick is sending 2 more denuders with Fei but we must establish how many denuders were sent up, how many have been broken and to whom to the existing denuders belong. A retort stand would be useful in the lab for coating denuders. Jeff may wish to bring one up with him when he comes.
6. Time setting. I have been making sure that the speciation system and the pyrolysis system are on the same time (within about 15 seconds of each other). This time is set with Tim's data logger so that we can relate the time back to the met data from Tim and the ozone data from Ralf.
7. Naming of files. Patrick has named the files and referred to the 2537 for the speciation system as 85 which is the serial number of the pump unit. I started naming things according to its correct serial number on March 16.
8. This crew has been very respectful of the BR being on and when they run it, they tell us so that we can record it or if the BR needs to be running all day they have put it on the ice. Please make this arrangement with the new crew that comes in. It should not be on as much as the weather is getting warmer but they will still have it on and this WILL affect the PHg data!
9. Soda lime trap change: it is evident in the data when the soda lime trap must be changed. You will see it in the GEM data throughout the cycle. At the beginning of the cycle it will be low and then as the 2 hours continues it reaches normal ambient concentrations. When you see this pattern show up the soda lime trap needs to be changed.
10. Sending data to Sandy. I would like if you can send the data on a daily basis to me in Toronto. As I have mentioned we need to ramp up surface water and snow sampling when we see the switch from PHg to RGM predominance. I am willing to keep a close eye on the data if you will just e-mail me the raw data files - I will put it together and send if back to you. You will download the data on a daily basis anyway so if you can just e-mail it as well that would be great.

Pyrolysis or Total Atmospheric Mercury Measurements:
Initially this system was running on 2 instruments SN 170 (ambient – total gaseous mercury (TGM)) and SN 51 (heated/pyrolysed- total atmospheric mercury (TAM)) air. On March 27 SN 170 stopped functioning and was not repairable on the ship. This instrument was having similar problems on Leg 6 but managed to fix itself, but that was not the case on Leg 7. It was packed up and a switching box was installed on SN 51. The 2 inlets are installed into the switch box and the box uses a solenoid to switch from one inlet line to the other every 3 samples. This took a week to install and get functioning properly due to contamination problems in the sample lines and subsequently the instrument. The dates when data is collected with this system are shown in Table 1. The Flags for this data are as follows:
FLAG 0 – ambient air (TGM)
FLAG 2 – heated air (TAM)
FLAG 1 or 3 – standard addition
FLAG 5 or 7 – zero
Note:
a) when 2 flags fall on the same sample the system adds the numbers on the flags
b) because the switching valve is at the end of the sample lines, the air that is in the lines when not sampled is stagnant and thus the first sample after a switch is not valid

NOTE: when the power is shut off on SN51 the date resets itself to 2014. Please follow the directions on the post it note stuck to the instrument when this happens to reset the TIME/DATE and the NEXT autocal settings.

Figure 1: Speciation data for on-ship measurements



Speciation on the Ice:

Debbie and Sandy had a box constructed to house the 2537 and the 1130 pump unit, in order to operate this system on the ice. A stand was built to house the 1130/35 system on the ice so that the inlet is about 6 inches form the snow surface. The purpose of collecting this information is to try and understand whether the actual atmospheric chemistry for AMDEs occurs immediately at the snow surface or further up in the boundary layer. Further, it is desired to assess if the distribution of the species RGM and PHg differ at the lower level close to the ice than up higher from the ship. Organising this instrumentation took longer than anticipated and was only deployed on the ice for the first time on April 1st. The instrument setup is illustrated in Figures 2 and 3.

Figure 2: speciation system

Figure 3: pump and atomic fluorescence instrument

There were a few more issues to deal with in order to get the system running (freezing of lines, freezing of solenoid valves, power to the system and the lack of a controller unit etc). Data was collected manually (via hand controller) between April 1st and April 3rd when the controller arrived. We got 1 night of data with the controller unit and the system was operating well. On April 4th the ice broke up and the equipment was removed from the ice. Up to this time the system was operating on ship power via a power cord from the port bow of the ship. The system was redeployed to the ice on April 12 using a gas generator. The system was installed on the port bow side of the boat. The system ran using this set up from the 12th to the 13th of April and then was removed from the ice because of ice break up. The system was redeployed to the ice on the 16th of April and was left on the ice until the change of Leg 7. Preliminary data is shown below in Figure 4.

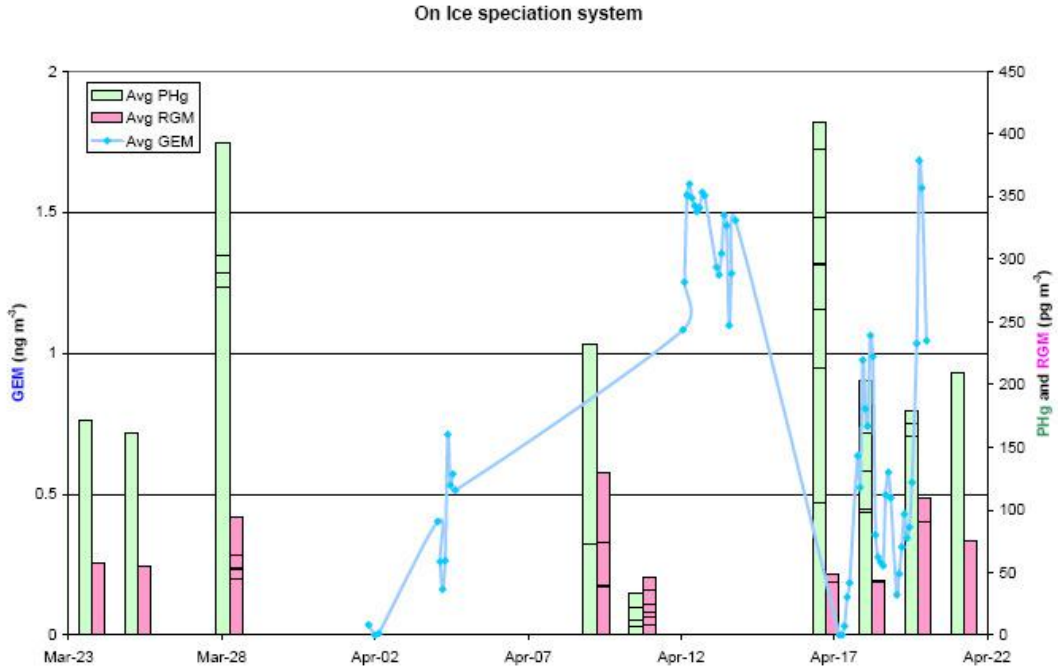


Figure 4: Speciation data for on-ice system

Ozone (TECO):
The ozone analyser (OASIS) will continue to be run throughout the Hg campaign. It is located in the OASIS shed by the bridge. This system will be checked daily along with the Max-DOAS measuring BrO from the person in charge of the Hg air program. Details for these checks have been left on the ship and will be in the handover notes.

Table 1: Dates of preliminarily valid data

Atmospheric species	Instrument	Dates collected
GEM	SN 323	March 14 to April 24
PHg	SN 323	March 14 to April 24
RGM	SN 323	March 14 to April 24
TGM (CRPU)	SN 51	
TAM (CRPU)	SN 170	March 14 to March 26
	SN 51	March 14 to March 26
	Switch box on SN51	April 13 to April 24
GEM (ice surface)	SN 71	April 1-4, 12-13, 16-24
RGM (ice surface)	SN 71	April 1-4, 12-13, 16-24
PHg (ice surface)	SN 71	April 1-4, 12-13, 16-24

Table 2: Dates of Atmospheric Mercury Depletion Events

Depletion No on Leg 7	Depletion Event Start	Depletion Event End
1	March 11	March 20
2	March 20	March 25
3	March 25	March 27
4	March 31	April 5
5	April 10	April 11
6	April 15	…

Dissolved Gaseous Mercury – DGM

A system has been developed to measure dissolved gaseous mercury (DGM) in surface waters collected from either a niskin or the sea water sample line which has been installed directly into the PILMS laboratory. The system uses a specially designed vessel in which mercury free air generated by a zero air generator is bubbled through the sample and then measured by a Tekran 2537B unit. The zero air is purged through the vessel for 50 minutes in order to recover a high portion of the DGM in the 1 liter of sample water.

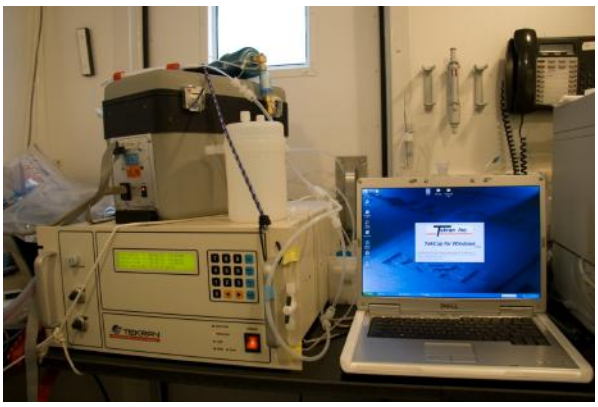


Table 1. Sampling Location and Date for DGM Measurements During CFL Leg 7

Sample ID	Date	Lat	Long	Wind Speed
BLANK	27/03/2008	71° 03.859	121°47.227	n/a
BLANK	27/03/2008	71° 03.859	121°47.227	n/a
SW23	27/03/2008	71° 03.859	121°47.227	7
Blank	31/03/2008	71° 03.859	121°47.227	n/a
SW24	01/04/2008	71° 03.859	121°47.227	12
SW25	01/04/2008	71°03.857	121°47.208	10
SW26	01/04/2008	71° 03.859	121°47.235	11
SW27	01/04/2008	71° 03.859	121°47.235	10
BLANK	01/04/2008	71° 03.859	121°47.235	N/A
BLANK	01/04/2008	71° 03.859	121°47.235	N/A
SW28	01/04/2008	71° 03.841	121°47.221	15
BLANK	02/04/2008	N/A	N/A	N/A
P blank	02/04/2008	N/A	N/A	N/A
SW29	02/04/2008	71o 154.76	124o 37.084	15
BLANK	02/04/2008	N/A	N/A	N/A
P blank	02/04/2008	N/A	N/A	N/A
blank	04/06/2008	N/A	N/A	N/A
SW30	04/06/2008	71° 12.263	124° 08.316	15
SW31	04/06/2008	71° 12.263	124° 08.316	17
BLANK	04/07/2008	N/A	N/A	N/A
SW32	04/07/2008	76° 16.973	124° 25.496	9
SW33	04/11/2008	71° 15.079	124° 36.666	6
SW34	04/11/2008	71° 15.079	124° 36.666	5
BLK	04/11/2008	N/A	N/A	N/A
SW35	15/4/2008	70° 51.789	122° 29.951	14
blk	15/4/2008	N/A	N/A	N/A
blk	17/4/2008	N/A	N/A	N/A
BLK	17/4/2008	N/A	N/A	N/A
SW36	18/4/2008	70o 37.069	121o 54.931	17
SW37	18/4/2008	70o 37.069	121o 54.931	17
SW38	18/4/2008	70o 37.069	121o 54.931	19
BLK	21/4/2008	N/A	N/A	N/A
SW39	21/4/2008	70o 40.76	121o 42.19	15
SW40	21/4/2008	70o 40.76	121o 42.19	15
SW41	21/4/2008	70o 38.706	121o 43.933	12

Mercury in Ice, Brine an d Snow

In order to study the cycling of Mercury in the Arctic environment, we need to understand how it moves through the barrier separating the atmosphere and ocean known as ice. Movement through ice is thought to be carried through the network of brine channels that are formed within the ice and the interaction of that brine with the water column with the onset of spring. Another important factor to

consider is the impact of snow or deposition as a source from the atmosphere to the snowpack, ice column and directly into the ocean.

On leg 7 we collected ice cores, snow samples and brine samples at varying depths in order to track the movement of mercury with these media. Samples of each were collected over varying time series at stations: D29B, D33 (thick) and D33 (thin), Land Fast Ice Camp Site, D36 (new ice, thin ice and thick ice), D38, D41 duplicate cores. All ice cores were cut according to ice microstructure and cut into duplicates. Each duplicate was scrapped with a freshly cleaned and tested ceramic blade. Both pieces were placed into separate zip lock bags and then stored in one larger bag to melt. When sampling, each individual zip lock bag was rinsed with MQ water over the area that would be cut and then sampled. A small amount was rinsed out and then the sample was collected. For example, a 5 cm piece of ice split would yield two 25 mL samples of water in the end.
The scrapping was very clean, and the gloves were changed between each section of the core to be scrapped. This is essential to good reproducible results.

Snow samples were collected on a daily basis but need to be run at a 10x dilution or they are too high. We sampled one 30 cm snow pit was sampled at every 5 cm at Station D33 and I encourage others to continue this for leg 8.

The Hg profiles in brine are very interesting and brine holes at the depths of 40 cm, 60 cm, 80 cm, and 100 cm were sampled as a time series event. The results are quite exciting and this work should continue as long as possible. As the temperatures increase with the season the amount of brine produced increases and the mercury levels vary consistently between depths. Salinity was measured on all brine samples in the airlock of PILMS (CEOS probe). Salinity of the holes even after being fully drained, remains the same, as do the mercury levels. Sampling frequency was once in the evening after the holes had been drilled then everyday thereafter. Brine samples have been diluted 5x before running on the tekran.

Methyl Mercury

The form of mercury that accumulates within the foodweb is the organic form of mercury known as methyl mercury. We are interested in determining the pathways in which mercury (Hg) becomes methylated and to study the levels in the abiotic and biotic environments. The instrument is not stable when the ship is moving and the system seems to give us varying results but we are determined to have a ship based program up and running soon. This is the first time this technology has been used on a ship of this size and in ice breaking conditions which seems to pose some vibration problems.

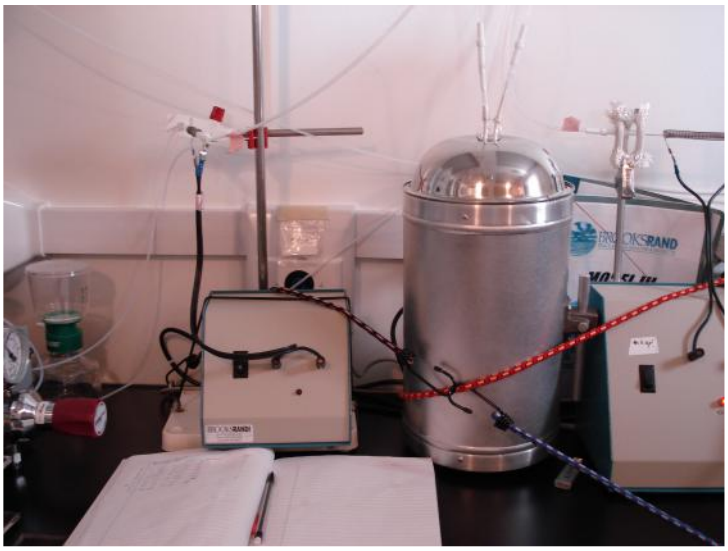


Figure 1: Trap and column to separate the organic mercury species

We found that the sensitivity of the instrument was quite low although our reagents were working well. It was also determined that the traps needed to be heated before use to avoid extra unknown peaks. It is essential that they be burned off the day before use. The lamp was changed in the detector and the gas pressure was set to 10 psi on the small regulator to ensure proper peak separation on the GC column. We have produced some results but it is not easy to maintain the sensitivity.

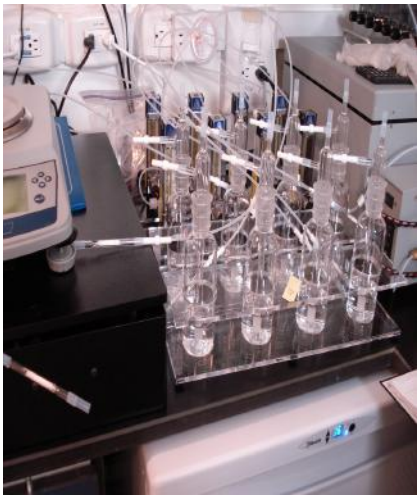


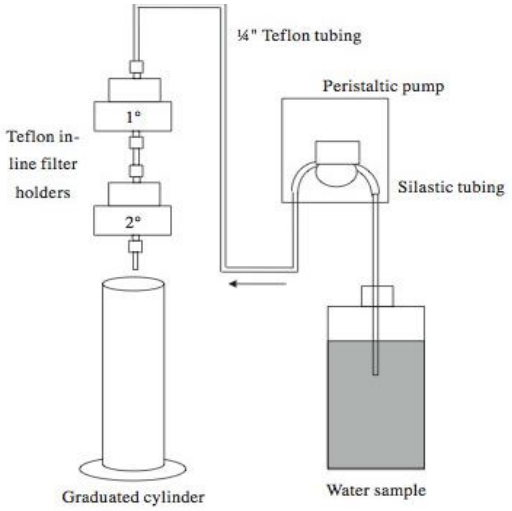
Figure 2: Purge and trap module to trap the organic species of mercury

2.7.3. Biotic sampling (HCH, Hg, MeHg, Stable Isotopes, Fatty Acids)

The main purpose of this study is to link physical and biological processes to mercury/HCH levels in the food web and to target the pelagic food web biomagnification and bioaccumulation of HCH and mercury with stable isotopes and fatty acids. Thus, all biological samples collected will be measured for HCHs, total mercury and MeHg along with stable isotopes to place organisms into their associated trophic levels.

Algae (HCH)
At stations D38 and D41 ice and under ice algae were sampled for HCH analysis. Samples were taken by divers from under the ice with a slurp gun (under ice algae community) and ice scraper (bottom ice algae community). Subsequently, they were filtered through the GFF filters, frozen and taken back to Winnipeg for further analysis.

Algae (Hg, MeHg)
Phytoplankton samples were taken in conjunction with zooplankton tows. Samples were sieved through 710µm, 350µm, 50µm and 20µm mesh and frozen. Samples were also preserved with lugol's for speciation.
Phytoplankton was collected at stations D36 (x7), D38 (x3), D40 (x3), D41 (x6).
Surface water phytoplankton was collected with a clean niskin bottle, from the ice-water interface with a battery powered pump on a metre long under ice arm, and collected with a slurp gun from the ice-water interface during the dive program. These samples were filtered onto pre-combusted and weighed glass fibre filters (GF/F) for chlorophyll a, dry mass, and filtered in series with a clean set up for mercury, with a blank (see figure). The filters were frozen, and will be shipped to Winnipeg for further analysis.



Filtration set up for algal Hg (exception: the peristaltic pump is between the filters and the waste container)

Surface water algae was collected at stations D29, D33 (x2), D36, D38 (x2), D41 (x2).
Ice algae was collected by coring, and also during the dive program via an ice scraping contraption. An ammount was preserved for speciation, while the buk was frozen for shipping.
Ice algae was collected at stations D29 (x2), D31, D34, D33, D38, D41 (x2).

Alex Hare and Alexis Burt coring

Zooplankton

Zooplankton samples were collected on a daily basis. Various zooplankton families were collected using the vertically towed Tucker net (mesh size 0.2 mm) from the moon pool, and vertical, horizontal, and oblique tows from the ice using a double tucker net (200µm mesh). To obtain the species specifically grazing under the ice (e.g. *Calanus glacialis* AF) vertical tows 0-60m were done from the ice with a 200µm Ring net. Zooplankton was sorted into families,, or to genus and species where possible, placed in plastic vials and Whirlpak bags and frozen until they can be analyzed for HCH, THg, MeHg, stable isotopes and fatty acids. Common species found were *Calanus hyperboreus*, *Calanus glacialis,* Paraeuchaeta *glacialis*, *Sagitta elegans, Sagitta maxima*, *Themisto abyssorum*, *Themisto libellula, Metridia longa, Ostracoda* sp., Cnidarians, Ctenophores, and Polychaetes. Some less common species found were *Cleone limacina*, *Gaidius* sp., *Hyperoche* sp., Euphasiids, *Pandalus* sp., and one *Liparis* sp. (a bottom feeding fish). Zooplankton was collected at stations D29 (x 3), D33 (x12), D36 (x 3), D38 (x2), D40, D41 (x4) for a total of 24 zooplankton hauls.

Double Tucker Net (horizontal and oblique tows on the ice)

Special thanks to Gerald Darnis, Luc Michaud, and Catherine Lalande for their patience and expertise on all things related to zooplankton.
Thanks to Tim Papakyriakou for the use of equipment in the field, and always caring how the day is going.
Thanks to Alex for encouragement and tips.
Thanks to the crew for always being there. 24-7.

Leg 8

25 April – 5 June 2008

edited and compiled by Michel Gosselin, Jean-Éric Tremblay and David Barber
(Chief Scientists)

1. General overview

1.1. Introduction

Leg 8 of the CFL project was succefully completed on June 5. The science plan allowed for several drift stations in Amundsen, a transit north to McClure Strait and sampling across the flaw lead just west of Banks Island. The ship also visited the multiyear pack ice at the north end of our sampling area. Towards the end of the period we established a late season fast ice site in Darnley Bay. The chief scientist duties were shared by Michel Gosselin (8A), Jean-Eric Tremblay (first 2 weeks of 8B) and David Barber (last week of 7B). A summary of these three periods are as follows:

Leg 8A (Michel Gosselin)
On 24 April, the charter flight left Quebec City on time at 2:00 AM and landed in Winnipeg to get other science personnel. The plane arrived in Inuvik at 10:00 AM. The exchange of personnel went smoothly, all the science and Coast Guard personnel was on board the ship at 7:30 PM. A landing strip was made on the pack ice close to the ship. The ship was located at the drifting station D43 on the eastern side of the 1000 transect line of Amundsen Gulf.

On 25 April, the science personnel located their materials and equipment and organized their laboratories, assisted to the ship familiarization and participated to 2 science meetings. During Leg 8A, science meetings occurred every night at 7:00 or 8:00 PM. There were 5 steering committee meetings during this leg to discuss the expedition plan and the sampling strategy.

The sampling started on 26 April at Sta D43. From 24 April to 5 May, the ship drifted 100 n.m. westward along the 1000 transect line. Before leaving this station, a beacon was left at this station, in case of further need of the landing strip. On 6 May, we sampled an open water station (1020A) west of Sta D43. On 7 May, we transited to Cape Parry and encounted heavy ice conditions along our route. At 7:30 PM, the ship was parked in the landfast ice of Cape Parry (water depth: 55 m). On 8 May, a Twin Otter landed at Cape Parry for the exchange of the 2 media persons and to conduct the aerial beluga survey on the west coast of Banks Island. The landfast ice station of Cape Parry (Sta F1) was sampled on 8 and 9 May.

On 10 May, we left Cape Parry for Franklin Bay. We sampled at two open water stations along the ice edge (Stas O1 and O2) during our voyage to the overwintering site of CASES in Franklin Bay. From 12 to 15 May, we worked at the landfast ice of Sta F2. This station was close to Sta 1116, the overwintering site of CASES. The ice edge was located around 2.5 n.m. north of Sta. F2. A landing strip was made on the landfast ice in preparation for the mid-leg crew change.

Leg 8b (Jean-Éric Tremblay)

Fifteen people (including JET, 12 scientists and 2 artists) arrived onboard in early afternoon after uneventful flights. The flight plan was modified slightly because there was no fuel left in Paulatuk and the weather (freezing rain) did not allow the beluga survey to proceed. Ten scientists and 2 media disembarked and flew back to Innuvik. Sampling activities continued on the 3-day cycle. In the evening of the 15th the wire of the scamp caught into the port side of the moonpool opening, presumably in a dent that we can't see. The instrument was recovered only in the morning with a long gaffe. Some of the wire was lost, but there was no damage to the instrument. During the time the ship was operating in Franklin Bay, easterly and north-easterly winds pushed drifting ice floes against the fast ice, creating a pressure ridge along the whole longitudinal swath of the bay. For a while it looked like the ship was going to be trapped, but an ice patrol on Saturday 17 May confirmed that we could leave the bay via the eastern side. The beluga survey proceeded in the afternoon; the plane arrived at around 14h00, took off at 16h30 and came back at ca. 22h00.

We continued on the regular sampling cycle (same as drift mode) until Sunday morning at 9h30, at which time the ship broke off and sailed into the open waters of the Gulf of Amundsen. An e-mail was sent to Joane Eldridge to inform the HTC of our plans for the next few days. On 19 May, we began a full station 2 miles off the mooring site (CA18-07, or 405) which we called 405b. There was some concern expressed by the captain that Rosette operations were sometimes difficult because the rosette wire cannot always be seen beneath the cable guide in productive waters. This led to an e-mail exchange between Steve, Luc and I. The decision was made to continue rosette operations in the moonpool since many ice stations were planned for the future. Work proceeded swiftly and we left 405b on schedule, sailing north to go into the entrance to Prince-of-Whales Strait. The ship stopped in the ice at around 06h00. The station (F-3) was in the middle of the strait, at the southern margin of the fast ice. We opened the moonpool, which was clear of ice but unfortunately the ship moved a little and it filled up with ice. With the other operations being underway (ice raids), it took nearly 4 hours before the moonpool could be emptied with the cage and so the station finished at 02h00 with moonpool operations (the physics team sampled over one spring tidal cycle - 13 h). Meanwhile white-out conditions prevented the helicopter from retrieving the fuel drums and all the flights planned for John Iacozza and Randy Scharien were cancelled. Later in the evening a successful snowmobile expedition led by René (with 3 crew members and Roger) recovered the drums.

The ship left the station soon after 02h00 on 20 May and sailed for the edge of the drifting ice in the Gulf of Amundsen. We stopped at a location (70°43.76′N; 123°59.92′W) mid-way between stations 1010 and 1012 along the 1000 line, where a 1.7 mile wide ice floe had been spotted on the latest Radarsat image. We called this station 1011. The station was picked to contrast the conditions sampled in the open Gulf two days earlier (405b) with the situation in the retreating pack of drifting ice floes. The ice raid begun at 14h30 on 20 May and open water operations followed until 00h30. We spent the night in an ice flow and finished operations in the morning.

On 21 May we sailed to the northwest, crossing the pack of drifting ice floes to reach the open waters of the flaw lead west of Banks Island. A message was sent to Joane Eldridge to that effect. It took three helicopter patrols during the day to guide the ship across the floes. Nathalie Asselin came on all flights to record beluga sighthings (one large pod and several individuals were sighted, which proved very useful for her work). We reached the open water in the evening of May 21st and parked in a floe for the night. In the morning of the 22nd we positioned the ship at station 1806 and began a full station there. During that time the barge was tested as it was our intended means of deployment for sampling in the land-fast ice near the coast. The visibility was very poor (fog) and the EM flight planned for John Iacozza over the fast ice was postponed. Operations finished at 20h00. The ship moved closer to the coast into 30-m deep water on a perpendicular approach. We anchored there for the night, hoping that the weather would be good enough to do the helicopter flights. In the morning of the 24th we brought the ship in at the ice margin and deployed the ice raid. The weather was nice and the helicopter flew to Sachs with George Gartrell and David Scott after the completion of the EM survey. The helicopter came back with Anne Debroise. We organized an outing for the crew and scientists so that they could see the rafted multi-year ice while the ice teams finished their work. We left this site at

19h00 and sailed west toward the pack ice while completing a CTD transect (line 6000) west of station 1806.

In the morning of the 25th we began operations on multi-year ice (station M1). John did an EM survey and Nathalie deployed a beacon on the ice while conducting a short beluga survey. While some people worked on the ice the ship moved slightly off in open waters to conduct open water sampling. When we retrieved the ice raid another beacon was put on the floe where people had worked. During the night we transited to the western end of the northern transect. We approached a multi-year ice floe in the morning of 26 May, dropped the ice raid (station M2) and moved off for open water operations at station 8010. The station was finished at dinner time and we proceeded along the CTD transect (line 9000) until midnight. Full station 9008 was completed on 27 May, after which we finished the CTD transect at station 9002 and deployed a box core (9001) slightly to the southeast.

The ship entered the ice bridge in McClure Strait at midnight on 27 May and we spent the night at the edge prior to sampling the first-year ice on 28 May (station F5). The third ice beacon was deployed on this piece of ice. I sent an e-mail to Joanne Eldridge (Sachs HTC) to inform her of our plans to be in Sachs on Thursday. We left this site at noon, conducted a rosette cast and zooplankton nets, and began our transect south toward Sachs Harbour. I then realized the e-mail sent to Joanne Eldridge had bounced back so I tried with another address and got through this time. Eight CTD stations were planned along the way, but the rosette failed just before commencing the CTD cast at station 1815. Steeve attempted to fix the problem during the next 2.5 hours. The problem was initially with the carousel, which was swapped with that of the other rosette. It looked like it was working and then the multi-conductor cable failed (no power to the CTD). The cable needed to be re-spliced and it would not have been possible to sample again until we had to be in Sachs. In the morning of 29 May, Steeve confirmed that the repair was successful and that the rosette would be available the next day after the spice had dried. The rest of the line was cancelled and we sailed south.

The ship arrived in the vicinity of Sachs at 11h30 on 29 May. In early afternoon I found an e-mail from Joanne Eldridge informing us that HTC members wanted the ship to move or cancel the beluga survey and crew change because the “main bunch was arriving today”. Roger’s interpretation of the message is that the “birds are scheduled to arrive today”. Assuming that such a sixth sense exists in the community, it is puzzling that the HTC did not reply to my update of Thursday before seeing the ship. I sent an e-mail offering to move the ship a few miles in their preferred direction, and to modify the flight path of the helicopter according to their wishes, but I go no reply.

Leg 8B (David Barber)
Barber arrived on the ship on May 29 with the idea of establishing a late season fast ice camp. The exchange was don in Sachs Harbour via the Beluga survey twin otter aircraft. Two journalists also came onboard (Olivier and Tatiana). We had some communications from the community that they did now want the ship to stay around too long as the White geese were returning and we night affect their hunting. We departed that evening for station D44

May 30 was conducted at a draft station along the SW coast of Banks Island (D44). We operated a full suite of moonpool and on ice sampling. May 31 we moved further into Amundsen Gulf to another drift station (D45). Again a full suite of moon pool and on ice activities were completed (see log in the appendex or the master list (ship’s log).

On June 1 we completed the mooring station (405) in the middle of AMundsen Gulf. This station had a combination of moon pool sampling, foredeck sampling and on ice sampling. We then made our way to the Darnley Bay fast ice to begin a fast ice camp operation. We entered into the ice on the evening of June 1 and began sampling on June 2. We had a complete range of ice and moonpool sampling for both June 2 and 3.
We then moved the ship on the evening of June 3 towards the crew change location at Cape Parry. We spent the June 4 day their preparing for the crew change and then June 5 was the major crew change day. Barber remains onboard as Chief Scientist for the first part of leg 9A.

1.2. Cruise maps and station identifiers

JET, Michel and Veronique Lago acted as a 'keepers of station ID's on this leg. He produced a map showing the drift stations identifiers and has in his records a more complete description of the lats and longs of each drift station. Note that box coring may not be co-located exactly with other sampling as quite often we had to move the ship to do a box core; we did however keep the same station identifier.

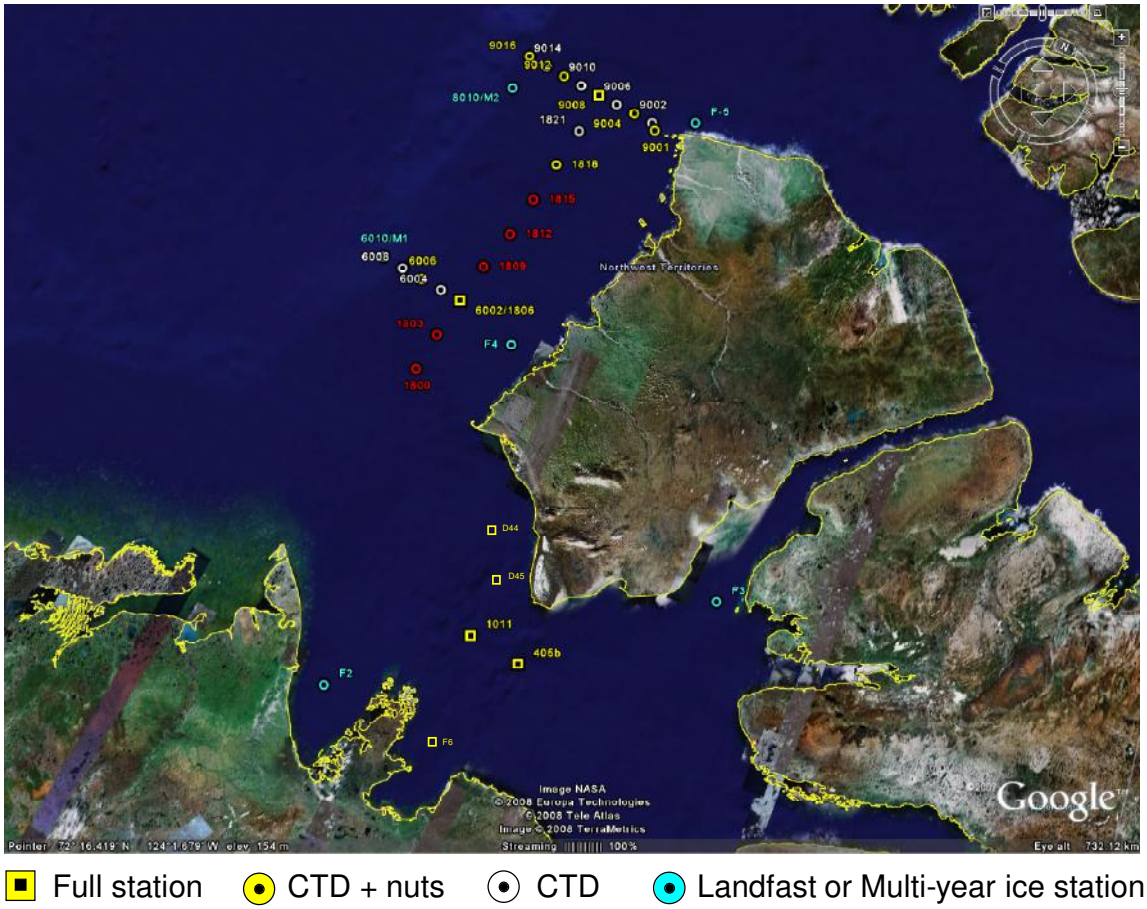


Figure 1. Drift stations completed during leg 8. Individual maps of these stations and their ID's are located in the Appendix of this report. Refer to the bridge log (appendix of this report) for specifics of locations, drift rates and timing of all events from these stations.

1.3. Cruise schedule

Science operations on this leg consisted of on ice sampling, sampling through the moonpool and sensors which collected data while underway. The ships log should be consulted for specifics of what sampling occurred when, where and at what time. Note also that we were in the drift mode of the CFL project at this time so position locations at the beginning of a station stop are not necessarily and same as those in the middle or end of that same station.

1.4. Ship Log of Science Activities

Date	Hre	Latitude		Longitude		Prof (M)	Vent	T° Air ©	T° Eau (C)		Hum (%)
							Dir	Vit			
26/Apr/2008	7h00	70*35,241	°N	122*26,138	° W	197	surface water off ice	550	310	4	-16.7
26/Apr/2008	7h20	70*35,240	°N	122*26,133	° W	196.9	Rosette in - **cast 1**	550	310	4	-16.4
26/Apr/2008	7h35	70*35,279	°N	122*26,129	° W	196.6	surface water off ice	550	320	4	-16.1
26/Apr/2008	8h01	70*35,240	°N	122*26,125	° W	196.8	Rosette out	550	320	4	-15.7
26/Apr/2008	8h50	70*35,23	°N	122*26,12	° W	196.8	Hydrobios in	556	330	0/5	-15.7
26/Apr/2008	9h10	70*35,23	°N	122*26,23	° W	196.8	snow pits off ice	560	calme	calme	-15.6
26/Apr/2008	9h10	70*35,23	°N	122*26,21	° W	196.8	chemistery and biology off ice	560	calme	calme	-15.6
26/Apr/2008	9h15	70*35,23	°N	122*26,11	° W	196.8	ice team trace metal	560	calme	calme	-15.6
26/Apr/2008	9h34	70*35,23	°N	122*26,11	° W	196.8	hydrobios out	557	calme	calme	-14.3
26/Apr/2008	9h55	70*35,23	°N	122*26,11	° W	196.8	Tucker in	554	calme	calme	-14.1
26/Apr/2008	10h39	70*35,23	°N	122*26,12	° W	196.8	Tucker out	554	calme	calme	-14
26/Apr/2008	10h46	70*35,23	°N	122*26,11	° W	196.8	Tucker in	554	calme	calme	-14
26/Apr/2008	11h22	70*35,234	°N	122*26,122	° W	196.8	Tucker out	544	calme	calme	-14
26/Apr/2008	11h20	70*35,234	°N	122*26,122	° W	196.8	ice team snow pits back	544	calme	calme	-14
26/Apr/2008	11h25	70*35,23	°N	122*26,12	° W	196.8	Chemistery and biology back	544	calme	calme	-14
26/Apr/2008	11h50	70*35.23	°N	122*26,12	° W	196.8	Trace metal back	544	calme	calme	-12
26/Apr/2008	12h35	70*35.24	°N	122*26,15	° W	196,8	Rosette in - **cast 2**	563	calme	calme	-12.9
26/Apr/2008	13h20	70*35,24	°N	122*26.18	° W	197	Chamistery and biology off ice	556	calme	calme	-12.9
26/Apr/2008	13h40	70*35,24	°N	122*26,19	° W	197	Rosette out / snow pits off ice	556	calme	calme	-13.3
26/Apr/2008	14h10	70*35,25	°N	122*26,21	° W	197,1	Trcae metal off ice	556	calme	calme	-11.6
26/Apr/2008	13h40		°N		° W		SCAMP	556	calme	calme	
26/Apr/2008	15h00	70*35,25	°N	122*26,25	° W	196,6	SCAMP out	556	calme	calme	-12.3
26/Apr/2008	15h18	70*35,26	°N	122*26,25	° W	196,8	Rosette in - **cast 3**	556	calme	calme	-11.3
26/Apr/2008	15h35	70*35,26	°N	122*26,25	° W	196,9	Balloon / snow pits back	564	calme	calme	-11.8
26/Apr/2008	15h40	70*35,26	°N	122*26,25	° W	196,9	Rosette out	564	calme	calme	-11.8
26/Apr/2008	15h45	70*35,26	°N	122*26,25	° W	196,9	SCAMP in	564	calme	calme	-12.3
26/Apr/2008	16h10	70*35,267	°N	122*26,263	° W	197	SCAMP out	550	65	5	-12.7
26/Apr/2008	16h11	70*35,267	°N	122*26,263	° W	197	SCAMP in	550	65	5	-12.7

26/Apr/2008	16h35	70*35,277	°N	122*26,273	° W	197,1	SCAMP out	550	85	5	-13.1
26/Apr/2008	17h45	70*35,297	°N	122*26,353	° W	196,8	biology and chamistery off ice	550	102	7	-13
26/Apr/2008	18h27	70*35,307	°N	122*26,393	° W	197,1	trace metal off ice	550	100	5	-13
26/Apr/2008	18h29	70*35,307	°N	122*26,393	° W	197,1	weather off ice	550	100	5	-13
26/Apr/2008	18h42	70*35,317	°N	122*26,414	° W	196,5	weather back	550	110	7	-13
26/Apr/2008	19h04	70*35,327	°N	122*26,434	° W	196,5	Rosette in - **cast 4**	551	100	8	-13.1
26/Apr/2008	19h32	70*35,337	°N	122*26,253	° W	197,1	Rosette out	551	95	8	-13.4
27/Apr/2008	8h08	70*35,64	°N	122*28,24	° W	197,6	Rosette in - **cast 5**	555	70	17	-18
27/Apr/2008		70*35,64	°N	122*28,24	° W	197,6	Rosette out	552	70	15	-18
27/Apr/2008	8h43	70*35,71	°N	122*28,61	° W	197,6	Preparation hydrobios	551	70	15	-18
27/Apr/2008	8h47	70*35,73	°N	122*28,67	° W	197,6	snow pits off oce				
27/Apr/2008	8h54	70*35,73	°N	122*28,73	° W	197,6	hydrobios in	551	70	15	-18
27/Apr/2008	9h08	70*35,81	°N	122*29,13	° W	197,6	hydrobios out	551	70	20	-16.5
27/Apr/2008	9h50	70*35,86	°N	122*29,41	° W	197,6	contaminant off ice	554	70	20	-16.1
27/Apr/2008	9h56	70*35,88	°N	122*29,49	° W	197,6	Preparation tucker	552	70	20	-16.1
27/Apr/2008	10h05	70*35,90	°N	122*29,60	° W	197,6	Tucker in	555	70	20	-16.1
27/Apr/2008	10h15	70*35,93	°N	122*29,77	° W	197,6	contaminant back				
27/Apr/2008	10h38	70*35,97	°N	122*30,12	° W	197,6	Tucker out	553	78	20	-15.5
27/Apr/2008	10h39	70*35,97	°N	122*30,12	° W	197,6	Snow pits back	553	78	20	-15.5
27/Apr/2008	10h43	70*35,97	°N	122*30,12	° W	197,6	Tucker in	552	78	20	-15.5
27/Apr/2008	11h30	70*36,13	°N	122*31,11	° W	197,6	tucker out	546	78	22	-14.8
27/Apr/2008	12h05	70*36,24	°N	122*31,81	° W	197,9	Rosette in - **cast 6**	551	84	23	-14.4
27/Apr/2008	12h35	70*36,36	°N	122*32,54	° W	197,8	Rosette out	553	85	27	-14.1
27/Apr/2008	12h40	70*36,37	°N	122*32,6	° W	197,8	SCAMP in	553	80	20	-14
27/Apr/2008	14h00	70*36,68	°N	122*34,45	° W	197,8	SCAMP out	544	80	26	-13.3
27/Apr/2008	15h00	70*36,95	°N	122*35,97	° W	199	Rosette in - **cast 7**	532	80	24	-12.7
27/Apr/2008	15h25	70*37,08	°N	122*36,6	° W	199	Rosette out	521	75	25	-12.4
27/Apr/2008	19h00	70*38,236	°N	122*41,907	° W	199,9	Rosette in - **cast 8**	507	80	29	-12.7
27/Apr/2008	19h24	70*38,355	°N	122*42,418	° W	200,5	Rosette out	513	85	27	-12.9
28/Apr/2008	7h02	70*41.161	°N	123*00,022	° W	202,6	Rosette in - **cast 9**	560	70	32	-13.7
28/Apr/2008	7h30	70*41,217	°N	123*00,595	° W	203,0	Rosette out	571	75	31	-13.8
28/Apr/2008	8h15	70*41,33	°N	123*01,75	° W	203	hydrobios in	571	80	30	-13.7
28/Apr/2008	8h30	70*41,36	°N	123*02,259	° W	203	contaminant off ice	563	80	30	-13.7

28/Apr/2008	8h35	70*41,36	°N	123*02,496	° W	203	phytoflash CTD off ice	560	80	30	-13.5
28/Apr/2008	8h50	70*41,36	°N	123*02,60	° W	202,6	hydrobios out	558	80	30	-12.9
28/Apr/2008	9h22	70*41,38	°N	123*03,303	° W	202,6	Tucker in	540	80	30	-12.9
28/Apr/2008	9h40	70*41,43	°N	123*03,752	° W	202,6	phytoflash CTD back	540	80	30	-13.1
28/Apr/2008	10h15	70*41,474	°N	123*04,144	° W	202,6	Tucker out	534	80	30	-13.1
28/Apr/2008	10h27	70*41,5	°N	123*04,903	° W	202,1	Rosette in - **cast 10**	510	80	30	-12.2
28/Apr/2008	10h55	70*41,562	°N	123*05,139	° W	202,5	contaminant back	510	80	30	-12.2
28/Apr/2008	11h35	70*41,58	°N	123*06,46	° W	202,2	Rosette out	498	80	30	-12.2
28/Apr/2008	13h30	70*41,69	°N	123*09,47	° W	202,1	Rosette in - **cast 11**	507	75	27	-10.9
28/Apr/2008	13h57	70*42,01	°N	123*10,14	° W	202	Rosette out	511	80	28	-10.9
28/Apr/2008	19h00	70*43,05	°N	123*17,10	° W	201,3	Rosette in - **cast 12**	465	80	22	-9.7
28/Apr/2008	19h20	70*43,01	°N	123*17,5	° W	200,6	Rosette out	448	80	24	-9.9
28/Apr/2008	20h25	70,43,17	°N	123*18,70	° W	200	SCAMP in	448	80	20	-10
28/Apr/2008	20h37	70*43,18	°N	123*18,84	° W	200	SCAMP out	448	80	20	-10
28/Apr/2008	20h50	70*43,19	°N	123*19,14	° W	200	SCAMP in	448	80	20	-10
28/Apr/2008	21h05	70*43,20	°N	123*19,42	° W	200	SCAMP out	448	75	20	-10
28/Apr/2008	21h20	70*43,22	°N	123*19,69	° W	200	SCAMP in	448	75	20	-10
28/Apr/2008	21h35	70*43,23	°N	123*20,02	° W	200	SCAMP out	448	80	20	-10.2
29/Apr/2008	6h18	70*44,466	°N	123*31,376	° W	197,6	hydrobios in	534	83	22	-11.1
29/Apr/2008	6h52	70*44,565	°N	123*32,096	° W	197,6	hydrobios out	534	83	21	-11.1
29/Apr/2008	7h05	70*44,582	°N	123*32,247	° W	197,7	water sampling off ice	535	85	20	-11.1
29/Apr/2008	7h20	70*44,606	°N	123*32,497	° W	197,8	Tucker in	537	85	18	-11
29/Apr/2008	7h53	70*44,65	°N	123*33,105	° W	196.3	Tucker out	545	85	18	-11
29/Apr/2008	8h05	70*44,70	°N	123*33,60	° W	196.5	Tucker in	545	85	18	-11
29/Apr/2008	8h26	70*44,692	°N	123*33,672	° W	196.9	trace metal off ice	547	85	18	-11
29/Apr/2008	8h37	70*44,69	°N	123*33,85	° W	196.9	Tucker out	547	85	18	-11
29/Apr/2008	8h43	70*44,70	°N	123*33,88	° W	196.9	Tucker in	547	85	18	-11
29/Apr/2008	8h45	70*44,704	°N	123*33,952	° W	197	snow pits off ice	554	85	18	-11
29/Apr/2008	9h05	70*44,717	°N	123*34,400	° W	197.1	water sampling back	554	85	18	-10.8
29/Apr/2008	9h05	70*44,717	°N	123*34,45	° W	196.9	Tucker out	554	80	18	-10.8
29/Apr/2008	9h05	70*44,717	°N	123*34,45	° W	196.9	chemistery and biology off ice				
29/Apr/2008	9h31	70*44,717	°N	123*34,669	° W	196.5	Rosette in - **cast 13**	532	80	18	-10.8
29/Apr/2008	10h00	70*44,72	°N	123*35,22	° W	195.4	snow pits back	547	80	15	-10.8

29/Apr/2008	10h00	70*44,72	°N	123*35,22	° W	195.1	Rosette out	537	80	15	-10.8
29/Apr/2008	10h06	70*44,716	°N	123*35,281	° W	195.1	SCAMP in	537	80	15	-10.8
29/Apr/2008	10h25	70*44,713	°N	123*35,576	° W	195.1	SCAMP out	536	75	15	-10.9
29/Apr/2008	10h45	70*44,712	°N	123*35,965	° W	195.9	Rosette in - **cast 14**	538	75	15	-10.9
29/Apr/2008	11h20	70*44,712	°N	123*36,490	° W	195.4	chemistery and biology back	538	80	18	-10.9
29/Apr/2008	11h05	70*44,714	°N	123*36,73	° W	195.6	Rosette out	538	80	18	-10.9
29/Apr/2008	11h35	70*44,714	°N	123*36,76	° W	195.6	Rosette in - **cast 15**	538	80	18	-10.9
29/Apr/2008	12h00	70*44,7	°N	123*37,2	° W	194.7	trace metal back	533	85	16	-10.9
29/Apr/2008	12h35	70*44,75	°N	123*37,7	° W	194.3	Rosette in - **cast 16**	536	85	17	-10.8
29/Apr/2008	12h55	70*44,8	°N	123*38,1	° W	193.6	Rosette out / SCAMP in	535	80	16	-10.8
29/Apr/2008	13h30	70*44,79	°N	123*36,65	° W	193.5	SCAMP out	536	75	16	-10.7
29/Apr/2008	13h35	70*44,79	°N	123*36,65	° W	193.5	Rosette in - **cast 17**	536	75	16	-10.7
29/Apr/2008	14h00	70*44,8	°N	123*39,13	° W	193.7	Rosette out	540	80	16	-10.7
29/Apr/2008	14h30	70*44,9	°N	123*39,7	° W	193.4	Rosette in - **cast 18**	534	85	14	-10.5
29/Apr/2008	15h00	70*44,98	°N	123*40,19	° W	192	Rosette out/SCAMP in/contaminant off ice	535	80	14	-10.4
29/Apr/2008	15h30	70*45,06	°N	123*40,75	° W	193.4	SCAMP out / Rosette in - **cast 19**	534	85	18	-10.4
29/Apr/2008	15h35	70*45,06	°N	123*40,75	° W	193.4	snow pits back	534	85	18	-10.4
29/Apr/2008	15h56	70*45,149	°N	123*41,279	° W	192.8	Rosette out	534	85	18	-10.3
29/Apr/2008	16h10	70*45,129	°N	123*41,518	° W	192.7	contaminant off ice	534	90	19	-10.1
29/Apr/2008	16h30	70*45,246	°N	123*41,794	° W	192	Rosette in - **cast 20**	534	86	14	-10.1
29/Apr/2008	16h51	70*45,335	°N	123*42,200	° W	192	Rosette out	535	90	15	-10.2
29/Apr/2008	17h20	70*45,44	°N	123*42,77	° W	192	Trcae metal and contaminant back	533	95	14	-10.1
29/Apr/2008	17h25	70*45,44	°N	123*42,77	° W	192	Rosette in - **cast 21**	533	95	14	-10.1
29/Apr/2008	17h51	70*45,516	°N	123*43,139	° W	191.7	Rosette out	533	85	15	-10
29/Apr/2008	18h23	70*45,6	°N	123*43,6	° W	190.7	Rosette in - **cast 22**	532	80	16	-10
29/Apr/2008	18h48	70*45,650	°N	123*43,926	° W	190.8	Rosette out	531	82	14	-10
29/Apr/2008	18h50	70*45,650	°N	123*43,926	° W	190.8	SCAMP in	531	82	14	-10
29/Apr/2008	19h14	70*45,702	°N	123*44,333	° W	190.5	SCAMP out	530	90	15	-9.9
29/Apr/2008	19h25	70*45,715	°N	123*44,459	° W	190.5	Rosette in - **cast 23**	530	85	17	-10
29/Apr/2008	20h08	70*45,778	°N	123*45,138	° W	189.9	Rosette out	532	85	17	-10
29/Apr/2008	20h10	70*45,778	°N	123*45,138	° W	190	SCAMP in	532	85	15	-10.1

29/Apr/2008	20h11	70*45,778	°N	123*45,138	° W	189.8	ice team peeper. off ice	532	85	15	-10
29/Apr/2008	20h37	70*45,801	°N	123*45,560	° W	190.6	SCAMP out	530	85	15	-10.2
29/Apr/2008	20h48	70*45,82	°N	123*45,57	° W	190.8	Rosette in - **cast 24**	530	85	15	-10.2
29/Apr/2008	21h05	70*45,82	°N	123*45,91	° W	190.9	Rosette out	529	95	15	-10.2
29/Apr/2008	21h08	70*45,82	°N	123*45,92	° W	190.9	peeper back	530	95	15	-10.2
29/Apr/2008	21h28	70*45,825	°N	123*46,247	° W	190.9	Rosette in - **cast 25**	528	95	15	-10.2
29/Apr/2008	21h52	70*45,84	°N	123*46,58	° W	190.9	Rosette out	528	95	12	-10.2
29/Apr/2008	21h53	70*45,84	°N	123*46,58	° W	190.9	SCAMP in	528	95	12	-10.2
29/Apr/2008	22h20	70*45,83	°N	123*46,97	° W	189.3	SCAMP out	524	90	12	-10
30/Apr/2008	07h05	70*46,466	°N	123*54,127	° W	181.1	Rosette in - **cast 26**	462	80	14	-9.5
30/Apr/2008	07h44	70*46,513	°N	123*54,468	° W	180.3	Rosette out	464	80	13	-9.2
30/Apr/2008	08h42	70*49,295	°N	124*19,369	° W	179.1	hydrobios in	466	80	15	-9
30/Apr/2008	09h03	70*46,57	°N	123*55,306	° W	178.5	water sampling off ice	465	80	15	-9
30/Apr/2008	09h11	70*46,57	°N	123*55,4	° W	178.8	hydrobios out	464	80	15	-8.7
30/Apr/2008	09h42	70*46,59	°N	123*55,75	° W	179.1	Tucker in	464	80	15	-8.7
30/Apr/2008	09h50	70*46,59	°N	123*55,88	° W	178.9	water sampling back	464	80	15	-8.7
30/Apr/2008	10h02	70*46,598	°N	123*55,993	° W	178.9	snow sampling off ice	464	80	15	-8.7
30/Apr/2008	10h15	70*46,604	°N	123*56,137	° W	178.8	Tucker out	463	90	13	-8.3
30/Apr/2008	11h00	70*46,624	°N	123*56,583	° W	178.5	snow sampling back	460	85	15	-8.3
30/Apr/2008	11h15	70*46,63	°N	123*56,71	° W	178.2	Rosette in - **cast 27**	460	85	15	-8.3
30/Apr/2008	11h30	70*46,64	°N	123*56,87	° W	178.1	Rosette out	460	85	15	-8.3
30/Apr/2008	13h40	70*46,8	°N	123*57,9	° W	177.4	SCAMP out	455	120	10	-5.1
30/Apr/2008	13h45	70*46,8	°N	123*57,9	° W	177.4	SCAMP in	455	120	10	-5.1
30/Apr/2008	14h10	70*46,9	°N	123*58,2	° W	178	SCAMP out/in	455	115	13	-5.2
30/Apr/2008	14h10	70*46,9	°N	123*58,2	° W	178	eq. sampling off ice	455	115	13	-5.2
30/Apr/2008	14h40	70*46,9	°N	123*58,5	° W	178.2	SCAMP out	455	102	11	-5.3
30/Apr/2008	15h40	70*47,09	°N	123*59,14	° W	177.9	eq.sampling back	455	120	13	-4.8
30/Apr/2008	15h55	70*47,13	°N	123*59,3	° W	178.2	ice hole off ice	455	110	12	-4.8
30/Apr/2008	16h45	70*47,35	°N	124*00,10	° W	178	ice hole back	473	105	16	-5.1
30/Apr/2008	19h00	70*47,670	°N	124*01,361	° W	178.9	Rosette in - **cast 28**	515	90	15	-6.3
30/Apr/2008	19h25	70*47,735	°N	124*01,630	° W	178.2	Rosette out	524	95	14	-6.8
30/Apr/2008	19h31	70*47,752	°N	124*01,700	° W	178.2	SCAMP in	524	90	12	-6.9
30/Apr/2008	19h39	70*47,775	°N	124*01,795	° W	178.4	SCAMP out	526	80	11	-7.2

30/Apr/2008	19h58	70*47,82	°N	124*02,000	° W	178	SCAMP in	535	80	10	-7.2
30/Apr/2008	20h20	70*47,876	°N	124*02,294	° W	178	SCAMP out	540	80	10	-8
30/Apr/2008	20h38	70*47,876	°N	124*02,294	° W	178	SCAMP in	540	80	10	-8
30/Apr/2008	20h45	70*47,938	°N	124*02,571	° W	178	SCAMP out	549	80	10	-8.5
30/Apr/2008	21h15	70*47,988	°N	124*02,960	° W	176.7	SCAMP in	545	88	13	-9.1
30/Apr/2008	21h25	70*47,988	°N	124*02,960	° W	176.7	SCAMP out	543	88	13	-9.1
1/May/2008	07h03	70*48,803	°N	124*11,745	° W	180.9	Rosette in - **cast 29**	464	87	22	-9.1
1/May/2008	07h35	70*48,850	°N	124*12,339	° W	181.1	Rosette out	432	80	19	-9.2
1/May/2008	08h20	70*48,93	°N	124*13,33	° W	181.8	hydrobios in	440	85	15	-9.1
1/May/2008	09h00	70*48,98	°N	124*13,99	° W	181	hydrobios out	434	85	20	-9.1
1/May/2008	09h10	70*48,99	°N	124*14,17	° W	181.3	water sampling off ice	430	85	20	-9.1
1/May/2008	09h22	70*49,01	°N	124*14,40	° W	181.1	Tucker in	430	85	20	-9
1/May/2008	09h34	70*49,01	°N	124*14,40	° W	181	CO2 team off ice	425	85	20	-9
1/May/2008	09h45	70*49,058	°N	124*14,91	° W	181.1	balloon launched	421	85	20	-9.1
1/May/2008	09h46	70*49,058	°N	124*14,91	° W	181.1	gear setup team off ice	421	85	20	-9.1
1/May/2008	09h51	70*49,065	°N	124*15,146	° W	181.1	Tucker out	420	85	15	
1/May/2008	09h57	70*49,065	°N	124*15,146	° W	181.6	Tucker in	420	85	20	-9
1/May/2008	09h57	70*49,065	°N	124*15,146	° W	181.6	water sampling back	420	85	20	-9
1/May/2008	09h58	70*49,065	°N	124*15,146	° W	181.6	gear setup back	420	85	20	-9
1/May/2008	10h30	70*49,106	°N	124*15,78	° W	181.5	Tucker out	420	85	20	-8.8
1/May/2008	10h34	70*49,11	°N	124*15,86	° W	182.3	Tucker in	420	85	20	-8.8
1/May/2008	10h45	70*49,12	°N	124*16,11	° W	181.8	Tucker out	420	85	15	-8.8
1/May/2008	11h00	70*49,15	°N	124*16,46	° W	181.8	Rosette in - **cast 30**	418	90	15	-8.8
1/May/2008	11h30	70*49,20	°N	124*17,15	° W	181.8	CO2 team back	418	90	15	-8.8
1/May/2008	12h00	70*49,25	°N	124*17,7	° W	181.3	Rosette out	430	80	21	-9
1/May/2008	13h00	70*49,4	°N	124*18,9	° W	181.8	SCAMP in	483	85	24	-9.1
1/May/2008	15h08	70*49,75	°N	124*21,33	° W	183.2	SCAMP out / Rosette in - **cast 31**	470	90	23	-9
1/May/2008	15h30	70*49,82	°N	124*21,78	° W	183.3	Rosette out/snow sampling off ice	469	90	24	-8.9
1/May/2008	16h19	70*49,967	°N	124*22,705	° W	183.3	water sampling off ice	475	95	18	-8.8
1/May/2008	17h15	70*50,15	°N	124*23,96	° W	183.4	snow sampling back	477	90	20	-8.6
1/May/2008	17h54	70*50,27	°N	124*24,891	° W	184	ice team off ice	487	90	22	-8.7
1/May/2008	18h05	70*50,320	°N	124*25,249	° W	183.3	ice team back	458	90	21	-8.7

1/May/2008	19h00	70*50,470	°N	124*26,430	° W	183.9	Rosette in - **cast 32**	475	90	25	-8
1/May/2008	19h23	70*50,526	°N	124*26,941	° W	183.8	Rosette out	485	95	20	-7.9
1/May/2008	20h00	70*50,60	°N	124*27,69	° W	184	Tucker in	496	90	20	-7.8
1/May/2008	20h08	70*50,62	°N	124*27,84	° W	184	Tucker out	496	90	20	-7.8
1/May/2008	20h15	70*50,62	°N	124*27,97	° W	184	Tucker in	495	90	20	-7.8
1/May/2008	20h20	70*50,64	°N	124*28,09	° W	184	Tucker out	495	90	20	-7.8
1/May/2008	22h40	70*50,76	°N	124*31,51	° W	184.8	water sampling back	398	90	20	-7.8
2/May/2008	07h04	70*50,496	°N	124*41,058	° W	188.4	Rosette in - **cast 33**	392	75	20	-6.9
2/May/2008	07h05	70*50,496	°N	124*41,058	° W	188.4	water sampling off ice	392	75	20	-6.9
2/May/2008	07h21	70*50,498	°N	124*41,420	° W	189.1	water sampling back	392	75	24	-6.8
2/May/2008	07h31	70*50,499	°N	124*41,632	° W	188.5	Rosette out	390	80	23	-6.9
2/May/2008	08h18	70*50,52	°N	124*42,49	° W	188.7	hydrobios in	380	80	25	-6.8
2/May/2008	08h40	70*50,55	°N	124*43,26	° W	188.4	CO2 team off ice	386	80	25	-6.8
2/May/2008	08h42	70*50,55	°N	124*43,26	° W	188.4	hydrobios out	388	80	25	-6.8
2/May/2008	09h00	70*50,585	°N	124*43,999	° W	188	ice coring off ice	395	80	25	-6.4
2/May/2008	09h08	70*50,59	°N	124*44,00	° W	187.7	Tucker in	404	85	25	-6.4
2/May/2008	09h40	70*50,61	°N	124*44,60	° W	188.6	Tucker out	415	80	25	-6.6
2/May/2008	09h50	70*50,62	°N	124*44,88	° W	188.6	Tucker in	415	80	25	-6.6
2/May/2008	10h15	70*50,62	°N	124*45,65	° W	188.8	Tucker out	410	80	25	-6.6
2/May/2008	10h20	70*50,62	°N	124*45,65	° W	188.9	Tucker in	390	80	20	-6.6
2/May/2008	10h20	70*50,66	°N	124*45,69	° W	188.9	air born emscan	390	80	20	-6.6
2/May/2008	10h30	70*50,67	°N	124*45,88	° W	189.4	tucker out	385	80	20	-6.6
2/May/2008	10h30	70*50,68	°N	124*46,02	° W	189.2	Tucker in	379	80	25	-6.4
2/May/2008	10h39	70*50,68	°N	124*46,11	° W	189.2	Tucker out	377	80	25	-6.3
2/May/2008	10h43	70*50,68	°N	124*46,22	° W	189.3	Tucker in	376	80	25	-6.3
2/May/2008	10h53	70*50,69	°N	126*46,48	° W	189.3	Tucker out	376	80	25	-6.2
2/May/2008	11h05	70*50,71	°N	124*46,85	° W	189.2	ice coring team back	377	80	25	-6.2
2/May/2008	11h10	70*50,70	°N	124*46,87	° W	189.2	CTD in - **cast 34**	380	80	25	-6.2
2/May/2008	11h20	70*50,72	°N	124*47,270	° W	189.2	CTD out	380	80	25	-6.2
2/May/2008	11h30	70*50,73	°N	124*47,57	° W	189.2	CO2 team back	380	80	25	6.1
2/May/2008	12h45	70*50,82	°N	124*49,51	° W	188.6	CTD team off ice	389	80	27	-5.4
2/May/2008	13h05	70*50,83	°N	124*49,83	° W	189	chemistery and biology team off ice	341	85	23	-5.4

2/May/2008	13h23	70*50,86	°N	124*50,29	° W	189.8	CTD team back	389	83	27	-5.4
2/May/2008	14h55	70*50,93	°N	124*52,59	° W	189.3	Rosette in - **cast 35**	397	75	29	-5.2
2/May/2008	15h20	70*50,95	°N	124*53,17	° W	189.2	Rosette out	404	75	27	-5
2/May/2008	15h25	70*50,95	°N	124*53,17	° W	189.2	SCAMP in	404	75	27	-5
2/May/2008	16h20	70*50,019	°N	124*54,719	° W	190.5	SCAMP out	375	75	27	-4.7
2/May/2008	16h21	70*50,019	°N	124*54,719	° W	190.5	SCAMP in	375	75	27	-4.7
2/May/2008	16h21	70*50,019	°N	124*54,719	° W	190.5	chemistery and biology team back	375	75	27	-4.7
2/May/2008	16h48	70*51,051	°N	124*55,539	° W	191.3	SCAMP out	376	75	30	-4.6
2/May/2008	16h49	70*51,057	°N	124*55,570	° W	191.3	SCAMP in	376	75	30	-4.6
2/May/2008	17h00	70*51,08	°N	124*55,9	° W	191.2	CO2 team back	368	80	30	-4.7
2/May/2008	17h15	70*51,01	°N	124*56,36	° W	190.5	SCAMP out	368	70	29	-4.6
2/May/2008	18h56	70*51,290	°N	124*58,973	° W	192.1	Rosette in - **cast 36**	371	80	32	-4.3
2/May/2008	19h18	70*51,342	°N	124*59,679	° W	192.5	Rosette out	371	75	37	-4.3
2/May/2008	20h20	70*51,52	°N	125*01,67	° W	192.4	Tucker in	368	780	30	-4.3
2/May/2008	20h30	70*51,26	°N	125*02,06	° W	192.7	Tucker out	368	80	30	-4.3
2/May/2008	20h38	70*51,58	°N	125*02,24	° W	193.2	Tucker in	368	80	30	-4.3
2/May/2008	20h48	70*51,61	°N	125*02,580	° W	193.2	Tucker out	368	80	30	-4.3
3/May/2008	10h40	70*54,86	°N	125*25,86	° W	204	ice sampling and CTD off ice	351	90	25	-6.6
3/May/2008	11h05	70*54,97	°N	125*26,54	° W	207	Rosette in - **cast 37**	380	90	20	-6.6
3/May/2008	11h25	70*55,056	°N	125*27,08	° W	207	ice sampling and CTD back	388	90	20	-6.6
3/May/2008	11h30	70*55,07	°N	125*27,20	° W	207	Rosette out	390	100	20	-6.6
3/May/2008	12h50	70*55,39	°N	125*29,27	° W	206.5	SCAMP in	407	90	29	-5.6
3/May/2008	14h25	70*55,71	°N	125*31,43	° W	210.6	SCAMP out	411	95	22	-4.9
3/May/2008	15h00	70*55,83	°N	125*32,21	° W	210	Rosette in - **cast 38**	416	95	24	-4.7
3/May/2008	15h25	70*55,9	°N	125*32,68	° W	210.1	Rosette out	414	90	23	-4.5
3/May/2008	17h45	70*56,380	°N	125*35,363	° W	214.3	pumping deployment team off ice	370	90	14	-4.1
3/May/2008	18h20	70*56,5	°N	125*35,9	° W	214.3	pumping team back	370	65	10	-3.8
3/May/2008	19h02	70*56,639	°N	125*36,484	° W	215.8	Rosette in - **cast 39**	394	15	13	-2.1
3/May/2008	19h05	70*56,639	°N	125*36,484	° W	215.8	snow pits team off ice	394	15	13	-2.1
3/May/2008	19h21	70*56,696	°N	125*36,792	° W	215.8	Rosette out	409	35	8	-2.1
4/May/2008	07h04	70*59,691	°N	125*50,809	° W	228.1	Rosette in - **cast 40**	409	100	16	-7.9
4/May/2008	07h26	70*59,784	°N	125*51,149	° W	227.6	Rosette out	408	100	17	-8

4/May/2008	08h15	70*59,99	°N	125*52,06	° W	229.7	hydrobios in	408	100	15	-8
4/May/2008	08h40	71*00,12	°N	125*52,62	° W	230	hydrobios out	407	95	20	-8.1
4/May/2008	09h10	71*00,27	°N	125*53,28	° W	228.4	Tucker in	407	95	20	-8.1
4/May/2008	09h20	71*00,32	°N	125*53,46	° W	229	tucker out	407	95	20	-8.1
4/May/2008	09h38	71*00,42	°N	125*53,85	° W	230	water sampling team off ice	409	95	20	-8.1
4/May/2008	09h45	71*00,46	°N	125*54,01	° W	228	Tucker in	409	90	20	-8.1
4/May/2008	10h15	71*00,62	°N	125*54,68	° W	230	Tucker out	410	90	20	-8.1
4/May/2008	10h20	71*00,67	°N	125*54,89	° W	231.6	water sampling team back	408	95	20	-7.6
4/May/2008	11h10	71*00,67	°N	125*56,33	° W	232.9	Rosette in - **cast 41**	408	95	20	-7.4
4/May/2008	11h50	71*01,21	°N	125*57,09	° W	231.6	Rosette out	395	95	17	-7.3
4/May/2008	14h15	71*02,25	°N	126*00,2	° W	236	optic team off ice	400	90	19	-6.8
4/May/2008	15h00	71*02,31	°N	126*00,77	° W	236.3	contaminant team off ice / Rosette in - **cast 42**	399	100	19	-6.8
4/May/2008	15h30	71*02,52	°N	126*01,38	° W	237.1	Rosette out / contaminant team back	400	112	,19	-6.7
4/May/2008	15h40	71*02,581	°N	126*01,547	° W	237.2	SCAMP in	401	105	23	-6.6
4/May/2008	16h10	71*02,758	°N	126*02,007	° W	238.3	optic team back	402	95	18	-6.5
4/May/2008	16h55	71*03,01	°N	126*02,70	° W	238.7	SCAMP out	402	95	17	-6.2
4/May/2008	19h07	71*03,700	°N	126*04,340	° W	242.4	Rosette in - **cast 43**	396	110	14	-6.3
4/May/2008	19h26	71*03,827	°N	126*04,617	° W	243.1	Rosette out	397	110	15	-6.2
5/May/2008	6h17	71*08,268	°N	126*13,888	° W	255.3	Hydrobios in	411	110	16	-10.9
5/May/2008	6h45	71*08,462	°N	126*14,123	° W	256.1	Hydrobios out	411	110	17	-10.9
5/May/2008	7h10	71*08,619	°N	126*14,328	° W	256.1	Tucker in	411	110	18	-10.7
5/May/2008	7h10	71*08,619	°N	126*14,328	° W	256.1	water sampling team off ice	411	110	18	-10.7
5/May/2008	7h36	71*08,792	°N	126*14,601	° W	256.8	Tucker out	412	110	20	-10.4
5/May/2008	7h46	71*08,852	°N	126*14,699	° W	257.3	Tucker in	411	105	21	-10.4
5/May/2008	7h46	71*08,852	°N	126*14,699	° W	257.3	water sampling team off ice	411	105	21	-10.4
5/May/2008	8h15	71*09,03	°N	126*15,00	° W	258	Tucker out	411	90	10	-10.4
5/May/2008	8h30	71*09,03	°N	126*15,3	° W	259.4	CO2 team off ice / Rosette in - **cast 44**	412	90	15	-10.4
5/May/2008	8h53	71*09,35	°N	126*15,5	° W	259.4	Rosette out	413	90	15	-10.4
5/May/2008	9h05		°N		° W		Biology team off ice				
5/May/2008	9h15	71*09,57	°N	126*16,0	° W	260	SCAMP in	413	90	15	-10.4
5/May/2008	9h32	71*09,65	°N	126*16,20	° W	259.6	SCAMP out	413	90	15	-10.4

5/May/2008	9h50	71*09,75	°N	126*16,33	° W	259.6	Rosette in - **cast 45**	417	105	15	-9.4
5/May/2008	10h10	71*09,86	°N	126*16,61	° W	260	Rosette out	417	110	15	-9.4
5/May/2008	10h33	71*10,06	°N	126*17,04	° W	260	Rosette in - **cast 46**	418	110	20	-9.3
5/May/2008	10h41	71*10,15	°N	126*17,21	° W	260	Rosette out	418	110	20	-9
5/May/2008	11h30	71*10,64	°N	126*18,25	° W	260	Rosette in - **cast 47**	420	110	15	-8.9
5/May/2008	12h00	71*10,8	°N	126*18,68	° W	262.8	Rosette out / SCAMP in	421	100	17	-8.9
5/May/2008	13h00	71*11,39	°N	126*19,89	° W	264.4	SCAMP out / Chemistery and biology off ice / Rosette in - **cast 48**	424	105	16	-9.1
5/May/2008	13h30	77*11,63	°N	126*20,37	° W	265.7	Rosette out / Rosette in - **cast 49**	424	100	12	-8.7
5/May/2008	13h50	71*11,8	°N	126*20,68	° W	266.1	Rosette out / CO2 team off ice	424	115	25	-8.3
5/May/2008	14h33	71*12,15	°N	126*21,31	° W	265.4	Rosette in - **cast 50**	427	100	14	-7.9
5/May/2008	14h54	71*12,32	°N	126*21,58	° W	265.9	Rosette out / SCAMP in	428	100	17	-7.5
5/May/2008	15h28	71*12,58	°N	126*21,99	° W	268	SCAMP out / Rosette in - **cast 51**	430	105	16	-7.6
5/May/2008	15h48	71*12,73	°N	126*22,21	° W	267.7	Rosette out / Chemistery and biology team back	430	95	18	-7.6
5/May/2008	16h28	71*13,010	°N	126*22,580	° W	268.9	Rosette in - **cast 52**	431	95	18	-7.7
5/May/2008	16h46	71*13,130	°N	126*22,742	° W	269.4	Rosette out	424	97	16	-7.6
5/May/2008	17h20	71*13,376	°N	126*23,07	° W	269.7	CO2 team back	425	95	18	-7.6
5/May/2008	17h30	71*13,45	°N	126*23,165	° W	270.3	Rosette in - **cast 53**	432	95	18	-7.7
5/May/2008	17h46	71*13,565	°N	126*23,325	° W	274.2	Rosette out	435	105	18	-7.7
5/May/2008	17h53	71*13,630	°N	126*23,408	° W	271.6	SCAMP in	433	100	18	-7.7
5/May/2008	18h20	71*13,793	°N	126*23,631	° W	271.7	SCAMP out	435	90	18	-7.6
5/May/2008	18h35	71*13,877	°N	126*23,755	° W	271.4	Rosette in - **cast 54**	436	92	18	-7.6
5/May/2008	18h55	71*14,010	°N	126*23,958	° W	271.9	Rosette out	437	100	15	-7.8
5/May/2008	20h57	71*14,82	°N	126*25,40	° W	275.6	CTD in - **cast 55**	437	100	15	-7.8
5/May/2008	21h15	71*14,92	°N	126*25,61	° W	274.7	CTD out	444	103	15	-8.7
5/May/2008	21h20	71*14,96	°N	126*25,68	° W	274.8	SCAMP in	445	100	15	-8.7
5/May/2008	22h25	71*15,42	°N	126*26,64	° W	275	SCAMP out	448	100	15	-8.7
6-May-08	08h15	71*09,43	°N	126*39,50	° W	216	start algea collection	398	85	17	-10.2
6-May-08	03h35	71*09,44	°N	126*39,74	° W	215	stop algea collection	402	90	15	-10.2
6-May-08	09h10	71*08,00	°N	126*47,5	° W	211	EM ice start (helico)	400	90	15	-10.2
6-May-08	09h35	71*03,46	°N	126*58,44	° W	100	start secchi disk	471	88	23	-8.8

6-May-08	09h40	71*03,46	°N	126*58,44	° W	100	end secchi disk	471	90	23	-8.6
6-May-08	09h42	71*03,45	°N	126*58,47	° W	100	start PNF profile	471	90	23	-8.6
6-May-08	09h50	71*03,44	°N	126*58,55	° W	102	stop PNF profile	471	90	23	-9.3
6-May-08	10h00	71*02,51	°N	126*56,32	° W	77	start UV profile	290	90	23	-9.3
6-May-08	10h23	71*02,54	°N	126*56,53	° W	100	stop UV profile	294	80	15	-9.1
6-May-08	10h30	71*02,49	°N	126*56,28	° W	113	start Phytoflash/CTD	290	80	15	-9.1
6-May-08	11h10	71*02,39	°N	126*56,46	° W	90	end Phytoflash/CTD	290	73	20	-9.1
6-May-08	12h10	71*01,59	°N	126*57,89	° W	99	Rosette in - **cast 56**	297	73	25	-8.4
6-May-08	13h05	71*01,48	°N	126*58,69	° W	94	Rosette out	279	75	24	-8.1
6-May-08	13h10	71*01,44	°N	126*58,75	° W	102	cage water sampling #1 out	277	75	24	-8.1
6-May-08	13h48	71*00,94	°N	126*59,41	° W	157.2	cage water sampling #1 back / #2 out	270	85	18	-8.2
6-May-08	14h18	71*00,85	°N	127*01,13	° W	176.9	cage water sampling #2 back	270	85	18	-8.2
6-May-08	14h30	71*00,85	°N	127*01,08	° W	60	secchi disk	270	85	18	-8.2
6-May-08	14h40	71*00,92	°N	127*01,09	° W	120	PNF	270	85	18	-8.2
6-May-08	15h15	71*01,25	°N	127*03,07	° W	65	Rosette in - **cast 57**	259	85	18	-8
6-May-08	16h03	71*01,97	°N	127*03,552	° W	84	Rosette out	259	73	21	-8
6-May-08	16h18	71*01,109	°N	127*04,135	° W	80	Tucker vertical down	256	80	20	-8.1
6-May-08	16h35	71*01,267	°N	127*04,217	° W	35	Tucker vertical up	255	80	20	-7.7
6-May-08	16h48	71*01,473	°N	127*03,773	° W	50	Zooplankton horizontal net down	259	72	18	-7.8
6-May-08	17h05	71*01,33	°N	127*03,18	° W	157	Zooplankton horizontal net up	262	78	23	-7.8
6-May-08	17h45	71*01,446	°N	127*02,996	° W	91.1	Ice cage, ice team deployment	nd	81	15	-7.8
6-May-08	18h00	71*01,72	°N	127*04,87	° W	66.5	Ice cage, sea ice out	254	80	14	-7.7
6-May-08	18h23	71*01,74	°N	127*05,24	° W	112	Ice cage, sea ice back	252	80	17	-7.9
6-May-08	18h40	71*01,741	°N	127*05,250	° W	75	Box core down	254	80	14	-7.9
6-May-08	18h45	71*01,769	°N	127*05,425	° W	75	Box core at sea floor	253	80	15	-7.8
6-May-08	18h50	71*01,785	°N	125*05,614	° W	75	Box core up	251	76	15	-7.7
6-May-08	21h30	71*02,38	°N	127*05,30	° W	100	balloon launched	247	85	15	-8
8-May-08	07h10	70*10,944	°N	127*49,854	° W	198	water sampling team off ice	53	80	20	-9.8
8-May-08	08h00	70*10,944	°N	124*49,851	° W	197.4	water sampling ice team back	45	80	22	-9.8
8-May-08	09h11	70*10,94	°N	124*49,851	° W	197.4	snow ice thickness team off ice	45	80	20	-9.8
8-May-08	09h23	70*10,94	°N	124*49,851	° W	197.4	chemistery and biology team	45	80	15	-9.2

							off ice				
8-May-08	09h30	70*10,94	°N	124*49,85	° W	198.9	zooplankton team off ice	46	88	20	-9.1
8-May-08	09h40	70*10,94	°N	124*49,85	° W	198.9	snow ice thickness team off ice	46	90	15	-9.1
8-May-08	11h35	70*10,94	°N	124*49,85	° W	198.9	chemistery and biology team back	46	90	15	-9.1
8-May-08	11h35	70*10,94	°N	124*49,85	° W	198.89	zooplankton team back	46	90	15	-8
8-May-08	13h20	70*10,94	°N	124*49,85	° W	197	snow and ice thickness team back	47	85	19	-7.1
8-May-08	13h20	70*10,94	°N	124*49,85	° W	197	chemistery and biology / zooplankton team off ice	47	85	19	-7.1
8-May-08	14h40	70*10,94	°N	124*49,85	° W	197	zooplankton team back	47	85	16	-6.7
8-May-08	17h05	70*10,94	°N	124*49,85	° W	197	chemistery and biology team back	47	85	19	-6.6
8-May-08	19h45	70*10,94	°N	124*49,85	° W	197	chemistery and biology team back	47	85	17	-6.8
8-May-08	19h45	70*10,94	°N	124*49,85	° W	197	chemistery and biology team back	47	85	17	-6.8
8-May-08	19h50	70*10,94	°N	124*49,85	° W	197	snow pits team off ice	47	85	15	-6.5
8-May-08	19h50	70*10,94	°N	124*49,85	° W	197	zooplankton team off ice	36	85	15	-6.8
8-May-08	20h25	70*10,94	°N	124*49,85	° W	197	snow pits team back	36	83	20	-6.9
8-May-08	20h30	70*10,94	°N	124*49,85	° W	197	balloon launched	37	85	20	-6.8
8-May-08	20h32	70*10,94	°N	124*49,85	° W	197	zooplankton team back	36	85	18	-6.8
9-May-08	08h46	70*10,94	°N	124*49,85	° W	197	CO2 and CO team off ice	34	75	25	-6.4
9-May-08	09h00	70*10,94	°N	124*49,85	° W	197	zooplankton team off ice	34	75	25	-6.03
9-May-08	09h23	70*10,94	°N	124*49,85	° W	197	zooplankton team back	53	75	16	-6.3
9-May-08	11h26	70*10,94	°N	124*49,85	° W	197	CO2 and CO team back	44	75	25	-6
9-May-08	13h10	70*10,94	°N	124*49,85	° W	197	contaminant team off ice	44	75	23	-5.5
9-May-08	13h50	70*10,94	°N	124*49,85	° W	197	CO2 and zooplankton team off ice	44	80	21	-5.3
9-May-08	14h30	70*10,94	°N	124*49,85	° W	197	contaminant team back	44	75	21	-5.1
9-May-08	14h55	70*10,94	°N	124*49,85	° W	197	zooplankton team back	44	75	23	-5.1
9-May-08	16h25	70*10,95	°N	124*49,849	° W	198.8	CO2 team back	56	76	28	-4.8
9-May-08	19h05	70*10,920	°N	124*49,876	° W	199.2	Rosette in - **cast 58**	52	76	28	-4.9
9-May-08	19h23	70*10,920	°N	124*49,876	° W	199.1	Rosette out	51	80	29	-5
9-May-08	20h00	70*10,920	°N	124*49,87	° W	199.4	snow pits team off ice	45	80	30	-5

9-May-08	20h15	70*10,920	°N	124*49,87	° W	199.4	zooplankton team off ice	45	80	27	-5
9-May-08	20h50	70*10,920	°N	124*49,87	° W	199.4	snow pits team back	45	80	30	-5
9-May-08	21h15	70*10,920	°N	124*49,87	° W	199.4	zooplankton team back	45	70	25	-5
9-May-08	21h15	70*10,920	°N	124*49,87	° W	199.4	contaminant team off ice	45	70	25	-5
9-May-08	21h40	70*10,920	°N	124*49,87	° W	199.4	contaminant team back	45	70	25	-5
10-May-08	08h35	70*12,81	°N	124*45,74	° W	85	zooplankton horizontal net down	45	70	5	-4.4
10-May-08	08h52	70*12,98	°N	124*45,19	° W	88	zooplankton horizontal net up	45	70	5	-4.2
10-May-08	15h03	70*03,87	°N	125*27,23	° W	270	secchi disk down	93	270	5	-2.7
10-May-08	15h07	70*03,85	°N	125*27,23	° W	259	secchi disk up	93	270	5	-2.7
10-May-08	15h09	70*03,85	°N	125*27,25	° W	265	PNF down	93	270	5	-2.7
10-May-08	15h16	70*03,83	°N	125*27,20	° W	266	PNF up	94.5	270	5	-2.7
10-May-08	15h25	70*03,82	°N	125*27,12	° W	255	UV profile down	94	260	5	-2.6
10-May-08	15h32	70*03,82	°N	125*27,06	° W	249	balloon launched	93	250	5	-2.6
10-May-08	15h45	70*03,80	°N	125*27,01	° W	251	UV profile up	93	250	5	-2.6
10-May-08	15h49	70*03,79	°N	125*27,03	° W	261	UV profile down	94	250	5	-2.6
10-May-08	16h00	70*03,78	°N	125*27,05	° W	296	UV profile up	100	260	7	-2.4
10-May-08	16h10	70*03,81	°N	125*27,00	° W	310	Phytoflash down	99	260	8	-2.4
10-May-08	16h27	70*03,83	°N	125*26,85	° W	295	Phytoflash up	96	260	8	-2.4
10-May-08	16h39	70*03,83	°N	125*26,84	° W	299	CTD down	96	260	8	-2.4
10-May-08	16h28	70*03,83	°N	125*26,78	° W	290	CTD up	96	265	6	-2.5
10-May-08	16h57	70*03,86	°N	125*26,76	° W	277	cage, water sampling - contaminant team down	96	265	7	-2.4
10-May-08	17h24	70*03,88	°N	125*26,64	° W	293	cage, water sampling - contaminant team up	88	270	8	-2.3
10-May-08	17h37	70*03,89	°N	125*26,61	° W	276	cage, water sampling down	88	265	6	-2.3
10-May-08	17h57	70*03,85	°N	125*26,61	° W	268	cage, water sampling up	88	275	5	-2.2
10-May-08	18h18	70*03,80	°N	125*26,57	° W	301	Tucker vertical down	96	275	6	-2.2
10-May-08	18h25	70*03,80	°N	125*26,55	° W	305	Tucker vertical up	96	280	6	-2.2
10-May-08	18h35	70*03,80	°N	125*26,52	° W	305	Tucker vertical down	95	280	6	-2.2
10-May-08	18h39	70*03,81	°N	125*26,50	° W	299	Tucker vertical up	96	275	6	-2.2
10-May-08	18h53	70*03,97	°N	125*26,41	° W	var	zooplankton horizontal net down	93	275	6	-2.3
10-May-08	19h02	70*04,05	°N	125*26,84	° W	var	zooplankton horizontal net up	100	275	6	-2.2

10-May-08	19h34	70*03,75	°N	125*26,13	° W	var	beam trawl down	98	280	6	-0.4
10-May-08	20h10	70*04,46	°N	125*26,31	° W	var	beam trawl up	88	280	5	-0.4
11-May-08	10h35	69*59,00	°N	126*01,73	° W	257.9	cage sampling start	196	n	5	-2.1
11-May-08	11h15	69*59,00	°N	126*01,765	° W	258.8	cage sampling stop	196	n	5	-2.1
11-May-08	11h20	69*59,00	°N	126*01,765	° W	258.8	cage, snow sampling start	196	n	5	-2.1
11-May-08	11h25	69*59,00	°N	126*01,765	° W	285.8	cage sampling stop	196	n	5	-2.1
11-May-08	11h30	69*59,00	°N	126*01,765	° W	258.8	cage, water sampling start	196	n	5	-2.1
11-May-08	12h00	69*59,00	°N	126*01,765	° W	258.8	cage, water sampling stop	197	320	9	-2
11-May-08	13h06	69*59,05	°N	126*02,19	° W	40	secchi disk down	198	330	10	-2.4
11-May-08	13h10	69*59,04	°N	126*02,19	° W	36	secchi disk up	198	330	10	-2.4
11-May-08	13h14	69*59,04	°N	126*02,17	° W	21	PNF profile down	198	320	7	-2.3
11-May-08	13h19	69*09,03	°N	126*02,17	° W	22	PNF profile up	198	320	7	-2.2
11-May-08	13h30	69*09,04	°N	126*02,21	° W	259	cage and UV profile down	198	330	6	-1.8
11-May-08	13h43	69*09,03	°N	126*02,19	° W	230	cage and UV profile up	198	330	7	-1.1
11-May-08	13h45	69*59,03	°N	126*02,18	° W	235	cage and UV profile down	198	330	6	-1.1
11-May-08	13h55	69*59,04	°N	126*02,16	° W	206	cage and UV profile up	198	330	7	-0.5
11-May-08	14h16	69*59,05	°N	126*03,13	° W	155	Phytoflash down	199	300	8	-1.2
11-May-08	14h32	69*59,04	°N	126*03,05	° W	298	Phytoflash up	199	300	11	-0.7
11-May-08	14h36	69*59,05	°N	126*03,05	° W	319	CTD down	199	300	11	-0.7
11-May-08	14h43	69*59,53	°N	126*02,95	° W	360	CTD up	199	300	12	-1.7
11-May-08	14h55	69*59,04	°N	126*02,97	° W	351	Tucker vertical down	198	300	11	-2
11-May-08	15h07	69*59,03	°N	126*02,92	° W	340	Tucker vertical up	199	300	11	-2
11-May-08	15h20	69*59,04	°N	126*02,96	° W	357	Tucker vertical and secchi disk down	198	300	11	-1.9
11-May-08	15h33	69*59,04	°N	126*02,91	° W	353	Tucker vertical up	199	300	12	-1.9
11-May-08	15h36	69*59,04	°N	126*02,91	° W	353	phytoplankton net down	199	300	11	-1.9
11-May-08	15h39	69*59,04	°N	126*02,91	° W	354	phytoplankton net up	199	300	11	-1.9
11-May-08	15h44	69*59,04	°N	126*02,91	° W	356	cage, water sampling down	199	295	14	-1.9
11-May-08	15h59	69*59,04	°N	126*02,92	° W	356	cage, water sampling up	206	295	11	-1.9
12-May-08	07h00	69*59,045	°N	126*02,916	° W	0.4	Rosette in - **cast 59**	205	310	4	-4.3
12-May-08	07h44	69*59,045	°N	126*02,917	° W	0	Rosette out	205	335	4	-4
12-May-08	08h40	69*59,045	°N	126*02,92	° W	0	Rosette in - **cast 60**	205	355	4	-3.7
12-May-08	09h15	69*59,044	°N	126*02,918	° W	359.9	Cage, water sampling start	206	25	5	-3.7

12-May-08	09h20	69*59,044	°N	126*02,918	° W	359.9	Rosette out	206	25	5	-3.7
12-May-08	09h30	69*59,044	°N	126*02,918	° W	359.4	cage, water sampling stop	206	25	5	-3.7
12-May-08	10h00	69*59,04	°N	126*02,92	° W	359.5	Hydrobios in	206	20	5	-3.7
12-May-08	10h15	69*59,04	°N	126*02,92	° W	359.5	Hydrobios out	206	20	5	-3.7
12-May-08	18h05	69*56,804	°N	126*10,317	° W	23	ice physic team #1 off ice	200	96	15	-1.6
12-May-08	18h10	69*56,804	°N	126*10,317	° W	23.3	sediment traps team off ice	199	96	15	-1.6
12-May-08	18h10	69*56,804	°N	126*10,317	° W	23.3	ice ohysic team #2 off ice	199	96	15	-1.6
12-May-08	19h00	69*56,81	°N	126*10,31	° W	23	oceano team off ice	199	90	15	-1.6
12-May-08	19h15	69*56,804	°N	126*10,31	° W	23	ice physic #1-2 back	199	90	15	-1.6
12-May-08	19h16	69*56,804	°N	126*10,317	° W	23	Rosette in - **cast 61**	199	90	18	-1.5
12-May-08	19h29	69*56,804	°N	126*10,317	° W	23	Rosette out	199	90	16	-1.6
12-May-08	19h35	69*56,81	°N	126*10,31	° W	23	contaminant team back	199	90	15	-1.6
12-May-08	21h05	69*56,80	°N	126*10,32	° W	23	sediment traps team back	199	90	20	-1.6
12-May-08	21h30	69*56,80	°N	126*10,32	° W	23	contaminant team off ice	199	90	20	-1.6
12-May-08	22h05	69*56,80	°N	126*10,32	° W	23	contaminant team back	199	90	20	-1.6
12-May-08	23h25	69*56,80	°N	126*10,32	° W	23	oceano team back	199	90	20	-2.6
13-May-08	07h08	69*56,805	°N	126*10,318	° W	23	Rosette in - **cast 62**	199	100	13	-4.4
13-May-08	07h30	69*56,805	°N	126*10,318	° W	23	Rosette out	199	100	14	-3.9
13-May-08	08h15	69*56,81	°N	126*10,31	° W	23	chemistery and biology off ice	199	100	15	-3.6
13-May-08	08h16	69*56,81	°N	126*10,31	° W	23	deployment hydrobios	199	100	15	-3.6
13-May-08	08h26	69*56,81	°N	126*10,31	° W	23	hydrobios in	192	100	15	-3.6
13-May-08	08h45	69*56,81	°N	126*10,31	° W	23	hydrobios out	192	100	15	-3.6
13-May-08	09h00	69*56,81	°N	126*10,31	° W	23	Tucker in	192	95	15	-1.5
13-May-08	09h05	69*56,81	°N	126*10,31	° W	23	Tucker out	192	95	15	-1.5
13-May-08	09h15	69*56,81	°N	126*10,31	° W	23	Tucker in	192	95	15	-1.5
13-May-08	09h30	69*56,81	°N	126*10,31	° W	23	Tucker out	192	95	15	-1.5
13-May-08	09h42	69*56,81	°N	126*10,31	° W	23	CO2 team off ice	192	95	15	-1.5
13-May-08	10h00	69*56,81	°N	126*10,31	° W	23	contaminants team off ice	192	100	15	-0.6
13-May-08	10h27	69*56,81	°N	126*10,31	° W	23	contaminants team back	192	100	15	-0.6
13-May-08	10h55	69*56,806	°N	126*10,37	° W	23	physic team off ice	192	100	15	-0.7
13-May-08	11h08	69*56,806	°N	126*10,37	° W	23	Rosette in - **cast 63**	192	95	17	-0.7
13-May-08	11h22	69*56,806	°N	126*10,37	° W	23	chemistery and biology back	192	95	15	-0.6
13-May-08	11h44	69*56,806	°N	126*10,37	° W	23	CO2 team back	192	95	15	-0.6

13-May-08	11h47	69*56,806	°N	126*10,37	° W	23	Rosette out / physic team back	192	95	15	-1.6
13-May-08	13h05	69*56,806	°N	126*10,37	° W	23	chemistery and biology off ice	192	105	18	2.4
13-May-08	13h10	69*56,806	°N	126*10,37	° W	23	physic team off ice	192	105	18	2.4
13-May-08	13h40	69*56,806	°N	126*10,37	° W	23	sea ice team off ice	192	100	17	2.5
13-May-08	15h07	69*56,806	°N	126*10,37	° W	23	Rosette in - **cast 64**	192	115	15	3.5
13-May-08	15h56	69*56,806	°N	126*10,37	° W	23	Rosette out	199	120	10	3.7
13-May-08	16h08	69*56,806	°N	126*10,37	° W	23	Tucker in	199	120	16	1.2
13-May-08	16h08	69*56,806	°N	126*10,37	° W	23	chemistery and biology team back	199	120	16	1.2
13-May-08	16h25	69*56,806	°N	126*10,37	° W	23	Tucker out	199	120	16	1.2
13-May-08	16h30	69*56,806	°N	126*10,37	° W	23	physic team back	199	120	17	4.1
13-May-08	16h30	69*56,806	°N	126*10,37	° W	23	Tucker in	199	120	17	4.1
13-May-08	16h45	69*56,806	°N	126*10,37	° W	23	Tucker out	199	122	17	4.3
13-May-08	16h45	69*56,806	°N	126*10,37	° W	23	sea ice team back	199	122	17	4.3
13-May-08	17h45	69*56,806	°N	126*10,37	° W	23	contaminant team off ice	199	120	13	4.3
13-May-08	18h00	69*56,806	°N	126*10,37	° W	23	oceano team off ice	199	125	16	4.8
13-May-08	18h15	69*56,806	°N	126*10,37	° W	23	sea ice team off ice	199	130	17	5.1
13-May-08	18h30	69*56,805	°N	126*10,319	° W	23.7	oceano team back	199	130	16	5.3
13-May-08	18h30	69*56,805	°N	126*10,319	° W	23.7	CO2 team back	199	130	16	5.3
13-May-08	18h59	69*56,805	°N	126*10,319	° W	23.7	Rosette in - **cast 65**	199	130	15	5.5
13-May-08	19h12	69*56,805	°N	126*10,319	° W	23.7	Rosette out	199	125	14	5.1
13-May-08	19h18	69*56,805	°N	126*10,319	° W	23.7	SCAMP in	199	125	15	5.1
13-May-08	19h45	69*56,805	°N	126*10,319	° W	23.7	Contaminant team back	199	130	14	4.8
13-May-08	19h50	69*56,805	°N	126*10,319	° W	23.7	sea ice physic team back	199	135	14	4.7
13-May-08	20h30	69*56,805	°N	126*10,319	° W	23.7	sea ice physic team off ice	199	135	14	4.7
13-May-08	20h40	69*56,805	°N	126*10,319	° W	23.7	SCAMP out	199	135	14	4.6
13-May-08	21h18	69*56,805	°N	126*10,319	° W	23.7	sea ice physic back	199	135	15	4.6
14-May-08	07h14	69*56,805	°N	126*10,319	° W	23.7	Rosette in - **cast 66**	199	0	1	-1.4
14-May-08	07h35	69*56,805	°N	126*10,319	° W	22.9	Rosette out	199	20	5	-0.8
14-May-08	08h13	69*56,805	°N	126*10,319	° W	22.9	Hydrobios in	192	50	5	-0.2
14-May-08	08h27	69*56,805	°N	126*10,319	° W	22.9	Hydrobios out	192	50	5	-0.2
14-May-08	08h38	69*56,805	°N	126*10,319	° W	22.9	Tucker in	192	90	3	1.9
14-May-08	09h06	69*56,805	°N	126*10,319	° W	22.9	Tucker out	192	90	3	2

14-May-08	09h18	69*56,805	°N	126*10,319	° W	23.1	sediment traps and physic team off ice	192	108	6	2.3
14-May-08	09h19	69*56,805	°N	126*10,319	° W	23.1	Tucker in	192	108	6	2.3
14-May-08	09h29	69*56,805	°N	126*10,319	° W	23.1	Tucker out	192	108	6	2.3
14-May-08	09h32	69*56,805	°N	126*10,319	° W	23.1	Tucker in	192	108	6	2.3
14-May-08	09h46	69*56,805	°N	126*10,319	° W	23.1	Tucker out	192	95	10	1.2
14-May-08	10h05	69*56,805	°N	126*10,319	° W	23.1	physical oceano team back	192	95	10	1.2
14-May-08	10h05	69*56,805	°N	126*10,319	° W	23.1	contaminant team off ice	192	95	10	1.2
14-May-08	10h45	69*56,805	°N	126*10,319	° W	23.1	albedo team off ice	192	105	12	1.4
14-May-08	10h46	69*56,805	°N	126*10,319	° W	23.1	sediment traps team off ice	192	105	12	1.4
14-May-08	10h55	69*56,805	°N	126*10,319	° W	23.1	Rosette in - **cast 67** / chemistery and biology and physic teams off ice	192	105	12	1.4
14-May-08	11h15	69*56,805	°N	126*10,319	° W	23.1	Rosette out	192	105	12	1.4
14-May-08	11h32	69*56,805	°N	126*10,319	° W	23.1	contaminant team back	192	105	12	2.5
14-May-08	11h45	69*56,805	°N	126*10,319	° W	23.1	alobedo team back	192	var	0	2.6
14-May-08	12h46	69*56,805	°N	126*10,319	° W	23.1	SCAMP in	192	115	12	2.8
14-May-08	13h00	69*56,805	°N	126*10,319	° W	23.1	CTD team off ice	192	110	11	2.2
14-May-08	13h25	69*56,805	°N	126*10,319	° W	23.1	weather balloon lauched	192	100	12	2.3
14-May-08	13h53	69*56,805	°N	126*10,319	° W	23.1	SCAMP out	192	105	13	1.9
14-May-08	14h15	69*56,805	°N	126*10,319	° W	23.1	CTD team back	192	100	18	2.3
14-May-08	14h55	69*56,805	°N	126*10,319	° W	23.1	Rosette in - **cast 68** / chemistery and biology and physic teams off ice	192	105	17	2.7
14-May-08	15h05	69*56,805	°N	126*10,319	° W	23.1	Rosette out	192	105	18	2.8
14-May-08	15h30	69*56,805	°N	126*10,319	° W	23.1	Physic team back	192	120	18	3.9
14-May-08	15h40	69*56,805	°N	126*10,319	° W	23.1	contaminant team back	192	119	20	3.9
14-May-08	16h00	69*56,805	°N	126*10,319	° W	23.1	sea ice physic team off ice	199	114	20	3.7
14-May-08	17h00	69*56,805	°N	126*10,319	° W	23	sea ice physic team back	199	110	22	3.4
14-May-08	18h25	69*56,806	°N	126*10,318	° W	22.9	sea ice physic off ice	199	110	18	2.6
14-May-08	18h40	69*56,806	°N	126*10,318	° W	22.9	sea ice physic back	199	110	19	2.5
14-May-08	18h57	69*56,806	°N	126*10,318	° W	22.9	Rosette in - **cast 69**	199	110	20	2.2
14-May-08	19h09	69*56,806	°N	126*10,318	° W	22.9	Rosette out	199	110	19	2.1
14-May-08	21h10	69*56,806	°N	126*10,318	° W	23	contaminant team off ice	192	100	20	0.8
14-May-08	22h10	69*56,806	°N	126*10,318	° W	23	contaminant team back	192	95	30	0.2

15-May-08	06h58	69*56,806	°N	126*10,318	° W	22.8	Rosette in - **cast 70**	199	90	32	-3.7
15-May-08	07h15	69*56,806	°N	126*10,318	° W	22.8	Rosette out	199	90	33	-3.5
15-May-08	09h08	69*56,806	°N	126*10,318	° W	22.8	surface water sampling team off ice	199	85	30	-3.5
15-May-08	10h08	69*56,806	°N	126*10,318	° W	22.8	surface water sampling team back	199	90	20	-2.8
15-May-08	11h00	69*56,806	°N	126*10,318	° W	22.8	Rosette in - **cast 71**	199	85	20	-2.8
15-May-08	11h45	69*56,806	°N	126*10,318	° W	22.9	Rosette out	199	95	20	-2.8
15-May-08	13h15	69*56,806	°N	126*10,318	° W	22.9	SCAMP in / water sampling team off ice	199	85	13	-2.8
15-May-08	13h28	69*56,806	°N	126*10,318	° W	22.9	water sampling team back	199	80	18	-0.4
15-May-08	14h18	69*56,806	°N	126*10,318	° W	22.9	SCAMP out	199	75	12	-0.4
15-May-08	15h00	69*56,806	°N	126*10,318	° W	22.9	Rosette in - **cast 72**	199	50	10	-0.5
15-May-08	15h10	69*56,806	°N	126*10,318	° W	22.9	chemistery and biology team off ice	199	55	11	-0.6
15-May-08	15h15	69*56,806	°N	126*10,318	° W	22.9	chemistery and biology team back	199	55	11	-0.6
15-May-08	15h30	69*56,806	°N	126*10,318	° W	22.9	Rosette out	199	55	11	-0.8
15-May-08	15h40	69*56,806	°N	126*10,318	° W	22.9	Tucker in	199	55	11	-0.8
15-May-08	16h02	69*56,806	°N	126*10,318	° W	23.1	Tucker out	199	30	7	-0.9
15-May-08	16h07	69*56,806	°N	126*10,318	° W	23.1	Tucker in	199	20	6	-0.9
15-May-08	16h05	69*56,806	°N	126*10,318	° W	23.1	Chris's team off ice	199	20	6	-0.9
15-May-08	16h05	69*56,806	°N	126*10,318	° W	23.1	physic team off ice	199	20	6	-0.9
15-May-08	16h20	69*56,806	°N	126*10,318	° W	23.1	Chris's team back	199	0	6	-0.9
15-May-08	16h20	69*56,806	°N	126*10,318	° W	23.1	ice team off ice	199	0	6	-0.9
15-May-08	16h20	69*56,806	°N	126*10,318	° W	23.1	Tucker out	199	0	6	-0.9
15-May-08	16h20	69*56,806	°N	126*10,318	° W	23.1	Tucker in	199	355	6	-0.9
15-May-08	16h43	69*56,806	°N	126*10,318	° W	23.1	Tucker out	199	350	9	-0.8
15-May-08	17h10	69*56,806	°N	126*10,318	° W	23.1	Physic team back	199	335	8	-0.9
15-May-08	18h00	69*56,806	°N	126*10,318	° W	23.1	balloon team off ice	199	310	10	-1.2
15-May-08	18h20	69*56,806	°N	126*10,318	° W	23.1	balloon team back	199	310	10	-1.1
15-May-08	19h05	69*56,806	°N	126*10,318	° W	23.1	Rosette in - **cast 73**	199	305	14	-1.1
15-May-08	19h15	69*56,806	°N	126*10,318	° W	23.1	Rosette out	199	310	15	-1.1
15-May-08	19h21	69*56,806	°N	126*10,318	° W	23.1	SCAMP in	199	310	14	-1
16-May-08	07h05	69*56,806	°N	126*10,318	° W	23.1	Rosette in - **cast 74**	199	300	19	-3.4

16-May-08	07h15	69*56,806	°N	126*10,318	° W	23.1	water sampling off ice	199	300	19	-3.4
16-May-08	07h20	69*56,806	°N	126*10,318	° W	23.1	Rosette out	199	300	19	-3.4
16-May-08	07h46	69*56,806	°N	126*10,318	° W	23.1	water sampling team back	199	305	18	-3.2
16-May-08	08h10	69*56,806	°N	126*10,318	° W	23.1	hydrobios in	199	305	18	-3.2
16-May-08	08h27	69*56,806	°N	126*10,318	° W	24	hydrobios out	192	305	18	-1.9
16-May-08	08h56	69*56,806	°N	126*10,318	° W	24	Tucker in	192	305	17	-2.8
16-May-08	09h12	69*56,806	°N	126*10,318	° W	24	Tucker out	192	305	18	-2.6
16-May-08	09h17	69*56,806	°N	126*10,318	° W	24	Tucker in	192	305	18	-2.6
16-May-08	09h30	69*56,806	°N	126*10,318	° W	24	Tucker out	192	305	18	-2.6
16-May-08	09h30	69*56,806	°N	126*10,318	° W	24	chemistery and biology team off ice	192	305	15	-2.6
16-May-08	09h38	69*56,806	°N	126*10,318	° W	24	CO2 team off ice	192	308	10	-2.6
16-May-08	09h40	69*56,806	°N	126*10,318	° W	24	snow physic team off ice	192	330	10	-2.6
16-May-08	11h00	69*56,806	°N	126*10,318	° W	24	chemistery and biology team back / Rosette in - **cast 75**	192	340	10	-1.4
16-May-08	11h15	69*56,806	°N	126*10,318	° W	24	Rosette out	192	340	10	-1.4
16-May-08	11h30	69*56,806	°N	126*10,318	° W	24	snow physic team back	192	340	10	-1.4
16-May-08	11h55	69*56,806	°N	126*10,318	° W	24	CO2 team back	192	15	5	-1.5
16-May-08	13h00	69*56,806	°N	126*10,318	° W	23.6	biology and physic team off ice	199	35	10	-1.9
16-May-08	13h45	69*56,806	°N	126*10,318	° W	22.9	ice coring team off ice	199	35	10	-1.9
16-May-08	15h20	69*56,806	°N	126*10,318	° W	23.3	Rosette in - **cast 76**	199	50	8	-1.7
16-May-08	15h30	69*56,806	°N	126*10,318	° W	23.3	Rosette out / biology and physic team back	199	60	8	-1.8
16-May-08	18h00	69*56,805	°N	126*10,317	° W	23.6	physic team off ice	80	80	11	-2.1
16-May-08	18h28	69*56,805	°N	126*10,317	° W	23.5	physic team back	95	95	8	-2.1
16-May-08	18h35	69*56,805	°N	126*10,317	° W	23.5	sea ice physic team off ice	95	95	8	-2
16-May-08	18h45	69*56,805	°N	126*10,317	° W	23.5	ice coring team back	100	100	9	-2
16-May-08	19h01	69*56,805	°N	126*10,317	° W	21.7	Rosette in -**cast 77**	199	95	8	-1.7
16-May-08	19h13	69*56,805	°N	126*10,317	° W	21.7	Rosette out / SCAMP in	199	85	8	-1.9
16-May-08	20h30	69*56,805	°N	126*10,317	° W	21.8	sea ice physic back	192	85	8	-1.9
16-May-08	20h35	69*56,805	°N	126*10,317	° W	21.8	SCAMP out	192	88	8	-1.9
16-May-08	20h55	69*56,805	°N	126*10,317	° W	23.4	cod cage out	192	100	8	-1.9
17-May-08	06h15	69*56,805	°N	126*10,317	° W	23.4	code cage in	199	103	8	-3.6
17-May-08	07h01	69*56,805	°N	126*10,317	° W	23.4	Rosette in - **cast 78**	199	103	8	-3.1

17-May-08	07h22	69*56,805	°N	126*10,317	° W	23.4	Rosette out	199	120	11	-2.5
17-May-08	08h20	69*56,805	°N	126*10,317	° W	23.4	Hydrobios in	199	108	9	-2.3
17-May-08	08h35	69*56,805	°N	126*10,317	° W	23.4	Hydrobios out	199	108	9	-2.3
17-May-08	08h36	69*56,805	°N	126*10,317	° W	24	ice physic team off ice	199	108	10	-2.2
17-May-08	09h07	69*56,805	°N	126*10,317	° W	24	Tucker in	199	110	10	-2.2
17-May-08	09h20	69*56,805	°N	126*10,317	° W	24	Tucker out	199	110	10	-2.2
17-May-08	09h25	69*56,805	°N	126*10,317	° W	24	Tucker in	199	110	10	-2.2
17-May-08	09h45	69*56,805	°N	126*10,317	° W	24	Tucker out	197	113	8	-2.5
17-May-08	09h49	69*56,805	°N	126*10,317	° W	24	Tucker in	197	113	8	-2.5
17-May-08	10h03	69*56,805	°N	126*10,317	° W	24	Tucker out	197	113	8	-2.5
17-May-08	10h45	69*56,805	°N	126*10,317	° W	24	sea ice physic team back	198	125	5	-1.1
17-May-08	11h00	69*56,805	°N	126*10,317	° W	24	Rosette in -**cast 79**	198	124	11	-0.7
17-May-08	11h25	69*56,805	°N	126*10,317	° W	24	Rosette out	198	124	10	-0.6
17-May-08	12h50	69*56,805	°N	126*10,317	° W	21.7	SCAMP in	199	135	7	-0.2
17-May-08	14h03	69*56,805	°N	126*10,317	° W	21.7	SCAMP out	199	120	9	-0.9
17-May-08	14h25	69*56,805	°N	126*10,317	° W	21.7	water sampling and contaminant team off ice	199	95	9	-1.7
17-May-08	14h30	69*56,805	°N	126*10,317	° W	21.7	CO2 team off ice	199	95	9	-1.7
17-May-08	15h00	69*56,805	°N	126*10,317	° W	21.7	Rosette in - **cast 80**	199	110	6	-0.2
17-May-08	15h15	69*56,805	°N	126*10,317	° W	21.7	Rosette out	199	100	8	-0.1
17-May-08	15h25	69*56,805	°N	126*10,317	° W	21.7	contaminant team back	199	110	11	-1.1
17-May-08	15h35	69*56,805	°N	126*10,317	° W	21.7	Tucker in	199	115	6	-0.8
17-May-08	15h55	69*56,805	°N	126*10,317	° W	21.7	Tucker out	199	90	6	-0.3
17-May-08	16h00	69*56,805	°N	126*10,317	° W	21.7	Tucker in	199	90	6	-0.3
17-May-08	16h14	69*56,805	°N	126*10,317	° W	21.7	Tucker out	199	85	10	-1.5
17-May-08	16h30	69*56,805	°N	126*10,317	° W	21.7	water sampling team back	199	100	8	-1.6
17-May-08	17h00	69*56,805	°N	126*10,317	° W	21.7	CO2 team back	199	85	7	-0.3
17-May-08	18h10	69*56,805	°N	126*10,317	° W	21.7	sea ice physic team off ice	199	70	9	-1.4
17-May-08	18h15	69*56,805	°N	126*10,317	° W	21.7	physic team off ice	199	70	9	-1.4
17-May-08	18h25	69*56,805	°N	126*10,317	° W	21.7	CO2 team off ice	199	80	8	-1.4
17-May-08	19h00	69*56,805	°N	126*10,317	° W	21.7	Rosette in - **cast 81**	199	65	8	-1.6
17-May-08	19h15	69*56,805	°N	126*10,317	° W	21.7	Rosette out	199	75	8	-1.9
17-May-08	19h45	69*56,805	°N	126*10,317	° W	21.7	sea ice physic team back	199	50	7	-2.2

17-May-08	19h45	69*56,805	°N	126*10,317	° W	21.7	CO2 team back	199	50	7	-2.2
17-May-08	19h55	69*56,805	°N	126*10,317	° W	23.5	physic team back	199	80	8	-2.2
17-May-08	19h55	69*56,805	°N	126*10,317	° W	23.5	cod cage in	199	80	8	-2.2
17-May-08	21h55	69*56,805	°N	126*10,317	° W	23.5	beluga survey team back	199	36	10	-3.1
18-May-08	06h10	69*56,805	°N	126*10,317	° W	23.5	sea ice physic off ice	199	330	9	-4.9
18-May-08	06h35	69*56,805	°N	126*10,317	° W	23.5	sediment traps off ice	199	355	7	-4.8
18-May-08	07h20	69*56,805	°N	126*10,317	° W	23.5	cod cage out	199	345	9	-4.8
18-May-08	07h50	69*56,805	°N	126*10,317	° W	23.5	sediment traps team back	199	325	8	-4.8
18-May-08	08h00	69*56,805	°N	126*10,317	° W	23.5	sea ice physic team back	199	325	10	-4.8
18-May-08	15h15	70*26,91	°N	124*11,84	° W	60	LAWAS start	316	35	7	-3.1
18-May-08	16h36	70*30,361	°N	123*53,342	° W	60	LAWAS stop	430	25	4	-3.1
18-May-08	20h45	70*48,77	°N	122*37,69	° W	5	cod cage in	420	84	6	-1.5
19-May-08	05h40	70*51,427	°N	122*41,007	° W	11.8	cod cage out	316	280	5	-3.5
19-May-08	07h20	70*39,63	°N	122*52,76	° W	324	Rosette in - **cast 82**	515	245	7	-2.8
19-May-08	08h08	70*39,462	°N	122*52,844	° W	358	Rosette out	527	265	6	-2.9
19-May-08	08h55	70*39,418	°N	122*54,392	° W	70	Tucker in	535	270	5	-2.9
19-May-08	09h22	70*39,233	°N	122*54,474	° W	345	Tucker out	562	256	9	-2.9
19-May-08	10h00	70*39,120	°N	122*53,233	° W	90	Tucker in	562	256	9	-2.9
19-May-08	10h06	70*39,089	°N	122*52,563	° W	85	Tucker out	548	256	9	-2.9
19-May-08	10h22	70*39,006	°N	122*51,152	° W	80	cage, water sampling start	548	246	9	-2.9
19-May-08	10h58	70*38,808	°N	122*50,121	° W	178	cage, water sampling stop	542	235	10	-2.1
19-May-08	12h14	70*40,27	°N	122*49,88	° W	210	Rosette in - **cast 83**	591	230	13	-2.6
19-May-08	13h18	70*41,57	°N	122*49,12	° W	306	Rosette out	596	230	14	-2.9
19-May-08	13h49	70*39,24	°N	122*52,41	° W	244	PNF in	535	230	12	-2.5
19-May-08	13h54	70*39,25	°N	122*52,40	° W	211	PNF out	535	230	12	-2.5
19-May-08	13h56	70*39,23	°N	122*52,39	° W	209	Secchi in/out	535	230	12	-2.5
19-May-08	14h01	70*39,22	°N	122*52,39	° W	236	Phytoflah in	537	230	13	-2.4
19-May-08	14h24	70*39,27	°N	122*52,38	° W	233	Phytoflash out	536	220	11	-2.1
19-May-08	14h27	70*39,28	°N	122*52,39	° W	229	CTD in	536	220	11	-2.1
19-May-08	14h41	70*39,34	°N	122*52,41	° W	195	CTD out	536	220	12	-2.2
19-May-08	14h55	70*39,32	°N	122*51,89	° W	155	cage / UV profile in	536	215	10	-2.1
19-May-08	15h01	70*39,35	°N	122*51,67	° W	157	UV profile out	538	220	9	-2
19-May-08	15h05	70*39,37	°N	122*51,54	° W	163	UV profile in	538	220	9	-2

19-May-08	15h12	70*39,41	°N	122*51,26	° W	158	UV profile out	538	220	9	-2
19-May-08	15h14	70*39,42	°N	122*51,21	° W	156	UV profile in	538	220	9	-2
19-May-08	15h23	70*39,48	°N	122*50,87	° W	154	cage / UV profile out	546	220	9	-2
19-May-08	15h33	70*39,49	°N	122*50,66	° W	220	Plankton net in	548	210	8	-2.1
19-May-08	15h49	70*39,53	°N	122*50,77	° W	200	Plankton net out	543	220	8	-2.2
19-May-08	16h02	70*39,54	°N	122*50,75	° W	196	Rosette in - **cast 84**	544	200	9	-2.1
19-May-08	16h52	70*39,55	°N	122*50,78	° W	187	Rosette out	544	190	6	-1.9
19-May-08	17h36	70*39,46	°N	122*52,67	° W	187	Rosette in -**cast 85**	510	170	5	-2
19-May-08	18h06	70*39,49	°N	122*52,68	° W	181	Rosette out	511	165	5	-1.8
19-May-08	18h42	70*39,54	°N	122*52,74	° W	158	Hydrobios in	521	145	6	-2
19-May-08	19h17	70*39,54	°N	122*52,96	° W	146	Hydrobios out	490	120	8	-2.2
19-May-08	19h43	70*39,63	°N	122*52,80	° W	123	LAWAS start	514	115	7	-2.3
19-May-08	20h24	70*39,684	°N	122*52,720	° W	130	Box core down	507	115	7	-2.3
19-May-08	20h35	70*39,674	°N	122*52,904	° W	135	Box core at sea floor	507	120	7	-2.5
19-May-08	20h45	70*39,674	°N	122*52,904	° W	135	Box core on board	507	120	7	-2.5
19-May-08	20h48	70*39,732	°N	122*52,908	° W	138	Box core down	507	120	7	-2.5
19-May-08	21h00	70*39,745	°N	122*53,209	° W	135	Box core at sea floor	494	115	5	-2.5
19-May-08	21h08	70*39,745	°N	122*53,209	° W	135	Box core on board	495	115	5	-2.5
20-May-08	09h00	71*34,380	°N	119*36,415	° W	357.3	EM scan setting off ice	123	115	5	-2
20-May-08	09h00	71*34,380	°N	119*36,415	° W	357.3	chemistery, biology and physic teams off ice	123	115	5	-2
20-May-08	09h00	71*34,380	°N	119*36,415	° W	357.3	contaminants team off ice	123	115	5	-2
20-May-08	09h20	71*34,380	°N	119*36,415	° W	357.3	EM scan team back	123	var	5	-1.8
20-May-08	09h20	71*34,380	°N	119*36,415	° W	357.3	primary production and CO2 team off ice	123	340	5	-1
20-May-08	09h42	71*34,380	°N	119*36,415	° W	357.3	snow transect team off ice	123	342	5	-1.8
20-May-08	09h42	71*34,380	°N	119*36,415	° W	357.3	contaminants team back	123	342	5	-1
20-May-08	11h00	71*34,380	°N	119*36,415	° W	357.3	chemistery, biology and physic teams back	123	311	10	-1
20-May-08	11h52	71*34,380	°N	119*36,415	° W	357.3	snow transect back	123	303	10	-1
20-May-08	12h00	71*34,380	°N	119*36,415	° W	357.3	Rosette in - **cast 86**	130	305	9	-1.1
20-May-08	12h27	71*34,380	°N	119*36,415	° W	357.3	Rosette out	130	315	10	-0.7
20-May-08	12h40	71*34,380	°N	119*36,415	° W	357.3	SCAMP in	132	315	10	-0.4
20-May-08	13h27	71*34,380	°N	119*36,415	° W	357.3	SCAMP out	132	300	11	-0.3

20-May-08	13h45	71*34,380	°N	119*36,415	° W	357.3	Rosette in - **cast 87**	132	300	10	-0.4
20-May-08	14h00	71*34,380	°N	119*36,415	° W	357.3	Rosette out	132	300	11	-0.6
20-May-08	14h05	71*34,380	°N	119*36,415	° W	357.3	SCAMP in	132	300	11	-0.6
20-May-08	14h26	71*34,380	°N	119*36,415	° W	357.3	SCAMP out	132	300	11	-0.3
20-May-08	14h40	71*34,380	°N	119*36,415	° W	357.3	Rosette in - **cast 88**	132	300	10	-0.2
20-May-08	14h47	71*34,380	°N	119*36,415	° W	357.3	Rosette out	132	300	10	-0.2
20-May-08	15h16	71*34,380	°N	119*36,415	° W	357.3	Rosette in - **cast 89**	132	300	10	-0.1
20-May-08	15h22	71*34,380	°N	119*36,415	° W	357.3	Rosette out	132	285	10	-0.1
20-May-08	15h55	71*34,380	°N	119*36,415	° W	357.3	Biology team back	132	285	11	-0.2
20-May-08	15h55	71*34,380	°N	119*36,415	° W	357.3	Rosette in - **cast 90**	132	300	11	-0.2
20-May-08	16h18	71*34,380	°N	119*36,415	° W	357.3	Rosette out	132	300	9	-0.1
20-May-08	16h22	71*34,380	°N	119*36,415	° W	357.3	SCAMP in	132	290	9	0
20-May-08	16h45	71*34,380	°N	119*36,415	° W	357.3	SCAMP out	132	300	10	-0.2
20-May-08	17h00	71*34,380	°N	119*36,415	° W	357.3	Rosette in - **cast 91**	132	305	11	-0.4
20-May-08	17h16	71*34,380	°N	119*36,415	° W	357.3	Rosette out	132	305	12	-0.6
20-May-08	17h35	71*34,380	°N	119*36,415	° W	357.5	sea ice physic back	132	300	11	-0.3
20-May-08	17h55	71*34,380	°N	119*36,415	° W	357.5	Rosette in - **cast 92**	132	300	10	-0.3
20-May-08	18h04	71*34,380	°N	119*36,415	° W	357.5	Rosette out	132	310	13	-0.4
20-May-08	18h17	71*34,380	°N	119*36,415	° W	357.5	Tucker in	132	300	11	-0.4
20-May-08	18h25	71*34,380	°N	119*36,415	° W	357.5	Tucker out	132	300	10	-0.4
20-May-08	18h33	71*34,380	°N	119*36,415	° W	357.5	Tucker in	132	300	10	-0.4
20-May-08	18h42	71*34,380	°N	119*36,415	° W	357.5	Tucker out	132	300	10	-0.4
20-May-08	18h42	71*34,380	°N	119*36,415	° W	357.5	sea ice physic off ice	132	300	10	-0.4
20-May-08	18h47	71*34,380	°N	119*36,415	° W	357.5	EM team off ice	132	300	10	-0.4
20-May-08	19h19	71*34,380	°N	119*36,415	° W	357.5	SCAMP in	132	300	13	-0.1
20-May-08	19h25	71*34,380	°N	119*36,415	° W	357.5	SCAMP out	132	300	13	-0.1
20-May-08	19h35	71*34,380	°N	119*36,415	° W	357.5	Rosette in - **cast 93**	132	300	14	-0.1
20-May-08	19h42	71*34,380	°N	119*36,415	° W	357.5	Rosette out	132	300	14	-0.1
20-May-08	19h48	71*34,380	°N	119*36,415	° W	357.5	sea ice physic back	132	300	16	-0.3
20-May-08	19h55	71*34,380	°N	119*36,415	° W	357.5	EM team back	132	300	19	-0.3
20-May-08	20h00	71*34,380	°N	119*36,415	° W	357.5	Rosette in - **cast 94**	132	300	19	-0.4
20-May-08	20h11	71*34,380	°N	119*36,415	° W	357.5	Rosette out	132	309	17	-0.4
20-May-08	21h00	71*34,380	°N	119*36,415	° W	357.5	Rosette in - **cast 95**	132	310	17	-0.6

20-May-08	21h05	71*34,380	°N	119*36,415	° W	357.5	Rosette out	132	310	17	-0.6
20-May-08	22h05	71*34,380	°N	119*36,415	° W	357.5	Rosette in - **cast 96**	132	310	17	-0.6
20-May-08	22h12	71*34,380	°N	119*36,415	° W	357.4	Rosette out	132	298	15	-1.2
20-May-08	22h26	71*34,380	°N	119*36,415	° W	357.5	SCAMP in	132	298	15	-1.2
20-May-08	22h45	71*34,380	°N	119*36,415	° W	357.5	SCAMP out	132	290	15	-1.4
20-May-08	23h03	71*34,380	°N	119*36,415	° W	357.5	Rosette in - **cast 97**	132	290	15	-1.4
20-May-08	23h15	71*34,380	°N	119*36,415	° W	357.4	Rosette out	132	290	15	-1.4
21-May-08	00h00	71*34,380	°N	119*36,415	° W	357.5	Rosette in - **cast 98**	132	300	17	-2
21-May-08	00h10	71*34,380	°N	119*36,415	° W	357.5	Rosette out	132	310	17	-2.1
21-May-08	00h57	71*34,380	°N	119*36,415	° W	357.5	Rosette in - **cast 99**	132	295	15	-2
21-May-08	01h08	71*34,380	°N	119*36,415	° W	357.4	Rosette out	132	295	18	-2
21-May-08	01h13	71*34,380	°N	119*36,415	° W	357.5	SCAMP in	132	295	18	-2
21-May-08	01h38	71*34,380	°N	119*36,415	° W	357.5	SCAMP out	132	300	14	-2.1
21-May-08	15h58	70*43,75	°N	124*01,17	° W	268	secchi disk down	439	270	11	-1.9
21-May-08	16h02	70*43,75	°N	124*01,16	° W	265	secchi disk up	439	270	13	-2.2
21-May-08	16h15	70*43,76	°N	124*01,14	° W	254	cage, UV profil down	439	260	14	-2.2
21-May-08	16h21	70*43,75	°N	124*01,12	° W	244	UV profile up	439	260	14	-2.3
21-May-08	16h23	70*43,75	°N	124*01,12	° W	244	UV profile down	439	260	14	-2.3
21-May-08	16h29	70*43,72	°N	124*01,13	° W	254	UV profile up	439	280	15	-2.3
21-May-08	16h31	70*43,72	°N	124*01,13	° W	257	UV profile down	439	280	14	-2.3
21-May-08	16h40	70*43,70	°N	124*01,11	° W	264	cage, UV profile up	439	260	14	-2.5
21-May-08	16h53	70*43,69	°N	124*00,76	° W	15	cage, contaminant team down	442	260	12	-2.7
21-May-08	17h21	70*43,74	°N	123*59,89	° W	8	cage, contaminant team up	444	270	12	-3
21-May-08	17h33	70*43,81	°N	123*59,95	° W	260	Rosette in - **cast 100**	436	270	14	-2.9
21-May-08	18h32	70*43,66	°N	123*59,87	° W	283	Rosette out	448	275	12	-2.3
21-May-08	17h45	70*43,79	°N	123*59,92	° W	256	Zodiac, SCAMP out	437	270	13	-2.8
21-May-08	19h15	70*43,467	°N	124*03,454	° W	256	ice teams back on ship	461	260	11	-1.7
21-May-08	19h15	70*43,467	°N	124*03,454	° W	256	skippy boat back on ship	461	260	11	-1.7
21-May-08	19h35	70*43,333	°N	124*03,340	° W	256	zodiac, SCAMP back	464	260	11	-1.7
21-May-08	19h50	70*42,807	°N	124*04,859	° W	270	cage, water sampling down	498	260	11	-1.7
21-May-08	20h07	70*42,701	°N	124*05,36	° W	270	cage, water sampling up	506	260	11	-1.7
21-May-08	20h12	70*42,490	°N	124*04,228	° W	270	LAWAS start	500	277	13	-1.7
21-May-08	20h36	70*42,182	°N	124*00,140	° W	90	Tucker in	461	277	13	-1.7

21-May-08	20h54	70*42,158	°N	123*59,940	° W	270	Tucker out	460	277	13	-1.7
21-May-08	21h15	70*42,179	°N	123*59,324	° W	270	Rosette in - **cast 101**	451	240	11	-1.8
21-May-08	21h57	70*42,117	°N	124*00,349	° W	297	Rosette out	461	260	15	-1.8
21-May-08	22h18	70*41,966	°N	123*59,537	° W	299	Mounster net in	461	260	15	-1
21-May-08	22h48	70*42,107	°N	123*59,685	° W	270	Mounster net out	461	252	13	-3
21-May-08	23h01	70*42,251	°N	123*59,250	° W	72	Plankton net in	461	252	13	-3
21-May-08	23h08	70*42,314	°N	123*58,541	° W	90	Plankton net out	461	252	13	-3
21-May-08	23h10	70*42,341	°N	123*58,562	° W	90	Plankton net in	461	252	13	-3
21-May-08	23h20	70*42,348	°N	123*58,000	° W	90	Plankton net out	461	252	13	-3
21-May-08	23h21	70*42,348	°N	123*58,000	° W	90	LAWAS stop	461	252	13	-3
21-May-08	23h22	70*42,209	°N	123*59,538	° W	270	Plankton net in	461	252	13	-3
21-May-08	23h35	70*42,300	°N	123*59,570	° W	270	Plankton net out	461	252	13	-3
21-May-08	23h43	70*42,281	°N	123*59,866	° W	270	Plankton net in	461	252	13	-3
21-May-08	23h51	70*42,31	°N	123*59,96	° W	270	Plankton net out	461	265	10	-3.4
22-May-08	00h05	70*42,35	°N	124*00,03	° W	249	Rosette in - **cast 102**	461	275	14	-3.5
22-May-08	01h05	70*42,29	°N	124*00,20	° W	266	Rosette out	457	255	11	-4
22-May-08	07h25	70*41,90	°N	124*17,68	° W	236	Hydrobios in	464	245	14	-2.3
22-May-08	07h56	70*41,91	°N	124*17,81	° W	246	Hydrobios out	451	245	14	-2.2
22-May-08	08h12	70*41,99	°N	124*18,11	° W	260	Phytoflash in	447	260	12	-2.1
22-May-08	08h31	70*42,02	°N	124*18,31	° W	241	Phytoflash out	444	245	13	-2
22-May-08	08h35	70*42,02	°N	124*18,34	° W	238	CTD, front deck in	442	245	13	-2
22-May-08	08h49	70*42,05	°N	124*18,36	° W	281	CTD, front deck out	450	250	14	-1.9
23-May-08	09h00	72*38,71	°N	127*22,75	° W	198	secchi disk in	135	225	7	-3
23-May-08	09h12	72*38,71	°N	127*22,75	° W	163	secchi disk out	136	225	7	-3
23-May-08	09h30	72*38,52	°N	127*38,52	° W	285	zodiac lauched	136	215	10	-3.2
23-May-08	09h33	72*38,54	°N	127*38,71	° W	285	zodiac back	136	215	10	-3.2
23-May-08	09h35	72*38,54	°N	127*22,71	° W	290	zodiac, SCAMP out	136	215	10	-3.2
23-May-08	09h46	72*38,62	°N	127*23,38	° W	249	Tucker in	135	208	10	-3.2
23-May-08	10h00	72*38,33	°N	127*23,09	° W	86	Tucker out	136	219	10	-3.2
23-May-08	10h21	72*37,98	°N	127*22,45	° W	220	Mounster net in	131	213	9	-3
23-May-08	10h31	72*38,00	°N	127*22,35	° W	264	Mounster net out	129	211	11	-3.1
23-May-08	11h30	72*38,97	°N	127*23,36	° W	296	zodiac, SCAMP back	138	207	12	-2.9
23-May-08	11h50	72*38,92	°N	127*23,85	° W	223	Rosette in - **cast 103**	137	207	12	-3.1

23-May-08	12h23	72*38,86	°N	127*23,50	° W	235	Rosette out	139	200	14	-2.8
23-May-08	12h41	72*38,86	°N	127*23,51	° W	220	secchi in	139	200	14	-2.8
23-May-08	12h47	72*38,86	°N	127*23,47	° W	220	secchi out	139	200	14	-2.8
23-May-08	12h53	72*38,85	°N	127*23,51	° W	218	PNF in	138	200	14	-2.7
23-May-08	12h57	72*38,84	°N	127*23,50	° W	224	PNF out	137	200	15	-2.7
23-May-08	13h30	72*39,69	°N	127*23,22	° W	297	Zodiac, light profile in	139	210	13	-2.8
23-May-08	13h36	72*39,72	°N	127*23,33	° W	226	Zodiac, light profile out	138	210	13	-2.8
23-May-08	13h55	72*39,74	°N	127*23,33	° W	237	Phytoflash in	137	200	14	-2.5
23-May-08	13h56	72*39,74	°N	127*23,33	° W	222	Phytoflash out	137	200	14	-2.5
23-May-08	14h05	72*39,71	°N	127*23,24	° W	175	CTD, front deck in	142	200	13	-2.5
23-May-08	14h45	72*39,77	°N	127*21,36	° W	240	CTD, front deck out	140	200	18	-2.5
23-May-08	15h00	72*39,85	°N	127*21,72	° W	262	cage, surface water sampling down	137	200	17	-2.6
23-May-08	15h04	72*39,89	°N	127*21,79	° W	272	cage, surface water sampling up	137	200	17	-2.6
23-May-08	15h23	72*39,95	°N	127*21,80	° W	211	Rosette in - **cast 104**	137	195	15	-2.4
23-May-08	16h05	72*39,97	°N	127*21,70	° W	211	Rosette out	139	200	16	-2.4
23-May-08	16h21	72*39,99	°N	127*21,60	° W	214	cage down, contaminant team	137	195	16	-2.4
23-May-08	16h43	72*40,02	°N	127*21,67	° W	216	cage up, contaminant team	139	195	16	-2.5
23-May-08	16h49	72*39,99	°N	127*241,68	° W	238	plankton net in	139	190	15	-2.4
23-May-08	16h58	72*40,08	°N	127*21,90	° W	263	plankton net out	138	195	17	-2.4
23-May-08	17h11	72*39,37	°N	127*23,66	° W	206	plankton net in	143	195	14	-2.3
23-May-08	17h15	72*39,37	°N	127*23,64	° W	203	plankton net out	143	195	16	-2.3
23-May-08	17h20	72*39,36	°N	127*23,59	° W	206	plankton net in	143	195	15	-2.3
23-May-08	17h25	72*39,37	°N	127*23,57	° W	209	plankton net out	143	195	15	-2.3
23-May-08	17h29	72*39,39	°N	127*23,60	° W	221	plankton net in	144	195	16	-2.4
23-May-08	17h35	72*39,41	°N	127*23,64	° W	210	plankton net out	143	185	15	-2.4
23-May-08	17h59	72*39,46	°N	127*23,66	° W	219	Rosette in - **cast 105**	143	190	12	-2.3
23-May-08	18h28	72*39,48	°N	127*23,81	° W	205	Rosette out	139	185	15	-2.3
23-May-08	18h18	72*39,48	°N	127*23,78	° W	216	LAWAS start	139	185	14	-2.3
23-May-08	18h45	72*39,48	°N	127*23,79	° W	212	Hydrobios in	139	180	14	-2.2
23-May-08	19h01	72*39,49	°N	127*23,79	° W	209	Hydrobios out	141	180	13	-2.1
23-May-08	19h21	72*39,54	°N	127*23,75	° W	245	Epibenthic trawl in	145	185	15	-1.9
23-May-08	19h39	72*39,51	°N	127*24,90	° W	262	Epibenthic trawl out	141	180	13	-2

24-May-08	10h40	72*36,605	°N	126*02,186	° W	96	snow sampling team off ice	18	170	13	1.4
24-May-08	10h40	72*36,605	°N	126*02,186	° W	96	physic team off ice	18	170	13	1.4
24-May-08	10h40	72*36,605	°N	126*02,186	° W	96	chemistery team off ice	18	170	13	1.4
24-May-08	12h00	72*36,6	°N	126*02,16	° W	95.9	team off ice	45	175	12	1.6
24-May-08	16h00	72*36,6	°N	126*02,16	° W	95.9	team off ice	45	175	20	2.5
24-May-08	19h25	72*36,659	°N	126*02,980	° W	na	LAWAS stop	21	180	16	3.6
24-May-08	21h40	72*39,639	°N	127*29,69	° W	na	Rosette in - **cast 106**	152	162	20	1.4
24-May-08	22h55	72*39,639	°N	127*29,620	° W	na	Rosette out	152	162	20	1.4
24-May-08	22h40	72*36,78	°N	127*55,35	° W	na	Rosette in - **cast 107**	169	150	20	1
24-May-08	22h47	72*39,814	°N	127*55,259	° W	na	Rosette out	169	150	20	1
24-May-08	23h51	72*39,46	°N	128*20,87	° W	155	Rosette in - **cast 108**	224	140	17	0.7
25-May-08	00h27	72*39,46	°N	128*20,79	° W	166	Rosette out	226	140	18	0.5
25-May-08	08h10	72*39,81	°N	128*58,81	° W	130	Rosette in - **cast 109**	302	140	13	0.6
25-May-08	08h25	72*39,82	°N	128*58,80	° W	140	Rosette out	302	140	12	0.6
25-May-08	09h41	72*39,19	°N	129*26,61	° W	150	Rosette in - **cast 110**	611	150	10	0.9
25-May-08	10h40	72*38,90	°N	129*27,11	° W	101	Rosette out	595	126	6	1.2
25-May-08	13h20	72*33,4	°N	129*35,15	° W	20	multi year ice, team off ice	na	80	6	1.2
25-May-08	13h54	72*34,06	°N	129*31,94	° W	87	Zodiac, SCAMP out	655	90	7	0.6
25-May-08	14h17	72*33,89	°N	129*32,01	° W	70	cage down , UV profile	640	110	9	0.5
25-May-08	14h54	72*33,72	°N	129*32,01	° W	88	cage up, UV profile	649	120	10	0.5
25-May-08	15h00	72*33,70	°N	129*32,03	° W	90	secchi disk down	652	115	9	0.5
25-May-08	15h04	72*33,67	°N	129*32,05	° W	88	secchi disk up	652	115	9	0.5
25-May-08	15h22	72*33,58	°N	129*32,18	° W	71	Rosette in - **cast 111**	660	110	11	0.3
25-May-08	16h04	72*33,49	°N	129*32,21	° W	76	Rosette out	662	90	10	0.2
25-May-08	15h37	72*33,56	°N	129*32,15	° W	71	Zodiac, SCAMP back	660	110	9	0.3
25-May-08	18h05	72*32,24	°N	129*35,16	° W	140	Tucker in	720	115	9	0.3
25-May-08	18h17	72*31,98	°N	129*34,60	° W	125	Tucker out	706	85	7	0.2
25-May-08	18h35	72*31,86	°N	129*34,20	° W	63	Mounster net in	697	85	8	0.3
25-May-08	19h16	72*31,83	°N	129*34,17	° W	50	Mounster net out	696	65	12	0.2
25-May-08	20h40	72*31,58	°N	129*34,50	° W	40	Hydrobios in	699	43	15	0.2
25-May-08	21h21	72*31,24	°N	129*34,84	° W	64	Hydrobios out	694	76	16	0.1
26-May-08	09h15	74*09,00	°N	128*49,96	° W	229	Zodiac, SCAMP out	380	319	24	-1.3
26-May-08	09h24	74*08,90	°N	128*50,05	° W	230	ice team off ice	383	328	23	-1.4

26-May-08	10h01	74*08,35	°N	128*52,94	° W	326	Rosette in - **cast 112**	378	316	24	-1.9
26-May-08	11h00	74*08,01	°N	128*53,65	° W	340	Rosette out	381	300	24	-2
26-May-08	11h05	74*07,99	°N	128*53,52	° W	44	Zodiac, SCAMP back	378	309	20	-2
26-May-08	11h12	74*07,80	°N	128*52,51	° W	214	secchi disk in	380	321	23	-2.4
26-May-08	11h18	74*07,62	°N	128*52,66	° W	200	secchi disk out	379	317	21	-1.6
26-May-08	11h20	74*07,62	°N	128*52,66	° W	194	secchi disk in	379	317	21	-1.6
26-May-08	11h35	74*07,35	°N	128*53,69	° W	207	secchi disk out	381	316	22	-1.6
26-May-08	11h47	74*07,00	°N	128*55,52	° W	297	cage down, water sampling	379	310	21	-1.9
26-May-08	11h50	74*07,00	°N	128*55,52	° W	297	cage up, water sampling	379	310	21	-1.9
26-May-08	12h38	74*05,07	°N	128*56,52	° W	304	secchi disk in	385	300	18	-1.5
26-May-08	12h41	74*05,02	°N	128*56,78	° W	315	secchi disk out	385	300	18	-2
26-May-08	12h41	74*05,02	°N	128*56,78	° W	315	PNF in	385	300	18	-2
26-May-08	12h45	74*04,98	°N	128*56,84	° W	326	PNF out	383	300	20	-2
26-May-08	13h15	74*05.32	°N	128*57.20	° W	360	Tucker in	383	310	21	-2
26-May-08	13h29	74*05.32	°N	128*57.20	° W	360	Tucker out	383	320	23	-1.9
26-May-08	13h55	74*04.48	°N	128*58.81	° W	2	Mounster net in	386	330	22	-1.6
26-May-08	14h20	74*04.54	°N	128*58.97	° W	270	Mounster net out	388	330	18	-1.8
26-May-08	14h41	74*04.43	°N	129*00.60	° W	360	Rosette in - **cast 113**	386	315	18	-1.8
26-May-08	15h28	74*04.34	°N	129*01.12	° W	327	Rosette out	391	310	19	-2.1
26-May-08	15h53	74*04.38	°N	129*01.43	° W	329	Hydrobios in	392	305	17	-2.2
26-May-08	16h22	74*04.36	°N	129*01.75	° W	335	Hydrobios out	392	305	18	-2.4
26-May-08	18h18	74*21.09	°N	129*02.28	° W	345	Rosette in - **cast 114**	394	320	15	-2.5
26-May-08	19h10	74*21.08	°N	129*02.75	° W	358	Rosette out	397	335	15	-2.5
26-May-08	20h25	74*19.89	°N	129*31.66	° W	331	Rosette in - **cast 115**	378	320	14	-2.4
26-May-08	20h37	74*19.90	°N	128*32.04	° W	335	Rosette out	378	315	16	-2.6
26-May-08	21h36	74*20.16	°N	128*00.52	° W	330	Rosette in - **cast 116**	375	316	16	-2.7
26-May-08	22h15	74*19.89	°N	127*59.75	° W	330	Rosette out	370	320	13	-2.8
26-May-08	23h04	74*20.09	°N	127*29.77	° W	333	Rosette in - **cast 117**	341	310	17	-3
26-May-08	23h20	74*19.98	°N	127*29.95	° W	298	Rosette out	342	321	15	-3.1
27-May-08	07h18	74*19.91	°N	126*59.48	° W	310	Hydrobios in	347	320	8	-3.6
27-May-08	07h41	74*19.87	°N	126*59.67	° W	318	Hydrobios out	346	310	10	-3.8
27-May-08	08h10	74*19.95	°N	127*00.26	° W	284	secchi disk in	343	290	10	-3.8
27-May-08	08h15	74*19.93	°N	127*00.59	° W	295	secchi disk out	348	290	13	-3.9

27-May-08	08h21	74*19.92	°N	127*00.76	° W	282	Rosette in - **cast 118**	348	295	8	-4
27-May-08	08h56	74*19.69	°N	127*02.29	° W	318	Rosette out	345	307	11	-3.8
27-May-08	09h06	74*19.74	°N	127*02.57	° W	321	Plankton net in	343	304	11	-3.8
27-May-08	09h14	74*19.85	°N	127*03.25	° W	296	Plankton net out	344	307	11	-3.8
27-May-08	09h19	74*19.82	°N	127*03.31	° W	306	Plankton net in	341	302	11	-3.7
27-May-08	09h36	74*19.70	°N	127*03.58	° W	333	Plankton net out	343	294	13	-3.7
27-May-08	09h40	74*19.72	°N	127*03.63	° W	336	Plankton net in	343	302	15	-3.6
27-May-08	09h48	74*19.67	°N	127*03.53	° W	336	Plankton net out	341	295	13	-3.6
27-May-08	10h21	74*20.16	°N	126*59.85	° W	21	cage, UV profile down	348	298	11	-3.8
27-May-08	10h46	74*20,14	°N	126*58,95	° W	124	cage, UV profile up	346	290	13	-3.9
27-May-08	10h50	74*20,14	°N	126*58,70	° W	19	cage, water sampling down	345	305	15	-3.8
27-May-08	11h02	74*20,14	°N	126*58,38	° W	19	cage, water sampling up	345	305	15	-3.8
27-May-08	11h06	74*20,11	°N	126*58,00	° W	150	secchi disk in	348	303	12	-3.8
27-May-08	11h11	74*20,04	°N	126*57,93	° W	207	secchi disk out	348	310	12	-3.4
27-May-08	11h14	74*19,94	°N	126*57,88	° W	215	PNF in	346	305	12	-3.4
27-May-08	11h19	74*19,90	°N	126*57,12	° W	215	PNF out	346	305	12	-3.4
27-May-08	11h20	74*19,90	°N	126*57,72	° W	215	balloon lauched	346	305	12	-2.3
27-May-08	11h44	74*20,07	°N	127*01,08	° W	291	Rosette in - **cast 119**	345	305	14	-3.6
27-May-08	12h17	74*19,85	°N	127*01,65	° W	314	Rosette out	346	295	15	-3.9
27-May-08	12h39	74*19,71	°N	127*00,95	° W	27	Zodiac, SCAMP out	344	300	12	-4.3
27-May-08	12h46	74*19,90	°N	127*00,53	° W	12	Tucker net in	343	320	14	-4.3
27-May-08	13h03	74*20,25	°N	126*59,94	° W	324	Tucker net out	350	300	10	-4.2
27-May-08	13h20	74*20,23	°N	127*00,02	° W	314	Mounster net in	350	290	13	-4
27-May-08	13h41	74*20,27	°N	127*00,19	° W	312	Mounster net out	338	285	12	-3.8
27-May-08	15h10	74*19,67	°N	126*59,82	° W	307	Rosette in - **cast 120**	340	280	16	-3.8
27-May-08	16h03	74*19,67	°N	126*59,97	° W	324	Rosette out	343	280	13	-3.7
27-May-08	16h20	74*19,74	°N	126*59,92	° W	27	cage, contaminant team down	344	285	15	-3.8
27-May-08	16h40	74*19,75	°N	126*59,32	° W	5	cage, contaminant team up	349	285	11	-4
27-May-08	17h43	70*19,86	°N	126*31,65	° W	331	Rosette in - **cast 121**	342	270	10	-3.9
27-May-08	18h00	74*19,92	°N	126*31,39	° W	357	Rosette out	341	270	10	-3.9
27-May-08	18h54	74*19,99	°N	126*00,02	° W	329	Rosette in - **cast 122**	326	290	11	-3.8
27-May-08	19h36	74*20,00	°N	126*00,00	° W	327	Rosette out	326	290	12	-3.7
27-May-08	20h30	74*20,02	°N	125*30,16	° W	300	Rosette in - **cast 123**	284	293	10	-3.8

27-May-08	20h40	74*20,00	°N	125*30,24	° W	292	Rosette out	284	257	10	-3.8
27-May-08	21h10	74*17,93	°N	125*21,51	° W	129	Box core in	210	266	12	-3.5
27-May-08	21h22	74*17,84	°N	125*21,50	° W	171	Box core out	199	282	10	-2.9
28-May-08	00h05	74*30,56	°N	124*05,91	° W	134.2	Ice team off ice				
28-May-08	01h25	74*30,56	°N	124*05,91	° W	134.2	Ice team off ice	384	265	12	-3.3
28-May-08	08h00	74*30,56	°N	124*05,90	° W	135.4	CO2 team off ice	375	268	10	-2.1
28-May-08	08h05	74*30,56	°N	124*05,90	° W	135.4	chemistery and biology team off ice	375	268	10	-2.1
28-May-08	08h10	74*30,56	°N	124*05,90	° W	135.4	contaminant team 1 off ice	375	268	10	-2.1
28-May-08	08h10	74*30,56	°N	124*05,90	° W	135.4	contaminant team 2 off ice	375	268	10	-2.1
28-May-08	08h10	74*30,56	°N	124*05,90	° W	135.4	ice physic team off ice	375	268	10	-2.1
28-May-08	10h00	74*30,56	°N	124*05,90	° W	135.4	balloon lauched	375	268	10	-2.1
28-May-08	10h02	74*30,56	°N	124*05,90	° W	135.4	ice edge sampling start	375	268	10	-2.1
28-May-08	10h21	74*30,56	°N	124*05,90	° W	135.4	ice edge sampling stop	375	275	7	-2.1
28-May-08	10h42	74*30,56	°N	124*05,90	° W	135.4	contaminant team 1 back	375	283	10	-2.1
28-May-08	11h20	74*30,56	°N	124*05,90	° W	135.4	chemistery and biology team back	375	280	10	-2.1
28-May-08	11h22	74*30,56	°N	124*05,90	° W	135.4	contaminant team 2 back	na	na	na	na
28-May-08	11h25	74*30,56	°N	124*05,90	° W	135.4	ice physic team back	na	na	na	na
28-May-08	11h55	74*30,56	°N	124*05,90	° W	135.4	CO2 team back	na	na	na	na
28-May-08	11h55	74*30,56	°N	124*05,91	° W	135.4	water sampling team back	375	270	10	-1.5
28-May-08	12h32	74*30,97	°N	124*07,41	° W	259	Rosette in - **cast 124**	371	270	12	-2.3
28-May-08	13h28	74*30,87	°N	124*07,63	° W	291	Rosette out	371	285	10	-2.9
28-May-08	13h38	74*30,93	°N	124*07,95	° W	313	secchi disk in/out	373	280	14	-2.9
28-May-08	13h42	74*30,97	°N	124*07,92	° W	299	mounster net in	374	265	10	-3.1
28-May-08	14h05	74*31,05	°N	124*07,71	° W	304	mounster net out	373	280	13	-3.1
28-May-08	14h23	74*31,19	°N	124*07,81	° W	2	Tucker net in	374	280	11	-3.2
28-May-08	14h35	74*31,53	°N	124*07,43	° W	333	Tucker net out	376	280	13	-3.4
28-May-08	19h14	74*03,32	°N	127*02,10	° W	264	Rosette in - **cast 125**	266	270	11	-3.8
28-May-08	19h27	74*03,27	°N	127*02,14	° W	272	Rosette out	268	270	11	-3.9
28-May-08	21h00	73*46,52	°N	127*05,56	° W	272	Rosette in - **cast 126**	116	280	5	-3.5
28-May-08	21h22	73*46,56	°N	127*05,83	° W	269	Rosette out	115	305	7	-3.4
30-May-08	09h40	71*34,31	°N	125*17,75	° W	192	chemistery and biology team off ice	289	298	9	0.1

30-May-08	09h41	71*34,31	°N	125*17,75	° W	192	EM scan team off ice	289	298	9	0.1
30-May-08	09h42	71*34,31	°N	125*17,75	° W	192	sea ice physic team off ice	289	298	9	0.1
30-May-08	09h43	71*34,30	°N	125*17,75	° W	192	CO2 team off ice	289	298	9	0.1
30-May-08	09h43	71*34,30	°N	125*17,74	° W	192	Rosette in - **cast cancelled**	289	298	9	0.1
30-May-08	10h00	71*34,26	°N	125*17,72	° W	na	Rosette out	na	na	na	na
30-May-08	10h30	71*34,244	°N	125*17,703	° W	193	Hydrobios in	289	295	9	1.5
30-May-08	10h50	71*34,21	°N	125*17,68	° W	193	Hydrobios out	288	295	5	1.9
30-May-08	11h15	71*34,18	°N	125*17,63	° W	193	Rosette in - **cast 127**	289	295	5	1.9
30-May-08	12h00	71*34,14	°N	125*17,5	° W	194.2	Rosette out	289	280	9	0
30-May-08	13h00	71*34,12	°N	125*17,18	° W	194	CO2 team off ice	287	285	8	0
30-May-08	13h15	71*34,12	°N	125*17,09	° W	194	Tucker net in	286	280	7	0.2
30-May-08	13h40	71*34,13	°N	125*16,88	° W	194.2	Tucker out / EM scan team off ice	287	265	8	0
30-May-08	13h45	71*34,13	°N	125*16,88	° W	194.2	Tucker in	287	265	8	0
30-May-08	14h05	71*34,13	°N	125*16,65	° W	194.2	Tucker out / Tucker in	287	265	8	0
30-May-08	14h25	71*34,15	°N	125*16,44	° W	194.5	skippy boat off ice	285	265	8	-0.5
30-May-08	14h30	71*34,15	°N	125*16,44	° W	194.5	Tucker out	285	265	8	-0.5
30-May-08	15h00	71*34,16	°N	125*16,11	° W	194.5	Rosette in - **cast 128**	283	250	8	-0.7
30-May-08	15h17	71*34,18	°N	125*15,93	° W	194.8	Rosette out	284	240	7	-0.8
30-May-08	15h20	71*34,18	°N	125*15,93	° W	194.8	CO2 team back	284	240	7	-0.8
30-May-08	15h25	71*34,19	°N	125*15,8	° W	193.1	SCAMP in	282	245	7	-0.8
30-May-08	16h35	71*34,294	°N	125*14,896	° W	194	skippy boat back on ship	277	245	10	-0.6
30-May-08	17h05	71*34,33	°N	125*14,57	° W	194.3	SCAMP out	276	250	9	-0.5
30-May-08	18h05	71*34,4	°N	125*13,7	° W	196.6	EM scan team off ice	273	250	9	-0.3
30-May-08	18h53	71*34,464	°N	125*13,080	° W	198.9	Rosette in - **cast 129**	268	250	12	-0.4
30-May-08	19h09	71*34,491	°N	125*12,843	° W	193.4	EM scan team back	266	240	12	-0.4
30-May-08	19h12	71*34,491	°N	125*12,843	° W	193.4	Rosette out	266	240	12	-0.4
31-May-08	08h05	71*13,15	°N	124*41,05	° W	32	Rosette in - **cast 130**	274	245	15	-2.8
31-May-08	08h20	71*13,07	°N	124*40,94	° W	32	contaminant team off ice	274	276	15	-2.8
31-May-08	08h23	71*13,07	°N	124*40,94	° W	32	Rosette out	274	276	15	-2.2
31-May-08	08h38	71*13,07	°N	124*40,94	° W	32	EM scan team off ice	274	276	15	-2.2
31-May-08	08h39	71*13,07	°N	124*40,94	° W	32	Hydrobios in	274	276	15	-2.2
31-May-08	09h10	71*13,07	°N	124*40,94	° W	32	biology and chemistery team off ice	274	276	15	-2.2

31-May-08	09h10	71*13,07	°N	124*40,94	° W	32	CO2 team off ice	274	276	15	-2.2
31-May-08	09h12	71*12,85	°N	124*40,82	° W	32	physic team off ice	274	273	15	-2.2
31-May-08	09h30	71*12,85	°N	124*40,82	° W	32	Hydrobios out	274	273	15	-2.2
31-May-08	09h58	71*12,85	°N	124*40,82	° W	32	Tucker in	274	273	15	-2.2
31-May-08	10h00	71*12,85	°N	124*40,82	° W	32	EM scan team back	274	273	15	-2.2
31-May-08	10h01	71*12,85	°N	124*40,82	° W	32	biology and chemistery team back	274	273	15	-2.2
31-May-08	10h01	71*12,66	°N	124*40,84	° W	32	contaminant team back	274	273	15	-2.2
31-May-08	10h18	71*12,66	°N	124*40,84	° W	32	Tucker out	274	273	15	-2.2
31-May-08	10h21	71*12,66	°N	124*40,84	° W	32	Tucker in	274	273	15	-2.2
31-May-08	10h48	71*12,66	°N	124*40,84	° W	32	Tucker out	274	273	15	-2.2
31-May-08	10h50	71*12,52	°N	124*40,96	° W	32	physic team back	274	281	15	-1.19
31-May-08	11h30	71*12,48	°N	124*41,00	° W	32	CO2 team back	273	264	16	-1.19
31-May-08	11h33	71*12,48	°N	124*41,00	° W	32	Rosette in - **cast 131**	273	260	15	-1.19
31-May-08	12h15	71*12,44	°N	124*40,87	° W	41.7	Rosette out	273	270	16	-1.19
31-May-08	12h28	71*12,4	°N	124*40,8	° W	42.5	SCAMP in	274	270	14	-1.4
31-May-08	13h46	71*12,4	°N	124*40,0	° W	46.1	SCAMP out	272	280	12	-1
31-May-08	13h55	71*12,4	°N	124*39,89	° W	46.6	Ringnet in	273	275	13	-1
31-May-08	13h55	71*12,4	°N	124*39,89	° W	46.6	Physic team back	273	275	13	-1
31-May-08	14h05	71*12,4	°N	124*39,75	° W	47.1	Rignetout / Ringnet in	273	280	12	-1
31-May-08	14h15	71*12,4	°N	124*39,57	° W	47.5	Rignetout / Ringnet in	273	280	14	-1
31-May-08	14h26	71*12,4	°N	124*39,4	° W	47.7	Rignetout / Ringnet in	273	285	17	-0.9
31-May-08	14h35	71*12,4	°N	124*39,3	° W	48	Ringnet out	270	280	15	-0.9
1-Jun-08	10h15	70*38,75	°N	123*11,12	° W	16	skippy boat out	491	250	2	-1.8
1-Jun-08	10h18	70*38,74	°N	123*11,09	° W	16	Zodiac, SCAMP out	491	250	2	-1.8
1-Jun-08	10h58	70*38,63	°N	123*10,69	° W	266	secchi disk in	527	218	4	-2.2
1-Jun-08	11h03	70*38,62	°N	123*10,66	° W	281	secchi disk out	528	204	4	-2.1
1-Jun-08	11h58	70*38,16	°N	123*11,59	° W	2	Rosette in - **cast 132**	542	245	0	-2
1-Jun-08	11h58	70*38,20	°N	123*11,54	° W	145	Zodiac, SCAMP back	543	230	5	-1.5
1-Jun-08	12h30	70*38,21	°N	123*11,21	° W	98	Rosette out	544	230	5	-0.5
1-Jun-08	13h35	70*38,19	°N	123*10,67	° W	290	Mounster net in	540	200	4	-2.1
1-Jun-08	14h04	70*38,20	°N	123*10,53	° W	270	Mounster net out	544	210	5	-1.9
1-Jun-08	14h20	70*38,20	°N	123*10,56	° W	271	skippy boat on board	544	210	5	-1.9

1-Jun-08	14h30	70*38,13	°N	123*10,55	° W	119	cage down, water sampling + UV profile	539	225	4	-1.4
1-Jun-08	15h10	70*38,10	°N	123*10,11	° W	67	cage up, water sampling + UV profile	538	calme	0	0.7
1-Jun-08	15h54	70*37,78	°N	123*10,38	° W	205	Rosette in - **cast 133**	490	calme	0	-1.6
1-Jun-08	17h01	70*37,72	°N	123*10,40	° W	216	Rosette out	500	115	8	-1.5
1-Jun-08	17h15	70*37,69	°N	123*10,54	° W	205	Phytoplankton net in	508	120	6	-1.5
1-Jun-08	17h36	70*37,52	°N	123*10,78	° W	228	Phytoplankton net out	529	125	6	-1.7
1-Jun-08	18h16	70*37,45	°N	123*11,13	° W	225	Tucker in	531	122	6	-1.5
1-Jun-08	18h25	70*37,26	°N	123*11,00	° W	83	Tucker out	548	120	5	-1.5
1-Jun-08	18h51	70*37,225	°N	123*10,991	° W	100	Phytoflash in	549	100	5	-1.5
1-Jun-08	19h07	70*37,24	°N	123*10,96	° W	108	Phytoflash out	549	95	4	-1.4
1-Jun-08	19h26	70*37,22	°N	123*11,01	° W	107	Hydrobios in	549	95	4	-1.6
1-Jun-08	20h00	70*37,22	°N	123*11,06	° W	105	Hydrobios out	548	88	9	-1.7
1-Jun-08	20h16	70*37,22	°N	123*11,15	° W	103	secchi disk in	548	90	10	-1.8
1-Jun-08	20h19	70*37,22	°N	123*11,15	° W	102	secchi disk out	548	93	10	-1.9
1-Jun-08	20h20	70*37,22	°N	123*11,15	° W	102	PNF profile in	548	93	10	-1.9
1-Jun-08	20h25	70*37,23	°N	123*11,23	° W	97	PNF profile out	548	96	10	-1.9
1-Jun-08	20h28	70*37,23	°N	123*11,23	° W	97	Ringnet in	548	96	10	-1.9
1-Jun-08	21h00	70*37,23	°N	123*11,23	° W	97	Ringnet out	548	96	10	-1.9
1-Jun-08	21h09	70*37,36	°N	123*11,20	° W	68	Rosette in - **cast 134**	546	88	12	-1.9
1-Jun-08	21h45	70*37,48	°N	123*10,63	° W	101	Rosette out	525	99	9	-1.6
2-Jun-08	06h53	69*51,595	°N	123*45,115	° W	72	EM scan by the ship	71	10	18	-1.9
2-Jun-08	07h07	69*51,595	°N	123*45,115	° W	72	Rosette in - **cast 135**	71	5	17	-2
2-Jun-08	07h28	69*51,595	°N	123*45,115	° W	72	Rosette out	71	355	15	-2
2-Jun-08	09h02	69*51,595	°N	123*45,115	° W	72	Rosette in - **cast 136**	71	355	15	-2
2-Jun-08	09h10	69*51,595	°N	123*45,115	° W	72	Rosette out	71	355	15	-2
2-Jun-08	09h28	69*51,595	°N	123*45,115	° W	72	Tucker in	71	355	15	-2
2-Jun-08	09h28	69*51,595	°N	123*45,115	° W	72	contaminants team off ice	71	355	15	-2
2-Jun-08	09h30	69*51,595	°N	123*45,115	° W	72	Chemistery and biology team off ice	71	355	15	-2
2-Jun-08	09h31	69*51,595	°N	123*45,115	° W	72	tower setup and CO2 teams off ice	71	355	10	-2
2-Jun-08	09h32	69*51,595	°N	123*45,115	° W	72	Tucker out	71	355	10	-2

2-Jun-08	10h20	69*51,595	°N	123*45,115	° W	72	contaminants team back	71	355	10	-2
2-Jun-08	11h02	69*51,595	°N	123*45,115	° W	72	chemistery and biology team back	71	355	10	-2
2-Jun-08	11h22	69*51,595	°N	123*45,115	° W	72	Rosette in - **cast 137**	71	325	10	2.1
2-Jun-08	13h20	69*51,595	°N	123*45,115	° W	173	chemistery and biology team off ice	71	325	11	1.2
2-Jun-08	14h00	69*51,595	°N	123*45,115	° W	173	light physic, CO2 and tower teams off ice	71	320	10	0.8
2-Jun-08	15h05	69*51,595	°N	123*45,115	° W	173	Rosette in - **cast 138**	70	335	13	2.4
2-Jun-08	15h15	69*51,595	°N	123*45,115	° W	173	Rosette out	70	330	12	2.1
2-Jun-08	15h52	69*51,595	°N	123*45,115	° W	173	balloon released	70	320	12	2.2
2-Jun-08	16h20	69*51,595	°N	123*45,115	° W	173	CO2 team back	71	340	13	2.1
2-Jun-08	17h36	69*51,595	°N	123*45,115	° W	173	light physic team back	71	330	11	0.8
2-Jun-08	18h15	69*51,595	°N	123*45,111	° W	173	tower setup team off ice	71	330	9	2
2-Jun-08	18h25	69*51,595	°N	123*45,111	° W	173	setup diving hole team off ice	71	330	9	2
2-Jun-08	18h35	69*51,595	°N	123*45,111	° W	173	contaminant team off ice	71	340	9	1.2
2-Jun-08	18h40	69*51,595	°N	123*45,111	° W	173	EM scam by ship team off ice	71	340	9	1.2
2-Jun-08	19h01	69*51,595	°N	123*45,111	° W	173	Rosette in - **cast 139**	71	330	9	0.4
2-Jun-08	19h07	69*51,595	°N	123*45,111	° W	173	Rosette out	71	330	8	0.4
2-Jun-08	19h16	69*51,595	°N	123*45,111	° W	173	SCAMP in	71	330	9	0.6
2-Jun-08	19h35	69*51,595	°N	123*45,111	° W	173	contaminant team back	71	345	8	0
2-Jun-08	20h15	69*51,595	°N	123*45,111	° W	173	EM scan team back	71	345	8	0
2-Jun-08	20h45	69*51,595	°N	123*45,111	° W	173	tower setup ad CO2 team back	71	350	6	-2.2
2-Jun-08	21h10	69*51,595	°N	123*45,111	° W	173	SCAMP out	71	350	6	-2.2
2-Jun-08	22h50	69*51,595	°N	123*45,111	° W	173	cod cage in moon pool	71	350	6	-2.2
3-Jun-08	00h05	69*51,595	°N	123*45,111	° W	173	light physic back	71	15	5	-2.3
3-Jun-08	03h00	69*51,595	°N	123*45,111	° W	173	light physic off ice	71	111	4	-2.2
3-Jun-08	04h00	69*51,595	°N	123*45,111	° W	173	light physic team back	70	92	5	-1.8
3-Jun-08	06h00	69*51,595	°N	123*45,111	° W	173	light physic team off ice	70	107	10	-1.6
3-Jun-08	06h07	69*51,595	°N	123*45,111	° W	173	generator maintenance	70	105	10	-1.6
3-Jun-08	06h15	69*51,595	°N	123*45,111	° W	173	Rosette in - **cast 140** / light physic team off ice	70	100	10	-1.6
3-Jun-08	07h00	69*51,595	°N	123*45,111	° W	173	cod cage out moon pool	71	100	12	-1.6
3-Jun-08	07h10	69*51,595	°N	123*45,111	° W	173	light physic team back	71	100	12	-1.6

3-Jun-08	07h15	69*51,595	°N	123*45,114	° W	173	Rosette in - **cast 141**	71	95	10	-1.6
3-Jun-08	07h28	69*51,595	°N	123*45,114	° W	173	Rosette out	71	95	11	-1.6
3-Jun-08	08h37	69*51,595	°N	123*45,114	° W	173	Tucker in	71	90	10	-1.4
3-Jun-08	08h42	69*51,595	°N	123*45,114	° W	173	EM scan team by ship	71	90	10	-1.4
3-Jun-08	08h43	69*51,595	°N	123*45,114	° W	173	Tucker out	71	90	10	-1.4
3-Jun-08	08h50	69*51,595	°N	123*45,114	° W	173	Tucker in	71	90	10	-1.4
3-Jun-08	09h00	69*51,595	°N	123*45,114	° W	173	Tucker out	71	90	10	-1.4
3-Jun-08	09h08	69*51,595	°N	123*45,114	° W	173	Tucker in	71	90	10	-1.4
3-Jun-08	09h23	69*51,595	°N	123*45,114	° W	173	chemistery and biology teams off ice	71	90	10	-1.4
3-Jun-08	09h24	69*51,595	°N	123*45,114	° W	173	CTD and light profiles teams off ice	71	90	10	-1.4
3-Jun-08	09h25	69*51,595	°N	123*45,114	° W	173	Tucker out	71	90	10	-1.4
3-Jun-08	09h43	69*51,595	°N	123*45,114	° W	173	CTD and light profiles back	71	90	10	-1.4
3-Jun-08	10h00	69*51,595	°N	123*45,114	° W	173	EM scan team back	71	90	10	-1.4
3-Jun-08	10h06	69*51,595	°N	123*45,114	° W	173	contaminant team back	71	90	10	-1.4
3-Jun-08	10h18	69*51,595	°N	123*45,114	° W	173	CO2 and tower teams off ice	71	90	10	-1.4
3-Jun-08	10h58	69*51,595	°N	123*45,114	° W	173	chemistery and biology teams back	71	90	10	-1.4
3-Jun-08	11h02	69*51,595	°N	123*45,114	° W	173	Rosette in - **cast 142**	71	90	10	-1.4
3-Jun-08	11h09	69*51,595	°N	123*45,114	° W	173	Rosette out	71	90	10	-1.4
3-Jun-08	11h11	69*51,595	°N	123*45,114	° W	173	CO2 and tower team back	71	90	10	0.7
3-Jun-08	12h05	69*51,595	°N	123*45,114	° W	173	CTD profiles team off ice	70	85	14	0.7
3-Jun-08	12h55	69*51,595	°N	123*45,114	° W	172.9	CTD profiles team back	70	85	15	0.8
3-Jun-08	13h00	69*51,595	°N	123*45,114	° W	172.9	chemistery and biology teams off ice	70	85	15	0.8
3-Jun-08	13h15	69*51,595	°N	123*45,114	° W	172.9	SCAMP in	70	82	15	0.7
3-Jun-08	13h20	69*51,595	°N	123*45,114	° W	172.9	chemistery and biology teams back	70	82	15	0.7
3-Jun-08	14h22	69*51,595	°N	123*45,114	° W	172.9	SCAMP out / coring team back	70	82	19	0.9
3-Jun-08	14h43	69*51,595	°N	123*45,114	° W	172.9	tower team off ice	70	81	21	0.9
3-Jun-08	14h58	69*51,595	°N	123*45,114	° W	172.9	Rosette in - **cast 143**	70	80	19	0.9
3-Jun-08	15h13	69*51,595	°N	123*45,114	° W	172.9	Rosette out	70	81	19	0.9
3-Jun-08	16h00	69*51,595	°N	123*45,114	° W	172.9	tower team back	70	76	22	1
3-Jun-08	17h00	69*51,595	°N	123*45,114	° W	172.9	CTD and light profiles team	70	75	20	1.4

							back				
3-Jun-08	17h08	69*51,595	°N	123*45,114	° W	172.9	light profiles team back	70	75	20	1.4
3-Jun-08	18h15	69*51,595	°N	123*45,114	° W	172.9	contaminant team off ice	70	83	15	1.6
3-Jun-08	18h35	69*51,595	°N	123*45,114	° W	172.9	light profiles team off ice	70	85	14	1.6
3-Jun-08	18h40	69*51,595	°N	123*45,114	° W	172.9	biology team off ice	70	85	14	1.6
3-Jun-08	18h45	69*51,595	°N	123*45,114	° W	172.9	Contaminant team back	70	85	15	1.5
3-Jun-08	19h01	69*51,595	°N	123*45,114	° W	172.9	Rosette in - **cast 144**	70	85	15	1.5
3-Jun-08	19h05	69*51,595	°N	123*45,114	° W	172.9	EM scan team off ice	70	85	15	1.4
3-Jun-08	19h06	69*51,595	°N	123*45,114	° W	172.9	Rosette out	70	80	15	1.4
3-Jun-08	19h24	69*51,595	°N	123*45,114	° W	172.9	light physic team back	70	80	15	1.2

2. Team reports

2.1. Team 1

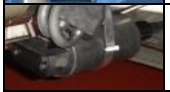
PI: Yves Gratton (INRS-ETE, 490, Rue de la Couronne, Québec)
Participants: Véronique Lago, Caroline Sévigny (INRS-ETE, 490, Rue de la Couronne, Québec)

2.1.1. CTD/Rosette

Objectives
Description of water masses and general circulation over a year in Beaufort Sea and Amundsen Gulf.

Materials
Physical parameters were recorded using a ship mounted RDInstruments Ocean Surveyor ADCP (150kHz), and a rosette frame equipped with 24 bottles of 12 L and the following sensors:

Table 1: Sensors used on the Rosette

Photo	Item	Manufacturer	Type & Properties	Serial Number
	CTD	SeaBird	SBE-911 Sampling rate : 24 Hz	
	Temperature	SeaBird	SBE 3plus Range: -5°C to + 35°C Accuracy: 0.001	4204
	Pressure	SeaBird	Accuracy: 0.015% of full range	90584
	Conductivity	SeaBird	SBE 4C Range: 0 to 7 S/m Accuracy: 0.0003	2696
	Oxygen	SeaBird	SBE-43 Range: 120% of saturation Accuracy: 2% of saturation	0420
 pH	SeaBird	SBE-18 Range: pH from 0 to 14 Accuracy: pH 0.01	0444	
	Nitrates	Satlantic	MBARI ISUS Range: 0.5 to 200 µM Accuracy: ± 2 µM	134
	PAR	Biospherical		4664
	SPAR	Biospherical		20147
	Fluorometer	Sea Point		2465
	Transmissometer	WetLab	Path length: 25 cm	CST-558DR
 Altimeter	Benthos		1061	

Method

For the whole leg, because of heavy ice conditions, the rosette was deployed from the Moonpool. CTD or Rosette casts were usually performed four times a day while stucked in the ice at 7a.m., 11a.m., 3p.m. and 7p.m. Three times, we did a 13 hours non-stop CTD sampling. Water was sampled according to each team requests. Here are examples of usual depths collected by them.

- *Nutrients* (Team 7; PI: Jean-Éric Tremblay): salinity of 33.1, chlorophyll maximum, 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300 and every 100 m up to the bottom.
- *DIC* (Team 6; PI: Lisa Miller): salinity of 33.1, 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300 and every 100 m up to the bottom.
- *doc/don* (Team 7; PI: Christine Michel): salinity of 33.1, 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300 and every 100 m up to the bottom.
- *Contaminants* (Team 8; PI: Gary Stern): chlorophyll maximum, 10, 25, 50m and every 50m up to the bottom.
- *DNA* (Team 7; PI: Connie Lovejoy)
- *Microbes and Virus* (Team 7; PIs: Carlos Pedros and Roxanne Maranger): "interesting" features in the O_2, NO_3, fluorescence, temperature and salinity profiles.
- *CDOM* (Team3 ; PI: Pierre Larouche): 10, 25m and chlorophyll maximum while in the ice and 50%, 20% of light, chlorophyll maximum and 60m while in open water.
- *Pigment* (Team 3; PI: Suzanne Roy): 10, 25m and chlorophyll maximum while in the ice and 50%, 15% of light and chlorophyll maximum while in open water.
- *Primary production*(Team 3; PI: Michel Gosselin): 10, 25m and chlorophyll maximum while in the ice and 50%, 30%, 15%, 5%, 1%, 0.2% of light, chlorophyll maximum, 75 and 100m while in open water.

Sampling locations

We focused on the Amundsen Gulf and on the west of Banks island.

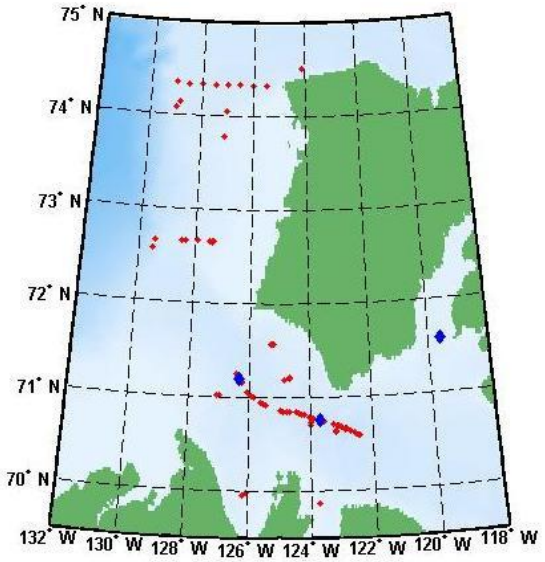


Figure 1: Positions of Rosette casts are shown as red dots and stations of 13 hours sampling are blue diamonds.

Probes calibration

Salinity: Samples were taken on many casts with small bottles of 200 mL. They were analysed with an autosal GuildLine, model 8400B. Its range goes from 0.005 to 42 and its accuracy is <0.002. The results were satisfying. The difference in between the salinity probe recordings and the samples was around 0.036.

pH: Tests were done twice using two buffers. The sensor is quite stable. Results are as follow:
Buffer 4.01 gave 4.09
Buffer 7.00 gave 7.37
Sea water is usually around pH=8, we can expect pH data to be a little over estimated.

Oxygen: Oxygen sensor calibration was performed using Winkler's method and a Mettler Toledo titration machine. Reagent Blanks was performed once, results show that chemicals are still good (m<4). We sampled oxygen on five casts. Each time, we choose five depths of different oxygen concentration and sampled it three times. The results are not satisfying; the slope of comparison between the sensor and the samples is varying. We think that the water might be sursaturated in oxygen which make it harder to analyse with the Winkler method.

Figure 2: Reagents Blanks (m=0.5600).

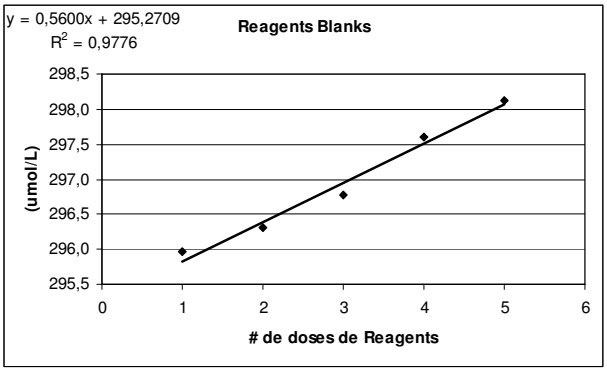


Figure 3: Relation between samples and probe recordings during cast #072 (m=1.1237).

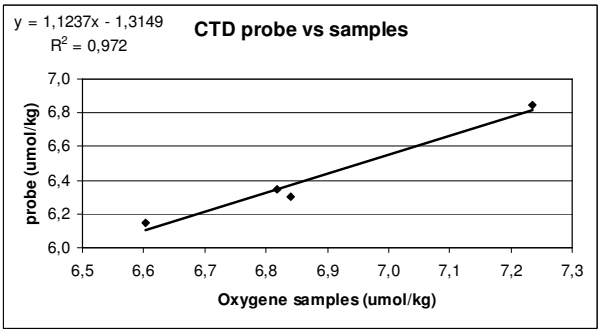


Figure 4: Relation between samples and probe recordings during cast #113 (m=1.2987).

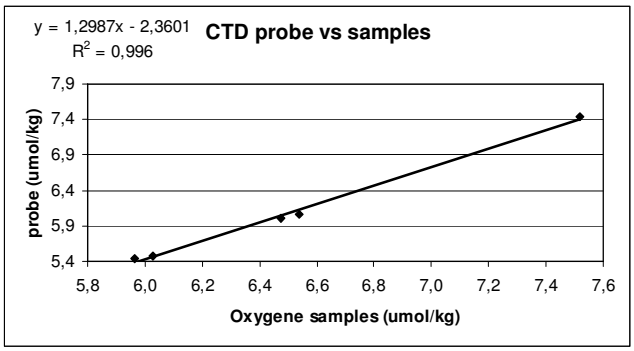
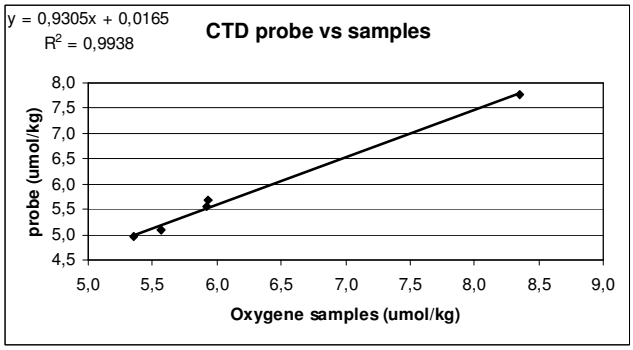


Figure 5: Relation between samples and probe recordings during cast #132 (m=0.9305).



Problems

- **Sensors**
  The analysis of water samples for dissolved oxygen by the Winkler method does show stable results. This might be caused by a sursaturation in oxygen of the water at this period of the year, which makes the analysis harder. The data will probably be hard to correct.
- **Deck material (winch, A-frame, etc.)**
  The connexion from the deck unit to the sensors broke once. Therefore data from one cast are corrupted.
- **ADCP:**
  The currents were only partly measured sometimes during the leg. The ADCP could not determine the middle range of the water column currents for a still unknown reason. The ADCP also stopped receiving proper information a few times due to ice under the ship.

Available data

All information concerning the Rosette casts are summarized in the CTD Logbook. It includes cast and station numbers, date and time of sampling in UTC, latitude and longitude, bottom and cast depth, comments concerning the cast and its name. A Rosette sheet was also created for every single cast. It includes the same information than the CTD Logbook plus the bottle distribution among every sampling team. The weather information is written in every Rosette Log as well as in a meteorological logbook. For every cast, data recorded at the moment of bottle closure were averaged and recorded in the so-called 'bottle files'. Averaged data are those recorded between 3 seconds before bottle closure and 7 seconds after it. It includes the bottle position, time and date, pressure, temperature, salinity, transmissivity, chlorophyll, oxygen, irradiance and pH measurements. All those files are available on the 'Shares'.

- Rosette sheets and the CTD logbook : Shares\Leg8Rosette\logs
- Bottles files : Shares\Leg8\Rosette\btlfiles
- Plots of every cast including salinity, temperature, oxygen, transmissometer, nutrients, fluorometer and irradiance : Shares\Leg8\Rosette\plots

Between April 24th, 2008 and June 5th, 2008, 144 casts were performed.

Preliminary Results

The three "13 hour marathons" were performed on two different locations: stations 2008-D43 and 2008-F3.

Figure 6 shows temperature, salinity and oxygen data recorded on the 13 hours sampling done on station 2008-D43 on April 29th

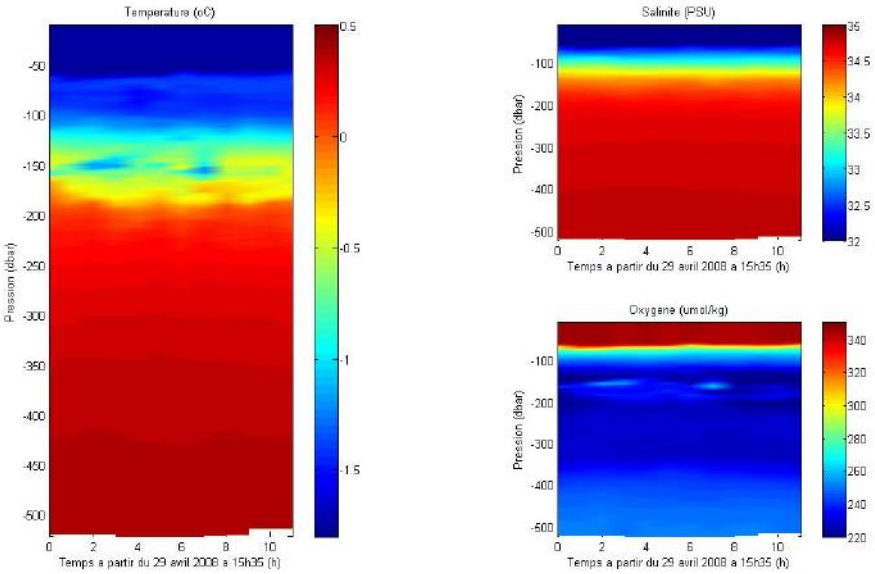


Figure 7 shows temperature, salinity and oxygen data recorded on the 13 hours sampling done on station 2008-D43 on May 5th.

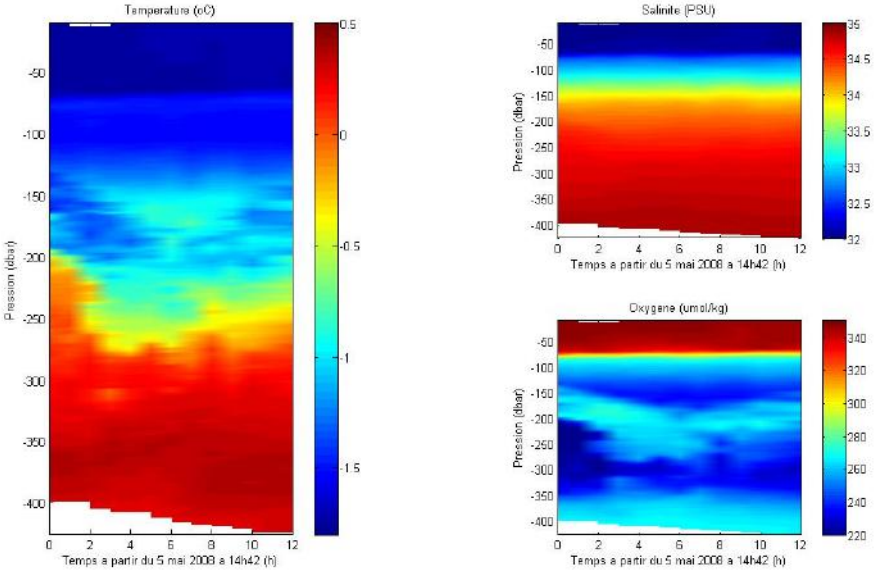
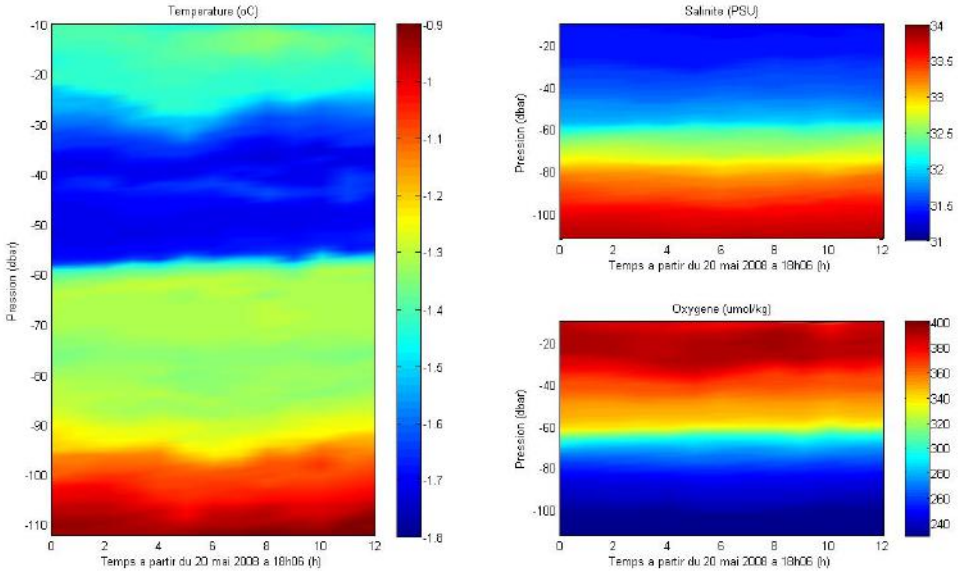
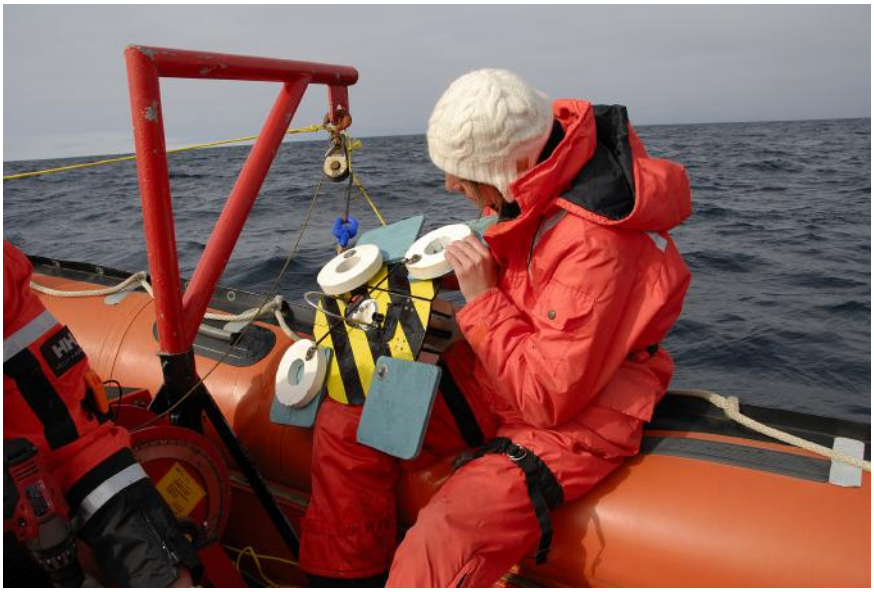


Figure 8 shows temperature, salinity and oxygen data recorded on the 13 hours sampling done on station 2008-F3 on May 20th



2.1.2. Self Contained Autonomous MicroProfiler (SCAMP)



The SCAMP is a CTD type profiler (see figure 6). It samples at a frequency of 100 Hz (i.e. 100 times per second). It free falls at approximately 10 cm s^{-1}, resulting in a vertical resolution of approximately one (1) millimetre, down to a maximum depth of 100 m. The instrument measures the temperature and salinity fluctuations at the micro-scale in order to estimate the turbulent mixing occurring in the water column. To properly measure (as opposed to "estimate") turbulence we should also be measuring the velocity fluctuations. Unfortunately, we do not have velocity sensors (too expensive for now). The current sensors on the SCAMP include temperature (three sensors), salinity (i.e. conductivity; two sensors) and fluorescence.

Turbulent transports and mixing are among the most important processes in natural systems. They are much more efficient and act much faster than purely diffusive (i.e. molecular) processes. By analogy with the molecular diffusive processes, turbulent mixing is often called “eddy diffusion”. The mixing energy is introduced at large scales, often by the wind at the sea surface and tides at the bottom. Turbulent mixing is called “eddy diffusion” because energy can be thought as being transferred from larger scales to smaller scales, i.e. cascading from larger eddies to smaller and smaller eddies until it reaches the molecular scale where it will be ultimately dissipated into heat. Studying turbulent processes will help us understand how the Mixed Layer (ML) if formed and how it evolves over daily, seasonally and yearly time scales. A better knowledge of the ML properties will help determine how the biological production is affected by the physical processes in the surface layer. A better understanding of the dynamics of the ML will improve our climatic forecasting abilities. Indeed, the mixed layer is the main buffer between the atmosphere and the ocean and it controls most of the heat exchange between the two. One of the major problems is that the ML is evolving hourly, making it very difficult to parameterize in larger numerical circulation models. A better understanding of the ML dynamics will improve the forecasting capacities of both oceanic and atmos-pheric models.

The table below summarizes the basic information about the SCAMP profiles obtained during Cruise 0803, i.e. in CFL leg 8. Profiles have been taken from the zodiac at the open water stations or from the moon pool at the ice stations (stations labelling DX or FX).

Station	Date (UTC)	Time (UTC)	# profiles	Profiling depth (m)
2008-D43	26avr2008	19h49	5	100
2008-D43	27avr2008	18h42	3	100
2008-D43	29avr2008	02h23	3	100
2008-D43	29-30avr2008	16h10-03h54	6	100
2008-D43	01may2008	19h35	4	100
2008-D43	02may2008	21h31	3	100
2008-D43	03may2008	20h30	3	100
2008-D43	04may2008	21h40	3	100
2008-D43	05-06may2008	15h11-03h55	4	100
2008-F2	17may2008	02h55	3	100
2008-F2	17may2008	18h50	3	100
405b	19may2008	15h30	4	100
2008-F3	20-21may2008	18h40-07h15	6	100
6010	25may2008	19h54	2	100
8010	26may2008	15h15	4	100
9008	27may2008	18h40	4	100
2008-D46	30may2008	21h25	4	100
2008-D47	31may2008	19h46	3	100
405	01jun2008	16h18	4	100
2008-F6	03jun2008	01h16	6	70
2008-F6	03jun2008	19h15	4	70

2.2. Team 2

2.2.1. Ice Dynamics

PI: David Barber (CEOS, University of Manitoba)

Participants: John Yackel (University of Calgary)[2]. Klaus Hochheim[1], Randall Scharien[2], Andrea Rossnagel[1], John Iacozza[1] Lauren Candlish[1], Chris Fuller[2] , Natalie Asselin[1] ([1] University of Manitoba, [2]University of Calgary)

Ground-based Scatterometer System

Sea ice physical properties vary considerably over various spatial and temporal scales, making the identification of ice types and inversion of sea ice geophysical properties using radar imagery difficult. This is particularly true in the spring melt season, when the presence of free water in the snow and in pools on the surface (melt ponds) modifies the radar signal.

As part of the Team 2 EM sampling program, a portable, fully-polarimetric, C-band (5.3 GHz microwave, University of Calgary) radar scatterometer was deployed on the sea ice for the collection of radar backscattering signatures (Figure 1). complement to larger-scale scans acquired from the ship (CEOS).

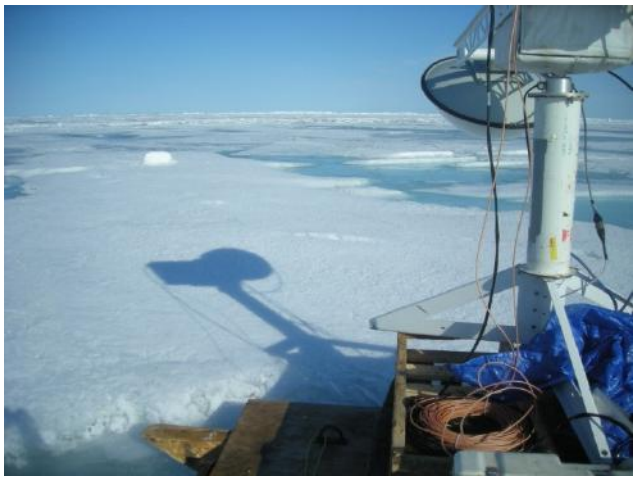


Figure 1. View from behind the ground-based scatterometer (foreground right) and field of view over a snow patch on melt ponded first-year sea ice.

A ground-based polarimetric scatterometer is used to measure complete[1] microwave backscattering signatures of specific surface features on the cm to m-spatial scale. The system is designed to scan the surface over a range of incidence angles, as well as across a specified azimuth range, depending on the size and orientation of the target of interest. It is designed with the same specifications as the ship-based scatterometer, and is used as a Data collection occurred on occasions where the ship was stationary for a sufficient length of time to enable successful on-ice assembly, sampling, and disassembly. During Leg 8B, two successful deployments were made: from May 16-18 on snow-covered landfast first year-sea ice in Franklin Bay and June 2-3 on snow and melt-pond-covered landfast first-year sea ice Darnley Bay. Microwave backscattering signatures were collected as a time series of *scans*, with each scan comprising fully polarimetric microwave backscattering coefficients (σ°) and phase information over the incidence angle range 24-64° at a 2° sampling interval. A typical scan takes 20-30 minutes depending on the azimuth range used to integrate the backscattering signature at each incidence angle.

Table 1. List of scatterometer samples acquired during Leg 8A.

Site	Date (DMY)	Y	X	Start (Local)	Stop (Local)	Scans
FB	16/05/2008	69° 56'50"N	126°11'20"W	19:34:00	20:30:00	2
FB	17/05/2008	69° 56'50"N	126°11'20"W	09:38:00	23:59:00	33
FB	18/05/2008	69° 56'50"N	126°11'20"W	00:00:00	02:30:00	7
FB	18/05/2008	69° 56'50"N	126°11'20"W	06:39:00	07:30:00	2
Darnley	02/06/2008	69° 51'36"N	123° 45'07"W	20:56:00	23:59:00	10
Darnley	03/06/2008	69° 51'36"N	123° 45'07"W	00:00:00	20:00:00	47

[1] A fully polarimetric radar measures the backscattering return in 4 transmit-receive combinations of horizontally (H) and vertically (V) polarized waves (i.e., HH, VV, HV, and VH) as well as phase information.

While operational, the following complementary data were collected within the vicinity of the scatterometer:

- Diurnal measures of snow and ice physical properties, i.e., snow pit and ice core samples (Table 2);
- Snow volume dielectric permittivity measurements;
- Qualitative assessment of snow layer properties and snow and ice surface roughness; and
- Destructive sample of snow depth within the scatterometer footprint (i.e., after moving or disassembling the scatterometer).

Table 2. Locations, dates and times of snow and ice physical property measurements made coincident to ground-based scatterometer measurements.

Site	Date (DMY)	Time	Comments
FB	5/16/2008	19:30:00	Next to ground scatterometer site
FB	5/17/2008	08:54:00	Next to scatterometer site
FB	5/17/2008	18:28:00	Next to scatterometer site
FB	5/18/2008	06:35:00	Next to scatterometer site
Darnley	6/2/2008	19:20:00	Between ship and ground scatterometer site
Darnley	6/3/2008	09:00:00	Between ship and ground scatterometer site
Darnley	6/3/2008	19:30:00	Between ship and ground scatterometer site

During each snow pit, the following variables were collected:

- Depth;
- Temperature (snow surface, 2cm interval to depth, ice surface);
- Salinity (2 cm interval to depth, ice surface);
- Density (2 cm interval to depth);
- Grain photos (2 cm interval to depth);
- Snow volume dielectric permittivity (2 cm interval to depth);
- Snow water volumetric content (2 cm interval to depth).

Snow permittivity and water volume content were measured using a Stevens Water Monitoring Systems, Inc. Hydraprobe. This probe effectively replaces the conventional capacitance plate methodology for determining snow water content and estimates of permittivity.
The scatterometer system will be re-established on the ice at the Darnley Bay ice station at the beginning of Leg 9A.

Snow and Melt Pond Distribution on Sea Ice
Summer sea ice varies considerably in its complex combination of surface types on a scale of less than one square kilometre. Deep snow, bare ice, melt ponds, open water areas, cracks, and ridges all have different physical properties that each affect the solar energy absorbed by the Arctic sea ice-ocean system differently. This research is focused on understanding the evolution of snow distribution over first-year sea ice, and the relationship of snow thickness distribution (in winter) to the melt pond distribution and morphology (in spring). Surface data will be co-located with coincident synthetic aperture radar (SAR) backscatter and other satellite-based remote sensing datasets for the purpose of improving snow and sea ice inversion property inversion algorithms.

Snow thickness distribution statistics for 12 sites of varying ice surface roughness over landfast sea ice in Franklin Bay, NWT were collected during leg 8A by Dr. John Yackel and Chris Fuller of University of Calgary (with the assistance of John Iacozza, University of Manitoba). Figure 2 shows these sites on a low resolution RADARSAT-1 SAR image, where very smooth areas appear as dark tones and extremely rough sites appear as bright tones. Each site represents the location of approximately 200 snow thickness samples conducted during leg 8A along both the downwind and cross-wind direction of the predominate snow drift pattern**.**

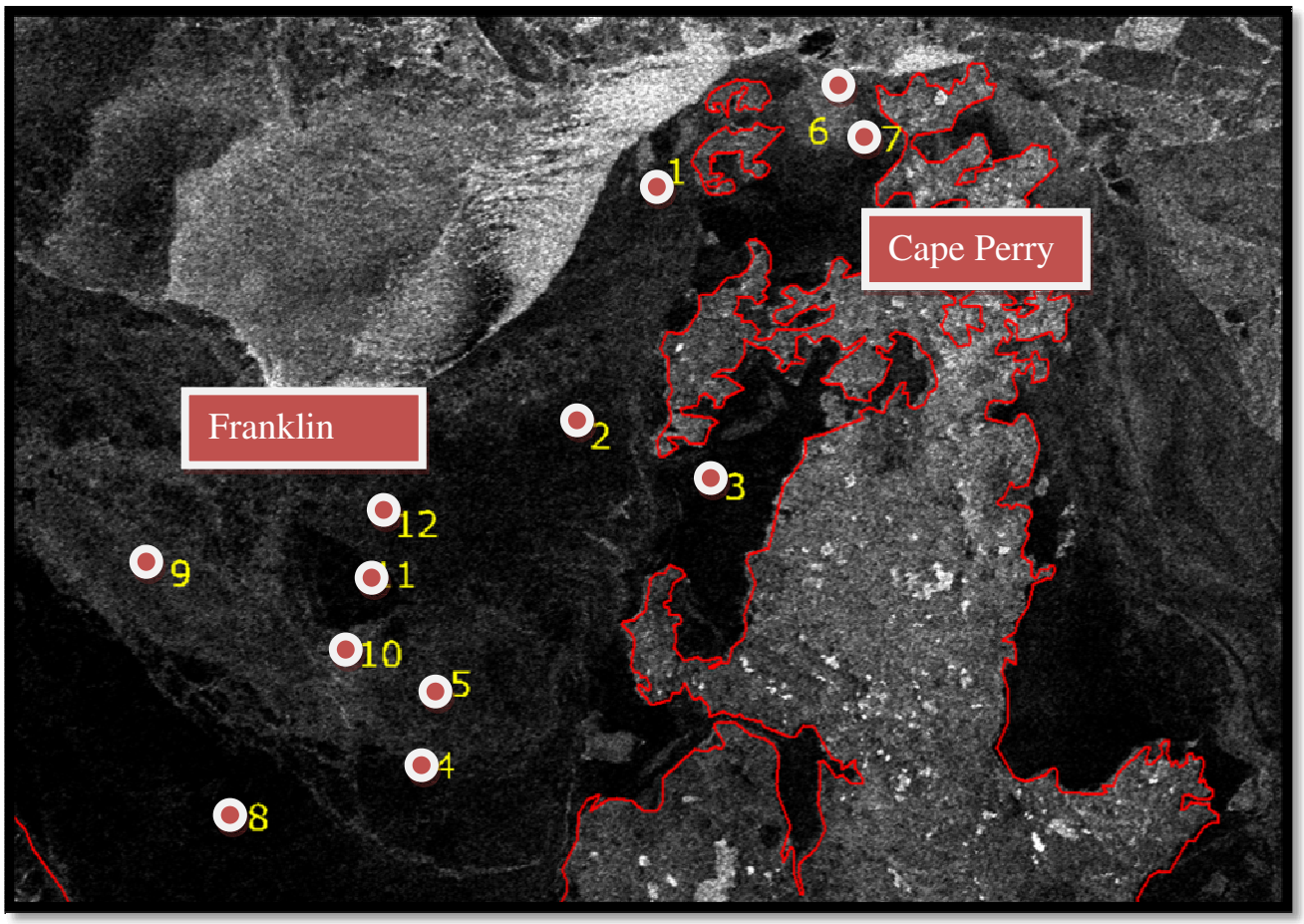


Figure 2. Distribution of snow thickness sites established during Leg 8A overlaid on a RADARSAT-1 ScanSAR (low resolution) image acquired over Franklin Bay on April 8. RADARSAT-1 image © Canadian Space Agency, 2008.

In leg 8B, 9 sites (i.e., all but sites 2, 3, and 9) were re-visited via helicopter over three flights on June 2 and 3. At each site, snow thickness and melt pond thickness distributions from orthogonal 100m long depth transects across and along the predominant drift/pond pattern were acquired. For sites where melt ponds had developed, each sample point along a transect was assigned a surface ID representing one of three predominant surface types: (1) snow; (2) melt pond; and (3) bare ice. Qualitative observations on the decay state of the snow and ice, as well as surface roughness and predominant features in a microwave scattering context, were made as well.

Snow and ice physical property (i.e., snow pit and ice core) data were acquired from 4 sites situated along a north to south gradient (sites 6, 1, 12, and 8 in Figure 2) in order to relate the decay state of the snow and ice volume across this gradient.

Ship-based EM Measurements – Scatterometer

The Kipp & Zonen tracker, which moves the scatterometer in range and azimuth, failed on May 31. The failure caused the radar to increase in incidence angle until its movement became restricted by the roof of the scatterometer shed. An assessment of the radar itself showed no apparent damage, though some of the cables were perhaps stretched beyond their normal 'comfort' range. One of the gear drive motors in the tracker also wasn't functioning properly after being counter-forced by the resistance of the top of the shed. A full gear drive lubrication procedure was executed as per the Kipp & Zonen tracker manual. The tracker was reconfigured and, after several attempts, began functioning normally again.

Pending access to the ice, the following complementary data were collected within the vicinity of the footprint of the ship-based scatterometer:

- Diurnal measures of snow and ice physical properties, i.e., snow pit and ice core samples (Table 3);
- Snow volume dielectric permittivity measurements;
- Qualitative assessment of snow layer properties and snow and ice surface roughness; and
- Destructive sample of snow depth within the scatterometer footprint (i.e., when moving or disassembling).

Table 3. Locations, dates and times of snow and ice physical property measurements made coincident to ship-based scatterometer measurements.

Site	Date (DMY)	Time	Comments
F3	5/20/2008	10:15:00	Next to ship scatterometer site
F3	5/20/2008	19:00:00	Next to ship scatterometer site
F4	5/24/2008	10:30:00	Approx. 200m away from ship scatterometer site
F4	5/24/2008	14:00:00	Approx. 200m away from ship scatterometer site
M1	5/25/2008	12:15:00	Next to ship scatterometer site; over refrozen MYI pond
M1	5/25/2008	13:15:00	Next to ship scatterometer site; over MYI hummock
M2	5/26/2008	09:30:00	Next to ship scatterometer site; over refrozen MYI pond
F5	5/28/2008	08:47:00	Next to ship scatterometer site
D46	5/30/2008	09:45:00	Next to ship scatterometer site
D46	5/30/2008	18:00:00	Next to ship scatterometer site
D47	5/31/2008	09:00:00	Next to ship scatterometer site
F6	6/2/2008	07:00:00	Ship scatterometer site (scat not running)
F6	6/2/2008	19:20:00	Next to ship scatterometer site
F6	6/3/2008	09:00:00	Next to ship scatterometer site
F6	6/3/2008	19:30:00	Next to ship scatterometer site

During each snow pit, the following variables were collected:

- Depth;
- Temperature (snow surface, 2cm interval to depth, ice surface);
- Salinity (2 cm interval to depth, ice surface);
- Density (2 cm interval to depth);
- Grain photos (2 cm interval to depth);
- Snow volume dielectric permittivity (2 cm interval to depth);
- Snow water volumetric content (2 cm interval to depth).

Snow permittivity and water volume content were measured using a Stevens Water Monitoring Systems, Inc. Hydraprobe. This probe effectively replaces the conventional capacitance plate methodology for determining snow water content and estimates of permittivity.

Ship-Based Radiometer (SBR)

Dual polarized passive MW radiometers operating at 37 GHz and 89 GHz on the port side of the ship were used to temperature brightness data on snow/ice surface. The SBR conducted at least twice daily scans to correspond with our physical sampling program. The system was operated in a scan mode, changing the incident angle from 30° to 70° using 5° steps. During transit and over night the radiometers were kept at an incident angle of 55°. A network camera was used to monitor the surface conditions at a sampling rate of 10s on a continual basis to match the footprint of the SBR. In addition, a hand-held camera is used at each site to provide more information on the surface conditions. An IR transducer measured surface temperature on a continuous basis. A summary of SBR data collected is provided in Table 4.

Table 4. Passive Microwave measurements off the Amundsen

Site (SBR)	Date (DMY)	START	Start UTC	END	end UTC
D46	30/05/2008	09:37:04	15:37:04	20:06:00	02:06:00
D46	30/05/2008	21:23:00	03:23:00		
D46	31/05/2008			08:19:45	14:19:45
D47	31/05/2008	08:21:48	14:21:48	08:25:48	14:25:48
D47	31/05/2008	08:27:09	14:27:09	15:04:06	21:04:06
transit	31/05/2008	15:05:09	21:05:09		
F6	02/06/2008			15:05:00	21:05:00
F6	02/06/2008	15:05:00	21:05:00	21:10:00	03:10:00
F6	02/06/2008	21:48:02	03:48:02		
F6	03/06/2008	07:45:00	13:45:00	09:12:00	15:12:00
F6	03/06/2008	09:13:45	15:13:45	15:13:45	21:13:45
transit	03/06/2008	21:14:30	03:14:30		
transit	04/06/2008			09:43:00	15:43:00
Cape Peary	04/06/2008	09:45:00	15:45:00	10:58:00	16:58:00
Cape Peary	04/06/2008	11:00:00	17:00:00	13:08:00	19:08:00
Cape Peary	04/06/2008	13:08:00	19:08:00	TBA	TBA

CTD and Optical Measurements

The objectives of this experiment are to examine potential impact of sea ice (and related environmental parameters) on light intensity under various sea ice, snow and solar zenith angle regimes during the spring transition period (Legs 7, 8b and 9a). To address this objective we will be measuring light fields (PAR) above and under the ice down to 60 m, albedo, snow properties (temperature, grain size, salinity) and upper ocean properties (conductivity and temperature) along with other relevant surface validation data (Table 5). These measurements will be done in fast ice floes as well as in leads and the marginal ice zone. The ultimate intent is to extrapolate these observations/results to regional scales.

Figure 3. A CTD and PAR profile through the snow and ice

CTD (Conductivity, Temperature, and Depth) and PAR (Photosynthetically Active Radiation) profiles were done opportunistically with a focus on different snow and ice conditions as well as different times of the day. This is to see the affect of different snow and ice regimes on PAR in the water column below the ice. Profiles were also done through melt ponds, thin ice as well as open water between floes from the skippy boat. Transects from open water to the ice edge and across floes were also done when possible. Sampling was done at different times of the day to see the effect of solar zenith angle.

Snow pits including a vertical pit photo, and snow grain photos, density and salinity were done for the top, middle and bottom of each snow pack when possible.

Table 5. Parameters sampled at optical profiling stations

STATION	DATE	Licor PAR	Alec PAR	ASD DW & UW	SNOW	ICE DEPTH	CTD
F2_1	16/05/08	Yes	Yes	No	Dep, T, S	Yes	Yes
F2_2	17/05/08	Yes	Yes	No	No Snow	Yes	Yes
F2_3	17/05/08	Yes	Yes	No	Dep, T, S	Yes	Yes
F2_4	17/05/08	Yes	Yes	No	Dep, T, S, D	Yes	Yes
F2_5	13/05/08	No	No	Yes	Dep, T, S	No	No
F2_6	13/05/08	No	No	Yes	No	No	No
F2_7	13/05/08	No	No	Yes	Dep, T, S, D	No	No
F2_8	14/05/08	No	No	Yes	Dep, T	No	No
F2_9	14/05/08 (am) 14/05/08 (pm) 15/05/08 16/05/08	No	No	Yes	Dep, T	No	No
F2_10	14/05/08 15/05/08 16/05/08	No	No	Yes	Dep, T	No	No
F3_1a	20/05/08	Yes	Yes	Yes	Dep, T, Cap,S,D	Yes	Yes
F3_1b	20/05/08	No	Yes	Yes	Snow from F3_1a cleared	Yes	Yes
D45_1	21/05/08	No	Yes	No	Dep, T, S	Yes	No, PAR mooring
D45_2	21/05/08	No	Yes	No	Dep, T, S	Yes	No, PAR mooring
D45_3	21/05/08	No	Yes	No	No, ice edge	Yes	No, PAR mooring
D45_4	21/05/08	No	Yes	No	No, open water	No, open water	Yes
D45_5	21/05/08	No	No	Yes	No	No	No
F4	24/05/08	No	Yes	Yes	Dep, T, S, D,SGA	Yes	Yes
MY1	25/05/08	No	Yes	Yes	Dep, T, S, SGA	Yes	Yes
MY2	26/05/08	No	Yes	Yes	Dep, T, S	Yes	Yes
F5_1	28/05/08	No	Yes	No	Dep	Yes	No, PAR mooring
F5_2	28/05/08	Yes	Yes	No	No	No, ice edge	Yes
F5_3	28/05/08	No	Yes	Yes	Dep, T, S	Yes	Yes
D46_1	30/05/08	No	Yes	Yes	Dep, T	Yes	Yes
D46_2	30/05/08	No	Yes	Yes	n/a	Lead / Open Water	Yes
D46_3	30/05/08	No	Yes	No	n/a	Lead / Open Water	Yes
D46_4	30/05/08	No	Yes	No	n/a	Ice edge	Yes

D46_5	30/05/08	No	Yes	Yes	Dep, T	Yes	Yes
D46_6	30/05/08	No	Yes	Yes	Melt Pond	Yes	Yes
D47_1	31/05/08	No	Yes	Yes	Dep	Yes	Yes
D47_2	31/05/08	No	Yes	Yes	Melt Pond	Yes	Yes
D47_3	31/05/08	No	Yes	No	Ice Edge	No	Yes
D47_4	31/05/08	No	Yes	No	Dep	Yes	Yes
STN405_1	1/06/08	No	Yes	No	n/a	Ice Edge	Yes
STN405_2	1/06/08	No	Yes	No	Dep	Yes	Yes
STN405_3	1/06/08	No	Yes	No	Dep	Yes	Yes
STN405_4	1/06/08	No	Yes	No	Dep	Yes	Yes
STN405_5	1/06/08	No	Yes	No	Dep	Yes	Yes
STN405_6	1/06/08	No	Yes	No	Dep	Yes	Yes
STN405_7	1/06/08	No	Yes	No	Dep	Yes	Yes
STN405_8	1/06/08	No	Yes	No	Dep	Yes	Yes
STN405_9	1/06/08	No	Yes	No	Dep	Yes	Yes
F6_1	2/06/08	No	Yes	Yes	Dep, T	Yes	Yes
F6_2	2/06/08	No	Yes	No	Melt pond edge	Yes	Yes
F6_3	2/06/08	No	Yes	Yes	Melt pond	Yes	Yes
F6_D1	2/06/08 to 3/06/08	No	Yes	No	Dep	Yes	Yes
F6_D2	2/06/08 to 3/06/08	No	Yes	No	Melt pond	Yes	Yes
F6_4	3/06/08	No	Yes	No	Dep	Yes	Yes
F6_5	3/06/08	No	Yes	No	Dep	Yes	Yes
F6_6	3/06/08	No	Yes	No	Dep	Yes	Yes
F6_7	3/06/08	No	Yes	No	Dep	Yes	Yes
F6_8	3/06/08	No	Yes	No	Melt pond	Yes	Yes

Snow Pits: T = temperature profile, Cap = capacitance plate, SGA = snow grain analysis, D = density Dep = Depth
ASD: DW = Downwelling, UW = Upwelling

Figure 5. Setting up the ASD to collect downwelling irradiance.

Moorings of PAR sensors were made and installed two times during the leg to examine diurnal light profiles. One series was installed for a period of 2 hours and the second one for 5 days. Each mooring went down to 50 m. To study diurnal light, temperature and conductivity profiles in the water column below the ice a melt pond site and a snow covered site were selected. Profiles down to sixty metres

were carried out every three hours for 27 hours at both these sites. This was done at station F6 from June 2 to June 3 and are called F6_D1 and F6_D2 in the previous Table.

Downwelling and upwelling irradiance as well as under ice transmitted irradiance measurements were done at most ice stations with a Licor quantum PAR sensor under different surface conditions in conjunction with Team 3. A table of sampling dates can be found in the Team 3 section of the cruise report. Downwelling and upwelling irradiance was also measured with an ASD at most sites. If there were different surface types at one location downwelling and upwelling irradiance was measured with the ASD at more than one location for each site.

HyperOCR Profiles

HyperOCR ocean profiles were conducted along flow edges, under ice and off the skippy boat in open water. These are hyperspectral profiles (256 channels, 300-800nm) of the ocean, to a depth of 50-60m. These measurements will be supplementing other optical work by Team 2; specifically measuring PAR under and adjacent to ice. Hyperspectral profiles are made during Leg 8b, are summarized in Table 6.

Table 6. HyperOCR profiles conducted during Leg 8a

Date	Station	Profile
May 31, 2008	Station D49, Two profiles, off ice edge, in close proximity to drift ice	Profile to 55 m
June 1 , 2008	Station 405, Three profiles, 1) off ice edge, 2) open water, 3) between ice edge and other floes.	Profile to 55 m
June 3, 2008	Station F6 One profile off small floe /open water, 200 mout from fast ice edge	Profile to 55 m

Figure 6. May 31 HYPEROCR profile site

Figure 7. One of June 1 HYPEROCR profile sites

POPS Buoy

A POPS buoy was deployed June 2 in the fast ice (Station F6). The surface unit records air temperature, sea surface (SST) temp. barometric pressure, and incoming shortwave radiation. The profiler is programmed to conduct a CTD profile every hour. A PAR sensor was also attached to profiler.

Figure 8. POPS buoy at station F6

Helicopter-Based EM Induction System (IcePic)

The helicopter-based EM induction system (or IcePic; Figure 9) was used during leg 8 to derive snow+ice thickness and surface roughness for both mobile and fast ice in Amundsen Gulf and the Beaufort Sea area. PIC #9 (UofM) was used for all transects.

Figure 9. EM induction system mounted on the front of the helicopter.

Over mobile sea ice, the objective of this experiment is to derive edge roughness of the floes in an area approximately 5 km x 5 km. This system is being used over fast ice to examine the relationship between surface roughness, snow distribution and melt pond distribution. Thus a number of sites were sampled with this instrument during the beginning of this leg, and will be revisited again during leg 9. Sampling began on May 11 and continued until June 5, 2008. Table lists the data and location of the sampling transects during leg 8, as well as the file name for the data.

Table 7. Dates and location of the transects completed with the EM Induction system. The asterisks indicate that snow sampling was done along the transects.

Date	Start Location	End Location	File Name	Comments
May 11	70.08N 125.574W	70.10N 124.982W	FEM 28130	Franklin Bay transect (to determine ice camp location)
May	70.08N	69.61N	FEM 28131	Franklin Bay transect (to

11	125.574W	125.851W		determine ice camp location)
May 13*	70.14N 124.72W	70.17N 124.91W	FEM 28133	Franklin Bay snow-melt pond study
May 13*	69.89N 125.05W	69.93N 125.44W	FEM 28134	Franklin Bay snow-melt pond study
May 13*	70.14N 125.22W	69.88N 125.45W	FEM 28135	Franklin Bay snow-melt pond study
May 13*	69.82N 125.69W	69.64N 125.76W	FEM 28136	Franklin Bay snow-melt pond study
May 13*	69.78N 125.87W	69.69N 126.16W	FEM 28137	Franklin Bay snow-melt pond study
May 13*	69.67N 126.11W	69.86N 126.30W	FEM 28138	Franklin Bay snow-melt pond study
May 14	69.82N 125.69W	69.64N 125.76W	FEM 28139	Franklin Bay snow-melt pond study (reflown)
May 14	69.78N 125.87W	69.69N 126.16W	FEM 28140	Franklin Bay snow-melt pond study (reflown)
May 14	69.67N 126.11W	69.86N 126.30W	FEM 28142	Franklin Bay snow-melt pond study (reflown)
May 14	Ship location		FEM 28144	10 transects east of ship
May 14	Ship location		FEM 28145	10 transects west of ship
May 14	Runway		FEM 28147	Determine the thickness of runway
May 15	70.14N 124.72W	70.17N 124.91W	FEM 28151	Franklin Bay snow-melt pond study (reflown)
May 15	69.89N 125.05W	69.93N 125.44W	FEM 28152	Franklin Bay snow-melt pond study (reflown)
May 15	70.14N 125.22W	69.88N 125.45W	FEM 28153	Franklin Bay snow-melt pond study (reflown)
May 17	69.82N 125.69W	69.64N 125.76W	FEM 28155	Franklin Bay snow-melt pond study (reflown)
May 17	69.78N 125.87W	69.69N 126.16W	FEM 28156	Franklin Bay snow-melt pond study (reflown)
May 17	69.67N 126.11W	69.86N 126.30W	FEM 28157	Franklin Bay snow-melt pond study (reflown)
May 21			FEM 28158	15 transects over marginal ice
May 24	72.77N 125.80W	72.62N 126.02W	FEM 28163	Landfast ice west of Banks Island
	72.79N 125.62W	72.61N 125.79W	FEM 28165	Landfast ice west of Banks Island
	72.81N 125.37W	72.61N 125.79W	FEM 28166	Landfast ice west of Banks Island
	72.66N 126.00W	72.55N 125.85W	FEM 28164	Landfast ice west of Banks Island
May 25	72.51N 130.32W	72.59N 130.63W	FEM 28168	MYI transects in pack ice
	72.50N 130.59W	72.56N 130.40W	FEM 28170	MYI transects in pack ice
	72.61N 130.59W	72.65N 130.31W	FEM 28169	MYI transects in pack ice
May			FEM 28171 -	6 Transects within M'Clure

28			28175	Strait
May 31	71.21N 124.67W	(ship location)	FEM 28167 and 28178	9 transects west of ship location
May 31	71.21N 124.67W	(ship location)	FEM 28169	9 transects south of ship location
June 1	70.64N 123.18W	(ship location)	FEM 28180 FEM 28181	Marginal ice sampling south of ship
June 2	70.14N 124.72W	70.17N 124.91W	FEM 28183	Franklin Bay snow-melt pond study (reflown)
	69.89N 125.05W	69.93N 125.44W	FEM 28184	Franklin Bay snow-melt pond study (reflown)
	70.14N 125.22W	69.88N 125.45W	FEM 28185	Franklin Bay snow-melt pond study (reflown)
June 2	69.86N 123.75W		FEM 28186	Two transects in front of ship
June 3	69.82N 125.69W	69.64N 125.76W	FEM 28187	Franklin Bay snow-melt pond study (reflown)
	69.78N 125.87W	69.69N 126.16W	FEM 28188	Franklin Bay snow-melt pond study (reflown)
	69.67N 126.11W	69.86N 126.30W	FEM 28189	Franklin Bay snow-melt pond study (reflown)

Video imagery was captured along the transects in Franklin Bay on May 13, May 17 and June 2/3, as well as on the fast ice along the west side of Banks Island (May 24). The video frames were collected with an AXIS 210 Network Camera using an 4mm lens for 250 pixels across the camera's frame width providing a resolution of 1/2m at the 130m flying height. It is housed in a "Pod" along with a laser (Optec Sentinel 3100 laser) that is strapped to the helicopter skid gear. The computer program reads the flying height and helicopter speed to collect camera frames with a 50% overlap.

Atmospheric Sampling Program

The purpose of the atmospheric sampling program is to monitor cloud cover and cloud properties, upper level and boundary layer winds, temperature, and humidity.

All-Sky Camera

The all-sky camera system is used to take pictures of sky in order that percentage and type of cloud cover may be determined throughout the cruise. The camera takes pictures every 10 minutes.

Ceilometer

The ceilometer is used to measure the height of the cloud layers above the ship. The ceilometer was fully functional for Leg 8. Backups were performed at regular intervals.

Atmospheric Profiling Radiometer

The profiling radiometer is used to continuously measure the temperature, relative humidity, and pressure within the atmosphere to a 10 km altitude . The profiling radiometer has been running smoothly, with only occasional crashing of the interface software on the laptop due to a memory leak. Data collection was not affected. The profiler was calibrated with LN2 which will be valid till the end of CFL.

Radiosondes (weather balloons)

There were 12 balloon launches during Leg 8, most were launched towards the latter part of Leg 8. Balloon launches were conducted to correspond mainly with low-pressure depressions and cyclones, but a small number profiled high pressure systems, and low-level inversions. The balloon tether system, constructed by our Russian team 2 collaborators during Leg 5, was improved and employed on several occasions in an attempt to collect time-series data at

approximately 250m above the ground. Battery charge life, and changing wind conditions prevented us from collecting time series greater than 4 hours. Balloons used for tethered experiments were generally re-used immediately after as regular profiling balloons due to no storage location for the balloons.

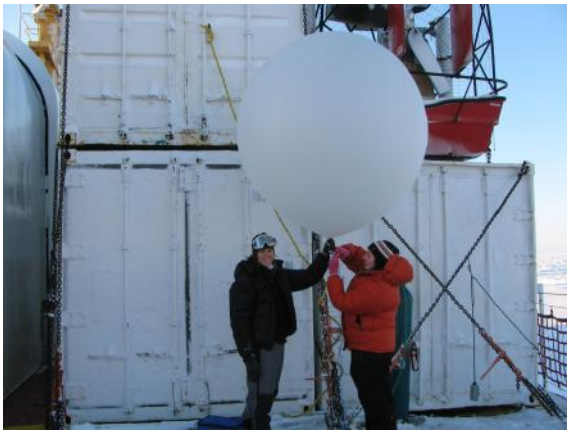


Figure 10. Attaching a radiosonde to a balloon for an atmospheric profile.

Laser Precipitation Gauge

This instrument was fully functional throughout Leg 8. The instrument continues to run as per normal, and all data has been downloaded and archived.

Ice Motion Beacons

We deployed four ice motion beacons. Two in thick first year ice and two in multi-year flows.

Figure 11. Ice motion beacon installed in a first-year ice floe.

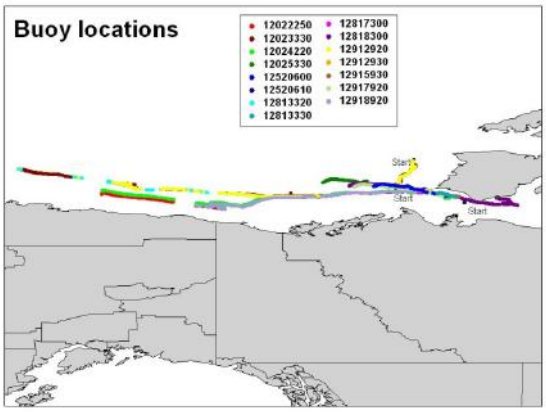


Figure 12. Ice motion buoy locations as of February 25, 2008.

Met-ocean MOBS Buoys
Two improved MOBS buoys were received, but have not been operated. The buoys are presently stored near and inside the benthic lab.

AVOS (Environment Canada MetObs System)
This system was operating normally, with the exception of a few glitches in data transmission that were worked out by the ship's electronics officer.

2.3. Team 3

2.3.1. Primary Production

PI: Michel Gosselin

Introduction
Primary producers fuel nearly all of the Earth's ecosystems by converting the sun's energy to an available food source through a process called photosynthesis. During photosynthesis, primary producers fix carbon dioxide, an important greenhouse gas, into food molecules connecting them, albeit indirectly, to our global climate. In this project we have focused our efforts to better understand physical (e.g., light) and chemical (e.g., nutrients) factors affecting primary production within the circumpolar flaw lead within the Amundsen Gulf.

In seasonally ice-covered seas, primary producers can be found in two generalized environments (habitats): (1) associated with sea ice (ice algae) and (2) suspended in the upper water column (phytoplankton). The timing, intensity and duration of primary production in these two environments are different. Both habitats play a very important and integrated role within the ecosystem. In a typical Arctic marine ecosystem, the relative importance of sea ice algae and phytoplankton follow a seasonal progression, with sea ice algae providing an initial food source for heterotrophs in early spring when the region is ice-covered, followed by a shift to phytoplankton production as the ice melts away during summer months. However, in the flaw lead system where open water can exist even in winter, the general location of primary producers is understandably much more complex. Contrasting the environments of primary producers in the flaw lead with the surrounding ice cover is a driving goal of our research. Furthermore, we have not had the opportunity to examine this dynamic region throughout the entire year, until now with the Circumpolar Flaw Lead System Study.

The Sea Ice Community
A very unique community exists within the inter-connected brine channels and brine pockets found between the larger ice crystals of the sea ice matrix. Therefore, within the sea ice, our group has focused not only on the primary producers, but on the entire community from bacteria through to meiofauna. In this section we describe the sea ice community dataset collected during leg 8 of CFL (April 24 – June 05, 2008).

Ice samples were mainly obtained via ice core extraction using 9 cm core barrels (Kovacs© Mark II Coring System). Ice core sampling was conducted at 10 stations. Depending upon the analysis needed and the snow depth available, cores were collected under low (< 5 cm), medium (8 – 15 cm) and high (> 15 cm) snow covers. General measurements taken at each core hole included snow depth, ice thickness and freeboard. Our group also worked closely in the field with teams 2, 6 and 7 to collect data on PAR albedo, transmitted PAR, vertical profiles of temperature, salinity and concentrations of various gases in the sea ice (e.g., CO_2, CO, N_2O and DMSP) and nutrients of the sea ice. The following sections are separated into sea ice algae and sea ice meiofauna.

Sea ice algae

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State Variables

If available, 3 snow depths were targeted at every sampling station. The bottom 0 – 3 cm and 3 – 10 cm sections of the ice cores were collected from each snow depth. Depending on the amount of material needed for analysis and the amount of algae visible in the sea ice, 4 to 7 cores were collected from each snow depth site. One of the medium site ice cores extracted was also used for a full vertical profile. Ice cores were pooled in cooler jugs and 0.2 µm filtered seawater (FSW) was added at a dilution of 100 ml FSW per 1 cm of core prior to melting. The samples were then left to melt overnight in the cooler jugs. Once melted, nutrient (Nut) samples were taken, followed by a measurement of the salinity and total volume of the samples. It is noted that nutrient samples for FSW were collected as well as nutrient samples for additional core sections (i.e., no FSW added) which were stored in whirl-pack bags and placed in darkness to melt. Salinity, temperature and conductivity were measured on each melted sample.

Samples were filtered for determination of size fractionated (0.7 µm, 5µm and 20µm) chlorophyll *a* (chl *a*), particulate organic carbon and nitrogen (CHN), spectral absorption of particulate matter (Ap.), high performance liquid chromatography pigment analysis (HPLC), general cell identification (Cells; fixed in Lugol Acid and Formalin and to be counted via inverted microscopy), cell identification of autotrophs and heterotrophs via epifluorescence microscopy (Epi.), abundance and size class of pico/nanoalgae and bacteria via flow cytometry (Cyto.) and DNA fingerprinting of ice samples (DNA) (Table 3.1). Furthermore, at every medium snow depth site, a vertical profile core was collected for determination of Chl *a*, Cells, Ap, cyto and HPLC (Table 3.1).

Table 3.1. Data collection timeline for ice core extraction samples. L, M and H stand for low, medium and high snow depths and thin represents ice less than 70 cm thick with a 3 – 4 cm snow cover.

Station	Date	PAR/ CTD	Nut.	Chl *a*	CHN	Ap.	HPLC	Cells	Epi.	Cyto.	DNA
D43	April 26, 2008	LMH/ M	LMH	LMH	LMH	LMH	LMH	LMH	LMH	LMH	
D43-1	April 29, 2008	LM/M	LM	LM	LM	LM	LM	LM	LM	LM	LM
D43-2	May 2, 2008	LMH/ M	LMH	LMH	LMH	LMH	LMH	LMH	LMH	LMH	
D43-3	May 5, 2008	LH/H	LH	LH	LH	LH	LH	LH	LH	LH	
F1	May 8, 2008	LM/M	LM	LM	LM	LM	LM	LM	LM	LM	LM
F2	May 13, 2008	M	M	M	M	M	M	M	M	M	
F2-1	May 16, 2008	L	L	L	L	L	L	L	L	L	L
F3	May 20, 2008	MH	MH	MH	MH	MH	MH	MH	MH	MH	
1011 (D-45)	May 21, 2008	M	M	M	M	M	M	M	M	M	
F4	May 24, 2008		L	L	L	L	L	L	L	L	
F5	May 28, 2008		L	L	L	L	L	L	L	L	
D44	May 30, 2008		L	L	L	L	L	L	L	L	L
F6	June 2,	L and	L	L	L	L	L	L	L	L	

	2008	meltpo nd									

Rate Variables
During leg 8, samples were collected to measure carbon uptake by algae under varying light conditions via ^{14}C labeling. Increasing light intensity is plotted against carbon uptake per unit chl *a* to create Photosynthesis-Irradiance (PI) curves. These curves are used to determine parameters such as the algal photoacclimation and maximum carbon uptake per chl *a* biomass. The method involved scraping the bottom of an extracted ice core into a known volume of FSW in the field. This method minimizes osmotic stress on the algae.

The samples were also analyzed using an under ice incubation array deployed by either an under ice arm. Samples were placed into 60 ml culture flasks and covered with a range of neutral density filters used to block a known percentage of light per flask. A Licor© PAR sensor was positioned in the center of the incubation array to log incoming light during the incubation.

Unfortunately, due to the schedule that we had, we were not able to perform this experiment. We did it once, but the scintillation counter was not able to recognize the vials. These problems were unexpected, and it would have been interesting to sample more stations to understand the phytoplankton bloom versus the decline of ice algae.

Open Water Variables
During the whole leg, many open water stations were sampled. In fact, even during ice stations, we were collecting water from the rosette for the 10m and 25m depths. For the upper part of the water column, a small pump was used to collect the water underneath the ice (interface) with the help of an under-ice arm, at 2m and 5m. The chl *a,* cells stained with lugol and nutrients were collected to help our understanding of the impacts of the water column on the ice algae. Salinity, temperature and conductivity were measured on each sample (Table 3.2). Open water stations were important in our measurements to determine the beginning of the phytoplankton bloom. Before sampling the water from the rosette, a secchi disk and a PAR profile of the water column were conducted to provide us the photic zone (in %). The different depths sampled were 100%, 50%, 30%, 15%, 5%, 1%, 0.2%, chl max, 75m and 100m. Usually, the 100% and 50% were collected from the cage, due to the fact that the rosette was starting at 10m (moonpool).

Samples were filtered for determination of size fractionated (0.7 µm, 5µm and 20µm) chlorophyll *a* (chl *a*), particulate organic carbon and nitrogen (POC/PON), high performance liquid chromatography pigment analysis (HPLC), general cell identification (Cells; fixed in Lugol Acid and Formaline and to be counted via inverted microscopy), abundance and size class of pico/nanoalgae and bacteria via flow cytometry (Cyto.). Refer to the table to see which depths were sampled for each analysis (Table 3.3).

Table 3.2. Data collection timeline for water samples occurring at the same time than ice stations. Sfc, 2m, 5m, 10 and 25m stand for the different depths sampled underneath the ice. Sfc represents interface water.

Station	Date	Nut.	Chl *a*	Cells
D43	April 26, 2008	Sfc, 2m, 5m, 10m, 25m	Sfc, 2m, 5m, 10m, 25m	Sfc, 2m, 5m, 10m, 25m
D43-1	April 29, 2008	Sfc, 2m, 5m, 10m, 25m	Sfc, 2m, 5m, 10m, 25m	Sfc, 2m, 5m, 10m, 25m
D43-2	May 2, 2008	Sfc, 2m, 5m, 10m, 25m	Sfc, 2m, 5m, 10m, 25m	Sfc, 2m, 5m, 10m, 25m
D43-3	May 5, 2008	Sfc, 2m, 5m, 10m, 25m	Sfc, 2m, 5m, 10m, 25m	Sfc, 2m, 5m, 10m, 25m
F1	May 8, 2008	Sfc, 2m, 5m	Sfc, 2m, 5m	Sfc, 2m, 5m
F2	May 13, 2008	Sfc, 2m, 5m, 10m, 25m	Sfc, 2m, 5m,	Sfc, 2m, 5m,

			10m, 25m	10m, 25m
F2-1	May 13, 2008	Sfc, 2m, 5m, 10m, 25m	Sfc, 2m, 5m, 10m, 25m	Sfc, 2m, 5m, 10m, 25m
F3	May 20, 2008	Sfc, 2m, 5m	Sfc, 2m, 5m	Sfc, 2m, 5m
1011 (D-45)	May 21, 2008	Sfc, 5m	Sfc, 5m	Sfc, 5m
F6	May 30, 2008	Sfc, 5m, 10m, 25m	Sfc, 5m, 10m, 25m	Sfc, 5m, 10m, 25m

Table 3.3. Data collection timeline for open water stations. All the optical depths were sampled for chl *a*. For POC/PON (CHN), DOC/DON and DOC/TOC, 50%, 15%, chl max and 100m were analyzed. 50% and chl max were filtered for HPLC. We sampled the 50%, 15% and chl max for the cells. For the flow cytometry, 50%, 30%, 5%, 1%, chl max and 100m were sampled.

Station	Date	Chl *a*	CHN	DOC/TOC DOC/DON	HPLC	Cells	Cyto.
1020A	May 6, 2008	√	√	√	√	√	√
O2	May 12, 2008	√	√	√	√	√	√
405b	May 19, 2008	√	√	√	√	√	√
1011	21/05/08	√	√	√	√	√	√
1806	23/05/08	√	√	√	√	√	√
8010	26/05/08	√	√	√	√	√	√
9008	27/03/08	√	√	√	√	√	√
405	June 1, 2008	√	√		√	√	√

Meiofauna

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The main purpose of the present investigation was to further assess the role of sea-ice metazoan meiofauna in organic fluxes in the Canadian Arctic. Specific objectives were to: (1) document sea-ice metazoan meiofaunal (metazoans between 40 µm and 500 µm living within the ice) dynamics; (2) estimate the grazing impact of sea-ice meiofauna on the bottom ice algal and bacteria standing stock; (3) identify trophic relationships in sea-ice; and to (4) quantify organic matter fluxes in sea-ice food webs. In the following sections, we report on the methods involved in the data collection during leg 8 of CFL (April 24 – June 05, 2008).

Ice samples were taken at 10 stations, some of being repeatedly sampled during the leg (Table 3.4). Three ice-core bottom sections (3 cm length) were collected for abundance, biomass and composition of sea-ice meiofauna, and bacteria abundance. Nine ice-core bottom sections were collected for the determination of isotopic signatures of fractionated particulate organic matter (POM) and meiofauna. Finally, on some occasions, nine ice-core bottom sections were also collected for nutrition experiments of copepods on phytodetritus.

Abundance, biomass and composition of sea-ice meiofauna and bacteria abundance
The bottom 3 cm of 3 ice-cores was cut, put in separate coolers and transported back to the ship. The bottom section of each ice-core was melted in 500 ml of surface water filtered through 0.22 µm hydrophilic Durapore membrane filters, at room temperature. After complete melting, 4 ml of the samples were pre-filtered onto a 40 µm nylon mesh, fixed with glutaraldehyde 25% grade II, frozen in liquid nitrogen and then stored at -80°C for the determination of bacteria abundance. The volume of the remaining melted sample was measured and then passed through 500 and 38 µm sieves, and the

500 and 38 µm screenings were fixed in 4% borax-buffered formaldehyde solution and stained with Rose Bengal for subsequent analyses.

Trophic relationships in sea-ice

For the determination of isotopic signatures of sea-ice POM and meiofauna, nine ice-core bottom sections were cut, put in separate coolers (3 sections/cooler) and transported back to the ship. The bottom ice-cores were melted in 1500 ml of surface water filtered through 0.22 µm hydrophilic Durapore membrane filters at room temperature. After complete melting, each sample was then passed through a 38 µm sieve. The animals retained onto the 38 µm sieve were separated from detritus and microalgae (here identified as POM) and identified at the taxon level. Then, POM and pooled animals of each taxon were filtered through precombusted (500°C, 5 h) Whatman GF/F filters. The filters were placed in petri dishes and dried at 60°C for 48 hours and then stored at room temperature for further analyses. The same procedure was applied to the sample smaller than 38 µm.

Quantification of organic matter fluxes in sea-ice food webs

For the quantification of organic matter fluxes in sea-ice food webs, nine ice-core bottom sections were cut, put in separate coolers (3 sections/cooler) and transported back to the ship. The bottom ice-cores were melted in 1500 ml of surface water filtered through 0.22 µm hydrophilic Durapore membrane filters at room temperature. After complete melting, each sample was then passed through a 38 µm sieve. The animals obtained onto the 38 µm sieve were separated from detritus and microalgae and identified at the taxon level. Among these animals, *Halectinosoma sp.* were harvested for feeding experiments (pulse-chase technique) on phytodetritus using the experimental procedure described in Charles (1994).

Table 3.4. Description of sampling program in the sea-ice. L: low snow; M: Middle snow; H: High snow; Bact.: Bacterial abundance; Meiof.: Meiofaunal community structure; SI meiof.: Stable isotopes on meiofauna; SI POM: Stable isotopes on POM; FE: Feeding experiments; Total chl *a*: Biomass of ice-algae; CHN: POC, PON. Numbers are numbers of replicates.

Station	Date	Site	Ice cores	Bact.	Meiof.	SI meiof.	SI POM	FE	Total Chl *a*	CHN
D-43	April 26, 2008	L	8	3	3	-	-	-	-	-
D43	April 26, 2008	M	2	-	-	1	1	-	-	-
D43	April 26, 2008	H	3	3	3	-	-	-	-	-
D43	April 29, 2008	L	15	3	3	3	3	-	-	-
D43	April 29, 2008	M	3	3	3	-	-	-	-	-
D43	May 02, 2008	L	12	3	3	3	3	-	-	-
D43	May 02, 2008	H	3	3	3	-	-	-	-	-
D43	May 05, 2008	L	12	3	3	3	3	-	-	-
D43	May 05, 2008	H	3	3	3	-	-	-	-	-
D44	May 06, 2008	L	4	3	3	-	-	3	1	-
F1	May 08, 2008	L	21	3	3	3	3	-	-	-
F1	May 08, 2008	M	3	3	3	-	-	-	-	-
F2	May 13, 2008	M	12	3	3	3	3	-	-	-
F2	May 16, 2008	L	3	3	3	-	-	3	-	-
F3	May 20, 2008	M	12	3	3	3	3	-	-	-
F3	May 20, 2008	H	3	3	3	3	3	-	-	-
1011	May 21, 2008	M	12	3	3	3	3	-	-	-
F4	May 24, 2008	M	12	3	3	3	3	-	-	-
F4	May 28, 2008	L	12	3	3	3	3	-	-	-

D45	May 30, 2008	L	12	3	3	3	3	-	-	-
D46	May 31, 2008	L	7	3	3	-	-	-	2	2
F6	June 2, 2008	L	12	3	3	3	3	-	-	-

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During legs 7 and 8 of the CFL project, ice samples were taken for studies on diversity, abundance and feeding ecology of sympagic meiofauna (metazoans > 20 µm living within the ice) (Tables 3.5 and 3.6). Ice cores were taken on seven ice floes and five fast-ice sites, using an engine-powered KOVACS ice corer (internal diameter 9 cm). Every 3-10 days, five ice-core bottom sections (5 cm length) were taken on a site of non-deformed ice, generally with medium snow cover (4-18 cm), nearby the PAR measurement area, for measurement of algal pigments (bottom section 1) and for analyses of meiofauna diversity, abundance and biomass on fixed (bottom section 2) and fresh samples (bottom sections 3-5). Once per floe or fast-ice site, one full ice core, cut in sections of 2-10 cm, was taken instead of bottom section 2 for analyses of meiofauna abundance and biomass on fixed samples with respect for vertical distribution. On the same sampling day, further three ice-core bottom sections (3-5 cm length; bottom sections 6-8) for analyses of meiofauna *in situ* gut contents were taken at sites with high, medium and low snow cover. Further ice samples, including ice-core bottom sections (3-10 cm length), ice underside (2-5 cm thick layer) scraped from blocks of ice, and pieces of ice picked up from the water next to the ship using the ice cage, were taken in order to gain meiofauna organisms and sympagic ciliates for taxonomy, fatty acid analyses and feeding experiments.

Bottom section 1 was melted in the dark at +4 °C and filtred on a Whatman GF/F glasfibre filtre; algal pigments were extracted in acetone in the dark at +4 °C, and chlorophyll *a* and phaeopigment *a* were measured fluorometrically. Bottom sections 6-8 were immediately placed in 50 ml of 0.2 µm filtred sea water (FSW) and shaken gently for one minute to flush out meiofauna organisms. The liquid was sieved on a 20 µm gauze, and the samples were fixed in picric acid formaldehyde (PAF) and stored at +4 °C. In the home laboratory, meiofauna will be sorted from these samples and cut in half, and the gut content will be analysed using a scanning electron microscope. All other ice samples, as well as the remains of bottom sections 6-8, were melted in an excess of FSW (200 ml per 1 cm of ice core) at +4 °C and enriched over a 20 µm gauze. Bottom section 2 or sections from the full ice core were then fixed in borax-buffered formaldehyde (37 % formaldehyde added to the sample, final concentration 2 %). These samples will be sorted at the home laboratory, and organisms will be measured; bulk abundances of meiofauna and ciliates will be determined, and biomass will be calculated according to Friedrich (1997). Bottom sections 3-5 were sorted onboard at +4 °C within two days after melting, and bulk abundances of meiofauna and ciliates were determined. All other ice samples were sorted onboard at +4 °C within a few days after melting.

Part of the organisms sorted from the samples onboard were preserved in formaldehyde (2-4 %), PAF or 95 % ethanol for later taxonomical and morphological studies. For fatty acid analyses, alive animals were rinsed by transferring them into fresh FSW several times, were then transferred onto a pre-combusted Whatman GF/F filtre, rinsed with MilliQ water, and stored at -80 °C. In the home laboratory, the samples will be extracted in dichloromethane:methanole (2:1 v:v), transesterificated and analysed in a gas chromatograph. The fatty acid composition will provide information on in *situ diets* (e.g. the degree of carnivory).

For determination of feeding preferences and ingestion rates, feeding experiments have been conducted onboard during leg 8, and will be carried on at the home laboratory. For this purpose, cultures of sympagic meiofauna and ciliates have been established. Sympagic meiofauna has been reared on a mixed diet of sympagic algae and ciliates isolated from melted and enriched ice samples; sympagic ciliates have been reared on a mixed diet of sympagic algae. In predation experiments, ciliates or other meiofauna taxa are offered as prey to a specific meiofauna taxon. Every 2-5 days, prey individuals are counted, the state of predator individuals is checked, and consumed prey as well as

dead predators are replaced, in order to keep the predator and prey densities constant over the duration of the experiment. In grazing experiments, individuals of a specific meiofauna taxon are placed in vials filled with a suspension of sympagic algae and ciliates. Most of the algae and part of the ciliates settle down on the bottom of the vial after short; this setup thus simulates *in-situ* conditions, where meiofauna graze on surfaces rather than in suspensions. At the end of the experiment, the grazers and part of the faecal pellets are removed, rinsed and fixed for microscopic studies and measurements at the home laboratory; algae and ciliates are resuspended and fixed with lugol solution for cell counts at the home laboratory. Both predation and grazing experiments are carried on for a couple of weeks. Comparison with controls (prey without predators / food suspension without grazers) will allow the calculation of ingestion rates (consumed food per predator / grazer and time, expressed as individuals or biomass). Setups with different predator / grazer and food densities will provide information about functional response and concurrence. During leg 8, predation experiments have already been conducted with harpacticoid copepods as predators and ciliates as prey (four different prey densities); grazing experiments have been conducted with the same copepod taxon as grazers (three different food suspensions).

Table 3.6. Samples for algal pigments and abundance, biomass, gut contents and fatty acid composition of meiofauna. Numbers are numbers of replicates. Chl : chlorophyll *a* and phaeopigment a in 5 cm bottom sections of ice cores; A: meiofauna abundance in fresh 5 cm bottom sections of ice cores; AB: meiofauna abundance and biomass in fixed 5 cm bottom sections of ice cores; Abvp: vertical profiles of meiofauna abundance and biomass from full ice cores; G: gut contents of sympagic meiofauna; Qual: qualitative samples for diversity, feeding experiments and fatty acids (see below); L: low snow site; M: medium snow site; H: high snow site; T: thin ice; IC: ice cage; IU: ice underside from blocks; FA: fatty acids

Station	Date	Site	Chl	A	AB	ABvp	G	qual
D29	March 17, 2008	L	1	3	1			+ FA
D29	March 17, 2008	H						+
D30	March 19, 2008	T/IC		1	1			+
D32	March 22, 2008	L						+
D32	March 22, 2008	M	1	2	1			+
D32	March 22, 2008	IU						+
D34	March 24, 2008	IC						+
D33	March 25, 2008	M	1	3	1			+
D33	March 25, 2008	IU						+
D33	March 28, 2008	L					1	+ FA
D33	March 28, 2008	M	1	2	1		1	+ FA
D33	March 28, 2008	H					1	+ FA
D33	March 29, 2008	L						+ FA
D33	March 29, 2008	M						+ FA
D33	March 30, 2008	IU						+
D33	March 31, 2008	M	1	3	1			+ FA
D35	April 2, 2008	IC						+
D33	April 3, 2008	L					1	+ FA
D33	April 3, 2008	M	1	3		1	1	+ FA
D33	April 3, 2008	H					1	+
D36	April 6, 2008	L					1	+ FA
D36	April 6, 2008	M	1	3		1	1	+ FA
D36	April 6, 2008	H					1	+
D36	April 9, 2008	T		3				+
D38	April 11, 2008	L	1	3	1		1	+
D38	April 11, 2008	H					1	+
D38	April 11, 2008	IU						+ FA
D38	April 13, 2008	IU						+ FA
D41	April 16, 2008	L						+

D41	April 16, 2008	M	1	3	1			+ FA
D41	April 19, 2008	L					1	+
D41	April 19, 2008	M	1	3		1	1	+
D41	April 19, 2008	H					1	+
D43	April 29, 2008	L					1	+
D43	April 29, 2008	M	1	3		1	1	+ FA
D43	April 29, 2008	H					1	+
D43	May 2, 2008	L						+
D43	May 2, 2008	M	1	3	1			+
D43	May 5, 2008	H	1	2	1		1	+
	May 6, 2008	T/IC	1	1	1			+
	May 6, 2008	IC						+
F1	May 8, 2008	L					1	+ FA
F1	May 8, 2008	M	1	1		1	1	+ FA
F2	May 13, 2008	H	1	1		1	1	+ FA
F2	May 16, 2008	L						+ FA
F3	May 20, 2008	M	1	3		1	1	+ FA
F3	May 20, 2008	H					1	+
F4	May 24, 2008	M	1	3		1	1	+
F5	May 28, 2008	L	1	3	1		1	+
D45	May 31, 2008	L						+

Table 3.7. Fatty acid samples. Numbers are numbers of samples for each taxon per station.

Taxon	**D29**	**D33**	**D36**	**D38**	**D41**	**D43**	**F1**	**F2**	**F3**
Nauplii Harpacticoida Species 1	1	7	2	4		1			
Copepodides Harpacticoida Species 1			1	4	1	1			
Nematoda indet.		1					6	5	1
Rotifera indet.							1		

Phytoplankton communities

Viability and photoprotection of phytoplankton communities (Eva Alou Font)

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Cell viability is a poorly known process in the ocean. Viruses and bacteria are implicated in cell mortality but cell death (e.g. apoptosis) can also be important. Recent work suggests than cell viability is strongly determined by the level of photo-protection in phytoplankton (Van del Poll et al., 2005).

With rapid global warming in polar environments ice reduction and melting should lead to increased irradiance in surface waters. Phytoplankton cells previously acclimated to lower light levels may then have insufficient photo-protection and consequently suffer significant mortality. Recent work linked cell survival with nutrient depletion in oligotrophic waters (Agusti et al., 2006).

The objective of the project is to examine the flaw lead system and land fast ice in the Canadian Arctic during Spring time focusing on the following specific hypothesis:

1) To test whether photo-protection is a major determinant in changes in cell viability and this will contribute to difference between the composition of phytoplankton population from the flaw lead system and the land-fast regions.

2) To test whether cells from the more nutrient-limited regions show lower viability compared to nutrient-rich regions, when exposed to high surface irradiance.

Objectives:

1) Cell viability quantification.
2) Test cell photoprotection (Pigments, D1 protein cycle) vs. changes in viability.
3) Test nutrients vs changes in viability.

To reach these objectives, we will measure through the program the following parameters whenever possible:

1) Transparency of the water with a Secchi disk (to choose the right depths in the rosette).
2) Downwelling irradiance vertical profiles (UVb, Uva, PAR).
3) The pigment composition of phytoplankton with the high performance liquid chromatography method (HPLC).
4) Cell viability (Enzymatic technique and stain).
5) D1 protein.
6) Photosynthetic response (Xe-PAM).
7) Ratio of variable to maximum fluorescence Fv/Fm as a measure of the cell physiology activity (fluorometer).

Leg 8 methods

- Water samples were taken from April 29 until June the 3 under the thinner ice of a refreezing flaw lead close to the southeast coast of Banks Island at station D43. Samples under the ice were taken using a pump and a hose lowered through a small hole perforated in the thin ice with a handheld ice auger at surface level and 5 meters. Other samples under the ice where taken with the rosette, at 10 meters, 25 meters and depth of maximum chlorophyll when it was present.

- In open water stations water samples where taken with the rosette regarding the transparency of the water measured with the Secchi disk, normally at 50 % irradiance, 15% 1% and chlorophyll maximum when was present.

- Samples for HPLC technique were filtered through 25 mm GF/F filters with a maximum of 2 L each depth and then stored in liquid nitrogen on board.

- Samples for protein D1 were filtered through 25 mm GF/F filters with a maximum of 2 L each depth and then stored in liquid nitrogen on board.

- Cell viability was measured for each depth for posterior epifluorescence microscopy analysis.

- Vertical radiation profiles where done in each open water station.

Conclusions

The CFL leg 8 operations where completed during April 29th and June 2nd.We particularly thank the crew members and the rest of the members of team 3 who helped with some operations.

Appendix: Sampling information: Number of depths sampled for each variable

Station	Date	Cast	HPLC	D1	Viability	Xe-PAM	Fluorimeter	Radiometer Profile (UV, PAR)
D43	April 29, 2008	13	2	2	2	2	2	
D43	April 30, 2008		1	1	1	1	1	
D43	May 1, 2008	29	6	6	3	6	6	

O43	May 3, 2008	37	1	1	1	1	1	
D43	May 4, 2008	41	4	4	4	4	4	
1020A	May 6, 2008	56/ 57	5	5	2	5	5	X
F1	May 7, 2008	-	3	3	3	0	0	
F1	May 9, 2008		5	5	2	2	2	
O1	May 10, 2008	-	1	1	1	1	1	X
O1	May 11, 2008	-	2	2	2	2	2	X
O2	May 12, 2008	59	4	4	4	0	4	
F2	May 14, 2008	67	3	3	3	3	3	
F2	May 16, 2008	75	4	4	4	4	4	
405b	May 19, 2008	84	4	4	5	0	2	X
1011	May 20, 2008	101	6	6	6	6	4	X
1806	May 23, 2008	103	5	5	3	0	3	
6010	May 25, 2008	111	2	2	2	2	2	X
9008	May 27, 2008	119	5	3	5	0	5	X
F5	May 28, 2008	124	3	3	3	0	3	
D44	May 30, 2008	127	4	2	4	4	4	
D45	May 31, 2008	131	4	4	4	0	4	
405	June 1, 2008	133	5	5	3	0	3	X
F6	June 2, 2008	138	5	2	3	0	5	

Remote sensing (Corinne Bourgault Brunelle)
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Rationale
To understand and to monitor biophysical processes in complex coastal waters it is necessary to use remote sensing methods. CASES measurements showed that optical properties of the Beaufort Sea and the Amundsen Gulf region are dominated by the freshwater outflow from the Mackenzie river leading to a bias in the estimation of phytoplankton biomass using remote sensing data. There is thus a need to develop specific methods to make more effective use of remote sensing data. The building of a database of inherent optical properties relating a wide variety of physical and biological conditions is a crucial step towards this goal.

Objectives

The general objective of our team is to study the relationship between the spatial and temporal distribution of the phytoplankton and the physical environment in the canadian Arctic with an emphasis on the Beaufort Sea and the Baffin Sea using remote sensing data.

Specific objectives for the CFL 2007-08 cruise are:

- The estimation of the ability of current bio-optical algorithms to measure chlorophyll-a concentration and species discrimination;
- The development of specific algorithms for a variety of ocean color sensors which will in turn provide a better understanding of the Beaufort Sea and the Baffin Sea physical and biological processes;
- The analysis of light absorption properties of arctic phytoplankton.

To reach these objectives, we will measure throughout the program the following parameters whenever possible:

(1) the transparency of the water with a Secchi disk;
(2) vertical profiles of inherent optical properties (light absorption and transmission, backscatter light, volume scattering function, particle size spectra, phytoplancton fluorescence, CDOM fluorescence, temperature and salinity using a custom built optical profiler system;
(3) the pigment composition of phytoplankton with the high performance liquid chromatography method (HPLC);
(4) the algal pigments light absorption;
(5) the total suspended matter and its partition into organic and inorganic matter;
(6) the chromophoric dissolved organic matter concentration.

Leg 8 methods

- Water samples were taken from April 26 to June 2 under thinner ice and in open water across the Beaufort Sea. A time series was made at station D43 and F2 where the ship was parked into the ice. Samples were taken using a pump and a hose lowered through a small hole perforated in the thin ice with a handheld ice auger. Samples were taken at depths of two and five meters from the surface water level. Two other samples were also taken using the rosette system at depths of 10 and 25 metres. Measurements were also made at other locations throughout the area in open water, fast ice and drift ice. Samples were taken West to Est and North to south of the Beaufort sea. In open water station, samples were taken at depths of 1 %, 10 %, 50%, 100% of surface irradiance, 60 meters and at the chlorophyll max.

- Filtration were performed for chlorophyll determination (HPLC techniques), a_{ph}, total suspended matter (TSM) and chromophoric dissolved organic materiel (CDOM).

- For chlorophyll-a, and algal pigments, water samples (up to 2.5 litres) were filtered through 25 mm GF/F filters, flash freezed and stored in liquid nitrogen on the ship. Samples will be transported south for analysis.

- CDOM samples were filtered using 0.2 µm Anotop® syringe filters (Whatman) and collected into 60 ml acid-cleaned amber glass bottles. The bottles were stored frozen (-20 ˚C) in the dark on the ship. Samples will be transported south for analysis .

- Total suspended matter was measured by filtering up to 2 litres of water using pre-weighted 25 mm GF/F filters. The filters were stored on the ship at –80 ˚C, to arrest pigment degradation (Sosik, 1999), and will be transported south to complete the analysis.

Samples of aph and CDOM will be transported south for analysis at the end of the leg.

Detailed sampling activities up to June 2 are summarised in the Appendix.

Conclusion

The CFL LEG8 operations were successfully completed between April 24 and June 2. This was a good leg that allowed to measure optical properties during the phytoplankton bloom which arrived at week 2 and 3. The chiefs scientists were comprehensive of the particular needs of the optics team.

Appendix: Sampling information: Refer to the CTD-Rosette logs for the location and timing of the rosette sampling.

Station	Date	cast	Chl-a (HPLC)	a ph	MPS	CDOM
D43	April 26, 2008	1	4	4	4	4
D43	April 27, 2008	6	2	2	2	2
D43	April 28, 2008	11	4	4	4	4
D43	April 29, 2008	13	4	4	4	4
D43	April 30, 2008	-	2	2	2	2
D43	May 1, 2008	29	4	4	4	4
D43	May 4, 2008	42	4	4	4	4
D43	May 5, 2008	44	4	4	4	4
A1020	May 6, 2008	57	5	5	5	5
F1	May 8, 2008	-	3	3	3	3
F1	May 10, 2008	58	6	6	6	6
O1	May 10, 2008	-	2	2	2	2
O2	May 11, 2008	-	2	2	2	2
O2	May 12, 2008	59	6	6	6	6
F2	May 13, 2008	62-64	6	6	6	6
F2	May 15, 2008	72	4	4	4	4
F2	May 16, 2008	75	4	4	4	4
405b	May 19, 2008	84	5	5	5	5
F3	May 20, 2008	90	4	4	4	4
1011	May 21, 2008	101	5	5	5	5
1806	May 23, 2008	104	6	6	6	6
6010	May 25, 2008	111	5	5	5	5
8010	May 26, 2008	113	6	6	6	6
9008	May 27, 2008	119	6	6	6	6
2008-F5	May 29, 2008	124	3	3	3	3
D44	May 30, 2008	127	4	4	4	4
2008-D45	May 31, 2008	131	4	4	4	4
405	June 1, 2008	133	5	5	5	5
2008-F6	June 2, 2008	138	4	4	4	4

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2.4. Team 4

2.4.1. Zooplankton, Fish Acoustic and Ecology

PI: Louis Fortier
Participants: Caroline Bouchard (U. Laval), Marc Ringuette (U. Laval), Steeve Gagné (electronic technician from U. Laval) and Jacques A. Gagné (Institut Maurice-Lamontagne)
Written by: C. Bouchard and J.A. Gagné (with some copy-paste from previous team four reports)

Introduction
The fragmented, thin, and often absent ice cover in the flaw lead allows solar radiation to reach the surface layer of the ocean where it triggers photosynthesis by microscopic algae. Team 4, Pelagic and Benthic Food Web, investigates how and to what extent microalgae growing in the flaw lead are consumed by the zooplankton and the benthos. Our simple hypothesis is that, relative to adjacent ice-covered regions, enhanced algal production in the flaw lead translates into biological hot spots where higher zooplankton and benthos production and abundance prevail. We also investigate how the Arctic cod, a central species in the Arctic food web, uses the flaw lead for feeding, overwintering, reproduction, and as a nursery ground for their young stages (http://www.ipy-cfl.ca/page1/page1.html).

General objectives
Our sampling program is derived from that of ArcticNet project 1.4 led by Dr. J.-É. Tremblay (U. Laval), 'Marine productivity and sustained exploitation of emerging fisheries', whose overarching goal is to assess the impact of sea-ice cover reduction and increasing sea temperatures on biological productivity, fisheries resources and marine mammal populations of the coastal Canadian Arctic. Since the beginning of the CFL field program last October, we focus on how physical processes moderate biogeochemical processes within the changing northern flaw lead ecosystem in the Amundsen Gulf - Banks Island area. The objectives of the team for leg 8 were to continue the work conducted during previous legs from the moon pool and to initiate the open water season by deploying zooplankton nets from the front deck (double (horizontal) and quadruple (vertical) 1-m^2 nets). We concentrated our sampling efforts on pelagic secondary producers as well as on larval, juvenile and adult Arctic cod. Our multidisciplinary ArcticNet-CFL team is strongly linked with Team 7 (Carbon Fluxes – Tremblay) of the CFL program.

The primary objectives of our team during CFL-8 were:
1-To assess zooplankton / fish abundance and diversity by using various sampling devices.
2-To track zooplankton / fish biomass and distribution with the EK60 Echo sounder, nets and traps.

Our secondary field objectives were to collect and use zooplankton samples to:

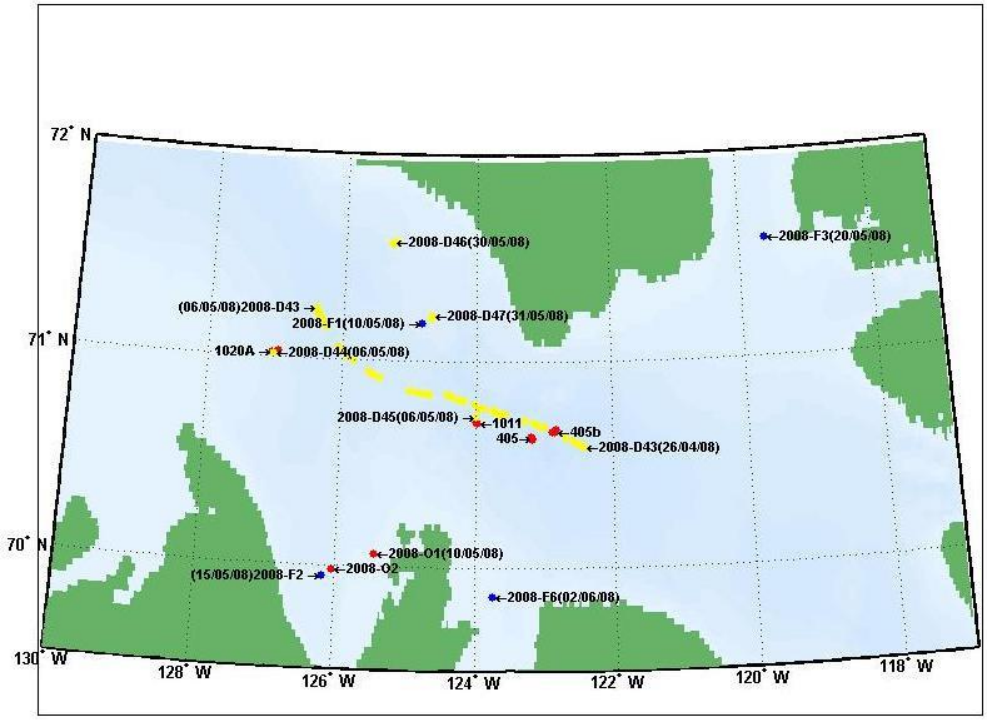
- investigate the cycling of contaminants by zooplankton and fish (G. Stern, U. Manitoba);
- identify the sources and pathways of omega-3 in the Arctic marine food web (J. Michaud, E. Dewaily and L. Fortier, U. Laval). This project is linked to the CFL-URSUK program and ArcticNet theme 1.5, focusing on the importance of omega-3 fatty acids in the traditional diet of Inuit communities;
- assess the biomass and respiration rates of the zooplankton community by the Electron Transfer System (ETS) activity at specific stations (G. Darnis and L. Fortier);

- collect samples for stable isotope analysis of the food web structure and carbon fluxes; this is a joint project between Teams 4 and 7 of CFL (A. Forest, L. Fortier, J-E. Tremblay);
- measure copepod *in-situ* egg production (EPR) and gonad maturation of *Calanus glacialis*, *C. hyperboreus* and *Metridia longa* (M. Ringuette, G. Darnis, L. Fortier);
- validate the daily increment deposition on the otoliths of larval Arctic cod using a fluorescent marker (C. Bouchard, L. Fortier).

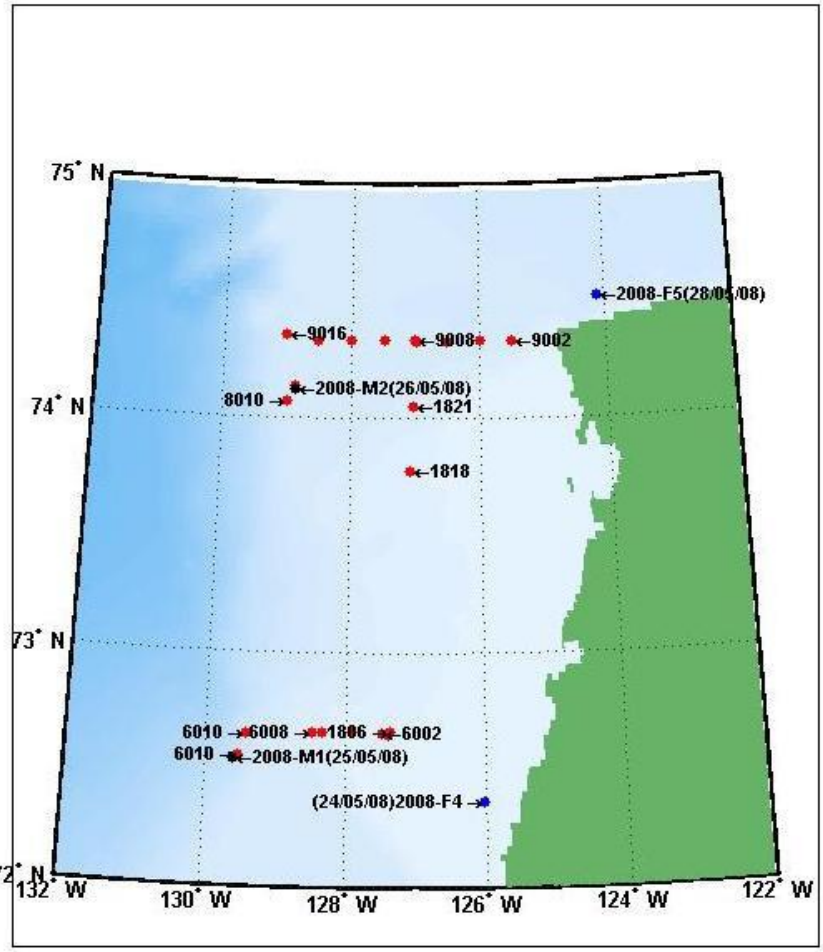
Sampling program

Leg 8 started in a drifting mode in an ice floe which we were supposed to leave a couple of days after the beginning of the leg. Because of the small size of our team (two people) and the planned short period of time at this station, we did not install the equipment for ice work. Departure from this drifting station was delayed however until May 6 because of unfavourable weather conditions. This 11-day period was devoted to moon pool sampling with one Hydrobios and at least one 1-m^2 vertical net cast per day (Table 2 and 3). We then transited to Cape Parry, initiating on the way the 2008 open water season and catching 3 Arctic cod larvae with the 2 x 1-m^2 zooplankton net. During the next two days spent in land fast ice near Cape Parry (depth ca. 50 m) for logistical operations, we dug out a 1-m^2 hole in the ice for plankton and gill net deployments (Table 5 and 6). We did not catch adult fish in the gillnet but the zooplankton samples provided us with our first live Arctic cod larvae which we used to initiate our marking experiment. Since Cape Parry appeared to be a good area to sample Arctic cod larvae, we performed a horizontal tow with the 2 x 1-m^2 zooplankton net just after leaving the F1 fast ice station (Fig. 1a). This cast brought us some 1800 Arctic cod larvae (Table 9). Zooplankton nets were again deployed from the foredeck at two open water stations (O1 and O2) before the ship was parked in Franklin Bay fast ice (station F2), near the CASES overwintering site; we resumed moon pool operations for the next five days during which we set the fish trap for two successive nights, once down to 10 m where we caught three 1 or 2 year-old juvenile cod and once just off the bottom (180 m) where we did not catch anything. At this station, a total of 17 vertical tows with the 1-m^2 zooplankton net and four Hydrobios deployments resulted in the catch of 122 Arctic cod larvae (Table 9) from which 58 were kept alive. On May 19, we sampled at station 405b (CASES CA-18) where a mooring is deployed. We set the fish trap once more that night with no catch. The next station was a full station (1011) in the open water of the flaw lead at the edge of the remaining pack ice near the southwest corner of Banks Island. We then proceeded north into the flaw lead where we completed two cross-lead transects between the land fast ice off Banks Island and the pack ice (Fig. 1b). We sampled at two open-water stations on each of the transects (stations 1806, 6010, 8010 and 9008) and caught a total of 69 Arctic cod larvae. Back in the ice, we caught 19 larvae in the fast ice of McClure Strait (station F5) and 6 at drift station D45 three days later. We then sailed back south towards Darnley Bay stopping over for a full open water station near mooring site 405 where we caught 42 larvae. Finally, we moved into the ice in Darnley Bay (station F6) where we caught only two larvae. The 30 m gillnet was deployed one last time for the leg about 100 m off the starboard side of the ship, vertically from the bottom of the ice in 70 m of water. The fish trap was set overnight just below the hull of the ship. We caught one adult cod in the trap and nothing in the gillnet. These concluded our sampling program for leg 8.

Figure 1. Location of stations visited during CFL leg 8.
a) Amundsen Gulf



a) West of Banks Island



1) Description of the sampling devices used during leg 8

a) Rosette. Samples to investigate the vertical distribution of the micro-zooplankton were collected from the rosette only once during leg 8.

b) 1-m^2 square net. A 1-m^2 square metal frame rigged with a 200 µm mesh plankton net, an external 10 cm diameter 50 µm net and equipped with a TSK flow meter. This instrument is used to obtain integrated water column samples. Downward and upward winch speeds are 40 and 30 m/min respectively. Quantitative samples from both nets for taxonomy and abundance estimates are preserved in formaldehyde. Qualitative samples (i.e. 'live tows') are also collected to obtain animals for contaminants, lipids, EPR and ETS studies.

c) Hydrobios. Multi-depth plankton profiler equipped with nine 200 µm-mesh nets (opening 0.5 m^2) for depth specific sampling of the water column. The Hydrobios is also equipped with a CTD to record water column properties while collecting biological samples. Downward and upward winch speeds are 40 and 30 m/min respectively. For most casts, the net collection was preserved in formaldehyde for taxonomic analysis. However, the content of each net from some deployments was divided 50% for taxonomy (4% buffered formaldehyde), 25% for biomass estimates and 25% for ETS analysis.

d) 1-m^2 ring net. A 1 m diameter metal ring equipped with a 200 µm mesh net, an external 10 cm diameter 50 µm net, a central GO flow meter and a RBR CTD. This net was deployed three times from a hole in the ice at proximity of the ship but at a site not influenced by its presence. The net was lowered manually to the bottom and pulled up by a snowmobile.

e) Monster net (Fig. 2a). Four 1-m^2 metal frames attached together, one rigged with a 1-m^2 500 µm mesh net and a GO flow meter for contaminant sampling, one with a 1-m^2 200 µm mesh net and a TSK flow meter for abundance measurements, two with a 1-m^2 200 µm mesh net without a flow meter for "live" sampling, and an external 10 cm diameter 50 µm net. The gear is deployed vertically from 10 meters off the bottom to the surface.

f) Tucker net (Fig. 2b). Two 1-m^2 metal frames attached together each rigged with a 1 m^2 500 µm mesh net, an external 10 cm diameter 50 µm net and equipped with a TSK flow meter. The gear is deployed obliquely to 90 meters or less (depth determined by cable length and angle).

g) Fish trap (Fig. 2c). Commercial fish trap (1.5 m x 1.5 m x 1.0 m) lowered at the desired depth from the moon pool and set overnight to catch juvenile and adult fish.

h) Trammel gill net (Fig. 2d). Three-layered trammel net, 30 m long and 1.8 m wide, with stretched mesh size of 2.9 and 6.4 cm for the internal and external panels respectively. It was especially designed to be deployed vertically from the surface to collect juvenile and adult fish.

i) Mesopelagic fish trawl. A single-warp pelagic trawl 37 m long with a 49 m^2 mouth opening and mesh sizes decreasing from 30 cm at the mouth down to 5 cm in the cod end which is covered with 9 mm mesh liner. Deployed from the port side of the foredeck, it is designed to catch juvenile and adult fish. The trawl was prepared early on during the second half of the leg but never deployed for the lack of any sign of sufficient pelagic fish concentration on the EK-60 echosounder.

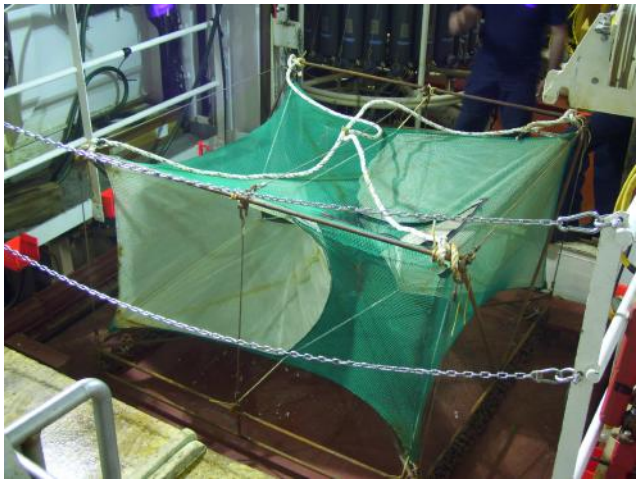
2) Sampling events during leg 8

Overall, 112 sampling events occurred from which 69 samples were preserved for taxonomy. Samples from the 'live tows', were used for further analyses and laboratory experiments as described below. Samples for lipid and stable isotopes analyses were placed in cryovials and stored at -80˚C. Other samples were preserved as a *bulk* at -80˚C for later gut fluorescence measurements. All these samples will be sorted and analysed at Laval University. Samples of ice algae were also collected upon request for lipid analysis. Samples for contaminants were sorted and kept by Dr. Stern's team.

Figure 2. Sampling gear used for the first time in 2008 during CFL leg 8.
a) 4 x 1-m^2 Monster net.

b) 2 x 1-m^2 Tucker net.

c) Fish trap



d) Trammel gillnet

Table 1: Summary of sampling activities with the Rosette in the moon pool during leg 8.

Date	Station	Sampling	Taxonomy
(UTC)		depth (m)	
13-05-08	2008-F2	170	x

Table 2: Summary of sampling activities with the 1-m^2 square net in the moon pool during leg 8.

Date	Station	Sampling	Cont.	Taxo.	Lipids	Isotopes	Biomass	EPR	Genetics
(UTC)		depth (m)				& gut fluo	and ETS		
26-04	2008D43-1	545		x					
26-04	2008D43-2		x					x	
27-04	2008D43-3	528		x					
27-04	2008D43-4				x	x			
28-04	2008D43-5	504		x					
29-04	2008D43-6	528		x					
29-04	2008D43-7						x		
29-04	2008D43-8		x						
30-04	2008-D43-9	450		x					
01-05	2008-D43-10	427		x					
01-05	2008-D43-11				x		x		
01-05	2008-D43-12		x						
02-05	2008-D43-13		x						
02-05	2008-D43-14		x						
02-05	2008-D43-15	393		x					
02-05	2008-D43-16							x	x
02-05	2008-D43-17		x						
02-05	2008-D43-18		x						
02-05	2008-D43-19		x						
03-05	2008-D43-20		x						

03-05	2008-D43-21		x						
04-05	2008-D43-22	376		x					
04-05	2008-D43-23				x	x			
05-05	2008-D43-24	393		x					
05-05	2008-D43-25						x		
06-05	2008-1020A	144		x					
11-05	2008-O1-1	98		x					
11-05	2008-O1-2	60							
11-05	2008-O2-1	203		x					
11-05	2008-O2-2	195					x		
13-05	2008-F2-1	193		x					
13-05	2008-F2-2	193				x			
13-05	2008-F2-3	185			x				
13-05	2008-F2-4	185							x
14-05	2008-F2-5	185		x					
14-05	2008-F2-6	185						x	
14-05	2008-F2-7	185	x						
15-05	2008-F2-8	186		x					
15-05	2008-F2-9	186							
15-05	2008-F2-10	186	x						
16-05	2008-F2-11	186		x					
16-05	2008-F2-12	186							
17-05	2008-F2-13	186		x					
17-05	2008-F2-14	186							
17-05	2008-F2-15	186	x						
17-05	2008-F2-16	186							
17-05	2008-F2-17	186							
21-05	2008-F3-1	125		x					
21-05	2008-F3-2	125							x
30-05	2008-D44-1	184		x					
30-05	2008-D44-2	276			x	x			
30-05	2008-D44-3	276		x					
31-05	2008-D45-1	267		x					
31-05	2008-D45-2	263	x						
02-06	2008-F6-1	60	x						
02-06	2008-F6-2	60		x					
03-06	2008-F6-3	60		x					
03-06	2008-F6-4	60							
03-06	2008-F6-5	60	x			x			

Table 3: Summary of sampling activities with the Hydrobios in the moon pool during leg 8.

Date	**Station**	**LAT**	**LONG**	**Sampling**	**Taxonomy**	**Lipids**	**Biomass**
(UTC)				**depth (m)**			**and ETS**
26-04-08	2008D43-A	70°35.23	122°26.12	530	x		
27-04-08	2008D43-B	70°35.73	122°28.73	530	x		
28-04-08	2008D43-C	70°41.33	123°1.15	550	x		x
29-04-08	2008D43-D	70°44.466	123°31.376	510	x		

30-04-08	2008-D43-E	70°49.295	124°19.369	430	x		
01-05-08	2008-D43-F	70°48.93	124°13.33	425	x	x	
02-05-08	2008-D43-G	70°50.52	125°2.24	360	x		
04-05-08	2008-D43-H	70°59.99	125°52.06	380	x		x
05-05-08	2008-D43-I	71°8.268	126°13.888	380	x		
12-05-08	2008O2-A	69° 59.04	126°2.92	185	x		x
13-05-08	2008F2-A	69° 56.81	126°10.31	180	x		
14-05-08	2008F2-B	69° 56.81	126°10.31	180	x		
16-05-08	2008F2-C	69° 56.81	126°10.31	180	x		
17-05-08	2008F2-D	69° 56.81	126°10.31	180	x		
20-05-08	2008-405b-A	70°39.54	122°52.74	497	x		x
22-05-08	2008-1011	71°41.9	124°17.68	435	x		
24-05-08	2008-1806	71°39.48	127°23.79	120	x		
26-05-08	2008-6010	72°31.58	129°34.5	680	x	x	
26-05-08	2008-8010	74°4.38	129°1.43	365	x		
27-05-08	2008-9008	74°19.91	126°59.48	330	x		x
30-05-08	2008-D44-A	74°34.244	125°17.703	270	x		
31-05-08	2008-D45-A	71°13.07	124°40.94	255	x		
02-06-08	2008-405c	70°37.22	123°11.01	530	x		

Table 4: Summary of sampling activities with the fish trap in the moon pool during leg 8.

Date	Station	LAT	LONG	Sampling	Captures
(UTC)				depth (m)	
17-05-08	2008-F2	69°56.81	126°10.31	10	3 bosa
18-05-08	2008-F2	69°56.81	126°10.31	180	
19-05-08	2008-near405b	70°48.77	122°37.69	10	
03-06-08	2008-F6	65°51.595	123°45.115	8	1 cod

Table 5: Summary of sampling activities through the ice with the 1-m^2 ring net during leg 8.

Date	Station	LAT	LONG	Sampling	Taxonomy
(UTC)				depth (m)	
09-05-08	2008-F1-1	70°10.94	124°49.85	55	x
10-05-08	2008-F1-2	70°10.94	124°49.85	55	x
10-05-08	2008-F1-3	70°10.94	124°49.85	55	x

Table 6: Summary of sampling activities through the ice with the trammel gill net during leg 8.

Date	Station	LAT	LONG	Sampling	Captures
(UTC)				depth (m)	
08-05-08	2008-F1	70°10.94	124°49.85	55	jellyfish
09-05-08	2008-F1	70°10.94	124°49.85	55	jellyfish
03-06-08	2008-F6	65°51.595	123°45.115	70	jellyfish

Table 7: Summary of open water sampling activities from the front deck with the 4 x 1-m^2 Monster net during leg 8.

Date	Station	Sampling	Cont.	Taxo.	Lipids	Isotopes	Biomass	EPR
(UTC)		depth (m)				& gut fluo	and ETS	
19-05-08	2008-405b	515	x	x	x	x	x	x
22-05-08	2008-1011	460	x	x		x		

23-05-08	2008-1806	121	x	x	x	x		
26-05-08	2008-6010	684		x				
26-05-08	2008-8010	372	x	x	x	x		
27-05-08	2008-9008	329	x	x	x	x		
28-05-08	2008-F5	370		x	x	x	x	
01-06-08	2008-405c	501	x	x	x	x		

Table 8: Summary of open water sampling activities from the front deck with the 2 x 1-m^2 Tucker net during leg 8.

Date (UTC)	Station	LAT	LONG	Sampling depth (m)	Contaminants	Taxonomy	Genetics
06-05-08	2008-1020A	71°1.473	127°3.773	75		x	
10-05-08	2008-F1	70°12.81	124°45.74	39		x	
11-05-08	2008-O1	70°3.97	125°26.41	42		x	
19-05-08	2008-405b	70°39.418	122°54.392	75	x	x	
22-05-08	2008-1011	70°42.182	124°0.14	90	x	x	
23-05-08	2008-1806	72°38.62	127°23.38	71	x	x	
26-05-08	2008-6010	72°32.24	129°35.16	81		x	x
26-05-08	2008-8010	74°5.32	128°57.2	92	x	x	
27-05-08	2008-9008	74°19.9	127°0.53	95	x	x	
28-05-08	2008-F5	74°31.19	124°7.81	85		x	
01-06-08	2008-405c	70°37.45	123°11.13	98	x	x	

Table 9: Summary of Arctic cod (larvae, juveniles and adults) catches during leg 8.

Date (UTC)	Station	Gear	Number of bosa
06-05-08	20081020A	2x1m^2 otow	3
09-05-08	2008F1-1	Under ice ring net	17
10-05-08	2008F1-2	Under ice ring net	15
10-05-08	2008F1-3	Under ice ring net	6
10-05-08	2008nearF1	2 x 1m^2 (HTOW)	1860
11-05-08	2008O1-1	1m^2 (VTOW)	2
11-05-08	2008O1	2 x 1m^2 (HTOW)	56
11-05-08	2008O2-1	1m^2 (VTOW)	3
11-05-08	2008O2-2	1m^2 (VTOW)	3
13-05-08	2008F2-1	1m^2 (VTOW)	11
13-05-08	2008F2-2	1m^2 (VTOW)	5
13-05-08	2008-F2-3	1m^2 (VTOW)	4
13-05-08	2008-F2-4	1m^2 (VTOW)	5
14-05-08	2008-F2-B	Hydrobios	6
14-05-08	2008-F2-5	1m^2 (VTOW)	5
14-05-08	2008-F2-6	1m^2 (VTOW)	7
14-05-08	2008-F2-7	1m^2 (VTOW)	19
15-05-08	2008-F2-8	1m^2 (VTOW)	9
15-05-08	2008-F2-9	1m^2 (VTOW)	10
16-05-08	2008-F2-C	Hydrobios	1
16-05-08	2008-F2-11	1m^2 (VTOW)	7
16-05-08	2008-F2-12	1m^2 (VTOW)	7

17-05-08	2008-F2	Fish trap	3
17-05-08	2008-F2-D	Hydrobios	1
17-05-08	2008-F2-13	1m^2 (VTOW)	10
17-05-08	2008-F2-14	1m^2 (VTOW)	2
17-05-08	2008-F2-15	1m^2 (VTOW)	7
17-05-08	2008-F2-16	1m^2 (VTOW)	2
17-05-08	2008-F2-17	1m^2 (VTOW)	12
19-05-08	2008-405b	4 x 1 m^2 (VTOW)	2
19-05-08	2008-405b	2 x 1m^2 (HTOW) A	31
19-05-08	2008-405b	2 x 1m^2 (HTOW) B	47
21-05-08	2008-F3-1	1m2 (VTOW)	1
22-05-08	2008-1011	2 x 1m^2 (HTOW) A	51
22-05-08	2008-1011	2 x 1m^2 (HTOW) B	50
22-05-08	2008-1011	4 x 1 m^2 (VTOW) A	5
22-05-08	2008-1011	4 x 1 m^2 (VTOW) B	4
22-05-08	2008-1011	4 x 1 m^2 (VTOW) C	3
23-05-08	2008-1806	4 x 1 m^2 (VTOW)	1
26-05-08	2008-6010	2 x 1m^2 (HTOW) A	4
26-05-08	2008-6010	2 x 1m^2 (HTOW) B	1
26-05-08	2008-8010	2 x 1m^2 (HTOW) A	4
26-05-08	2008-8010	2 x 1m^2 (HTOW) B	5
27-05-08	2008-9008	2 x 1m^2 (HTOW) A	24
27-05-08	2008-9008	2 x 1m^2 (HTOW) B	30
28-05-08	2008-F5	2 x 1m^2 (HTOW) A	10
28-05-08	2008-F5	2 x 1m^2 (HTOW) B	9
31-05-08	2008-D45-1	1m^2 (VTOW)	5
31-05-08	2008-D45-2	1m^2 (VTOW)	1
01-06-08	2008-405c	4 x 1 m^2 (VTOW) A	1
02-06-08	2008-405c	2 x 1m^2 (HTOW) A	29
02-06-08	2008-405c	2 x 1m^2 (HTOW) B	12
02-06-08	2008-F6-1	1m^2 (VTOW)	1
02-06-08	2008-F6-2	1m^2 (VTOW)	1
03-06-08	2008-F6	Fish trap	1
Total			**2431**

Laboratory analyses

1) Egg production rate experiments (EPR)

Copepod *in-situ* egg production rate (EPR) were monitored by incubating the females of three species (*Calanus glacialis*, *C. hyperboreus* and *Metridia longa*) at 0°C, a temperature similar to that they experience at depth. The results from the experiments conducted during leg 8 show that the egg production season is over for *C. hyperboreus* but still underway for *C. glacialis* and *Metridia longa*.

2) Biomass and Transfer System (ETS) activity

Samples were sorted for biomass and ETS activity assays on several occasions (Table 2, 3 and 7). At these stations, each Hydrobios net was subdivided: 50% for taxonomy (i.e. preserved in formol), 25% for population biomass estimates and 25% for ETS activity measurements. For biomass estimates, the

sub-sample (i.e. 25% of total sample) was fractionated with sieves in > 1000 µm and < 1000 µm size classes; these fractions were preserved at -0˚C. Sub-samples for zooplankton population ETS activity assays (i.e. 25% of the total sample) were also sieved through the same two size fractions. As no Sanyo incubator was available for the ETS experiments, samples were incubated in a Pyrex plate filled with water and heated to 40˚C on a hot plate. Temperature of this 'hot tub' proved to remain constant during the required incubation time. ETS experiments were also performed on individual copepods (females and copepodite stage 5) of *Calanus glacialis*, *C. hyperboreus* and *Metridia longa*.

3) Respiration experiments

To derive respiration from the activity of the Electron Transfer System (ETS), a ratio of respiration on ETS activity is required. Thus incubations were carried out to measure oxygen consumption of copepods in sealed chambers. The handheld oxygen meter that we started to use on leg 6 proved to be very easy and practical to use for such measurements.

Acoustic monitoring

The Simrad EK-60 Echosounder of the Amundsen allows our group to continuously monitor the spatial and vertical distribution of zooplankton and fish, the later mostly represented by Arctic cod (*Boreogadus saida*). The hull-mounted transducers are in operation 24h a day and will provide an extensive mapping of where the fishes are within the region of interest over a yearly cycle.

General Recommendations:

Some of our samples kept in one of the outdoor freezer (-20°C, starboard side) thawed for and unknown reason and an undetermined period of time. Keep an eye on that. The cold room in the zooplankton van had some difficulties to keep a stable temperature during leg 8a but seems to be working fine now. If you intend to use it, we suggest to monitor the temperature for 2-3 days before. For an unknown reason, the lab incubator also had a warming episode (up to 16°C) despite regular defrosts and no door opening (that happened early in the morning before anybody had come to the lab for that day). Keep an eye on that as well. In short, watch all temperature controls all the time!!!

This leg was a lot of work for only two people considering that: 1) the time-consuming measurements/conservation of the numerous Arctic cod larvae caught during the last 4 weeks of the leg, 2) the inexperience of the participants regarding some of the sampling methods and experiments, 3) the preparation work for the beginning of the foredeck sampling with the Monster and the Tucker nets. We did our best and hope everybody will be satisfied with the samples collected and experiments conducted. However, some variety in sampling activities (moonpool, ice, foredeck) prevented the work from becoming too monotonous. Otherwise, hockey game, ridge expedition and diving hole digging also entertained us. We would like to thank the captain and crew, chief scientists and all the people who helped us in any way during the leg, especially Steeve, Benoit and Roger (the three stars of the leg), Claire and Dan (the filtered water furnishers), Alexis, Joanne and Christian (the net helpers).

2.5. Team 6

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Participants: Will Drennan (U.Miami-RSMAS), Jens Ehn (U of M), Nicolas-Xavier Geilfus (Ulb – Belgium), Keith Johnson (IOS), Doris Leong (Dalhousie), Friederike Prowe (Dalhousie)

Overview

The main goal of Team 6 is to investigate the sea-ice-atmosphere exchanges of climatically active gases (such as carbon dioxide and dimethyl sulfide). Gas concentrations and near-surface fluxes are measured from installations on the ship and from the sea ice. In order to better understand the driving factors regulating those exchanges, we are looking at ice and water biogeochemistry, selecting a set of variables that describes the best ice and water column conditions in terms of physical, biological and

chemical properties. Meteorological and surface climatological data are also collected to relate the observed fluxes and ice/ocean properties to near-surface microenvironment. Collectively this information should provide a good description of the gas cycles and their dynamics in the arctic environment of the flaw lead system over the annual cycle.

Sampling and deployments were undertaken as part of CFL Drift Mode – where the ship would associate itself with an ice floe or landfast ice for a period of time ranging from a few hours to about a week. On leg 8, a number of days of open water transects were also conducted. Our sampling, monitoring and the associated data set is described in the following sections.

2.5.1. Surface Meteorology and Flux Project

Introduction

The surface meteorology and flux program (CFL Team 6) is designed to record basic meteorological conditions and to study exchanges of momentum, heat and mass across the atmosphere-sea ice-ocean interface. The main value of this program to the overarching objectives of Team 6 is the direct measurement of CO_2 fluxes and measures of the basic terms of the heat budget (sensible and latent heat, radiation fields).

Turbulent fluxes (CO_2, heat and momentum) are measured by the eddy covariance technique, which is dependent only on atmospheric measurements. To realize the potential of the data set the measurements of the CO_2 flux, in particular, require ancillary information on processes (physical, biological and chemical) that drive gas exchange. In an open-ocean situation this context is largely provided by measurement of sea-surface pCO_2, but the situation becomes much more complex when a sea ice cover is included in the equation. Surface flux monitoring facilities are deployed on the ship`s foredeck, and when possible, on the sea ice.

This section of the CFL Team 6 cruise report reviews the atmospheric and sea surface pCO_2 measurements that were made during Leg 8. Other sections of the report will deal with the sea ice measurements that were made in support of the CO_2 flux measurements.

Ship-Based Micrometeorology and Eddy Covariance Flux Tower

The micrometeorological tower located on the front deck of the Amundsen (Figure 1) provided a continuous record of meteorological variables and eddy covariance parameters. The setup on leg 8 was kept unchanged from the previous leg. A number of slow response sensors were installed on the tower that recorded bulk meteorological variables (i.e., air temperature, humidity, wind speed/direction, skin surface temperature). Other fast response sensors recorded the eddy covariance parameters (i.e., CO_2/H_2O concentration, 3D wind velocity, 3D ship motion, and air temperature) (Table 1). In addition, radiation sensors (Figure 1, Table 1) were installed on the roof of the wheelhouse to provide information on incoming radiation fields, including: long-wave, short-wave, photosynethetically active radiation (PAR), and ultra-violet radiation (UVA and UVB). All data was logged to Campbell Scientific dataloggers; a model CR5000 logger was used for the eddy covariance data, a CR1000 logger for general meteorological elements (e.g., temperature, relative humidity, etc.), and a CR23X for the radiation data. All loggers were synchronized to UTC time using the ship's GPS system as a reference.

The eddy covariance system on the tower makes use of two separate gas analyzers and a single 3D sonic anemometer. The dual gas analyzers system allows us to make use of both closed path and open path eddy covariance systems. The open path gas analyzer has the benefit of making measurements concurrently with the sonic anemometer, but the closed path gas analyzer is not as easily disturbed by adverse weather conditions.

In order to make sure that the two systems are comparable, careful calibrations were performed on both instruments. The closed path system is based on a LI-7000 gas analyzer which employs two optical cells, one of which was used to monitor the drift of the instrument by constantly passing a stream of ultra-high purity N_2. In addition, the sample cell of the instrument was calibrated daily using the ultra-high purity N_2 to zero the CO_2 and H_2O measurements, and a reference gas of known CO_2 to span the instrument. Occasionally, a span calibration of the H_2O sensor was performed using a dew point generator (model LI-610). The open path gas analyzer (LI-7500) could not be calibrated as conveniently, and so it was calibrated once at the end of the leg. In general, we find that this is effective for this particular instrument, which does not drift significantly over time.

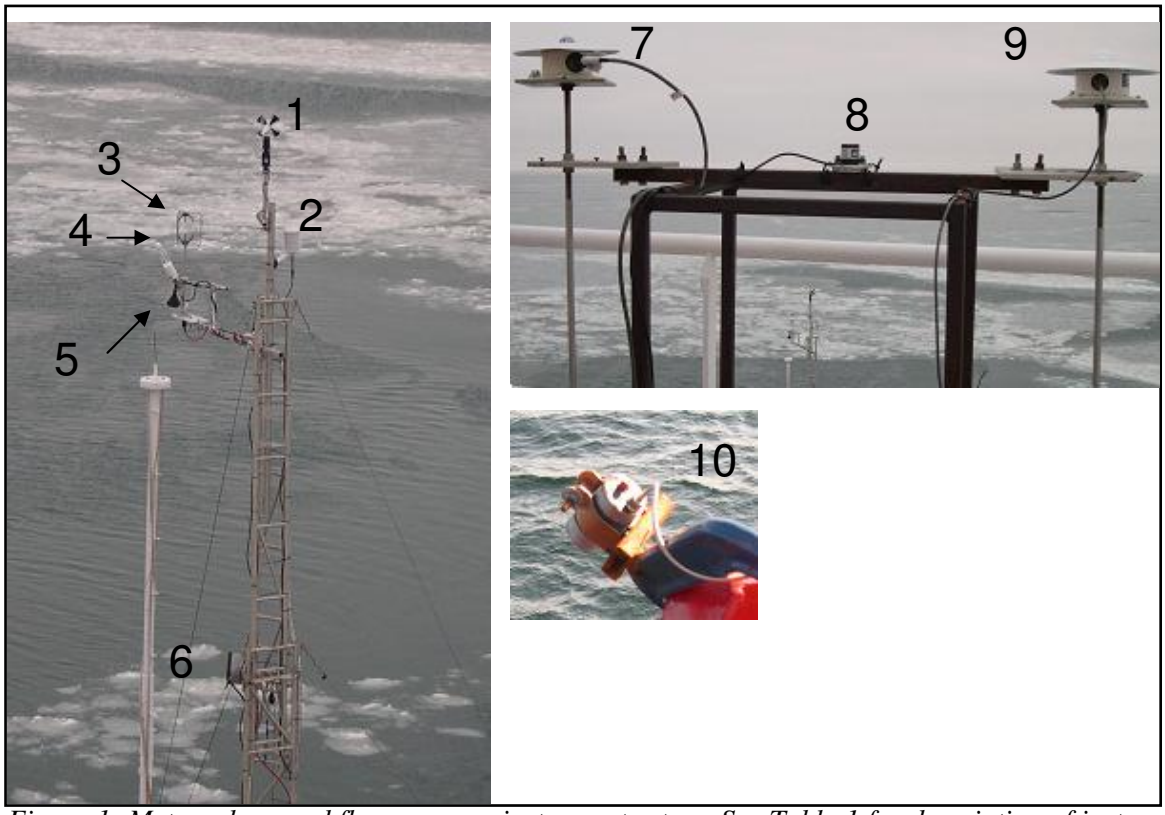

Figure 1: Meteorology and flux program instrument setup. See Table 1 for description of instruments based on the numbers. Note that on Nov. 18 the Motion Pak (6) was moved to the rear face of the tower to facilitate easier motion correction, and the UV sensor is not shown.

The meteorological tower at the bow of the ship ran consistently for the duration of the leg with the exception of occasional periods when the LI-7500 and Gill sonic anemometer were inoperable because of ice and frost build-up. This often happened especially during night-time when temperatures generally were colder and there was less radiative heating of sensors. During daytime, the instruments were typically in good conditions except for a few days when rainy and/or foggy weather conditions lead to moisture or ice build-up. The sensors and other instrumentation shown in Fig. 1 were checked and maintained every morning around 7am. A daily log of these activities was kept in a notebook. Atmospheric CO_2 data is shown together with seawater pCO_2 data for a few days in Figure 5. The extent of data lost due to atmospheric conditions cannot be estimated at this time, and will only be known once post processing is complete.

Table 1: Description of instruments shown in Fig. 1.

Fig 1	Sensor	Variables	Units	Ht from deck (m)	Scan (s) /Ave (min)	Specs
1	wind monitor (RMYoung 05103)	wind speed/direction	m/s; °	8.45	2/1	±0.6 m/s ±3° deg
2	temperature/relative humidity probe (Vasailla HMP45C212)	T and RH	ºC; %	7.53	2/1	Humidity ±2% 0-90% @ 20ºC ±3% 90-100% @ 20ºC 0.05% RH/ºC Temperature ± 0.1 ºC
3	3D wind velocity (Gill R3 ultra-sonic anemometer)	u,v,w, speed of sound (SOS)	m/s	7.1	10 Hz	RMS noise <1% offset <0.01 m/s SOS < 0.5% accuracy
4	LI7500 open path gas analyzer	CO_2/H_2O	µmol/m^3 mmol/m^3	7.1	10 Hz	RMS noise ±0.1 µmol/mol zero drift 0.1 µmol/mol/ºC gain drift 0.1%/ºC
5 (inlet, analyzer not shown)	LI7000 closed path gas analyzer	CO_2/H_2O	µmol/m^3 mmol/m	inlet at 7.1	10 Hz	RMS noise ±0.1 µmol/mol zero drift 0.3 µmol/mol/ºC gain drift 0.2%/ºC
6	multi-axis inertial sensor (MotionPak, Systron Donner)	rate x,y,z accel x,y,z	°/s; g	6.48	10 Hz	rate <0.004°/s acc <10 µg
7	pyranometer (Eppley, model PSP)	SW_in	W/m^2	1.5	2/1	~±5%
8	quantum sensor (Kipp & Zonen, PARLite)	PAR	µmol/m^2/s^1	1.5	2/1	~±5%
9	pyrgeometer (Eppley, model PIR)	LW_in	W/m^2	1.5	2/1	~±10%
10	surface temperature (Everest infrared transducer, model	Tsrfc	ºC	1.6 m	2/1	±0.5 ºC accuracy

	4000.44ZL)					
not shown	pressure transducer (RM Young, 61205V)	Patm	kPa	1.6	2/1	~±2%
not shown	UV Radiometer (Kipp & Zonen, UV-S-AB-T)	UVA, UVB	W/m^2	1.5	2/1	~±5%

Ice-Based Micrometeorology and Eddy Covariance Flux Tower

An ice-installation (Fig. 2) was installed on June 2 in Darnley Bay (a few days prior to the leg 9 crew change). The meteorology and flux instruments were installed on a 4.5m long tower section of a TV antenna-style (Fig. 2). A list of variables that were monitored is shown in Table 2. The installation was powered by lead-acid batteries (12 VDC), which themselves were trickle charged when necessary by a battery charger and a generator (which was then placed 30-40m upwind of the tower). The vertical ice temperature profile was monitored by thermocouples arranged in profile within a white PVC tube. Signals associated with the set-up logged by a Campbell Scientific loggers: model CR1000 for basic meteorology and temperature, and model CR3000 for the components of the eddy covariance system. Raw data from the flux sensors were sampled at 20Hz and immediately transferred to flash card. The closed path LI7000 system was not installed at the time. The LI-7500 was calibrated onboard the ship prior to deployment.

Meltponds had formed on the ice at the time of installation. Meltpond coverage was visually estimated to be about 60% of the surface. In the morning the ponds were covered by a thin (1-2cm) ice layer that could be walked upon. This ice layer was gradually deteriorating during the day. The tower was installed on a mound that had a white appearance roughly 400 m south of the ship. The ice thickness was about 1.8m and the snow cover had already melted away.

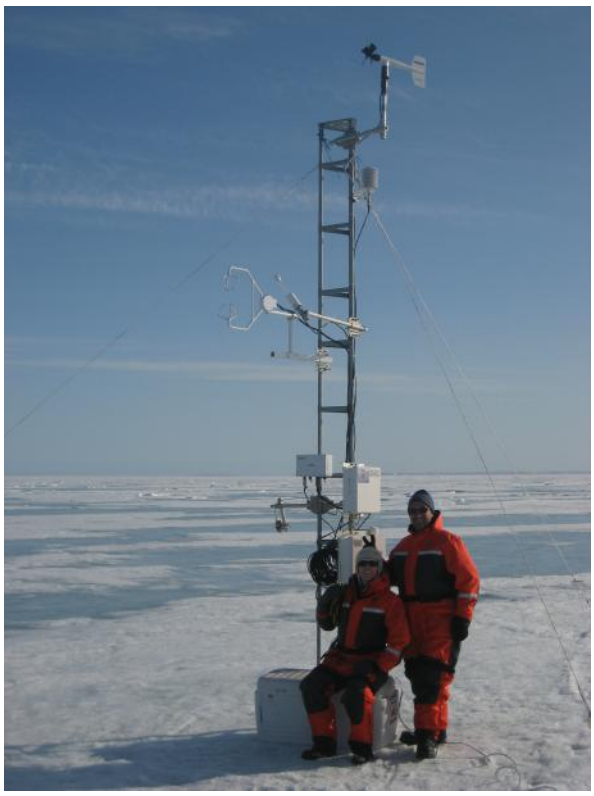

Figure 2: Meteorology and flux instrument setup on sea ice in Darnley Bay. See Table 1.2 for description of instruments that were installed. The cooler contains the 12VDC power supply.

Table 2: Description of instruments shown in Fig. 1.4 (going from the top).

Sensor	Variables	Units	Ht from srfc (m)	Scan (s) /Ave (min)	Specs
wind monitor (RM Young 05103)	wind speed/ direction	m/s; º	5.0	3/5	±0.6 m/s ±3º deg
temperature/relative humidity probe (Vasailla HMP45C212)	T and RH	ºC; %	4.5	3/5	Humidity ±2% 0-90% @ 20ºC ±3% 90-100% @ 20ºC 0.05% RH/ºC Temperature ± 0.1 ºC
LI7500 open path gas analyzer	CO_2/H_2O	µmol/ m^3 mmol/ m^3	3.0	20 Hz	RMS noise ±0.1 µmol/mol zero drift 0.1 µmol/mol/ºC gain drift 0.1%/ºC
3D wind velocity (CSAT3 ultra-sonic anemometer)	u,v,w, sonic temperature	m/s (ºC)	3.0	20 Hz	RMS noise <1% offset <0.01 m/s SOS < 0.5% accuracy
Radiation balance (CNR1 radiometer)	SW & LW _in & out	W/m^2	1.5	3/5	~±10%
surface temperature (Everest infrared transducer, model 4000.44ZL)	Tsrfc	ºC	1.5 m	3/5	±0.5 ºC accuracy
Type T thermocouples (note depths are presented from the snow/ice interface)			0.05, 0.15, 0.25, 0.35, 0.45, 0.55, 0.65, 0.75, 0.85, 0.95, 1.05,	3/5	~±2 ºC

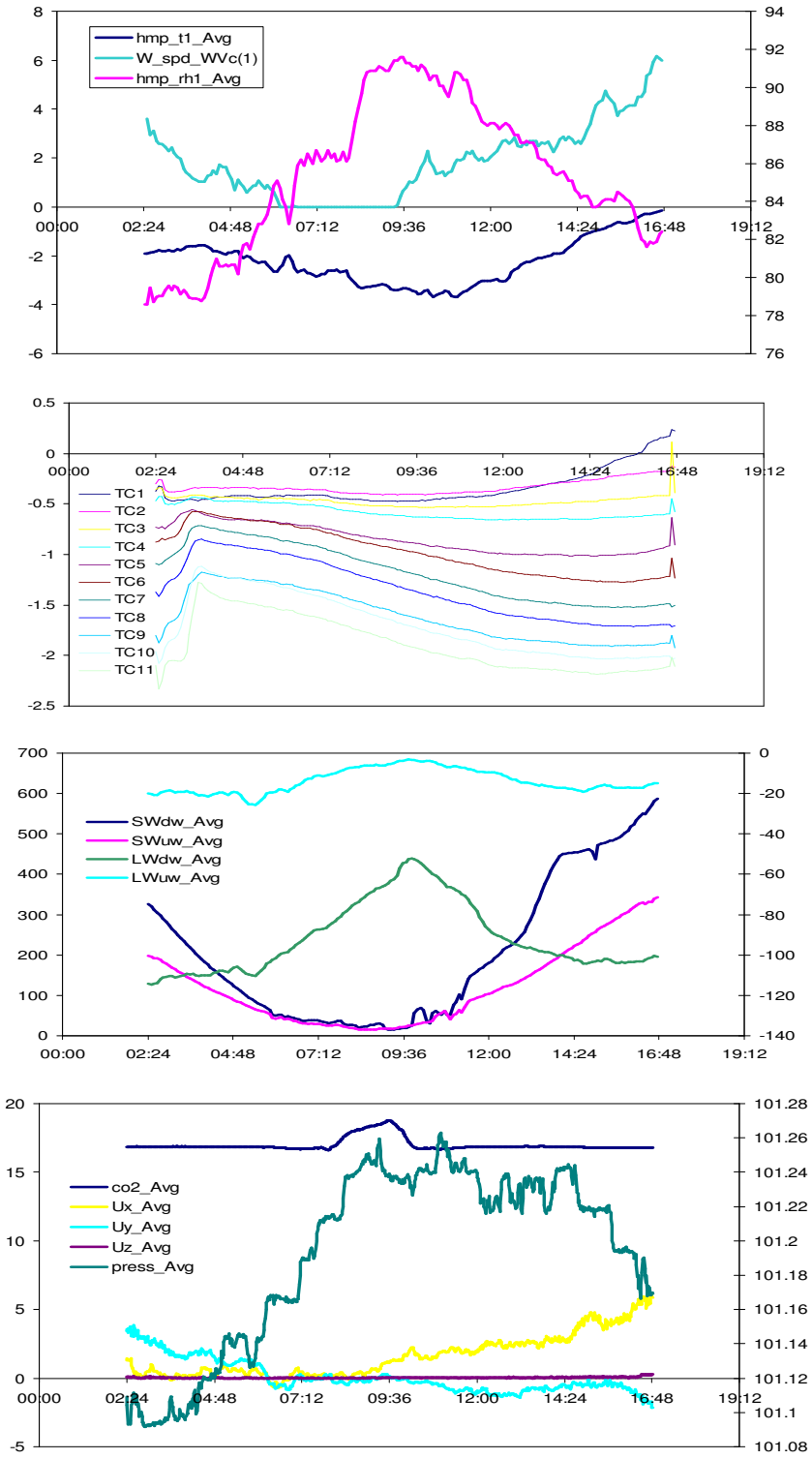

Figure 3: Data for the first 14 hours after installation. X-axis is universal time. Note that wind direction changed at around 0700-0800UTC. The labels are: t1-air temperature, rh1-relative humidity, W_spd-wind speed, TC-thermocouple (from surface down), SW-shortwave radiation, LW-longwave radiation (down- and upwelling), co2-CO_2 concentration in atmosphere, Uxyz-3D windspeed, press-Atmospheric pressure.

On-track pCO2 System

Methods

A custom-built pCO_2 system was utilized on this leg to measure dissolved CO_2 in the surface layer of the seawater in near real time. The system is located in the engine room of the Amundsen (Figure 4). It draws sample water from the ship's clean water intake. The water is passed into a sealed container through a shower head, maintaining a constant headspace. This set-up allows the air in the headspace to come into equilibrium with the CO_2 concentration of the seawater. The air is then cycled from the container into the LI-7000 gas analyzer in a closed loop. Thermocouples were used to measure water temperature immediately before entering the equilibration chamber, and to measure the temperature of the air in the chamber. All data were logged to a Campbell Scientific CR3000 datalogger.

As on the leg before, the LI-7000 gas analyzer was calibrated daily using ultra-high purity N_2 as a zero gas, and a gas with known CO_2 concentration as a span gas. Furthermore note that the other LI7000 closed path system located at the tower on foredeck, measuring the pCO_2 of the air, was also calibrated daily, allowing for an estimation of the CO_2 flux between air and seawater. Spanning of the H_2O sensor was not necessary because a desiccant column removes H_2O from the air stream before passing into the sample cell. The desiccant was changed roughly every 1-2 weeks when pH_2O levels 6-7 ppm. As with the foredeck closed path system, a stream of N_2 is constantly cycled through the reference cell of the LI-7000 to monitor and correct for drift of the instrument.

Figure 4: The on-track pCO_2 system located in the engine room of the Amundsen. The equilibration chamber is the clear cylinder. Seawater is filtered in the blue cylinder before entering the chamber. The gas analyzer is the box with the digital display. To the right of it, the container of desiccant is seen. The tanks with N_2 and CO_2 are seen in the foreground.

Sample Data

Figure 5 shows an example of a few days of CO_2 data recorded by the on-track system, along with water temperature. During 2-3 June the ship was in Darnley Bay, and the data can be compared with ice station data (Figure 3). However, further processing must still be undertaken to correct the values for changes in temperature that occur due to the length of the sample line (see section 2.4.3), and to properly calculate pCO_2.

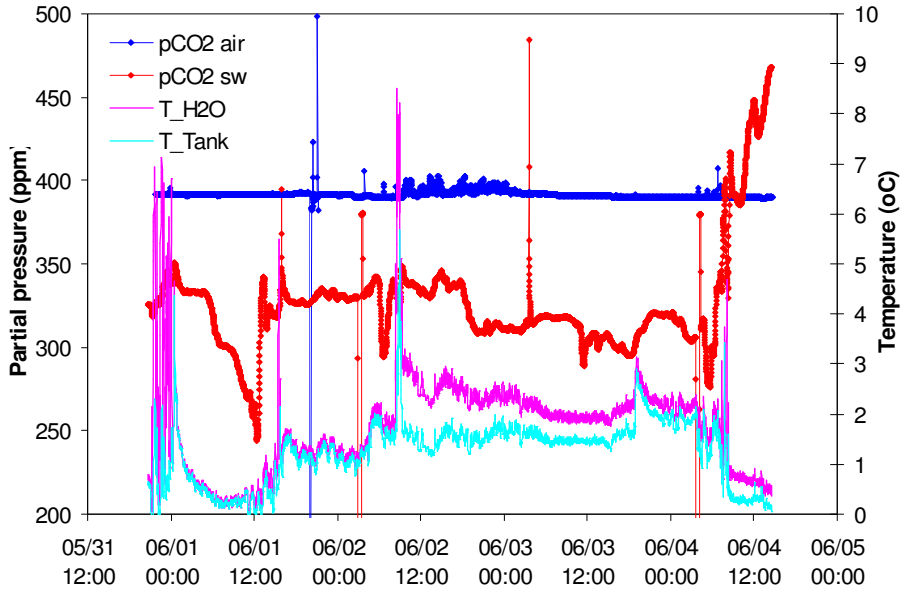

Figure 5: Sample on-track pCO_2 in air and in the seawater. The temperatures of the incoming seawater and the seawater in the tank is also shown.

Temperature corrections

On 27-May (0506 UTC) a water sample from the intake (near junction point for equilibrator source) was drawn for TA/DIC analysis. pCO2 was found to be 274ppm, compared to 315ppm from the equilibrator. To determine how much of the difference was a temperature effect, on 2 June (0200-0230) we lowered a CTD over the side of the vessel to measure temperature at intake depth (estimated by Steeve to be 5m). A profile to 5m on the port side near the intake position was halted after the CTD drifted below the vessel (there was little wind or waves). A second CTD was carried out near the bow on the STB side. Here, the CTD was lowered to 14m, with 30sec stops at each 1m. In addition, a bucket temperature sample at the intake was made. In Fig 1.8, we plot the CTD temperature profile, along with intake temperature and average values (0215-0230) of temperature from the TSG and pCO2 system "Tank_Temp_Avg". The pCO2 system "H2O_T_Avg"was about 0.12C higher than Tank_Temp_Avg, and is not shown.In summary, assuming a 5m intake depth, the intake bucket temperature is 0.1C warmer than T_water, the TSG temperature is 0.45C warmer and the equilibrator tank temperature in 1.9C warmer. Given a solubility effect of about 4%/deg (need to check this), the 1.9C increase can account for a 25ppm change in pCO2, over half that observed.

A comparison was also made between pCO2 values from the U of M equilibrator system and the SIES unit. On 1-June (2230), the SIES unit was plumbed into the seawater intake. By 2330, a steady value of 708ppm was registered. A CO2 gas span of 379.403 yielded 793ppm (at 2345). A subsequent N2 zero yielded 356ppm, giving a linear curve for the SIES unit as pCO2 = 0.868 * (out – 356). A reading of 708 is equivalent to 305ppm, compared to 333ppm (between 331-334 during 2230-2315) recorded on the U of M equilibrator. This difference of 18ppm is close to that expected based on the 1.8 deg difference between intake and equilibrator temperatures noted above.

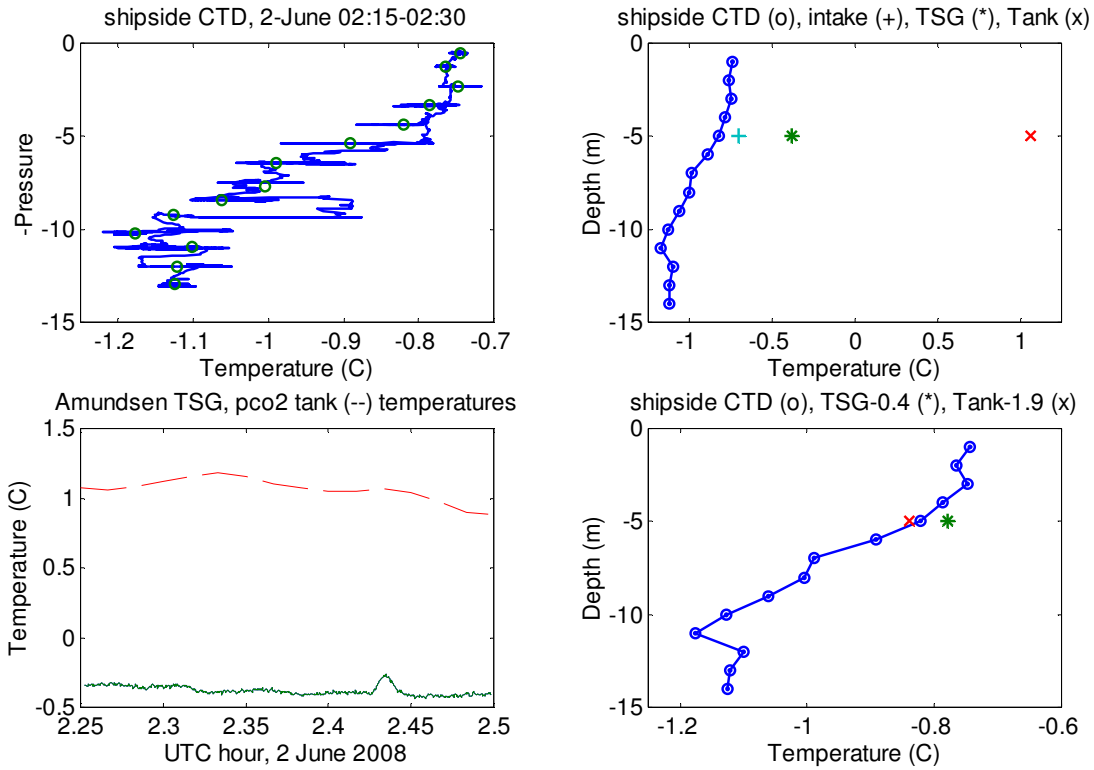

Figure 6: Temperature off set experiments of 2-June 02:00-02:30.Upper left: Temperature versus depth from CTD, where the green circles show means at each depth. Upper right: Temperature vs depth showing CTD means (o),bucket intakeat 0150 (+), TSG mean(*) and equilibratortank mean(x). Lower left: Time series of TSG and equilibrator tank temperatures during CTD. Lower right, as above with offset corrections for TSG and tank temperatures.

2.5.2. Sea Ice Biogeochemistry

In-Situ measurements and Ice Core Collection

In order to get a set of biogeochemical variables that will help us understand the dynamics of processes happening in sea ice and seawater, we collected ice cores for further analysis in both Winnipeg, Brussels and Liege labs. Basically, we took between 10 and 12 cores at each station. A major concern throughout the whole sampling procedure has been to prevent contamination of trace metal samples, especially iron. We followed the trace metal clean procedures proposed by Lannuzel et al. 2007. Nitrile gloves were used for handling the iron dedicated samples, and items used for sample collection and storage were acid-cleaned and sealed in plastic bags. The electropolished stainless steel core barrel (Lichtert Industries, Brussels, Belgium) has been specially designed and tested to be non-contaminant for iron. Seawater was pumped up with a portable peristaltic pump (Cole-Parmer, Masterflex E/P). Finally, the sea ice cores dedicated to iron determination were immediately packed in cleaned plastic bags and stored at minus 25 degrees Celsius.

Additionally, we measured a couple of standard variables in the field (e.g.: freeboard, snow thickness, snow temperature...). A complete list of the variables that will be accessible for the leg 8 is presented in Table 3.

Table 3: Summary of variables collected from snow/sea ice/brine/seawater samples

Fluxes	Bell	26-mai	29-mai	2-mai	5-mai	6-mai	9-mai	13-mai	16-mai	17-mai	20-mai	24-mai	25-mai	28-mai	30-mai	31-mai	2-juin
Snow	T/S/Chl	DM	DM	DM	DM	DM	DM	DM	DM		DM	DM	DM	DM	DM		DM
		AO	AO	AO	AO	AO	AO	AO	AO		AO	AO	AO	AO	AO		AO
	O18	ULB	ULB	ULB													
Ice Cores	Temperature/ salinity/18O/Chl	AO	AO	AO	AO	AO	AO	AO	AO		AO	AO	AO	AO	AO		AO
	Fabrics	UoM	UoM	UoM	UoM	UoM	UoM	UoM	UoM		UoM		UoM		UoM		UoM
	Nutrients	ULB	ULB	ULB	ULB	ULB	ULB	ULB	ULB		ULB			ULB	ULB		ULB
	Iron	ULB	ULB	ULB	ULB		ULB	ULB									
	Trace Metals	ULB	ULB	ULB	ULB		ULB	ULB									
	DMS,P,O (ULB)	ULB	ULB	ULB	ULB	ULB	ULB	ULB	ULB		ULB	ULB	ULB	ULB	ULB		ULB
	Total gas: O2, N2, CH4, Ar, CO2	ULB	ULB	ULB	ULB		ULB	ULB	ULB		ULB	ULB	ULB	ULB	ULB		ULB
	pCO2 of bulk ice	ULB	ULB	ULB	ULB	ULB	ULB	ULB	ULB		ULB	ULB	ULB	ULB	ULB		ULB
	TA & DIC (centrifugation)	ULB	ULB	ULB		ULB	ULB	ULB	ULB		ULB				ULB		ULB
	CaCO3	ULB	ULB	ULB	ULB		ULB	ULB	ULB						ULB		ULB
	DMS,P,O (UoM)		UoM		UoM		UoM	UoM	UoM		UoM				UoM		UoM
	Brine composition	ULB		ULB							ULB						
Brine Sack holes	direct pCO2	DM	DM	DM	DM	DM	DM	DM	DM	DM	DM	DM	DM	DM	DM	DM	DM
	TA/DIC (Vindta)	AO	AO	AO	AO		AO	AO	AO		AO	AO	AO	AO	AO		AO
	pCO2/DIC (Stenton Method)	UoM	UoM	UoM	UoM		UoM	UoM	UoM		UoM	UoM	UoM	UoM	UoM		UoM
	O18	ULB	ULB	ULB													
	T/S/Chl	AO	AO	AO	AO		AO	AO	AO	AO	AO	AO	AO	AO	AO	AO	AO
	DMS	ULB	ULB	ULB	ULB		ULB	ULB	ULB		ULB	ULB	ULB	ULB	ULB		ULB
Sea Water	direct pCO2	DM	DM	DM	DM	DM	DM	DM	DM	DM	DM	DM	DM	DM	DM	DM	DM
	TA/DIC (Vindta)	AO	AO	AO	AO		AO	AO	AO		AO	AO	AO	AO	AO		AO
	pCO2/DIC (Stenton Method)	UoM	UoM	UoM	UoM		UoM	UoM	UoM		UoM	UoM	UoM	UoM	UoM		UoM
	T/S/Chl/O18	AO	AO	AO	AO		AO	AO	AO	AO	AO	AO	AO	AO	AO	AO	AO
	DMS	ULB	ULB	ULB	ULB		ULB	ULB	ULB		ULB	ULB	ULB	ULB	ULB		ULB
	O18	ULB	ULB	ULB													

DM	Direct measurement
AO	Analyzed onboard
UoM	Ice cores /liquid phase sampled for subsequent analysis at the University of Manitoba
ULB	Ice cores / liquid phase sampled for subsequent analysis at the Université Libre de Bruxelles
Ulg	Ice cores sampled for subsequent analysis at the Universite de Liège
OG	measurements carried by other groups

Table 4: List of the different station sampled during leg 8.

26-mai	D43
29-mai	D43
2-mai	D43
5-mai	D43
6-mai	D44
9-mai	Cap Perry F1
13-mai	Franklin Bay F2
16-mai	Franklin Bay F2
17-mai	Franklin Bay F2
20-mai	Prince of Wales Strait F3
24-mai	West of Banks Island F4
25-mai	Thin ice by MYI
28-mai	M'Clure Strait F5
30-mai	D465
31-mai	D47
2-juin	Darnley Bay F6

Brine and Seawater Samples

Sampling of brine from the sea ice was conducted by drilling shallow sackholes (ranging from 20 cm down to almost full ice thickness) through the surface of the ice sheet. The brine from adjacent brine channel and pockets was allowed to seep into the sackhole for 15-120 min (depending on ice temperature), with the hole covered with a plastic lid (Gleitz et al., 1995), reportedly the best current method to sample brines for chemical studies (Papadimitriou et al., 2004). Brine and sea water were pumped from the hole using a peristaltic pump (Masterflex® - Environmental Sampler).
Samples for alkalinity (TA), dissolved inorganic carbon (DIC), chlorophyll (chl), pCO_2, temperature, salinity, O^{18}, and DMS were taken.

Analysis for DIC and TA was performed using the VINDTA 3C (Versatile Instrument for the Determination of Titration Alkalinity) developed by Marianda (see section 4).
Chlorophyll, temperature and salinity are also measuring immediately onboard (AO).
The samples for O^{18} and DMS will be sent back to Brussels and analyzed.

The pCO2 was measured directly on the field using the Sea Ice Equilibrator System (SIES). This device allows measurement of pCO_2 by utilizing a membrane contractor equilibrator (Membrana® Liqui-cell) coupled to an infrared gas analyzer (IRGA, Li-Cor® 6262). All instrumentation of the SIES unit were enclosed in an insulated box that contained a 12V power source and was warmed to keep the inside temperature just above 0°C. Seawater flow through the equilibrator at a rate of 1 L min-1 and a closed air loop ensures circulation through the equilibrator and the IRGA at a rate of 3 L min-1. Temperatures were measured in situ simultaneously in the brine sackhole and at the outlet of the SIES unit. A temperature correction of the pCO_2 was applied assuming that the relation from Copin-Montégut (1988) is valid at low temperatures and high salinities. The IRGA was calibrated using CO_2-in-air standards with mixing rations of 0 ppm and 369.4 ppm of CO_2 supplied by Air Liquide Belgium® shortly after returning to the ship (while the IRGA was still cold). Stable field pCO_2 readings could take considerable time to obtain (up to 1 hour from turning on the flow of gas) especially when pCO_2 values were low in the brine.

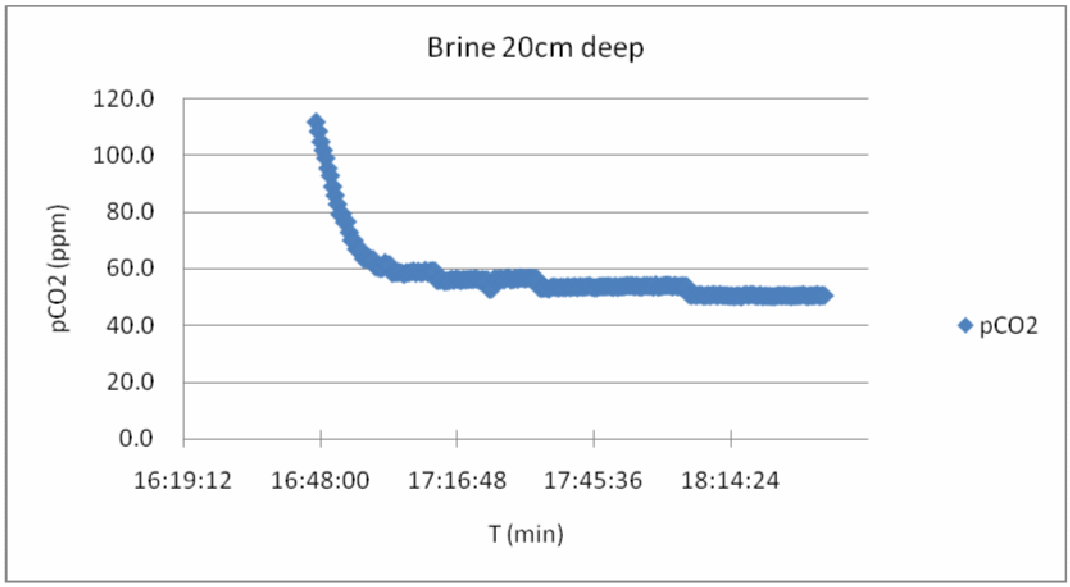

Figure 7: Equilibriation of pCO_2 of brine in the SIES unit at station F6.

Gas chamber measurements

A chamber coupled to the SIES was used to measure air-ice CO_2 fluxes. The accumulation chamber (West system®) is a metal cylinder closed at the top (internal diameter 20 cm; internal height 9.7 cm). A rubber seal surrounded by a serrated-edge iron ring ensured an air-tight connection between the base of the chamber and the ice. For measurement over snow, an iron tube was mounted at the base of the chamber to enclose the sampled snow down to the ice and to prevent lateral advection of air through the snow. The chamber was connected in a closed loop between the air pump (3 L min^{-1}) and the IRGA of the SIES. The measurement of pCO_2 in the chamber was recorded every 30 sec for at least 10 min. The flux was computed from the slope of the linear regression of pCO_2 against time ($r^2 \geq$~ 0.99) according to Frankignoulle (1988). The uncertainty of the flux computation due to the standard error on the regression slope is on average ±3%. CO_2 fluxes values correspond to the average of three measurements. The idea is to look at the changes in the pCO_2 between the beginning and the end of the gas chamber deployment. Any increase in this pCO_2 can then be understood as a positive flux from the ice – any decrease as a negative flux.

We did several gas chamber measurements during the main coring stations but also during small punctual stations. In order to investigate the influence of the ice properties on the fluxes, we put the chamber on different ice types and thicknesses.

Figure 8: Measurement of fluxes on drift station D44 (09/04/2008)

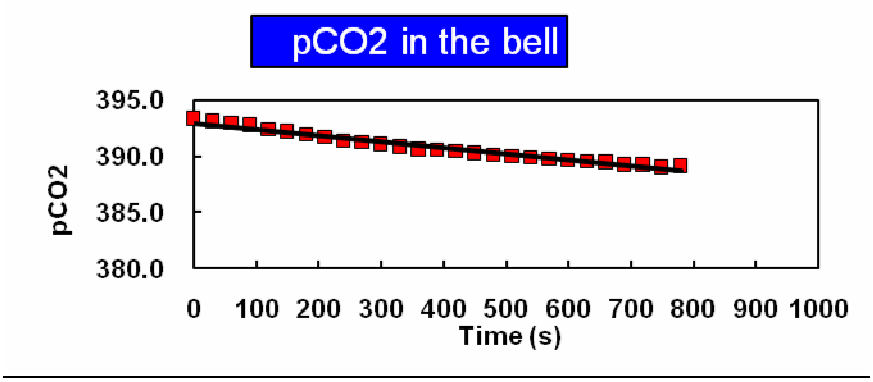

Figure 9: Bell (chamber) measurements on the last ice station of the leg (Darnley Bay; F6) showing a CO_2 flux down into the ice. At the time, on the last ice station, on the top of the ice wit melting point.

Ice Cores

All the ice cores are stored in a freezer container onboard.

On the field the temperature of the ice is taking directly after the extraction of the ice core. After, on the same ice core we cut it each 5 cm to measure salinity but also chlorophyll, and to take samples for O^{18}. Towards the end of the leg, when the sea ice was warm and significant brine drainage occurred after sample removal from the core hole, ice cores were cut into 5cm segments and placed in buckets immediately in the field.

Onboard, the ice core Cs3 was melted in a cold room at +4°C for the study of minerals of $CaCO_3$ and ikaite. The melt water was filtrated on a GF/F and the filter was stored in the freezer container for further analysis back in Belgium.

2.5.3. Dissolved Inorganic Carbon (DIC)/Alkalinity Project

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submitted by Friederike Prowe

The ocean's exchange of carbon dioxide with the atmosphere is governed by the biogeochemical cycling of carbon and physical processes throughout the water column, which determine the concentration of dissolved inorganic carbon in the surface waters. Of the seven relevant carbon system parameters, a minimum of two are needed to calculate the others and fully describe inorganic carbon chemistry, overdetermination of the system being beneficial. During CFL leg 8, seawater, brine and ice core samples were taken analyzed for dissolved inorganic carbon (DIC) and total alkalinity (TA), yielding two relevant parameters. Due to the high work load, unfortunately pH could not be determined. Parallel to seawater and brine for DIC and TA, samples were taken for d13C, preserved and stored for later analysis.

DIC and TA in the water column

500 ml water samples were collected in glass bottles from the rosette at several depths for determination of DIC and TA. Sampling was performed according to protocol SOP1 (Dickson et al, 2007). Samples were usually first to be taken from the niskin bottles, or preceded only by dissolved oxygen at individual casts and depths. Since the contaminants group was analyzing for mercury, samples were only preserved using 200 µl saturated solution of $HgCl_2$ to inhibit biological processes if they could not be analyzed within 24 hours of sampling. Spiking took place in the lab after sampling at the rosette had been completed, and samples were stored in the dark at room temperature until analysis, since no space was available to keep samples at 4°C.

30 ml brown glass bottles were filled according to the same sampling protocol as for DIC/TA, and in the lab preserved with 30 µl saturated solution of $HgCl_2$. Bottles were sealed with parafilm and stored in the dark at room temperature, until at 27.05.2008 space could be found to keep them at 4°C from then on.

DIC and TA in sea ice, brines and under-ice water

Brine was taken from sack holes at several depths per ice station, depending on ice thickness and temperature, and filled into 500 ml glass bottles using a peristaltic pump (see section 3.2). When only low volumes of brine formed, e.g. for shallow depths, 250 ml bottles were used instead. At the same time, seawater from the ice-water interface and from 1 m below the interface was taken. Upon return to the lab, samples were preserved with saturated solution of $HgCl_2$, and kept in the dark at room temperature until analysis. Temperature was measured in-situ, and salinity later measured in the lab.

Similar to seawater samples, 30 ml bottles were filled for d13C, preserved, sealed and stored in the dark at room temperature/4°C.

At ice stations, one ice core was drilled specifically for DIC/TA and 15 cm sections from top, bottom and the middle of the core put into gas inpermeable Tedlar bags with a valve for removing gas or liquid. The bags were closed with a clamp type seal, and surplus air removed through the valve using a nalgene hand pump. At the lab, 200 µl saturated solution of $HgCl_2$ was added through the valve, and the samples left to melt in the dark.

DIC and TA analysis

DIC and TA were analyzed on board using a VINDTA 3C (Versatile Instrument for the Determination of Titration Alkalinity) by marianda. Prior to analysis, samples were heated to 25°C in the lab and using a circulation water bath. TA was determined by titrating a volumetrically accurate subsample using 0.1 M HCl as titrant, and a set of three electrodes, a Ross pH electrode, a reference AgCl electrode and an auxiliary platinum electrode.

Seawater samples were analyzed using a total volume of 4.2 ml titrant at dosage steps of 0.15 ml. For brine samples with higher salinity and alkalinity, total volume and dosage were adjusted to 14.7 ml and 0.3 ml, respectively. These parameters were not adjusted to the individual salinity/alkalinity of every brine sample, but kept constant for the entire batch for reasons of comparability. Possibly due to this procedure, the latter method appeared to result in less accurate values because it involved greater errors in the fitting procedures applied to determine TA over the comparatively wide range of salinities found in the brines. Subsequent reevaluation of the titration data can probably reduce the involved deviations and lead to more consistent results.

For measuring DIC, a volumetrically determined subsample was acidified with 8.5% H_3PO_4 to convert all inorganic carbon into gaseous CO_2. The CO_2 was stripped out of the sample using ultra-pure N_2 gas, transferred into a coulometric titration cell and detected using the coulometric method (Johnson et al., 1993).

Ice core samples had not been analyzed until the end of the leg, and were kept for further onboard analysis in the following weeks.

Seawater standards (Certified reference material, CRM, batch 81, provided by Prof. Andrew Dickson, Scripps Institution of Oceanography, La Jolla, CA) were used to calibrate the DIC and TA data and ensure quality control. Samples were run in batches of 25-30 bottles on one coulometer cell, with a standard at the beginning and the end of the day.

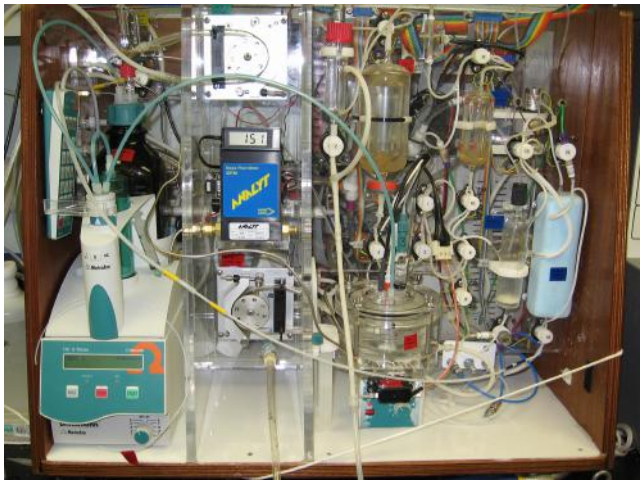

Figure 10: The VINDTA System.

Sampling Dates/Stations

Table 5: Stations sampled for DIC and TA

st	lat	lon		cast	date	samples taken	parameter	preserved
D43	70 35.245	122	26.127	0803002	26/04/08	water	**DIC, TA**	HgCl2
D43	70 35.245	122	26.137	brine, ic, sn	26/04/08	brines, ice cores, snow	DIC, TA	HgCl2
D43	70 41.572	123	4.919	0803010	28/04/08	water	DIC, TA	HgCl2
D43	70 45.452	123	41.678	br02, ic02, sn02	29/04/08	brines, ice cores, snow	DIC, TA	HgCl2
D43	70 49.166	124	16.477	0803030	01/05/08	water	DIC, TA	HgCl2
D43	70 51.112	124	51.737	br03, ic03, sn03, sw	02/05/08	brines, ice cores, snow, surface water	DIC, TA	HgCl2
D43	71 0.911	125	55.834	0803041	04/05/08	water	DIC, TA	HgCl2
D43	71 9.506	126	14.950	br04, ic04, sn04, sw02	05/05/08	brines, ice cores, snow, surface water	DIC, TA	HgCl2
1020A	71 1.589	126	57.924	0803056	06/05/08	water	DIC, TA	HgCl2
D44	71 1.560	127	3.350		06/05/08	ice cores	DIC, TA	HgCl2
F1	70 10.990	124	49.209		09/05/08	brines, ice cores, snow	DIC, TA	HgCl2
O2	69 59.034	126	2.917	0803060	12/05/08	water	DIC, TA	HgCl2
F2	69 57.093	128	9.597		13/05/08	brines, ice cores, snow	DIC, TA	HgCl2
F2b	69 57.130	126	10.251		16/05/08	brines + ice cores	DIC, TA	HgCl2
405b	70 40.265	122	49.830	0803083	19/05/08	water	DIC, TA	-
F3	71 34.367	119	36.719		20/05/08	brines + ice cores	DIC, TA	HgCl2
F3	71 34.295	119	36.416	0803086	20/05/08	water	DIC, TA	HgCl2
1011	70 43.811	123	59.932	0803100	21/05/08	water	DIC, TA	-
1806	72 39.941	127	21.800	0803104	23/05/08	water	DIC, TA	HgCl2
F4	72 38.605	126	2.186		24/05/08	brines	DIC, TA	HgCl2
6006	72 39.464	128	20.886	0803108	25/05/08	water	DIC, TA	HgCl2
6010	72 39.206	129	26.608	0803110	25/05/08	water	DIC, TA	-
8010	74 8.371	128	52.838	0803112	26/05/08	water	DIC, TA	-

9016	74	21.073	129	2.279	0803114	27/05/08	water	DIC, TA	HgCl2
9008	74	19.673	126	59.814	0803120	27/05/08	water	DIC, TA	-
F5	74	30.976	124	7.390	0803124	28/05/08	water	DIC, TA	HgCl2
F5	74	30.560	124	0.590		28/05/08	brines + ice cores	DIC, TA	HgCl2
D46	71	34.178	125	17.605	0830128	30/05/08	water	DIC, TA	HgCl2
D46	71	34.191	125	17.873		30/05/08	brines + ice cores	DIC, TA	HgCl2
D47	71	12.460	124	41.010	0803132	31/05/08	water	DIC, TA	-
F6	69	51.600	123	45.113	0803138	02/06/08	water	DIC, TA	-
F6	69	51.993	123	45.278		02/06/08	brines	DIC, TA	HgCl2

Table 6: Stations sampled for d13C

st	lat		lon		cast	date	samples taken
D43	70	35.245	122	26.137	brine	26/04/08	brines
D43	70	45.452	123	41.678	br02	29/04/08	brines
F1	70	10.990	124	49.209		09/05/08	brines
O2	69	59.034	126	2.917	0803060	12/05/08	water
F2	69	57.093	128	9.597		13/05/08	brines
F2b	69	57.130	126	10.251		16/05/08	brines
405b	70	40.265	122	49.830	0803083	19/05/08	water
F3	71	34.367	119	36.719		20/05/08	brines
F3	71	34.295	119	36.416	0803086	20/05/08	water
1011	70	43.811	123	59.932	0803100	21/05/08	water
1806	72	39.941	127	21.800	0803104	23/05/08	water
6006	72	39.464	128	20.886	0803108	25/05/08	water
6010	72	39.206	129	26.608	0803110	25/05/08	water
8010	74	8.371	128	52.838	0803112	26/05/08	water
9016	74	21.073	129	2.279	0803114	27/05/08	water
9008	74	19.673	126	59.814	0803120	27/05/08	water
F5	74	30.976	124	7.390	0803124	28/05/08	water
F5	74	30.560	124	0.590		28/05/08	brines
D46	71	34.178	125	17.605	0830128	30/05/08	water
D46	71	34.191	125	17.873		30/05/08	brines
D47	71	12.460	124	41.010	0803132	31/05/08	water
F6	69	51.993	123	45.278		02/06/08	brines

Barium in the water column

In the Canadian Arctic, barium (Ba) is mainly released from the North American continent and can therefore be used as a tracer for terrestrial freshwater input. Together with ^{18}O, a tracer for freshwater input from precipitation and ice melt, all freshwater sources to the Arctic can be quantified.

Samples for barium were taken from the rosette parallel to samples for ^{18}O, at approximate depths 5, 10, 25, 50, 75, 100, 150, 200 and 500 m. 15 ml nalgene bottles were rinsed three times, then filled and back at the lab spiked with 15 µl concentrated HCl. Sample bottles were sealed with parafilm and stored in the dark at 4°C until taken for later analysis using isotope dilution mass spectrometry.

Table 7: Stations sampled for Barium

st	lat		lon		cast	date
D43	70	41.572	123	4.919	0803010	28/04/08
1020A	71	1.589	126	57.924	0803056	06/05/08
O2	69	59.034	126	2.917	0803060	12/05/08

405b	70	40.265	122	49.830	0803083	19/05/08
F3	71	34.295	119	36.416	0830086	20/05/08
9008	74	19.673	126	59.814	0803120	27/05/08
F5	74	30.976	124	7.390	0803124	28/05/08
F6	69	51.600	123	45.113	0830138	02/06/08

References:

Johnson, K. M., K. D. Wills, D. B. Butler, W. K. Johnson and C. S. Wong. Coulometric total carbon dioxide analysis for marine studies: maximizing the performance of an automated gas extraction system and coulometric detector. Marine Chemistry, Vol. 44, pp. 167-187, 1993.

Dickson, A.G., C. L. Sabine and J. R. Christian (Eds.), *Guide to best practices for ocean CO_2 measurements*. PICES Special Publication 3, 191 pp., 2007

2.5.4. Laser Wave System (LAWAS) Project

The University of Miami LAWAS consists of 4 Riegl LD90-3 laser altimeters mounted in a square array of 0.3m diameter. LAWAS is mounted on a boom near the bow on the port side (see Fig. 8.1). A Systron Donner MotionPak is mounted at the center of the array to measure all six components of motion of the laser array.

Fig. 8.1 Photographs showing LAWAS position near bow of Amundsen.

The LAWAS system is designed to measure time series of wave slope in two directions, from which rms slope of the sea surface can be calculated. Of particular interest are measurements coincident with Quiksat overpasses. Typically six overpasses occur each day, between 01 – 13 UTC. The project objective is to relate CO2 gas transfer to Quikscat derived backscatter measurements. LAWAS deployments took place on May 18 (2129-2233), May 20 (0155-0315), May 22 (0220-0520), May 24 (0015-1315, multiple runs), May 26 (1958) almost continuously until May 28 (0524).

2.6. Team 7

2.6.1. Carbon & nutrient fluxes

PI: Jean-Éric Tremblay (Department of Biology, Laval University)

Participants: Jonathan Gagnon, Johannie Martin, Simon Pineault, Kyle Simpson (Department of Biology, Laval University)

Rationale. The Arctic climate displays high inter-annual variability and decadal oscillations that modulate growth conditions for marine primary producers. Much deeper perturbations recently became evident in conjunction with globally rising CO_2 levels and temperatures (ACIA 2004; Comiso 2003). The thickness and extent of Arctic sea-ice decrease rapidly (Johannessen et al. 1999; Rothrock et al. 1999) and the ice-free season is extending both in the Arctic (Laxon et al. 2003) and subarctic (Stabeno & Overland 2001). Models predict further reductions in ice cover (ACIA 2004). These changes entail a greater penetration of light into surface waters, which is expected to bolster phytoplankton production (Rysgaard et al. 1999), food web productivity and CO_2 drawdown by the ocean. At present, phytoplankton production varies by two orders of magnitude across the Canadian Arctic, but the forcing mechanisms are poorly understood and quantified. In the Canadian Archipelago, the productivity of phytoplankton is likely to be limited by light or the supply of allochtonous nitrogen, depending on ice conditions. The supply of allochtonous nitrogen is influenced by climate-driven processes, mainly the large-scale circulation, river discharge, upwelling and regional mixing processes. Over most of the western Arctic, and especially the Beaufort Sea, the concentrations of inorganic nitrogen (i.e. nitrate, nitrite and ammonia) at surface remain low throughout the year and the phytoplankton possibly depend on local recycling and the dissolved organic nitrogen (DON; e.g. urea, amino acids and primary amines) supplied by rivers. A large portion of the phytoplankton biomass is typically located within subsurface chlorophyll maxima (SCM). SCM productivity is possibly in balance with the episodic supply of nitrate across the halocline and/or the supply of ammonium and nitrate by local recycling and nitrification, respectively. Despite the importance of SCM for the food web and CO_2 fluxes, little is known about their structure, turnover and susceptibility to environmental variability and change.

Objectives. The main goals of our team for leg 8 of ArcticNet 2007&CFL were to **(1)** establish the horizontal and vertical distributions of phytoplankton nutrients and the influence of different processes (e.g. mixing, upwelling and biological processes) on these distributions, **(2)** characterize the detailed vertical structure of chlorophyll-*a* with respect to irradiance, nutrient supply and physical structure, **(3)** experimentally assess causal relationships between phytoplankton productivity and the availability of light **(4)** determine the utilisation of different sources of inorganic and organic nitrogen by phytoplankton, and **(5)** assessed the role of the ice algae during the initiation of the primary production in the water column. Ancillary objectives were to calibrate the *SeaPoint* fluorometer and *ISUS* nitrate probe attached to the Rosette.

Methods. Samples for inorganic nutrients (ammonium, nitrite, nitrate, orthophosphate and orthosilicic acid) and urea were taken at all rosette stations (see Table 1) to establish detailed vertical profiles. Ammonium was determined immediately after collection using modifications of the manual fluorometric method (e.g. Holmes et al. 1999). Urea samples were either frozen or analyzed fresh using the method of Mulveena & Savidge 1992. The concentrations of nitrate, nitrite, orthophosphate and orthosilicic acid were determined on fresh samples using an Autoanalyzer 3 (Bran+Luebbe) with colorimetric methods adapted from Grasshof (1999).

Samples for the natural abundance (Table 1) of ^{15}N and ^{13}C in particulate organic matter were taken from ice-core (bottom part; 2 to 4 cm), ice-water interface, at 5 m and at the chlorophyll maximum (30 m if no maximum were observed). Volumes ranging from few millilitres (for ice samples) to 12 to 20 litres (for water samples) were filtered onto 24 or 47 mm pre-combusted GF/F filters and the filters were desiccated at 60°C in a drying oven. These data will be used for nitrogen uptake calculations and to assess the nitrogen status of phytoplankton communities.

The relationship between light and the uptake of C and N by phytoplankton (light-gradient incubation in Table 1) from the chlorophyll maximum was assessed using dual labelling with stable isotopes of C and N in four light-gradient modules (10 light intensities). Temperature was maintained at *in situ* levels with a chilling circulator. Samples from all modules were spiked with ^{13}C-bicarbonate; two modules received saturating additions of ^{15}N-nitrate, ^{15}N-ammonium (or ^{15}N-urea, or ^{15}N-nitrite), and the other two trace additions. Incubations were terminated by filtration onto 24-mm GF/F filters. All

filters were desiccated at 60°C and stored dry for post-cruise determination of isotopic enrichment and particulate organic carbon and nitrogen.

SetCol protocol (Bienfang 1981) was carried with water from ice-core, ice-water interface and chlorophyll maximum (or 30 m) at the stations where ice was sampled or incubations were performed to measure the sinking rate of the micro algae cells. Fractions from the top, the middle and the bottom part of the column were filtered on GF/F filter and extracted with acetone to determine the chlorophyll concentrations. Samples for the taxa composition were taken in the top, the middle and the bottom fraction in a second column and were stored with acid lugol for a post-cruise analysis.

The size partitioning of ice algae was execute by filtering melted core on 200 µm and 20 µm filters (to obtained the isotopic signature of the different organisms) at same station that natural abundance analysis. The effects of incubation treatments (variable nutrient additions and light conditions) on the photosynthetic characteristics of phytoplankton were assessed by Pulse Amplitude Modulated fluorometry (PAM; Heinz-Walz). Nitrate data were used to calibrate the ISUS nitrate probe. Calibration of the Rosette fluorometer was achieved by comparing the instrument's output with extracted chlorophyll *a* and PAM data. The Phytoflash system, powered by a CTD (SBE-19), was deployed in self-contained mode from the front deck to obtained *in situ* photosynthetic yield in the water column.

Table 1. List of sampling stations and measurements during leg 8 of ArcticNet 2007&CFL.

Station	Cast	Date	Nuts	PAM	Light-gradient incubation	Natural Abundance (water)	Natural Adundance (ice)	Phytoflash
D43	002	26/04/08	X	X		X	X	
D43_1	010	28/04/08	X	X	X	X	X	
D43_2	030	01/05/08	X	X	X	X	X	
D43_3	041	04/05/08	X	X	X	X	X	X
1020A (D44)	056	06/05/08	X	X	X	X		X
F1	058	10/05/08	X			X	X	
O2	060	12/05/08	X	X	X	X		X
F2	071	15/05/08	X	X	X	X	X	X
405b	083	16/05/08	X	X	X	X		X
F3	086	20/05/08	X	X	X	X	X	
1011 (D45)	100	21/05/08	X	X	X	X	X	X
1806	104	23/05/08	X	X	X	X		X
F4	--	24/05/08				X	X	
6006	108	25/05/08	X					
6010	110	25/05/08	X					
8010	112	26/05/08	X					
9016	114	27/05/08	X					
9012	116	27/05/08	X					
9008	120	27/05/08	X	X	X	X		
9004	122	28/05/08	X					
F5	124	28/05/08	X	X	X	X	X	
D46	128	30/05/08	X	X	X	X	X	

D47	132	31/05/08	X	X			X	
405	134	01/06/08	X	X	X	X		X
F6	138	02/06/08	X	X		X	X	X

Preliminary Results. No preliminary results are available because post-runs corrections aren't done at this time.

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2.6.2. Carbon & nutrient fluxes in sea ice

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Subproject: Pathways of cycling and export of organic material in the sea ice and flaw lead system.

The overall objective of this project is to further our understanding of the cycling and downward export of organic material in the sea ice, at the ice-water interface, and in the flaw lead system. Sea ice contains a diverse community of organisms which is integral to the cycling of organic matter in the Arctic Ocean. Microorganisms are incorporated into the sea ice during periods of ice formation (Riedel et al. 2007). During the spring, there is a conspicuous ice algal bloom which develops in response to increasing light availability. Sea-ice production is coupled with both pelagic and benthic production (e.g. Michel et al. 1996, Renaud et al. 2007) and may contribute 25% or more to total Arctic primary production (Legendre et al. 1992, Gosselin et al. 1997). The objective for the seventh leg of the CFL system study was to investigate sea-ice organic carbon pools. This research will provide a better understanding of annual cycles of sea-ice carbon cycling in relation to exopolymeric substances (EPS) as well as physical sea-ice characteristics (Light, snow, ice).

Sample collection
Sea ice
Sea-ice associated samples collected during Leg 8 are summarized in Table 1. Complete ice cores were collected to obtain vertical profiles of the variables listed in Table 2, including nutrients and dissolved organic carbon (DOC) profiles. The ice sections for the vertical profiles were melted in sterile Whirl-Pak bags without the addition of filtered sea water. The cores were cut into 10 cm sections, except for the bottom section (nearest the water) which was cut into a 0 to 3 cm and 3 to 10 cm section. Three complete cores were collected on each sampling day and the corresponding sections were combined to obtain enough volume for all analyses.

Bottom ice samples (0-3 cm and 3-10 cm sections only) were also collected to measure spatial variability of bottom ice. A triangular sampling plan was used to assess the variability of all variables at 5, 3 and 1.5 m scales. We wanted to determine if there was detectable spatial variation in sea-ice constituents that could be linked to snow cover variability in the winter. Such variability could possibly be related to different rates of ice growth linked to the insulating properties of snow cover. The samples were melted with the addition of filtered seawater (0.2 µm polycarbonate membrane filters) to minimize osmotic stress during the melting process (Garrison & Buck 1986). Again 3 cores were combined to obtain enough volume for the analyses (Table 2). All ice cores were collected with a manual ice corer (Mark II coring system, 9 cm internal diameter, Kovacs Enterprise). With each ice collection we measured the freeboard and ice and snow thickness.

Surface water
On the majority of ice sampling days interface and 1m water samples were collected (Table 1). The water was collected from the ice-water interface using an under-ice arm and pump. This water was analyzed as described in Table 2 and a portion was filtered for the melting of the bottom ice samples.

Partial ice cores were removed to make sac holes into which brine could drain. The brine holes were covered with Styrofoam plugs and left to drain for 24 h before the brine was collected with a sterile syringe. A minimum of 10 cm of ice remained in all brine holes to limit the infusion of surface water.

Table 1. Summary of sea-ice associated sampling conducting during Leg 8.

			Samples collected					
Date (mm/dd/yr)	**Drift Station**	**Ice thickness (cm)**	**Ice profile**		**Spatial survey**		**Surface water**	**Trap deployment**
05/16/2008	F2	98	x				X	
05/18/2008	F2							x
05/20/2008	F3	127	x		x		X	
05/21/2008	D45	135	X		X		X	
05/30/2008	D46	87	X				X	
05/31/2008	D47	135			X			

Under-ice sediment traps
Short-term particle interceptor traps (sediment traps) were deployed at 1 m, 15m, 25m and 50m from the bottom of the ice. The traps were deployed for 3-4 day periods to collect sinking organic matter.
The sediment traps were PVC cylinders with an internal diameter of 10 cm and a height/diameter ratio of 7. Before each deployment, deep water (>150 m) was collected and filtered through a 0.2 µm polycarbonate membrane filter. The traps were filled with the filtered deep water so that the trap water would be denser than the surface waters in which the traps were deployed. Prior to deployment, the filtered seawater was analyzed for DOC, salinity, conductivity and temperature. Upon recovery of the traps, the total volume (~5.6 L) was used to assess DOC and total chl *a* concentrations. Salinity, conductivity and temperature were again measured. Cell samples were also collected for fecal pellet (microscopic counts) and bacterial (flow cytometry) abundances as well as cell taxonomy (preserved with acidic lugols). Exopolymeric substances (EPS) were measured to assess their association with sinking material.

Table 2. Summary of sediment trap deployments CFL Leg 8.

		Pos start		**Pos end**				
Deployment Nr	**Station**	**N**	**W**	**N**	**W**	**Deployment**	**Recovery**	**Depths**
1	F2	69 56,805	126 10,319	69 56,805	126 10,317	14.05.2008 10:30	18.05.2008 06:30	1, 15, 25

Rosette
DOC samples were collected at each depth of the nutrient rosettes of leg 8, shown in Table 3.

Table 3. Summary of Rosette casts for DOC for CFL Leg 8

Station #	Cast	# of depths	Date	Time	Position Start		Z start	Position End		Z end	DOC	DOC
			(mm-dd-yy)	(hh:mm)	Lat (deg N)	Long (deg W)	(m)	Lat (deg N)	Long (deg W)	(m)	(ml) A	(ml) B
Leg 8												
St. 405b	83	19	05/19/2008	12:14	70*40,27	122*49,88	591	70*41,57	122*49,12	596	40	40
F3	86	10	05/20/2008	12:00	71*34,380	119*36,415	130	71*34,380	119*36,415	130	40	40
St. 1011		17	05/21/2008	0:57	71*34,380	119*36,415	132	71*34,380	119*36,415	132	40	40
St. 1806	104	10	05/23/2008	15:23	72 39,95	127 21,80	137	72 39,97	127 21,70	139	40	40
St. 9008	118	17	05/27/2008	8:21	74*19.92	127*00.76	348	74*19.69	127*02.29	345	40	40
F5	124	16	05/28/2008	12:32	74*30,97	124*07,41	371	74*30,87	124*07,63	371	40	40
St. 405	132	18	06/01/2008	11:58	70*38,16	123*11,59	542	70*38,21	123*11,21	544	40	40

Sample analyses

The variables assessed for the ice associated samples are summarized in Table 2. The methods used for these analyses are briefly described below.

Table 4. Summary of variables analyzed for sea-ice, surface water and under-ice sediment trap samples during leg 8 of CFL.

	Ice profile	Sea-ice spatial survey (Bottom Ice)	Surface water	Under-ice trap
Salinity	X	X	x	x
Conductivity	X	X	x	x
Temperature	X	X	x	x
Total Dissolved Solids	X	X	x	X
pH	X	X	x	X
Inorganic nutrients	X	X	x	X
DOC/DON	X	X	x	X
POC/PON	X	X	x	x
Chl a/pheopigments	X	X	x	X
Flow cytometry[1]	X	X	x	X
EPS	X	X	x	X
EPS slides	X		x	
Cell taxonomy[2]	X	X	x	x
Bacterial activity	X	X	x	

DON/PON = dissolved/particulate organic nitrogen

Salinity, conductivity, total dissolved solids and temperature were determined with the hand held meter (HACH Sension 5). A desk-top meter was used to measure pH (Denver Instrument 250) after calibration with 3, 7 and 10 pH standards.

Subsamples for inorganic nutrients (NH_4, NO_2, NO_3, $Si(OH)_4$ and PO_4) were frozen in liquid nitrogen and then stored at -80°C for later analysis.

Duplicate DOC subsamples were filtered through precombusted Whatman GF/F filters. The filtrate was acidified with 50% H_2PO_4 and stored at 4ºC in the dark. POC subsamples were filtered onto precombusted Whatman GF/F filters and dried at 60°C for 24 h. We determined total chl *a* and pheopigment concentrations using the onboard fluorometer (10AU Turner Designs). Duplicate subsamples were filtered on Whatman GF/F filters (total chl *a*) after which the chl *a* was extracted for 18 to 24 h in 90% acetone.

Cell samples for taxonomy (20 to 250 ml) were preserved with either acidic lugols or buffered formaldehyde. Bacterial and protist samples were collected for both epifluorescent microscopy and flow cytometery analyses. Subsamples for flow cytometery (heterotrophic bacteria and pico/nanoplankton) were preserved with a final concentration of 0.1% glutaraldehyde and stored at -80°C. Subsamples for epifluorescence were preserved with formaldehyde (1% final concentration), stained with DAPI (4, 6-diamidino-2-phenylindole), at a final concentration of 1 µg ml^{-1}, and filtered onto 0.2 µm black Nuclepore filters. The prepared slides were stored at -80°C. The presence of active bacteria was investigated by incubating subsamples with 5-cyano-2,3-ditolyl tetrazolium chloride (CTC, final concentration 5 mM). The samples were incubated for 3 h at -1.5°C in the dark. Samples were preserved with a 5% final concentration of formalin and frozen.

EPS, defined as >0.4 µm acidic exopolysaccharides, were assessed with two methods. Bulk concentrations were estimated by Alcian blue staining of samples filtered on 47 mm 0.4 µm Nuclepore filters. EPS concentrations were measured colorimetrically (787 nm, onboard JENWAY 6300 spectrophotometer) after a 2 h extraction in 80% H_2SO_4. EPS slides were also prepared by filtering

subsamples on 25 mm 0.4 µm filters and staining with Alcian blue. The slides were prepared according to Logan et al. (1994), allowing for the observation of EPS using brightfield microscopy.

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2.6.3. Marine Microbiology Group

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Introduction
Microorganisms are a heterogeneous group that include representatives of the three kingdoms of live, Archaea, Bacteria and Eukarya. These organisms drive biogeochemical processes in the ecosystem. Autotrophic microorganisms are the base of the Arctic trophic web, which comprises 7 orders of size magnitude, ranging from the smallest cell of less than 1 µm to the largest mammals. All of these organisms are strongly influenced by annual cycles of light, temperature and ice cover in terms of the composition and activity of the species present.

How microbes use organic and inorganic matter and how this influences other components of the food web? This knowledge is needed to better predict the consequences of natural or anthropogenic changes on these trophic dynamics. This will also help us to evaluate the system's ability to buffer these changes at short and long timescales.

Objectives
The measurements completed during this leg covered the work of 4 teams headed by Corina Brussard, Connie Lovejoy, Roxane Maranger and Carles Pedrós-Alió. We aimed to determine the diversity of

species present and the importance of the biogeochemical processes driven by these organisms during the spring season.

Leg 8 had two more specific objectives. First, intensify bacterial respiration in ice measurements to confirm results obtained during leg 8. Bacterial respiration in ice hasn't been asserted until now and could play an important role in carbon fluxes at the sea-ice-atmosphere interface, especially in the event of a warming arctic climate. We also hope to link bacterial respiration data with carbon lability using regrowth experiments.

Second, N2O measurements were also intensified on a time and spatial scale by switching to daily sampling. N2O is a gas produced by bacteria, with a more potent greenhouse effect than CO2. We will try to see how N2O is related with bacterial activity and how it's cycle could be affected by climate change

Sampling

The details of the stations sampled and measurements performed can be found in tables 1 and 2, respectively. The following parameters were sampled;

1. Molecular genetics

Samples for DNA were collected on every station at 4 different depths. Six l seawater samples were prefiltered through a 50 µm mesh and then seperated into 'large' and 'small' DNA fractions by filtration through a 3 µm and then a 0.2 µm polycarbonate filter. After collection samples were stored at -80 ºC until processing in the Lovejoy laboratory in Université Laval.

2. Gene expression (RNA)

Samples for RNA were collected as for DNA.

3. Chlorophyll concentration

Samples for chlorophyll analysis were taken on each station at six or seven different depths. For each sample, one liter of water was filtered through a Whatman GF/F filter for microorganisms larger than the nominal pore size of 0.7 µm. In addition, 3 µm prefiltered obtain the small fraction, which was finally filtered through a Whatman GF/F filter. Afer filtration, the filters were stored overnight at -20ºC. Subsequently, the filters were introduced in acetone 90% and placed in a refrigerator, in the dark. After 24 hours, the fluorescence of the extracts, before and after acidification with 3 drops of 5% HCl, was determined by means of a Turner TD-700 fluorometer.

4. HPLC

Samples for High Performance Liquid Chromatography (HPLC) analysis were taken on each station at six different depths. Two fractions were collected, one for the total fraction (down to 0.7 µm) and one for the small fraction (from 3 µm to 0.7 µm). Samples were stored at -80 ºC and will be analyzed at Laval University.

5. Virus

See report of Evans and Brussaard leg 8.

6. Organic matter

Using pre-combusted GF/F filters (47 mm diameter) in a passive filtration system (by gravity) samples for dissolved organic carbon (DOC), total organic carbon (TOC), amino acids and carbohydrates were taken. Samples without filtration for total phosphorus determination were also collected.

7. Bacteria and Archaea abundance

Microscope preparations for bacterial abundance estimations were prepared by filtering a small volume of water (20ml) fixed with formaldehyde and staining with DAPI. Microscopy slides were prepared on all stations at 6 different depths. Slides were frozen (-20°C) until counting on a epifluorescence microscope.

Bacterial preparations were also obtained in some stations using glutaraldehyde instead of formaldehyde as the fixative. These slides were frozen at -20 ºC until counting.

8. Ciliates

Samples for ciliates abundance and diversity were collected and preserved using a Lugol acid solution. These samples will be analyzed off the ship.

9. FISH: eukaryotes

The Fluorescent In Situ Hybridization is a powerful technique to study specific groups of microorganisms. Samples for FISH were collected on all stations at 6 different depths. Samples were stored at -80 ºC until analysis off the ship.

10. CARD – FISH: bacteria and archaea

Samples for the abundance and distribution of specific groups of prokaryotic microbes were collected in all stations at 6 different depths. These samples have been frozen at -20 ºC until its analysis with different oligonucleotide probes off the ship.

11. MarFISH: bacteria and archaea

Incubations with 3H-labeled leucine and C14-labeled bicarbonate were carried out to detect active prokaryotes in the uptake of these substrates at two depths (surface and base of the nitrocline). Leucine incubations lasted for 8 hours and bicarbonate incubations lasted for 24h always in the dark. After fixation, samples were filtered and filters stored at –80 to be analyzed on land. In combination with the FISH technique this can give information on the phylogenetic identity of these active microorganisms. Beside the MarFISH incubations, samples were incubated with C14-labeled bicarbonate (at a lower concentration) to measure bulk bicarbonate uptake by bacteria and archaea in the dark. These samples were incubated for 24 hours and subsequently filtered. The filters were exposed to HCl fumes overnight, and embedded in cocktail for the scintillation counter measurement.

12. Bacterivory – FLBs grazing

In order to acquire values of ingestion rates of bacteria by heterotrophic eukaryotes, Fluorescent Labelled Bacteria (FLB) obtained from a culture of *Brevundimonas diminuta* were used on bacterial grazing experiments. Triplicates and a 0.2 µm seawater filtered control with 10^5 cells/ml added were used. Samples for flagellates and bacterial microscopy observation and for bacterial production were collected at the beginning and after 48 hours of incubation at seawater temperature (cold-room). This experiment was conducted once during the leg.

13. Algivory – Micromonas grazing

Two grazing experiments with the *Micromonas* strain RCC497 were performed in order to calculate an ingestion rate of *Micromonas* cells by heterotrophic flagellates. For each experiment, two replicates of 2000 ml seawater filtered by 200 µm were incubated during 96 hours, at surface seawater temperature (-1.4 ºC). A control of 0.2 µm filtered seawater was run in the same conditions at the

same time. Samples for FISH (to observe *Micromonas* ingestion) and flow cytometry (to observe *Micromonas* disappearance) were taken.

14. Bacterial production

Bacterial production rates were measured at six depths for each station using the leucine incorporation method (^{3}H labelled leucine) with 4 hours incubation at in-situ temperature. Samples were taken at every station at six depths, and also from surface waters below the ice. Rates of incorporation of radio labelled leucine were calculated using the ship scintillation counter.

15. Respiration

Bacterial/community respiration rates were measured using the FIBOX, which measures O_2 depletion in time using sensors glued in 500ml Erlenmeyers. The consumption of O2 in time can be converted in CO2 production to compare carbon respiration rate to bacterial carbon production rates. Each experiment lasted for about 15 days and oxygen measurements were made every 1-2 days. The erlenmeyers were kept in the dark inside a cooler in a cold room. We intensified the number of experiment on ice during leg 8. We were able to measure respiration rates in melted sea ice and during the regrowth experiment.

16. ETS

Due to the low respiration rates in Arctic waters, a back-up method was also used to obtain respiration rate surrogates via ETS (Electron transport system activity). This is achieved by filtering a large quantity (8L-10L) of water on GF/F filters to collect live cells and freeze them (-80°C) as quick as possible. Once off the ship, filters will be defrozen and the living cells will be subject to enzymatic tests to measure activity.

17. N2O in the upper water column

Dissolved N2O measurements were carried out using the headspace equilibration method with 1.1 L of seawater. 3 samples were taken from 3 depths and will be analyzed off the ship for N2O on an electron capture detector (GC). We intensified measurements for N2O on leg 8b to gain resolution on time and spatial scales by switching to daily sampling.

18. Carbon lability and consumption

To measure these variables we carried out two regrowth experiments. One of them will be passed to the leg 8 team. These experiment work on the principle of re-inoculation of a natural bacterial community (ice-water interface) in filter sterilized (0,2um) water or melted ice samples. To make sure that bacteria would only be limited by C, we added NaNO3 and NaPO4 to insure a minimal growth medium. Each 48h, we took samples for DOC analyses in Montreal, and each 4 day samples for flow cytometry to determine bacterial abundance. We hope that the DOC measures will give us more information on the lability of the carbon contained in the ice. Bacterial production was measured at the beginning and end of the experiments. These incubation were joined to respiration measurements using the same samples to see if DOC could sustain bacterial processes over a period of time (15-20 days).

Other activities

The team participated in all social activities of the ship. Claire gave interviews to media members. We also helped other teams on the digging of holes in the ice and ice core sampling. We also provided 0.7 µm filtered seawater for the zooplancton team and help other temas whenever possible.

Note:
Carles Pedros-Aliò had to leave prematurely before the mid-leg change, for family reasons. The complete sampling plan couldn't be carried out for the first half of the leg. Were still able to complete most of the regular sampling activities without major compromises.

Acknowledgements
We would like to thank our Chief Scientists (Michel Gosselin, Jean-Éric Tremblay and Dave Barber), Captain Stéphane Julien and crew of the Amundsen for the excellent work done during leg 8. Thanks to Benoit Philippe, Christian Nozais, Chantal Lacoste, Maike Kramer, and Rodd Laing for there help collecting the ice cores and to Véronique Lago and Caroline Sévigny for there help with the rosette.

Annex 1. Station locations

Date Start	Station ID	Cast #	Latitude (north)	Longitude (west)
29.04.2008	2008-D43	026 + ice hole	70°46,477	123°54,140
04.05.2008	2008-D43	Ice hole	71°00,99	115°54,201
17.05.2008	2008-F2	079	69°56,805	126º 10,317
19.05.2008	2008-405b	082	70°39,622	122° 52,788
20.05.2008	2008-F3	087+ice cores	71°34,380	119°36,415
21.05.2008	2008-D45	Ice cores	70°43,75	124°01,17
22.05.2008	2008-1011	102	70°42,35	124°00,03
23.05.2008	2008-1806	103	72°38,995	127º 23,816
25.05.2008	2008-F4	Ice cores	72°33,4	129°35,15
25.05.2008	2008-6010	110	72°39,19	129°26,61
26.05.2008	2008-8010	112	74°08,35	128°52,94
27.05.2008	2008-9008	118	74°19,92	127°00,59
30.05.2008	2008-D46	127	71°34,18	125°17,63
31.05.2008	2008-D47	131	71°12,48	124°41,00
01.06.2008	2008-405	133	70°37,78	123°10,38
02.06.2008	2008-F6	136	69º51,599	123º45,114
03.06.2008	2008-F6	143	69°51,599	123°45,114

Annex 2, Sampling details during leg 6, Numbers indicate depths/snow covers sampled

Station information	**Date**	30/04/08	4/05/08	17/05/08	19/05/08	20/05/08	21/05/08	22/05/08	23/05/08	24/05/08
	Drift station	2008-D43	2008-D43	2008-F2	2008-405b	2008-F3	2008-D45	2008-1011	2008-1806	2008-F4
	Cast number	26+ ice hole	Ice hole	079	082	87+cores	Ice cores	102	103	Ice cores
Protocols	**Bacterial production**		1		6		1		6	1
	ETS	2			2				2	
	Respiration				3				2	
	N2O			3	3	3		3	3	
	Bacteria and Archaea abundance	4	1		6	1	1		6	1
	Virus (abundance)	6	1		6				6	
	Organic matter and Total phosphorus									
	Ciliates	-			-				-	
	CARD-FISH (bacteria)	6			6				6	
	FISH (eukaryotes)	6			6				6	
	MAR FISH									
	Bacterivory	-							-	
	Alguivory									
	Regrowth Experiment						1			
	Virus diversity									
	DNA/RNA	4			4				4	
	HPLC				4				4	
	Chla	4							4	
	Algual abundance (cytometry)									
	HNF	6			6		1		6	1
	Ice respiration					1	1			1
	Biolog	3			3					

Station information	**Date**	25/05/08	26/05/08	27/05/08	30/05/08	31/05/08	1/06/08	2/06/08	3/06/08
	Drift station	2008-6010	2008-8010	2008-9008	2008-D46	2008-D47	2008-405	2008-F6	2008-F6
	Cast number	110	112	118	127	132 + ice hole	133	136	143
Protocols	**Bacterial production**			6				4	
	ETS			2				2	
	Respiration			3				3	
	N2O	3	3	3	3	4	3	3	3
	Bacteria and Archaea abundance			6				4	

	Virus (abundance)			6				4	
	Organic matter and Total phosphorus								
	Ciliates							1	
	CARD-FISH (bacteria)			1				4	
	FISH (eukaryotes)			1				4	
	MAR FISH			1					
	Bacterivory							1	
	Alguivory							1	
	Regrowth Experiment								
	Virus diversity								
	DNA/RNA			4				4	
	HPLC			4				4	
	Chla			4				4	
	Algual abundance (cytometry)			6				4	
	HNF			6				4	
	Biolog			3				3	

2.6.4. The significance of viruses for polar marine ecosystem functioning

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Background and Objectives

Microbial communities (phytoplankton, bacteria, Achaea, heterotrophic protozoa and viruses) comprise the majority of the biomass in the oceans and drive nutrient and energy cycling, and are thereby important components of polar food webs. With the emergent awareness that viruses are major players influencing biodiversity and biogeochemical processes the need to elucidate their role in polar ecosystems has been underlined as, despite their likely importance, their quantitative significance has barely been studied. We aimed to complete a comprehensive study of the viruses and viral mediated processes of the Arctic marine habitats encountered during legs 8 and 9 of the Circumpolar Flaw Lead Study. Samples will be taken and experiments performed on organisms from both the water column and the sea ice. The objectives of this study are; 1) To examine the abundance and composition of viruses and their prokaryotes and eukaryotic hosts (In collaboration with Prof. C Lovejoy University of Laval, 2) To determine viral induced mortality on both prokaryotic and eukaryotic microbial hosts alongside host growth rates and mortality due to grazing. 3) To gather a data set allowing comparison of the viruses and viral mediated processes of the Southern and Northern Polar regions. 4) To collect sample from which viruses might be isolated and therefore available for laboratory experiments.

Work onboard

A range of sampling was completed at four different station types which were; 'Level One' stations, 'Bacterial' water column stations, 'Algal' water column stations and 'Ice' stations. During the former RNA, DNA and pigments were sampled as part of a suite of other microbiologically-relevant measurements in collaboration with the other Microbiologist onboard (Prof. C Pedros-Alio leg 8A and Mr D Nguyen University of Montreal leg 8b). For more details see report of Mr D Nguyen. On bacterial water column stations measurements of abundance, diversity, grazing rate and viral-induced mortality were performed on the bacterial community at surface and/or chlorophyll maximum and bottom. On algal water column stations abundance, diversity, growth rate, viral lysis rate and grazing rate was determined on those algae present at the chlorophyll maximum. Finally at ice stations measurements were made to determine the abundance and diversity of the viruses and bacteria and the frequency of virus-infected bacteria. Details of the stations sampled are given in table one. At all experimental stations, samples were taken for viral diversity by concentrating 10 l volumes by 30 kDa ultrafiltration. These samples will be stored at -80 ºC until analysis by pulse field gel electrophoresis at the NIOZ. Samples for viral and bacterial abundance were fixed with glutaraldehyde, snap frozen and stored at -80 ºC for later analysis at NIOZ by flow cytomtery and SYBR Green.

Growth rates, viral lysis and grazing of the cyanobacteria, picoeukaryote, and nanoeukaryote communities present were determined by a dilution technique whereby whole water is combined with either 30 kDa filtered water (virus and grazer-free) or 0.4 um filtered water (grazer-free) in triplicate over a dilution series and incubated at *in situ* temperature and light conditions (environmental chamber). Fixed samples for algal enumeration were taken from all incubations at the start of the assay and after 24 h, allowing the calculation of growth rate. By plotting observed growth rate against the level of dilution the theoretical growth rate in the absence of mortality was calculated along with coefficients of grazing and viral induced mortality.

Rates of viral induced mortality of bacteria were determined by viral reduction assay. Briefly, the bacterial community was concentrated by tangential flow filtration and resuspended in viral free water generated by 30 kDa ultrafiltration. The production of viruses was followed by sampling for bacterial and viral abundance over a 12 h period (subsampling every 3 h). Rates of lysogenic infection of the

bacteria were determined in identical experiments with the addition of Mitomycin C, inducing lytic production of any lysogenic phage. In addition, rates of viral infection of bacteria will be elucidated by determining the frequency of infected cells which will be performed at the NIOZ on samples preserved with glutaraldehyde. Grazing of bacteria was assessed by an exclusion assay whereby bacterial numbers within incubations filtered to remove grazers 0.8 um were compared with whole water incubations containing grazers. Samples for virus isolation were collected from the chlorophyll maximum and will be screened against potential hosts at the NIOZ.

Station Designation	Date	UTC	Lat	Long	Sampling
D43	29/04/08	15:35	70º 44.726	123º 34.674	Ice
D43	29/04/08	16:35	70º 44.727	123º 34.675	Sub-ice Level one
D43	30/04/08	13:09	70º 46.476	123º 54.132	Level one
D43	1/5/2008	13:08	70º 48.814	124º 11.809	Algal
D43	2/5/2008	13:09	70º 50.506	124º 41.066	Bacterial
D43	4/5/2008	13:05	70º 59.696	125º 50.784	Bacterial
D43	5/5/2008	15:00			Ice
1020A	6/5/2008	21:19	71º 1.243	127º 3.098	Level one
F1	8/5/2008	15:00			Ice
O2	12/5/2008	13:11	69º 59.033	126º 2.9166	Algal
F2	13/05/08	17:08	69º 56.796	126º 10.33	Level one
F2	14/05/08	13:08	69º 56.795	126º 10.33	Bacterial
F2	15/05/08	13:00	69º 56.795	126º 10.33	Algal
F2	17/05/08	13:04	69º 56.795	126º 10.33	Bacterial
405B	19/05/08	13:28	70º 39.622	122º 52.768	Level one
F3	20/05/08	22:04	71º 34.295	119º 36.418	Bacterial
1011	21/05/08	3:13	70º 42.16	123º 58.955	Algal
1806	22/05/08	17:48	72º 38.995	127º 3.816	Level one + Algal
6008	25/05/08	14:05	72º 39.805	128º 28.871	Bacterial
9008	27/05/08	14:08	74º 19.868	127º 1.074	Level one + Algal
D44	30/05/08	15:37	71º 34.343	125º 17.66	Bacterial
D45	31/05/08	14:05	71º 13.168	124º 41.112	Bacterial
405	1/6/2008	17:50	70º 38.16	123º 11.713	Algal
F6	2/6/2008	13:10	69º 51.599	123º 45.114	Level one + Bacterial
F6	3/6/2008	13:15	69º 51.6	123º 45.114	Bacterial

Table One. Stations sampled

Preliminary results

All measurements will be performed on preserved samples either at NIOZ for, flow cytometry of viruses, bacteria and phytoplankton, pulse field gel electrophoresis of the viral community, and transmission electron microscopy to determine levels of infected cells and at University of Laval for DNA, RNA and pigment samples.

2.7. Team 8

PI: Gary Stern (DFO, Freshwater Institute)
Participants: Feiyue Wang (University of Manitoba), Joanne DeLaronde (DFO, Freshwater Institute), Monika Pucko (PhD student, University of Manitoba), Amanda Chaulk (MSc student, University of Manitoba), Alexis Burt (MSc student, University of Manitoba), Jeffrey Latonas (MSc student, University of Manitoba), Garry Codling (Lancaster University, UK), Fiona Wong (Environment Canada)

Objectives
The overarching question this project hopes to answer is how climate variability in physical forcing and the biogeochemical response to this primary forcing will affect the cycling of contaminants in the Arctic Ocean. The contaminants that of primary interest are mercury (Hg), polychlorinated compounds such as hexachlorocyclohexane (HCH) and polychlorinated biphenols (PCBs), and perfluorinated alkylated substances (PFAS). Ultimately, we aim to relate changes in delivery and biogeochemical cycling of these contaminants to their levels in fish, marine mammals and the people who consume these tissues as part of their traditional diets.

Leg 8 is a continuation of the work started from November 2007. Below is a brief report summarizing the major scope of work during this leg.

2.7.1. Organic contaminants

Hexachlorocyclohexane (HCH) (Pucko)

Technical HCH is a mixture of several isomers, the most abundant being α-HCH (60-70%), γ-HCH (5-12%) and β-HCH (10-15%). Technical HCH and pure γ-HCH (lindane, pesticide active isomer) have been used for over 50 years and are now ubiquitous in water throughout the northern hemisphere with the highest levels found in the surface water layers near pack ice in the Arctic Ocean.

Technical HCH was banned or heavily restricted by China, the former Soviet Union and India between the mid-1980s and 1990. Concentrations of α-HCH in arctic air responded quickly to these large-scale usage changes and declined by an order of magnitude from the early 1980s to mid-1990s in steps that closely matched global usage and emission estimates. As a consequence, the direction of net gas exchange in arctic waters reversed from deposition in the 1980s to air-water equilibrium or volatilization in the mid-1990s.

The α-isomer is the prominent in Arctic air, water, biota and soil, and moves northward via cold-condensation, a process whereby the contaminant evades into the atmosphere, drifts with atmospheric currents, and condenses in colder climates where at colder temperatures increasingly favours the water and extensive ice cover inhibit further evasion. Hence the contaminant accumulates disproportionately in the Arctic.

HCH water sampling
Water (4L) was collected from the rosette every 4-6 days. Where feasible, transects across water bodies were collected. In the lab, water was pumped through a glass-fiber filter followed by an ENV+ solid-phase extraction (SPE) cartridge using peristaltic pumps. Filters and cartridges are frozen and brought back the Freshwater Institute for analysis. $^{18}\delta O$ were also collected at each site and depth where HCH samples were taken.

During leg 8 water profiles were sampled at stations: D43, 405b, 1011, 1806 and 9008.

HCH air sampling
The air sampler was set up on the bow of the ship on the starboard side along with each ice sampling. Samples are collected on a glass fiber filter and polyurethane foam (PUF) for analysis of organic contaminants. Air samples collection time ranged between 4 and 10 hours. Filters and PUFs were frozen at -20°C and shipped frozen back to the FWI for HCH contaminant analysis.
During leg 8 air was sampled at stations: D43, 1020A, F1, O1, O2, F2, 405b, 1011, 1806, 6010-M1, 9008.

HCH biotic sampling
The main purpose of this study is to link physical and biological processes to mercury/HCH levels in the food web and to target the pelagic food web biomagnification and bioaccumulation of HCH and mercury with stable isotopes and fatty acids. Thus, all biological samples collected will be measured for HCHs, total mercury and MeHg along with stable isotopes to place organisms into their associated trophic levels.

Zooplankton
Zooplankton samples were collected on a daily basis. Various zooplankton families were collected using the vertically towed Tucker net (mesh size 0.2 mm) from the moon pool. To obtain the species from under the ice (e.g. Calanus glacialis AF) vertical tows 0-60m were done from the ice with a Tucker net. Zooplankton was sorted into families, placed in plastic vials and Whirlpak bags and frozen until they can be analyzed for HCH, THg, MeHg, stable isotopes and fatty acids.

Zooplankton sampling stations for HCHs were the same as those for mercury analysis.

Algae
All the bottom ice cores were filtered through pre-weight GFF filters in order to get sea ice algae. The filters were frozen and taken to Winnipeg for further analysis.

HCH ice sampling
Ice samples for HCHs concentration and enantiomeric composition were collected. The samples for oxygen isotope composition ($\delta^{18}O$) and salinity were taken along with all ice samples. The ice samples were collected in collaboration with team 2 and the ice microstructure and physical analysis was made on all of them (see team 2 cruise report). Ice cores were cut according to ice microstructure into 15-40cm layers or the whole core was taken, melted (4-8L of water) and pumped through a glass-fiber filter followed by an ENV+ solid-phase extraction (SPE) cartridge using peristaltic pumps. Surface water (4L) and 5m water were sampled along with almost every ice sampling using a Niskin bottle. The cartridges and GFFs were stored in -80 °C and brought to the DFO (Winnipeg) for further chemical analysis.

Ice was sampled at stations: D43, 1020A, F1, F2 and 6010-M1.

HCH snow/brine sampling
At some sites snow/frost flowers were sampled for HCH analysis. Air was always sampled along with the snow/frost flowers sampling. Where possible, snow was sampled in layers. Snow/frost flowers sampling for HCH analysis was mostly done in collaboration with team 2 snow pit sampling (snow density, salinity, temperature and grain characteristics were measured). Snow/frost flowers samples were taken with a metal pan into plastic bags. After melting, 8L of melt water was pumped through a glass-fiber filter followed by an ENV+ solid-phase extraction (SPE) cartridge using peristaltic pumps. The cartridges and GFFs were stored in -80 °C and brought to the DFO (Winnipeg) for further chemical analysis.

Snow was sampled at stations: D43, F2.
Brine was sampled at stations: D43, F1 and F2.

Bacterial experiment
Bacterial cultures from 9 different depths in the water column cultured by Marcela Ewert (Jody Deming's team) during leg 5 were maintained throughout leg 8 and will be taken back to Winnipeg for HCH EF degradation experiments.

The role of the Arctic in the global cycling of Persistent Organic Pollutants – ARCPOP
(Codling, Halsall group)

Overview
The purpose of the Halsall group's work is to examine the transfer of persistent organic pollutants (POPs) between the key Arctic compartments of air, snow, sea-ice and seawater during the period following polar sunrise (leg 7) to early summer (leg 8). Organic contaminants of interest include the 'legacy' POPs, such as the organochorine pesticides and polychlorinated biphenyls, as well as 'emerging' contaminants such as the perfluorinated alkylated substances (PFAS) and select current-use pesticides. The transfer and fate of these chemicals in the Arctic marine environment is poorly understood and yet their 'cycling' between air-seawater is likely to be strongly controlled by seasonal fluctuations in sea-ice cover. In addition, the role of snow in transferring airborne contaminants to marine surfaces with subsequent uptake to the marine foodweb is also an area for investigation.

Sampling strategy
Integrated sampling was conducted whenever possible; combining air, snow and seawater sampling at various CFL stations during leg 8. Due to the diversity of target analytes, separate sampling equipment and strategies where adopted. These were roughly distributed between 'large volume' techniques for legacy POPs, and 'low volume' sampling methods/techniques for PFAS.

Air samples
Leg 8a a High-Volume (Hi-Vol) air sampler set up on a 50m power cable was deployed where possible off the ship on the starboard side beginning at site D-43 initial 48 h samples were taken for 'legacy' POPs, with the sampler deployed on the ice, approximately 50 m upwind of the ship. At another station the Hi-Vol was deployed for PFAS sampling using a PUF/XAD/PUF sandwich. A second onboard Hi-Vol air sampler on the bow was used for POPs sampling though may have ship contamination.

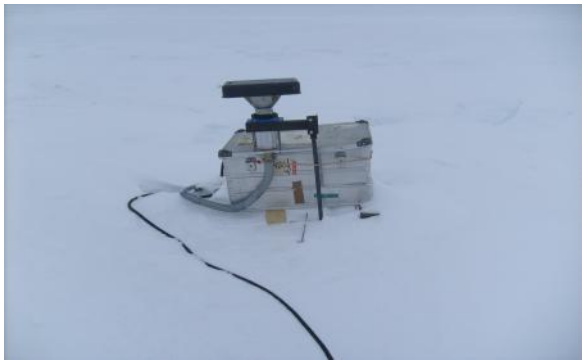


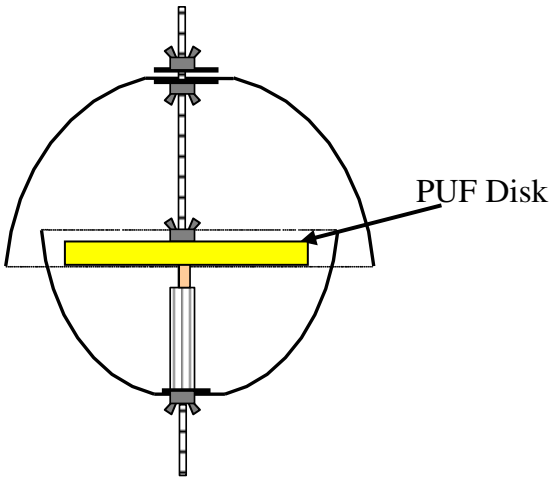
Figure 1. Hi-vol air sampler deployed on the ice at CFL station D43

For Leg 8 (b) due to the proposed sampling schedual the ship would not remain static long enough for ice deployment so the HI-Vol was redeployed on to the top of the wheelhouse. This was not ideal as filter showed influence from ship but allowed for more consistent sampling regimes.

Passive air samplers (PUF-disk samplers) were deployed on Leg 7 and taken down at the end of Leg 8 (b) (2) were deployed at the stern of the ship, close to the aft labs, as well as within the benthic laboratory (1) to assess ship-based contamination, particularly for polychlorinated biphenyls (PCBs) and polybrominated diphenyl ethers (PBDEs - flame retardants). Elevated levels of these compounds

are typical of many marine research vessels and deployment of PUF-disk samplers will serve as a useful quality control for the contaminant group as a whole.

PUF-disk samplers were also deployed (3) on the meteorological mast at the bow of the ship at different heights and these may reflect true contaminant levels in the Arctic marine boundary layer, and will be compared to the aft samplers. Two PUF-disk samplers were placed on the top of bridge in proximity of the Hi-Vol position.



Schematic of PUF Disk passive sampler

Seawater samples

The onboard (teflon-lined) seawater line was used to collect large volume seawater samples for POPs. Seawater was sampled from the well-mixed surface layer (~7 m depth) and passed through an in-line filter and XAD-cartridge system, which operationally collects the respective particle-bound and dissolved fractions of POPs Problems were encountered with the seawater-line; notably rust-like deposits present in the water as well as erratic flow rates from the pump/tap. This resulted in clogged filters and low sample volumes. Nonetheless, seawater samples comprising of volumes of <500L were collected and will be analysed fro OC pesticides and PBDEs, although these samples may be compromised due to the rust deposits.

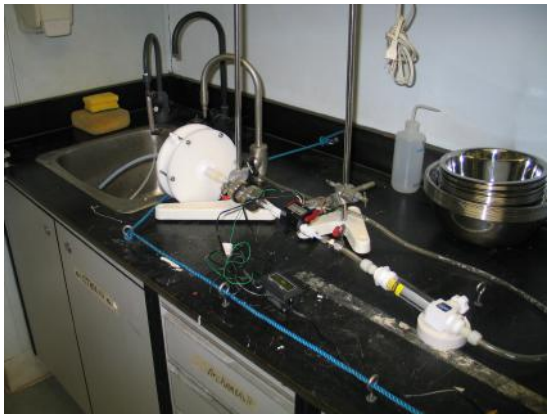


Figure 2. Onboard seawater sampling line in the Benthic lab

Low-volume samples (2-4L) were collected from beneath the sea-ice at interstitial and 5m depths. In open water surface and 5m low-volume samples were collected for PFAS.

For Leg 8 (b) due to the quality of the sample being produced from the on ship line an INFILTREX water system was used capable of pumping water through a filter for particulates and an XAD-2 filled

column for dissolved phase this was deployed 25m from the ship. Use was limited by the station sample lengths employed as a minimum of 24h on stable ice was required to get enough volume to sample.

Snow & ice samples
Three 50L gas-tight snow sampling cans were deployed at 10 stations over the course of the 6 weeks. The type of snow collected was largely dependent on the location and environmental conditions.


Figure 3. Snow-can meltwater extraction


Figure 4. Snow-cans deployed on the ice

Contaminant concentrations in snow will be related to snow physical properties as well as concentrations observed in air and underlying seawater. Snow-cans were also used to collect and melt sea-ice cores to examine contaminant levels in ice. Low volume (2-4 L) snowmelt and ice-core samples were also taken for PFAS. In open water free ice was collected on a 'grab' basis if available looking only for new ice.

Brine
Low volume (2-4L) of brine was also collected at 4 sites for analysis for PFAS compounds. These were collected as a sideline to the original project plan to determine if PFAS potentially detected in Ice and snow exist in greater or lesser concentrations in brine.

Currently Used Pesticides (CUPs) and Perfluoro Compounds in the Atmosphere (Wong)

The fate of pesticides applied to agricultural fields is of great interest because they are manufactured to be toxic to biota and some organisms. Currently used pesticides (CUPs) are generally more volatile and less persistent than the older style organochlorine pesticides, such as HCHs, but they can still undergo atmospheric transport through volatilization and deposition followed by reemissions. They ultimately make their way to sensitive ecosystems including the Canadian Arctic. CUPs include: dacthal, chlorothalonil, endosulfan and Chlorpyrifos, which have been reported in Arctic air (Hung et al., 2005; Jantunen et al., 2007, Shen et al., 2005; Pozo et al., 2006; Chernyak et al., 1996), seawater (Jantunen et al., 2007; Chernyak et al., 1996; Weber et al., 2006), sub-arctic/arctic lake water (Muir et al., 2004), snow (Hermanson et al., 2005; Chernyak et al., 1996) and fog (Chernyak et al., 1996). Perfluoro chemicals are emerging persistent organic pollutants which are found in a wide range of applications such as paints, packaging, lubricants, firefighting foams, stain repellents and cookware. They are found in Arctic where they accumulated in the food chain and in the atmosphere (Butt et al., XXX, Shoeib et al., 2006). There are is little known about their atmospheric levels in the Arctic.

During Leg 8B, air (~1200m^3, n=10) were continuously collected to determine occurrence and levels of CUPs. Air was drawn at a flow rate of 0.5 m^3/min, through a glass fiber filter (Whatman,

Maidstone, England, 20.3 x 25.4 cm, EPM 2000, collects 99% of particles >0.3µm) followed by two plugs of polyurethane foam (PUF), each 8 cm diameter x 7.5 cm tall, that collect the gaseous phase. Water samples (n=5) were also collected by pushing 100L of water through a glass fibre filter (GFF, 142mm) or a high capacity filter followed by a column of XAD-2 resin (Amberlite, macroreticular styrene divinylbenzene copolymer, 20-60 mesh size, Rohm and Haas, Supelco, Bellefonte PA, USA, 1.5 cm i.d., 75 mL settled volume) to concentrate the dissolved fraction. Sampling will continue during Leg 9B.

A separate set of air samples were collected for perfluoro compounds. Three ~350 m^3 air samples were taken with a PS-1 (Tisch Environmental, Village of Cleves, OH, U.S.A.) sampler, consisting of 7.6 cm diameter GFF followed by PUF-XAD-2-PUF plug sandwaich (6.8 cm diameter). These were collected for Mahiba Shoeib at Environment Canada, Toronto. Sampling will be continued in Leg 9B and 10A.

α-HCH Flux Experiments

Hexachlorocyclohexanes (HCHs) are the most abundant organochlorine pesticides in Arctic air due to their facile atmospheric deposition in the cold environment and slow degradation rates. In the past two decades, there has been a reduction in primary emissions of technical HCH with an accompanying decline in atmospheric HCHs concentrations. As a result, a reversed direction of air-water flux from net deposition to net volatilization has been observed in some arctic regions. This study was carried out to determine the gas exchange of HCHs using gradients of HCH concentrations and enantiomer fractions (EF) of α-HCH, where EF = concentrations of (+)/[(+) + (–)] enantiomers.

Air samples were collected at three heights above the surface, at ~1m, ~6m and ~12m to determine the flux of α- HCH and its enantiomers (35 m^3, n=27). A modified PS-1 (Tisch Environmental, Village of Cleves, OH, U.S.A.) sampler was used consisting of 7.6 cm diameter GFF followed by one PUF plug (6.8 cm diameter x 4.2 cm). Parallel low volume water samples (4L, n=6) were also collected but passing water through a glass fibre filter (47mm) followed by a ENV+ (200mg, Jones Chromatography) SPE cartridge.

Based on the results from Leg 1 (July 27 – August 16), which traveled from Quebec City to the Labrador Sea, through Hudson Strait and along a southern route in Hudson Bay to Churchill, Manitoba. It is found that α-HCH levels in air collected near the water surface at Hudson Bay were ~10% higher than those collected at 15 m above water. Similarly, EFs of α-HCH in air sampled closest to the water are expected to approach the nonracemic EFs in the surface water and tend toward more nearly racemic values with height. Sampling will continue during Leg 9B.

Reference

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Polychlorinated biphenyls (PCBs) project (leg 8A) (DeLaronde)

Participants: Joanne DeLaronde (DFO, Freshwater Institute, Winnipeg, MB.), Monika Pucko (PhD candidate, DFO and University of Manitoba)
Project members: Robie MacDonald (DFO, Institute of Ocean Sciences, Sidney BC), Gary Stern (DFO, Freshwater Institute, Winnipeg MB.), Zou Zou Kuzyk (PhD candidate, University of Manitoba)

General objective

As a result of extensive studies over the past 30 years, much has been learned about traditional contaminants like PCBs and their pathways, processes and effects in the Canadian Arctic. One of the only areas remaining as a major knowledge gap is Arctic seawater. PCB concentration data for Arctic seawaters are rare, largely because opportunities to collect the samples are rare, and also because it is challenging to sample and analyze PCBs at the low concentrations that occur in Arctic seawater without contamination or other biases. As we learn more about these challenges, increasingly it looks like some of the data collected in the past – including some in the Canadian Arctic – may be wrong.

The goal of this project is to obtain new, trustworthy measurements of dissolved PCB concentrations in Canadian Arctic Ocean seawater, guided by recent developments in our understanding of the challenges associated with this work, and how they can be overcome.

Equipment preparation and sampling techniques

Our group's experience with sampling Arctic seawater for contaminants in the course of the Canadian Arctic Shelf Exchange Study (CASES) and ArcticNet cruises has made us very cognizant of the challenges of this kind of sampling generally and also more specifically, for the conditions aboard Canadian Arctic research vessels.

Ultra-clean procedures were considered from the time that sampling materials (XAD-2 resin and glass fiber filters) were first prepared, through their storage and handling in the field and during and after sample collection. In preparation for sampling, XAD-2 resins were rigorously cleaned, proofed and packaged at AXYS Analytical Services Ltd. The filters were pre-combusted, stored in baked aluminum envelopes and vacuum sealed in plastic. New Teflon tubing and connectors as well as the pump filter plates were cleaned with hexane and vacuum sealed in plastic. These components were prepared at the Freshwater Institute, DFO, Winnipeg. The cleaned materials were stored on the ship in a vacuum seals bags inside a clean cooler to minimize their contact with the ship's atmosphere and other potential contamination sources.

Ideally, initial filter and column changes were to be conducted away from the ship on the sea ice. Because there was considerable retrofitting required due to the incompatibility of the stainless steel columns with the configuration of the pumps and the lack of the proper hardware this was not possible. The columns and filters were initially installed on the pumps in a cabin inside the ship. This was done as cleanly as possible, wearing latex gloves and ensuring critical pieces were kept clean and

off any potentially contaminated surfaces. Any open ends (water intake and outlet lines) were sealed with parafilm until deployment.

Two in situ pump systems (Infiltrex and SeaStar) were deployed beneath the sea ice to a depth of 15 m thus sampling Arctic Ocean seawater from the sea ice (rather than a ship) as a platform. The sampling area was upwind and approximately 500 m away of the ship to reduce the effects of the ships atmosphere.

The systems are equipped with glass fibre filters to collect suspended particulates (and associated PCBs) and stainless steel columns containing XAD-2 resin, which extract dissolved PCBs. During leg 8A the project was limited by the number of pre-cleaned columns available. Of the five columns, two were treated as procedural blanks and two as samples. Sampling with one column was not completed due to pump problems.

Two blanks were obtained by passing 1-L of seawater through each pumping system. The expected blank levels for filters and XAD-2 resin columns are in the order of 3-8 pg absolute.

Samples consist of between 250-400 L of seawater**.** (400-600 L would have been preferred.) Assuming that PCB concentrations in Canadian Arctic seawater are similar to recently reported values for the European Arctic (e.g., $\Sigma PCBs_{15}$=0.54-1.96 pg/L, PCB congener 52 concentrations = 0.10-0.24 pg/L; (Gustafsson et al., 2005)), sample volumes of 400-600 L should produce readily quantifiable PCB congener concentrations (40-120 pg absolute).

After the required volume of water was sampled, the columns and GF/F were placed in ziploc bags, sealed and returned to the ship where they were vacuum sealed. The columns were stored at 2ºC and the GF/F at -24ºC. When possible the columns and filters were exchanged in the in situ pump system on the ice at the sampling site. This was not always possible due to the cold conditions. On occasion the intake line and the column would freeze when he pump was removed from the water, causing it to shut down due to low flow. It was necessary to bring the pump back on board to thaw. If this was the case, all open ends were sealed with parafilm before bringing the unit on board the ship. The Infiltrex also requires the use of computer software to program flow rates and volumes prior to every deployment. Again, there were problems when it was extremely cold and the system had to be returned to the ship to warm up. Ideally we require a heated tent or some other form of shelter to not deviate from our intended protocol. The uncertainty of the ship movements (due to weather) was somewhat prohibitive to this project.

Preparing pumps for deployment:

Infiltrex

SeaStar

Samples collected

Date	Pump System	Sample Type	Column I.D.	Location		Depth (m)		total pumping time	total volume (L)
				Lat.	Long.	sample	bottom		
29-Apr-08	Infiltrex	blank	4415-26	70º 44.65 N	123º 33.105 W	15	545	10 minutes	1.0
29-Apr-08	Infiltrex	sample	4415-27	70º 44.65 N	123º 33.105 W	15	545	43.4 hours	392.0
30-Apr-08	SeaStar	blank	4415-28	70º 46.466 N	123º 54.127 W	15	462	10 minutes	1.1
09-May-08	SeaStar	sample	4415-29	70º 04.451 N	125º 09.051 W	15	31.5	27 hours	248.62

All samples and blanks pumped at a rate of 150 ml/min.

PCB congeners will be analyzed at AXYS Analytical Services Ltd. by high-resolution gas chromatography/mass spectrometry (US EPA method 1668A). Samples are analyzed in batches of 12-15 or less and a blank, spike and/or duplicate is analyzed with each batch.

This work will be continued during CFL Leg 9A.

Thanks to Stéphane Julien, Julio Salcedo and Garry Codling for their help!

2.7.2. Mercury

PI: Feiyue Wang (University of Manitoba)

Introduction

Mercury levels in marine mammals and fish are an ongoing concern in Arctic regions because of their inclusion in traditional subsistence diets among indigenous peoples in northern regions. Successful strategies to mitigate health impacts related to Hg in human diets require an understanding of both the social and cultural perspective of northern communities, as well as the natural environmental processes that lead to Hg in food resources. Our research on Hg in the Arctic is focused on determining the environmental processes responsible for the distribution and speciation of Hg in

Arctic marine ecosystems, for the purpose of supporting the development of strategies to lessen the impact of Hg on human and ecosystem health. Our specific objective during the CFL is to determine the **net** atmospheric flux of Hg to the aquatic ecosystem.

Atmospheric Mercury Speciation

Two systems have been running constantly during Leg 8 for real-time atmospheric mercury speciation monitoring in the air. In Leg 8, these two systems were operated by Dr. Fei Wang and Jeff Latonas.

Mercury Speciation System (SN323)
This system includes a Tekran 1135, a Tekran 1130, a Tekran 1130 Pump, and a Tekran 2537B (SN323). It provides real-time atmospheric Hg measurements for gaseous elemental mercury (GEM; every 5 min), particulate mercury (Hg_P) and reactive gaseous mercury (RGM; once every 3 hours). In leg 7 we had an additional 2537A monitoring GEM alongside SN323, however we lost use of that instrument due to a hardware problem. The system was installed in Leg 5 and has been continuously working without major problems. During Leg 8, we lost one day of data on April 25 due to unexpected computer shutdown and associated data logging problem.

Small scale mercury depletion event (MDE) episodes occurred throughout May 10, the GEM never dropped to zero as it did during Leg 7. Starting around May 6, the RGM concentration exceeded that of Hg_P, a phenomenon commonly observed during the later stage of MDEs.

GEM started to increase around May 10; levels up to 5 ng/m^3 were recorded, suggesting the end of the MDE season, degassing of dissolved gaseous mercury (DGM) is likely increasing as the ocean becomes more open. After the spike of GEM which began on May 10th, values returned to normal ~1.5ng/m^3. On May 27-29th the ship moved back north to the top of banks island, while up there two isolated depletion events were noted, we also seem to have a clear predominance of RGM since May 6th even though the frequency and depth of these depletions is low.

The glassware in the 1130/1135 speciation unit was changed on May 19th as well as June 02 including the RGM denuder and particulate mercury filter and pyrolyzer.

Total Atmospheric Mercury System (SN051)
We are also monitoring Total mercury (Hg_t) through a Tekran 1105 arctic pyrozlyzer unit which heats the sample to 900^{o}C before analysis by another Tekran 2537A (SN051), During Leg 7 Sandy Steffen modified this system to allow for the measurement of both ambient – total gaseous mercury (TGM) and heated/pyrolysed- total atmospheric mercury (TAM) in air by installing a switching valve which did 3 samples from the ambient line followed by 3 samples from the heated line. This later caused an electrical issue with the 2537 and the switching valve had to be removed; as of May 17th SN051 has been running on the heated air only.

During Leg 8, we replaced the Au Traps on the SN051 unit, and the unit has been stable and running well. A series of standard injections were performed on May 31st and the results were good.

Gaseous Elemental Mercury (SN071)
On May 20th it was decided that we would no longer be able to deploy our mercury speciation sled (Tekran 1130/1135/2537) onto the ice for any significant period of time, so the Tekran 2537 which was installed in that sled was removed and installed into the foredeck lab. In leg 7 we lost the use of the Tekran 2537 which was monitoring GEM alongside the SN323 speciation system due to a hardware malfunction. SN071 was installed on May 20th and began measurements of GEM in ambient air on May 24th.

The initial readings for ambient air were high and not corresponding to values measured by the other instruments. On may 31 a set of standard injections was performed to calculate a new permeation rate

for the internal mercury calibration source. This new value was inserted into SN071 and values were confirmed with additional injections.

Mercury in Surface Snow and Snow Pits

This work was done mainly by Amanda Chaulk during Leg 8. Time series of surface snow samples were collected whenever possible during Leg 8. The samples were analyzed within 1-3 days at PILMS. We continuously see the high Hg concentrations in surface snow. During the beginning of May, mercury concentrations in surface snow began to decline to levels observed earlier in the season pre-mercury depletion event. However, recent samples from the end of the leg have shown mercury concentrations in snow at higher levels observed earlier in the leg.

Snowpit samples were also taken at D43 (10cm) and F2 (70cm). The F2 snow pit showed low mercury concentrations (<10ppt) both at the surface and throughout the pit. The D43 showed some variation, having a higher mercury concentration at the top and declining concentration with depth.

Mercury in Ice, Brine Drainage and Melt Ponds

This work was done mainly by Amanda Chaulk during Leg 8. Ice cores were taken at stations D43, F2, D45, M1, and F5. The ice-core taken at M1 is a multi-year ice core 3.8meters long; this is the first time multi-year ice has been sampled during CFL. All ice cores were cut into partitions based on microstructure and individually scraped with clean gloves and an acid cleaned and tested ceramic blade. A new pair of gloves was used for each piece of core. The core was cut in half so each piece would be duplicate. During scraping blanks were also done; a zip-lock bag was filled with milli-Q water and allowed to freeze in the freezer lab while other cores were being scraped. The knife was wiped with a clean lab wiper and inserted into the blank bag, scraped along the ice or sloshed around in the water.

Brine time series were only collected at two sites during leg 8, D43 and F2. A single brine depth series was sampled at F5 as well. Brine wells were dug at 20cm, 40cm, 60cm, 80cm, and 100cm. The holes were covered and brine allowed to seep in. The brine was sampled twice per day with an acid cleaned and tested turkey baster, field blanks were also done by sucking milli-Q water into the baster and releasing it into a falcon tube. With the onset of the summer melt, the brine salinities as well as mercury concentrations decreased. Despite lower concentrations, brine data still showed similar trends to those observed in leg 7 (decreased mercury concentration the deeper the brine hole).

Leg 8 marked the first time melt ponds were observed. These were sampled at station F6, using an acid cleaned and tested turkey baster. Melt ponds were observed both with and without a thin ice cover over top, samples from both were taken and a difference in mercury concentrations was observed between those that were covered and those that were not. Field blanks were also done when sampling melt ponds. The thin ice cover over top of a melt pond was sampled as well.

Alexis Burt (dirty) and Amanda Chaulk (clean) sampling a melt pond on June 2, 2008

Mercury in Seawater

Water profiles were collected by the contaminants team, and analysed by Amanda Chaulk in PILMS. We collected seawater Hg depth samples from a total of 5 sites in Amundsen Gulf and Franklin Bay. Samples from the 10 m depth to the seafloor were collected with the ship-based Rosette sampling equipment in PVC "Niskin-style" sample bottles remotely operated from onboard the ship. Supplementary surface water samples from 0 to 10 m in depth were collected by a PVC Niskin water sampling bottle (General Oceanics, Miami, Florida) from a hole or open lead within a few hundred meters of the ship and within three hours of the Rosette collection. Within each profile, 11 to 20 different depths were sampled (including Niskin sampling), producing high resolution profiles for total Hg (Hg_T). At each depth sampled for Hg_T, water was also collected for $\delta^{18}O$ analysis in tightly sealed glass scintillation vials. After collection of $\delta^{18}O$ samples, bottles were further sealed with parafilm and stored at 4°C.

Samples for Hg_T analysis were preserved by 0.5% HCl and 0.5% BrCl, stored at 4°C, and analyzed within 1-3 days by cold vapour atomic fluorescence spectrophotometry (CVAFS) the Portable In Situ Laboratory for Mercury Speciation (PILMS) onboard the CCGS Amundsen.

Hg_T levels measured during Leg 8 were very low, averaging roughly 1 pM (0.2 ng/L) throughout the water column. These values are comparable with those measured during Leg 7. One exception was the profile taken from D43, where very high Hg concentrations (up to 8 ng/L) were found at a few depths. Since the precision of the 3 replicates was very good and since concentrations levels at other depths remained very low (< 0.5 ng/L), these high levels cannot be explained by contamination during sampling or sample preservation. Therefore, they were either due to contamination of the corresponding rosette bottles, or were true measurements of some exceptionally high Hg levels. We will further verify this with other ancillary data (e.g., nutrients, $\delta^{18}O$).

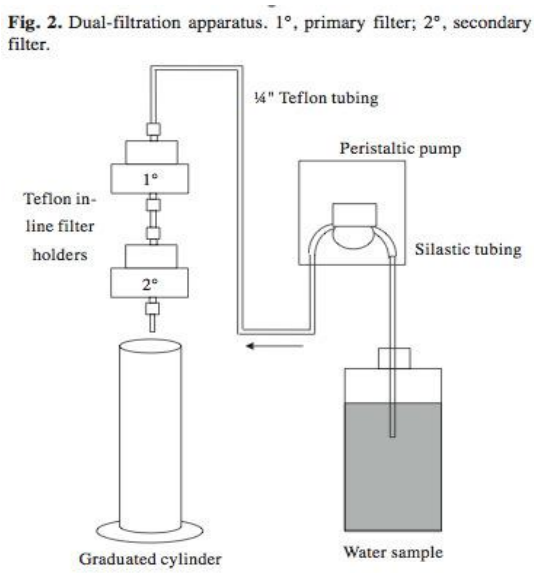
During Leg 8, the Niskin bottle used to collect surface water broke several times preventing the collection of full water profiles. Despite being fixed with contact cement several times by Jeffrey Latonas, the Niskin would break again fairly quickly.

Mercury in Phytoplankton and Zooplankton

Algae (Hg, MeHg)
Phytoplankton samples were taken in conjunction with zooplankton tows. Samples were sieved through 710µm, 350µm, 150µm, 50µm and 20µm mesh and frozen. Samples were also preserved with lugol's for speciation.

Phytoplankton was collected at stations D43, F2, 405, and F6. At open water stations, phytoplankton was collected with a 20um mesh net (stations 1011, 1806, 9008 and 405). The rosette was used to collect phytoplankton at the chlo max (stations 405B, 1806, 9008, and 405) these samples were filtered as below.

Under-ice algae was collected from the ice-water interface with a battery powered pump on a metre long under ice arm. These samples were filtered onto pre-combusted and weighed glass fibre filters (GF/F) for chlorophyll a, dry mass, and filtered in series with a clean set up for mercury, with a blank (see figure). The filters were frozen, and will be shipped to Winnipeg for further analysis. Bulk samples were frozen. Ice interface algae was collected at stations D43, F1, F2, 1011, D44, and F6.



Filtration set up for algal Hg (exception: the peristaltic pump is between the filters and the waste container)

Ice algae was collected by coring.
Ice algae was collected at stations D43, F1, F2, 1011 (melted in the freezer), and D45.

Zooplankton
Zooplankton samples were collected during the leg. Various zooplankton families were collected using the vertically towed Tucker net (200µm mesh) from the moon pool in ice covered areas, and when in open water, horizontal/oblique tows were done on the foredeck with a double Tucker net (500µm mesh) and vertical tows were done with the monster net (3x200µm, 1x500µm mesh nets). Zooplankton was sorted into families, or to genus and species where possible, placed in plastic vials and Whirlpak bags and frozen until they can be analyzed for THg, MeHg, stable isotopes and fatty acids. Common species found were *Calanus hyperboreus*, *Calanus glacialis, Paraeuchaeta glacialis*, *Sagitta elegans, Sagitta maxima*, *Themisto abyssorum*, *Themisto libellula, Metridia longa, Ostracoda* sp., Cnidarians, and Ctenophores. Some less common species found were *Cleone limacina*, *Gaidius* sp., *Hyperoche* sp., Euphasiids, and *Pandalus* sp. Zooplankton was collected at station D43 (x3) on leg 8a, and at stations F2, 405b, 1011, 1806, 8010, 9008, D44, D45, 405, and F6 for a total of 17 zooplankton hauls leg 8b.

Methylmercury (MeHg)

This work was done by Dr. Fei Wang. Progress was made during Leg 7 by Alex Hare and Debbie Armstrong in setting up the system. They were able to get a good calibration curve from MeHg standards. During Leg 8 we were able to reproduce the curve with similar intensity. However, we did not do any analysis until May 13 due to the ship movement. We carried out the distillation, but the detector was not stable for the ethylation and analysis to continue. The noise level was ~800 instead of 38 before the ship moved out from D43. The high noise was either due to the aged lamp (which was unlikely as it was replaced in Leg 7), or damage due to the ship movement.

Since a new automated system was ordered and is expected to arrive at the beginning of Leg 9, it was decided that the MeHg work be delayed until Leg 9.

Samples collected from Leg 7 were kept in the fridge and should be OK if analyzed in June according to the U.S. EPA protocol.

Leg 9

6 June – 17 July 2008

edited and compiled by David Barber and C.J. Mundy (Chief Scientists)

1. General overview

1.1. Introduction

On behalf of the scientific crew, I would like to express our sincere gratitude to Captain Lise Marchand, the officers and the crew of the Canadian Coast Guard Ship Amundsen for their comprehension, professionalism and camaraderie that helped make leg 9 of CFL a great success.

One of the main objectives of the CFL study was to compare and contrast the flaw lead system with that of the surrounding fast ice. With respect to this objective, leg 9 (5 June ï 17 July, 2008) encompassed an important transitional period where the fast ice rapidly ablated and broke-up giving way to an increasing polynya extent. This transition provided unique logistical challenges throughout the leg. Perhaps the most prominent of these challenges was the change from ice operations during leg 9A to open water operations during leg 9B. Leg 9 also provided for some unique opportunities and discoveries. For example, some of the highlights of the leg included: a unique sampling transect from marine waters through a river plume and into the fast ice edge; monitoring the melt progression of 2 shallow coastal bays (Franklin and Darnley Bay) from a thick winter ice cover through to complete break-up concluding with open water stations in both bays; observations of very high and sustained biological activity underneath the melting ice cover (i.e., prior to ice break-up in the bays); and the first detailed oceanographic transect of MðClure Strait, north of Banks Island. During leg 9, we also had a very successful community visit in Ulukhaktok (Holman).

1.2. Personnel

Leg 9 scientific and media participants included 55 scientific personnel, 7 media personnel and 1 wildlife observer (Table 1). The high number of scientific personnel was mainly due to the switch in operations from ice to open water that required different expertise and therefore, personnel. During leg 9A, 1 ï 2 media personnel were exchanged weekly allowing for 5 journalists from the World Federation of Science Journalists (WFSJ) to visit the ship. Two journalists from the WFSJ reported from the ship during leg 9B.

Table 1. Scientific and media personnel of CFL leg 9.

Participant	Position	Affiliation	PI	Embark	Disembark
Barber, Dave	Chief Scientist (5 - 20 June)	University of Manitoba	Barber, Dave	leg 8	20-Jun-08
Mundy, C.J.	PDF/Chief Scientist (20 June - 17 July)	University of Quebec in Rimouski (UQAR)	Gosselin, Michel	5-Jun-08	17-Jul-08
Gratton, Yves	Research Scientist	INRS	Gratton, Yves	5-Jun-08	26-Jun-08
Lago, Veronique	Graduate Student	INRS	Gratton, Yves	26-Jun-08	7-Aug-08
Dyck, Sarah	Graduate Student	University of McGill	Tremblay, Bruno	5-Jun-08	17-Jul-08
Brouard, Charles	Graduate Student	INRS	Gratton, Yves	5-Jun-08	17-Jul-08
Gupta, Mukesh	PhD Student	University of Manitoba	Barber, Dave	5-Jun-08	7-Aug-08
Scharien, Randy	PhD Student	University of Calgary	Yackel / Barber	leg 8	26-Jun-08
Chen, Zhihua (Zhao)	Master's Student	Oceans University of China	Zhao, Jinping	20-Jun-08	17-Jul-08
Zheng, Shaojun (Zhao)	PhD Student	Oceans University of China	Zhao, Jinping	20-Jun-08	17-Jul-08
Asselin, Natalie	Master's Student	University of Manitoba	Barber, Dave	leg 8	26-Jun-08
Rossnagel, Andrea	Master's Student	University of Manitoba	Barber, Dave	leg 8	26-Jun-08
Ehn, Jens	PhD Student	University of Manitoba	Barber, Dave	leg 8	26-Jun-08
Hop, Haakon	Research Scientist	Norweigian Polar Institute	Hop, Haakon	5-Jun-08	26-Jun-08
Hochheim, Klaus	Research Associate	University of Manitoba	Barber, Dave	leg 8	26-Jun-08
Brown, Thomas	Graduate Student	Plymouth University	Masse, Guillaume	5-Jun-08	17-Jul-08
Evans, Claire	PDF	Royal Netherlands Institute for Sea Research	Brussard, Corina	leg 8	17-Jul-08
Palmer, Molly	PhD Student	Stanford University	Arrigo, Kevin	5-Jun-08	17-Jul-08
Alou Font, Eva	PhD Student	University of Quebec in Rimouski (UQAR)	Roy, Suzanne	leg 8	17-Jul-08
Philippe, Benoit	Master's Student	University of Quebec in Rimouski (UQAR)	Gosselin, Michel	26-Jun-08	17-Jul-08
Ardyna, Mathieu	Master's Student	University of Quebec in Rimouski (UQAR)	Gosselin, Michel	26-Jun-08	7-Aug-08
Randall, Kevin	Master's Student	Laval University	Levasseur, Maurice	26-Jun-08	7-Aug-08
Link, Heike	PhD Student	University of Rimouski	Archambault, Philipe	5-Jun-08	7-Aug-08
Bourque, Mylène	Technician	University of Quebec in Rimouski (UQAR)	Archambault, Philipe	26-Jun-08	17-Jul-08
Darnis, Gerald	PhD Student	Laval University	Fortier, Louis	5-Jun-08	17-Jul-08
Lauzon, Samuel	Research Assistant	Laval University	Fortier, Louis	5-Jun-08	7-Aug-08
Clouiter, Helen	Technician	Laval University	Fortier, Louis	5-Jun-08	17-Jul-08
Thanassekos, Stephane	PhD Student	Laval University	Fortier, Louis	5-Jun-08	17-Jul-08
Shadwick, Elizabeth	PhD Student	Dalhousie University	Thomas, Helmuth	5-Jun-08	17-Jul-08
Gremes Cordero, Sylvia	PhD Student	University of Miami	Drennan, Will	26-Jun-08	7-Aug-08
Moore, Stephanie	Graduate Student	Dalhousie University	Thomas, Helmuth	26-Jun-08	7-Aug-08
Wong, Fiona	Graduate Student	Environment Canada	Bidleman, Terry	26-Jun-08	17-Jul-08
Aubry, Cyril	Technician	University of Quebec in Rimouski (UQAR)	Xie, Huixiang	5-Jun-08	17-Jul-08
Else, Brent	PhD Student	University of Manitoba	Papakyriakou, Tim	5-Jun-08	17-Jul-08
Geilfus, Nicolas-Xavier	PhD Student	University of Brussels	Delille, Bruno	leg 8	26-Jun-08
Martin, Johannie	PhD Student	Laval University	Tremblay, Jean-Eric	leg 8	17-Jul-08
Sallon, Amélie	Master's Student	University of Quebec in Rimouski (UQAR)	Michel, Christine	5-Jun-08	7-Aug-08
Laing, Rodd	Master's Student	University of Manitoba	Michel, Christine	26-Jun-08	17-Jul-08
Hirschberg, David	Research Scientist	Stony Brook University	Cochran, Kirk	5-Jun-08	26-Jun-08
Carpenter, Shelly	Technician	University of Washington	Deming, Jody	5-Jun-08	17-Jul-08
Kellogg, Colleen	Graduate Student	University of Washington	Deming, Jody	5-Jun-08	17-Jul-08
Cochran, Kirk	Research Scientist	Stony Brook University	Cochran, Kirk	26-Jun-08	17-Jul-08
Renfro, Alisha	Graduate Student	Stony Brook University	Cochran, Kirk	26-Jun-08	17-Jul-08
Pineault, Simon	Master's Student	Laval University	Tremblay, Jean-Eric	26-Jun-08	17-Jul-08
Maltais-Landry, Gabriel	MSc Student	University of Montreal	Maranger, Roxane	26-Jun-08	17-Jul-08
Nguyen, Dan	Graduate Student	University of Montreal	Maranger, Roxane	leg 8	26-Jun-08
Armstrong, Debbie	Technician	University of Manitoba	Wang, Fei	5-Jun-08	17-Jul-08
Burt, Alexis	Master's Student	University of Manitoba	Wang / Stern	leg 8	17-Jul-08
Latonas, Jeff	Master's Student	University of Manitoba	Stern/Wang	leg 8	17-Jul-08
MacHutchon, Allison	Technician	DFO-Freshwater Institute	Stern, Gary	5-Jun-08	17-Jul-08
Delaronde, Joanne	Technician	DFO-Freshwater Institute	Stern, Gary	5-Jun-08	26-Jun-08
Blondeau, Sylvain	Technician	Quebec - Ocean	Michaud, Luc	5-Jun-08	17-Jul-08
Stewart, Jeremy	Scuba diver	DFO-FWI		5-Jun-08	26-Jun-08
Trevor Lucas	Wildlife Monitor	Sachs Harbour HTC		27-Jun-08	10-Jul-08
Nield, Jennifer	Senior Policy Advisor	DFO		5-Jun-08	12-Jun-08
Raper, Andrea	Director, Strategic Business Management	DFO		5-Jun-08	12-Jun-08
Schiermeier, Quirin	Media	Nature Magazine		5-Jun-08	12-Jun-08
Mehta, Aalok	Media	World Federation of Science Journalists		12-Jun-08	20-Jun-08
Sharma, Dinesh	Science Editor, Mail Today (India)	World Federation of Science Journalists		12-Jun-08	20-Jun-08
Maggi, Maria	Media	World Federation of Science Journalists		20-Jun-08	26-Jun-08
Kalaugher, Liz	Media	World Federation of Science Journalists		20-Jun-08	26-Jun-08
Calderon Pineda, Lucy	Media	World Federation of Science Journalists		26-Jun-08	17-Jul-08
Pou Pujadas, Anthony	Media	World Federation of Science Journalists		26-Jun-08	17-Jul-08

1.3. Scientific operations

A log of all scientific ship operations recorded by the Amundsenôs officer-on-watch is provided below. During leg 9A, operations were largely in the ice cover of Franklin Bay (Stations FB5 and 7) and Darnely Bay (Station F7; Figure 1a). While in the ice cover, all on-ship operations were accomplished through the moonpool. In order to collect samples from the ice and surface waters, scientific operations also involved off-ship sampling. Another integral part of leg 9A was the dive program where SCUBA divers collected samples and made measurements underneath the sea ice for numerous scientific personnel on the ship.

Scientific log recorded by the CCGS Amundsen officer-on-watch.

Date	Sta.	Time (24hr)	Latitude		Longitude		Activity	Depth (m)
7-Jun-08	F-7	7:13	69 50.2	N	123 37.5	W	Rosette in	90
		7:38	69 50.2	N	123 37.5	W	Rosette out	90
		12:45	69 49.6	N	123 37.85	W	EM scan On	78.5
		13:30	69 49.6	N	123 37.85	W	Tucker net #1 in	78.5
		13:38	69 49.6	N	123 37.85	W	Tucker net #1 out	78.5
		13:45	69 49.6	N	123 37.85	W	Tucker net #2 in	78.5
		14:00	69 49.6	N	123 37.85	W	Tucker net #2 out	78.5
		14:07	69 49.6	N	123 37.85	W	Tucker net #3 in	78.5
		14:17	69 49.6	N	123 37.85	W	Tucker net #3 out	78.5
		14:25	69 49.6	N	123 37.85	W	Ring net in	78.5
		14:36	69 49.6	N	123 37.85	W	Ring net out	78.5
		14:50	69 49.6	N	123 37.85	W	Hydrobios in	78.8
		15:05	69 49.6	N	123 37.85	W	Hydrobios out	78.8
		15:30	69 49.6	N	123 37.85	W	Rosette in	78.5
		15:54	69 49.6	N	123 37.85	W	Rosette out	78.5
		18:55	69 49.6	N	123 37.85	W	Rosette in	78.8
		19:07	69 49.6	N	123 37.85	W	Rosette out	78.8
8-Jun-08	F-7	8:05	69 49.6	N	123 37.85	W	Rosette in	78.7
		8:15	69 49.6	N	123 37.85	W	Rosette out	78.7
		8:43	69 49.6	N	123 37.85	W	Tucker net #1 in	78
		8:48	69 49.6	N	123 37.85	W	Tucker net #2 out	78
		9:00	69 49.6	N	123 37.85	W	Tucker net #2 in	78
		9:10	69 49.6	N	123 37.85	W	Tucker net #2 out	78
		9:15	69 49.6	N	123 37.85	W	Tucker net #3 in	78
		9:25	69 49.6	N	123 37.85	W	Tucker net #3 out	78
		9:34	69 49.6	N	123 37.85	W	Tucker net #4 in	78
		9:42	69 49.6	N	123 37.85	W	Tucker net #4 out	78
		10:58	69 49.6	N	123 37.85	W	Rosette in	78
		11:24	69 49.6	N	123 37.85	W	Rosette out	78
		15:31	69 49.6	N	123 37.85	W	Rosette in	78.5
		15:49	69 49.6	N	123 37.85	W	Rosette out	78.4
		19:05	69 49.6	N	123 37.85	W	Rosette in	78.7
		19:17	69 49.6	N	123 37.85	W	Rosette out	78.7
9-Jun-08	F-7	7:11	69 49.6	N	123 37.85	W	Rosette in	78.3
		7:32	69 49.6	N	123 37.85	W	Rosette out	78.4
		9:30	69 49.6	N	123 37.85	W	Tucker net #1 in	78.4
		9:46	69 49.6	N	123 37.85	W	Tucker net #1 out	78.4
		9:56	69 49.6	N	123 37.85	W	Tucker net #2 in	78.4
		10:03	69 49.6	N	123 37.85	W	Tucker net #2 out	78.7
		10:18	69 49.6	N	123 37.85	W	Ring net in	78.7
		10:28	69 49.6	N	123 37.85	W	Ring net out	78.8
		11:00	69 49.6	N	123 37.85	W	Rosette in	78.8
		11:18	69 49.6	N	123 37.85	W	Rosette out	78.9
		14:22	69 49.6	N	123 37.85	W	tucker net #1 in	79
		14:31	69 49.6	N	123 37.85	W	Tucker net #1 out	79
		14:35	69 49.6	N	123 37.85	W	Tucker net #2 in	79
		14:42	69 49.6	N	123 37.85	W	Tucker net #2 out	79
		15:30	69 49.6	N	123 37.85	W	Rosette in	79
		15:49	69 49.6	N	123 37.85	W	Rosette out	79
		19:10	69 49.6	N	123 37.85	W	Rosette in	79
		19:40	69 49.6	N	123 37.85	W	Rosette out	79
10-Jun-08	405 B	6:43	70 39.654	N	123 01.521	W	Rosette in	554
		7:35	70 39.732	N	123 02.558	W	Rosette out	572
		7:45	70 39.752	N	123 02.718	W	Sediment Traps start	569
		8:25	70 39.84	N	123 02.86	W	Sediment Traps end	558

		8:40	70 39.8	N	123 01.76	W	PNF in	555
		8:49	70 39.7	N	123 01.9	W	PNF out	565
		8:50	70 39.7	N	123 01.9	W	secchi in	567
		8:55	70 39.7	N	123 02	W	secchi out	579
		8:58	70 39.6	N	123 02.1	W	Cage start	574
		9:26	70 39.5	N	123 02.6	W	Cage end	580
		9:51	70 39.7	N	122 59.7	W	Hydrobios in	571
		10:26	70 39.6	N	122 58.8	W	Hydrobios out	582
		10:55	70 39.5	N	122 59.8	W	Rosette in	589
		11:54	70 39.34	N	123 00.08	W	Rosette out	594
		12:05	70 39.32	N	123 00.38	W	Tucker net in	595
		12:19	70 39.22	N	123 00.06	W	Tucker net out	599
		12:42	70 39.28	N	123 00.75	W	Monster net in	615
		13:17	70 39.30	N	123 01.19	W	Monster net out	613
		13:48	70 39.85	N	123 00.05	W	Rosette in	562
		15:03	70 39.67	N	123 00.49	W	Rosette out	581
		15:56	70 39.747	N	123 01.519	W	Rosette in	568
		16:47	70 39.973	N	123 01.259	W	Rosette out	550
		17:08	70 39.535	N	123 02.674	W	Thorium pumping in	584
		18:31	70 40.564	N	123 02.130	W	Thorium pumping out	543
		20:00	71 41.24	N	123 07.69	W	Sediment trap start	462
		20:18	70 41.31	N	123 07.89	W	Sediment traps end	482
		21:03	70 39.7	N	123 00.4	W	Box Core in	570
		21:11	70 39.8	N	123 00.5	W	Box Core at the bottom	563
		21:23	70 39.8	N	123 00.6	W	Box Core out	563
		22:11	70 40.0	N	123 00.6	W	Box Core in	546
		22:18	70 40	N	123 00.6	W	Box Core at the bottom	546
		22:28	70 40	N	123 00.6	W	Box Core out	546
11-Jun-08	F-7	7:20	69 49.45	N	123 37.97	W	Rosette in	78.3
		7:37	69 49.45	N	123 37.97	W	Rosette out	78.3
		9:02	69 49.45	N	123 37.97	W	Tucker net #1 in	78.3
		9:15	69 49.45	N	123 37.97	W	Tucker net #1 out	78.3
		9:28	69 49.45	N	123 37.97	W	Tucker net #2 in	78.3
		9:36	69 49.45	N	123 37.97	W	Tucker net #2 out	78.3
		9:45	69 49.45	N	123 37.97	W	Tucker net #3 in	78.3
		9:54	69 49.45	N	123 37.97	W	Tucker met #3 out	78.3
		10:04	69 49.45	N	123 37.97	W	Tucker net #4 in	78.3
		10:15	69 49.45	N	123 37.97	W	Tucker net #4 out	78.3
		10:19	69 49.45	N	123 37.97	W	Tucker net #5 in	78.3
		10:27	69 49.45	N	123 37.97	W	Tucker net #5 out	78.3
		11:00	69 49.45	N	123 37.97	W	Rosette in	78.3
		11:19	69 49.45	N	123 37.97	W	Rosette out	78.3
		15:32	69 49.45	N	123 37.97	W	Rosette in	78.5
		15:50	69 49.45	N	123 37.97	W	Rosette out	78.5
		19:17	69 49.45	N	123 37.97	W	Rosette in	78.2
		19:30	69 49.45	N	123 37.97	W	Rosette out	78.2
12-Jun-08	F-7	7:04	69 49.45	N	123 37.97	W	Rosette in	78.4
		7:20	69 49.45	N	123 37.97	W	Rosette out	78.4
		8:07	69 49.45	N	123 37.97	W	Tucker net #1 in	78.5
		8:19	69 49.45	N	123 37.97	W	Tucker net #1 out	78.5
		8:25	69 49.45	N	123 37.97	W	Tucker net #2 in	78.5
		8:35	69 49.45	N	123 37.97	W	Tucker net #2 out	78.4
		8:42	69 49.45	N	123 37.97	W	Tucker net #3 in	78.4
		8:49	69 49.45	N	123 37.97	W	Tucker net #3 out	78.4
		9:18	69 49.45	N	123 37.97	W	Hydrobios in	78.5
		9:28	69 49.45	N	123 37.97	W	Hydrobios out	78.5

		9:46	69 49.45	N	123 37.97	W	Rosette in	78.5
		10:00	69 49.45	N	123 37.97	W	Rosette out	78.5
		10:35	69 49.45	N	123 37.97	W	Rosette in	79
		10:55	69 49.45	N	123 37.97	W	Rosette out	79
		11:31	69 49.45	N	123 37.97	W	Rosette in	79.1
		11:45	69 49.45	N	123 37.97	W	Rosette out	79.1
		12:35	69 49.45	N	123 37.97	W	Rosette in	79.1
		12:51	69 49.45	N	123 37.97	W	Rosette out	79.1
		13:35	69 49.45	N	123 37.97	W	Rosette in	79.2
		13:58	69 49.45	N	123 37.97	W	Rosette out	79.2
		14:40	69 49.45	N	123 37.97	W	Rosette in	79.2
		14:52	69 49.45	N	123 37.97	W	Rosette out	79.2
		15:37	69 49.45	N	123 37.97	W	Rosette in	79.2
		15:50	69 49.45	N	123 37.97	W	Rosette out	79.2
		16:34	69 49.45	N	123 37.97	W	Rosette in	79.1
		16:50	69 49.45	N	123 37.97	W	Rosette out	79.1
		17:30	69 49.45	N	123 37.97	W	Rosette in	79.1
		17:46	69 49.45	N	123 37.97	W	Rosette out	79.1
		18:40	69 49.45	N	123 37.97	W	Rosette in	79
		18:45	69 49.45	N	123 37.97	W	Rosette out	79
		19:30	69 49.45	N	123 37.97	W	Rosette in	79
		19:45	69 49.45	N	123 37.97	W	Rosette out	78.9
		20:36	69 49.45	N	123 37.97	W	Rosette in	78.9
		20:48	69 49.45	N	123 37.97	W	Rosette out	79
		21:33	69 49.45	N	123 37.97	W	Rosette in	78.9
		21:53	69 49.45	N	123 37.97	W	Rosette out	78.9
13-Jun-08	F-7	7:02	69 49.45	N	123 37.97	W	Rosette in	79
		7:20	69 49.45	N	123 37.97	W	Rosette out	78.9
		9:10	69 49.45	N	123 37.97	W	Tucker net #1 in	78.9
		9:18	69 49.45	N	123 37.97	W	Tucker net #1 out	78.9
		9:30	69 49.45	N	123 37.97	W	Tucker net #2 in	78.9
		9:40	69 49.45	N	123 37.97	W	Tucker net #2 out	78.9
		9:54	69 49.45	N	123 37.97	W	Tucker net #3 in	78.9
		10:01	69 49.45	N	123 37.97	W	Tucker net #3 out	78.9
		11:00	69 49.45	N	123 37.97	W	Rosette in	78.9
		11:18	69 49.45	N	123 37.97	W	Rosette out	78.9
		15:23	69 49.45	N	123 37.97	W	Rosette in	78.9
		15:35	69 49.45	N	123 37.97	W	Rosette out	78.9
		19:07	69 49.45	N	123 37.97	W	Rosette in	78.7
		19:20	69 49.45	N	123 37.97	W	Rosette out	78.8
14-Jun-08	1116	8:43	70 02.5	N	126 16.6	W	Box Core In	230
		8:46	70 02.5	N	126 16.6	W	Box Core at the bottom	230
		8:50	70 02.5	N	126 16.6	W	Box Core out	230
	FB-01	14:09	69 59.07	N	125 51.37	W	PNF + UV in	100
		14:50	69 59.2	N	125 51.14	W	PNF + UV out	99
		14:52	69 59.22	N	125 51.1	W	Rosette in	98
		15:20	69 59.31	N	125 50.93	W	Rosette out	96
		15:23	69 59.33	N	125 50.92	W	AC-9 in	94
		15:34	69 59.36	N	125 50.86	W	AC-9 out	96
		15:52	69 59.07	N	125 51.51	W	Tucker net in	102
		16:04	69 58.963	N	125 51.057	W	Tucker net out	98
		16:15	69 58.963	N	125 51.080	W	Monster net in	98
		16:27	69 58.984	N	125 51.107	W	Monster net out	98
		16:43	69 59.026	N	125 51.159	W	Rosette in	95
		17:03	69 59.079	N	125 51.202	W	Rosette out	96
		17:16	69 59.137	N	125 51.231	W	MVP in	96
		17:54	69 59.26	N	125 51.36	W	MVP out	97

	FB-02	18:30	69 58.504	N	125 51.852	W	MVP in	98
		18:43	69 58.497	N	125 51.954	W	MVP out	99
	FB-03	19:00	69 57.998	N	125 52.031	W	MVP in	98
		19:15	69 58.07	N	125 52.04	W	MVP out	99
		19:37	69 58.077	N	125 52.191	W	Rosette in	100
		20:05	69 58.137	N	125 52.230	W	Rosette out	101
		21:02	69 58.315	N	125 52.173	W	Rosette in	100
		21:23	69 58.3	N	125 52.2	W	Rosette out	99
15-Jun-08		6:56	69 58.033	N	125 51.880	W	Monster net in	100
		7:05	69 58.025	N	125 51.854	W	Monster net out	97
		7:27	69 58.067	N	125 51.860	W	MVP in	97
		7:37	69 58.077	N	125 51.887	W	MVP out	97
	FB-04	10:15	69 57.661	N	125 52.289	W	Rosette in	101
		10:25	69 57.662	N	125 52.289	W	Rosette out	101
	FB-05	11:05	69 57.4	N	125 52.5	W	Rosette in	106
		11:40	69 57.4	N	125 52.5	W	Rosette out	103
		12:58	69 57.38	N	125 52.5	W	Tucker net #1 in	103
		13:08	69 57.38	N	125 52.5	W	Tucker net #1 out	103
		13:19	69 57.38	N	125 52.5	W	Tucker net #2 in	104
		13:32	69 57.38	N	125 52.5	W	Tucker net #2 out	104
		13:37	69 57.38	N	125 52.5	W	Tucker net #3 in	104
		13:49	69 57.38	N	125 52.5	W	Tucker net #3 out	104
		14:10	69 57.38	N	125 52.5	W	Rosette in	104
		14:36	69 57.38	N	125 52.5	W	Rosette out	104
	FB-06	16:45	69 59.25	N	126 04.8	W	Thorium pumping in	205
		17:57	70 00.155	N	126 03.484	W	Thorium pumping out	208
		18:37	39 58.836	N	126 05.295	W	Hydrobios in	204
		18:54	69 58.976	N	126 04.988	W	Hydrobios out	204
		19:22	69 58.986	N	126 05.138	W	Rosette in	204
		19:48	69 59.126	N	126 05.007	W	Rosette out	205
16-Jun-08	FB-00	14:21	70 00.65	N	125 49.55	W	Rosette in	87
		14:52	70 00.62	N	125 45.99	W	Rosette out	91
		15:03	70 00.66	N	125 50.09	W	Monster net in	91
		15:10	70 00.67	N	125 50.11	W	Monster out out	91
		15:12	70 00.66	N	125 50.19	W	Filet Tom in	92
		15:18	70 00.66	N	125 50.19	W	Filet Tom out	92
		15:32	70 00.59	N	125 50.26	W	RMT in	93
		15:51	70 00.54	N	125 50.10	W	RMT out	94
		16:13	70 00.56	N	125 50.48	W	MVP in	94
		16:16	70 00.25	N	125 50.77	W	MVP out	96
		16:28	70 00.12	N	125 50.79	W	MVP in	98
		16:39	70 00.96	N	125 50.72	W	MVP out	98
		16:45	69 59.32	N	125 50.85	W	MVP in	94
		16:58	69 58.89	N	125 51.34	W	MVP out	98
		17:02	69 58.85	N	125 51.44	W	MVP in	96
		17:09	69 58.76	N	125 51.75	W	MVP out	98
	FB-03	18:56	69 58.08	N	125 51.71	W	Box Core in	97
		19:00	69 58.084	N	125 51.73	W	Box Core out	100
		19:24	69 58.30	N	125 51.41	W	Agassiz in	97
		19:47	69 58.64	N	125 51.39	W	Agassiz out	99
17-Jun-08	HR-1	6:15	69 56.460	N	126 41.7	W	Rosette in / Lawas	106
		7:05	69 56.86	N	126 41.77	W	Rosette out	111
		7:15	69 56.35	N	126 41.78	W	Monster net in	105
		7:26	69 56.46	N	126 41.68	W	Monster net out	106
		8:00	69 56	N	121 41	W	MVP in	111
		8:15	69 56.7	N	126 41.8	W	MVP out	110
		9:07	69 56.4	N	126 42.0	W	Rosette in	103
		9:34	69 56.5	N	126 42.1	W	Rosette out	105

		10:09	69 56.1	N	126 39.6	W	RMT in	126
		10:36	69 56.4	N	126 39.3	W	RMT out	133
		11:33	69 58.4	N	126 37.4	W	RMT in	166
		12:01	69 58.6	N	126 37.2	W	RMT out	156
18-Jun-08	F-7	6:26	69 50.31	N	123 40.80	W	RMT in	103
		6:51	69 50.27	N	123 42.52	W	RMT out	103
		9:02	69 48.9	N	123 39.0	W	Rosette in	79
		9:30	69 48.9	N	123 39.0	W	Rosette out	75
		10:20	69 48.9	N	123 39.0	W	Tucker net #1 in	75
		10:31	69 48.9	N	123 39.0	W	Tucker net #1 out	75
		10:38	69 48.9	N	123 39.0	W	Ring net in	75
		10:43	69 48.9	N	123 39.0	W	Ring net out	75
		11:03	69 48.9	N	123 39.0	W	Rosette in	75
		11:25	69 48.9	N	123 39.0	W	Rosette out	75
		14:08	69 48.9	N	123 39.0	W	Tucker net #1 in	76
		14:20	69 48.9	N	123 39.0	W	Tucker net #1 out	76
		14:27	69 48.9	N	123 39.0	W	Tucker net #2 in	76
		14:40	69 48.9	N	123 39.0	W	Tucker net #2 out	76
		15:01	69 48.9	N	123 39.0	W	Rosette in	76
		15:13	69 48.9	N	123 39.0	W	Rosette out	76
		18:50	69 48.9	N	123 39.0	W	Rosette in	75
		19:05	69 48.9	N	123 39.0	W	Rosette out	75
19-Jun-08	F-7	8:09	69 48.55	N	123 36.92	W	Rosette in	119
		8:31	69 48.56	N	123 36.74	W	Rosette out	121
		9:39	69 48.46	N	123 36.26	W	Tucker net in	125
		9:53	69 48.44	N	123 36.19	W	Tucker net out	124
		12:35	69 48.35	N	123 35.89	W	Rosette in	125
		13:13	69 48.35	N	123 35.89	W	Rosette out	124
	DB-01	15:02	69 49.73	N	123 36.63	W	Rosette in	91
		15:15	69 49.67	N	123 36.46	W	Rosette out	90
		15:36	69 49.61	N	123 36.27	W	Box Core in	95
		15:38	69 49.61	N	123 36.25	W	Box Core at the BOttom	95
		15:42	69 49.60	N	123 36.19	W	Box Core out	96
		16:30	69 49.47	N	123 34.83	W	Tucker net in	124
		16:48	69 49.56	N	123 34.95	W	Tucker net out	121
		17:05	69 49.56	N	123 34.80	W	Monster net in	122
		17:13	69 49.52	N	123 34.79	W	Monster net out	123
20-Jun-08	FB-07	9:00	69 56.72	N	125 53.36	W	Tucker net #1 in	108
		9:23	69 56.7	N	125 53.3	W	Tucker net #1 out	111
		9:30	69 56.7	N	125 53.3	W	Tucker net #2 in	111
		9:43	69 56.7	N	125 53.3	W	Tucker net #2 out	111
		9:50	69 56.7	N	125 53.3	W	Tucker net #3 in	111
		10:03	69 56.7	N	125 53.3	W	Tucker net #3 out	111
		10:21	69 56.7	N	125 53.3	W	Hydrobios in	111
		10:36	69 56.7	N	125 53.3	W	Hydrobios out	111
		11:04	69 56.7	N	125 53.3	W	Rosette in	111
		11:18	69 56.7	N	125 53.3	W	Rosette out	111
		15:49	69 56.7	N	125 53.3	W	Rosette in	108
		16:02	69 56.7	N	125 53.3	W	Rosette out	108
		19:05	69 56.7	N	125 53.3	W	Rosette in	108
		19:20	69 56.7	N	125 53.3	W	Rosette out	108
21-Jun-08	FB-07	7:04	69 56.8	N	125 53.46	W	Rosette in	109
		7:19	69 56.8	N	125 53.5	W	Rosette in	109
		9:05	69 57.03	N	125 53.66	W	Tucker net #1 in	110
		9:20	69 57.05	N	125 53.69	W	Tucker net #1 out	110
		9:29	69 57.08	N	125 53.73	W	Tucker net #2 in	111
		9:38	69 57.13	N	125 53.78	W	Tucker net #2 out	111

		9:53	69 57.15	N	125 53.80	W	Tucker net #3 in	111
		10:05	69 57.19	N	125 53.83	W	Tucker net #3 out	111
		10:14	69 57.22	N	125 53.86	W	Tucker net #4 in	111
		10:24	69 57.27	N	125 53.89	W	Tucker net #4 out	111
		10:36	69 57.30	N	125 53.92	W	Ring net in	111
		10:49	69 57.37	N	125 53.98	W	Ring net out	111
		11:10	69 57.46	N	125 54.04	W	Rosette in	112
		11:42	69 57.60	N	125 54.15	W	Rosette out	112
		15:39	69 58.7	N	125 55.4	W	Rosette in	121
		15:49	69 58.76	N	125 55.5	W	Rosette out	143
		18:46	69 59.7	N	125 57.2	W	Rosette in	142
		19:01	69 59.88	N	125 57.4	W	Rosette out	143
no station		21:42	70 06.32	N	125 32.79	W	POP recovery	100
		21:50	70 06.39	N	125 32.97	W	End POP recovery	140
23-Jun-08	1216	7:15	70 36.871	N	127 35.91	W	Rosette in	162
		7:27	70 36.801	N	126 36.12	W	Rosette out	158
		8:25	70 37.3	N	127 35.9	W	Sediment trap start	175
		9:00	70 37.2	N	127 35.8	W	Sediment trap end	173
		9:05	70 37.33	N	127 35.4	W	Lawas	179
		9:19	70 36.7	N	127 34.6	W	Rosette in	177
		9:54	70 36.4	N	127 34.5	W	Rosette out	172
		9:52	70 36.4	N	127 34.5	W	Secchi in	172
		9:56	70 36.4	N	127 34.5	W	Secchi out	172
		10:04	70 36.6	N	127 34.5	W	PNF in	174
		10:18	70 36.5	N	127 34.7	W	PNF out	172
		10:18	70 36.6	N	127 34.5	W	UV profile in	174
		10:42	70 36.2	N	127 34.6	W	UV profile out	165
		11:00	70 36.9	N	127 35.2	W	Monster net in	173
		11:10	70 36.9	N	127 35.2	W	Monster net out	172
		11:26	70 36.9	N	127 35.2	W	Small nets	169
		11:44	70 36.7	N	127 35.3	W	Rosette in	168
		12:20	70 36.49	N	127 35.88	W	Rosette out	155
		12:38	70 37.08	N	127 34.97	W	Tucker net in	178
		12:45	70 37.02	N	127 35.20	W	Tucker net out	174
		13:49	70 36.94	N	127 36.15	W	Rosette in	161
		14:10	70 36.85	N	127 36.52	W	Rosette out	155
		14:32	70 36.88	N	127 36.89	W	Box Core in	151
		14:37	70 36.89	N	127 36.95	W	Box Core at the BOttom	151
		15:44	70 36.63	N	127 25.13	W	Hydrobios in	233
		16:02	70 36.54	N	127 25.23	W	Hydrobios out	233
		16:40	70 36.46	N	127 25.81	W	RMT in	232
		17:00	70 36.07	N	127 26.89	W	RMT out	224
		17:30	70 35.90	N	127 27.12	W	Thorium pump in	222
		18:58	70 35.97	N	127 26.45	W	Thorium pump out	227
		19:19	70 35.88	N	127 26.58	W	Rosette in	225
		19:52	70 35.68	N	127 26.82	W	Rosette out	222
		20:51	70 33.03	N	127 31.96	W	Sediment Traps out	110
		22:25	70 43.2	N	128 09.8	W	MVP in	42
24-Jun-08		3:46	70 43.24	N	126 49.73	W	MVP out	296
	F-7	12:53	69 49.34	N	123 38.94	W	Lawas	81
		12:50	69 49.36	N	123 38.96	W	Rosette in	81
		13:12	69 49.24	N	123 39.34	W	Rosette out	85
		13:15	69 49.22	N	123 39.52	W	Secchi in	85
		13:18	69 49.22	N	123 39.56	W	Secchi out	85
		13:18	69 49.22	N	123 39.56	W	PNF-UV profile in	85
		13:27	69 49.19	N	123 39.81	W	PNF-UV profile out	86
		13:54	69 49.30	N	123 40.24	W	Monster net in	85

		14:05	69 49.36	N	123 40.63	W	Monster net out	84
		14:10	69 49.36	N	123 40.86	W	Ring net in	85
		14:18	69 49.38	N	123 40.94	W	Ring net out	86
		14:22	69 49.37	N	123 41.40	W	Ring net in	86
		14:26	69 49.37	N	123 41.46	W	Ring net out	86
		14:27	69 49.38	N	123 41.58	W	Ring net in	85
		14:30	69 49.37	N	123 41.82	W	Ring net out	86
		14:40	69 49.49	N	123 42.64	W	Surface bucket in	69
		14:47	69 49.63	N	123 43.21	W	Surface Bucket out	67
		15:27	69 49.32	N	123 39.56	W	Rosette in	90
		15:55	69 49.12	N	123 40.24	W	Rosette out	88
		16:14	69 48.92	N	123 40.93	W	Tucker net in	83
		16:28	69 48.53	N	123 42.82	W	Tucker net out	58
		17:23	69 49.54	N	123 37.93	W	Agassiz in	83
		17:42	69 50.02	N	123 37.27	W	Agassiz out	84
		18:05	69 49.24	N	123 38.56	W	CO2 Flux start	72
		19:30	69 51.09	N	123 34.10	W	CO2 Flux end	109
		19:30	69 50.97	N	123 34.42	W	MVP in	116
		19:30	69 51.09	N	123 34.10	W	Lawas	109
		21:53	70 03.0	N	123 27.6	W	MVP out	143
25-Jun-08	FB-7	6:02	69 57.06	N	125 52.11	W	Secchi in	101
		6:05	69 57.06	N	125 52.11	W	Secchi out	101
		6:15	69 57.12	N	125 52.29	W	PNF-UV profile in	101
		6:50	69 57.254	N	125 52.87	W	PNF-UV profile out	105
		7:00	69 57.28	N	125 53.10	W	Rosette in / Lawas	106
		7:33	69 57.32	N	125 53.34	W	Rosette out	108
		7:40	69 57.32	N	125 53.31	W	Monster net in	108
		7:55	69 57.3	N	125 53.1	W	Monster net out	110
		8:00	69 57.3	N	125 53.1	W	Small nets	110
		9:05	69 56.5	N	125 53.7	W	Tucker net in	113
		9:15	69 56.3	N	125 54.5	W	Tucker net out	122
		9:35	69 56.8	N	125 53.4	W	Rosette in	111
		10:05	69 56.6	N	125 53.7	W	Rosette out	110
		10:30	69 57.2	N	125 52.0	W	lawas	101
26-Jun-08	FB-7	19:38	70 24.1	N	125 13.49	W	rosette in	276
		19:57	70 24.2	N	126 13.8	W	rosette out	275
27-Jun-08	1216-1214	0:11	70 42.48	N	127 25.51	W	MVP in	200
		0:16	70 42.30	N	127 24.9	W	MVP out	210
27-Jun-08	1216-1214	0:37	70 44.1	N	127 18.39	W	MVP in	219
		0:42	70 44.09	N	127 18.43	W	MVP out	202
27-Jun-08	1214-1212	1:14	70 46.37	N	127 10.23	W	MVP in	232
		1:20	70 46.34	N	127 10.24	W	MVP out	231
27-Jun-08	1214-1212	2:06	70 49.89	N	127 08.78	W	MVP in	232
		2:11	70 49.86	N	127 08.76	W	MVP out	232
		2:43	70 51.16	N	126 58.33	W	MVP in	260
		2:47	70 51.09	N	126 58.34	W	MVP out	258
27-Jun-08	1212-1210	3:07	70 51.94	N	126 51.13	W	MVP in	279
	1200	11:03	71 32.6	N	124 21.0	W	MVP out	205
		11:15	71 32.3	N	124 21.3	W	LAWAS in	205
		11:54	71 31.92	N	124 20.13	W	Sedimant traps in	204
		12:49	71 32.75	N	124 20.48	W	rosette in	207
		13:43	71 32.38	N	124 19.82	W	rosette out	207
		14:50	71 32.8	N	124 20.41	W	secchi disk	208

		14:52	71 32.79	N	124 20.4	W	secchi out	208
		14:56	71 32.79	N	124 20.37	W	PNF in	207
		15:05	71 32.78	N	124 20.30	W	PNF out	207
		15:36	71 32.73	N	124 20.02	W	UV profile in. Molly (cage)	208
		16:07	71 32.69	N	124 19.77	W	UV profile out	207
		16:45	71 32.65	N	124 19.45	W	Monster net in	207
		17:00	71 32.56	N	124 19.63	W	Monster net out	207
		17:05	71 32.53	N	124 19.61	W	Phto in	206
		17:15	71 32.5	N	124 19.79	W	Phto out	207
27-Jun-08	1200	17:17	71 32.5	N	124 19.79	W	Filet micron in	207
		17:19	71 32.5	N	124 19.8	W	Filet micron out	207
		17:48	71 32.43	N	124 19.8	W	rosette in	207
		18:20	71 32.37	N	124 19.46	W	rosette out	205
		18:35	71 32.26	N	124 19.04	W	tucker in	206
		18:44	71 32.42	N	124 18.62	W	tucker out	207
		20:15	71 32.8	N	124 20.4	W	rosette in	207
		20:57	71 32.7	N	124 20.05	W	rosette out	207
		21:35	71 32.6	N	124 19.5	W	Agassiz in	207
		21:50	71 32.6	N	124 20.3	W	Agassiz out	207
		22:21	71 31.9	N	124 17.8	W	Box core in	207
		22:27	71 31.9	N	124 17.7	W	box core out	207
28-Jun-08	1200	0:40	71 32.79	N	124 20.49	W	rosette in	208
		1:10	71 32.73	N	124 20.08	W	rosette out	207
		1:53	71 32.72	N	124 20.30	W	hydrobios in	207
		2:12	71 32.65	N	124 32.65	W	hydrobios out	207
		2:37	71 32.62	N	124 19.43	W	RMT in	207
		2:50	71 32.61	N	124 19.95	W	RMT out	207
		3:36	71 27.99	N	124 18.00	W	rosette in	207
		03.50	71 27.88	N	124 18.06	W	rosette out	207
		4:07	71 27 07	N	124 18.49	W	recover sediment traps (start)	208
		4:24	71 27.68	N	124 18.57	W	recover sediment traps (end)	214
28-Jun-08	1204	7:37	71 18 29	N	125 11.73	W	rosette in	312
		8:52	71 18.3	N	125 10.6	W	rosette out	305
28-Jun-08	1208	11:15	71 04.3	N	126 04.6	W	Lawas in	402
		11:15	71 04.3	N	126 04.6	W	Mhas	402
		11:30	71 04.4	N	126 04.8	W	sediment traps in	410
		11:44	71 03.97	N	126 03.4	W	Mukesh's buoy in	392
		12:00	71 03.86	N	126 02.91	W	rosette in	398
		12:53	71 03.94	N	126 03.46	W	rosette out	391
		13:20	71 03.91	N	126 03.13	W	secchi in	400
		13:25	71 03.82	N	126 03.21	W	secchi oit	400
		13:27	71 03.93	N	126 03.23	W	PNF in	400
		13:34	71 03.94	N	126 03.34	W	PNF out	400
		13:45	71 03.97	N	126 03.51	W	UV profile in	390
		14:10	71 04.05	N	126 04.01	W	UV profile out	392
		14:57	71 03.84	N	126 02.66	W	hydrobios in	407
		15:24	71 03.81	N	126 02.96	W	hydrobios out	396
		16:20	71 03.87	N	126 04.11	W	rosette in	397
		17:07	71 03.89	N	126 05.23	W	rosette out	406
28-Jun-08	1208	17:30	71 03.94	N	126 05.83	W	monster in	403
		17:55	71 04.04	N	126 06.67	W	Monster out	394
		17:56	71 04.06	N	126 06.79	W	phyto net	394
		18:09	71 04.05	N	126 07.23	W	phyto net	397
		19:32	71 03.82	N	126 03.82	W	rosette 3 in	398
		20:13	71.03.7	N	126 04.8	W	rosette 3 out	394

		20:25	71 03.7	N	126 05.6	W	tucker in	396
		20:35	71 03.5	N	126 05.9	W	tucker out	396
		20:55	71 03.6	N	126 06.5	W	RMT in	392
		21:07	71 03.8	N	126 07.0	W	RMT out	394
		21:55	71 03.9	N	126 02.9	W	rosette 4 in	400
		22:25	71 03.8	N	126 03.6	W	rosette 4 out	400
28-Jun-08	1208	21:45	71 03.8	N	126 02.9	W	lawas test	400
		23:00	71 03.9	N	126 03.0	W	thorium pumping start	400
29-Jun-08	1208	0:24	71 04.11	N	126 04.47	W	thorium pumping end	408
		0:39	71 04.07	N	126 04.15	W	rosette 5 in	396
		1:11	71 04.06	N	126 04.87	W	rosette 5 out	400
		2:10	71 03.79	N	126 11.12	W	agassiz trawl in	401
		2:40	71 03 92	N	126 09.27	W	agassiz trawl out	400
		4:08	71 05.24	N	126 16.56	W	recover sediment traps start	400
		4:28	71 05.33	N	126 16.95	W	recover sediment traps end	399
29-Jun-08	1212	7:17	70 49.28	N	126 54.27	W	rosette in	274
		8:10	70 49.2	N	126 55.5	W	rosette out	275
	426	20:10	70 59.0	N	133.45	W	rosette stn 426 in	103
		20:40	70 58.9	N	133 45.6	W	rosette out	107
	427	21:35	70 52.8	N	133 43.0	W	CTD stn 427 in	79
		21:45	70 52.8	N	133 43.0	W	CTD out	79
	428	22:33	70 47.4	N	133 41.6	W	rosette stn 428 in	73
		22:56	70 47.4	N	133 41.5	W	rosette out	73
	429	23:47	70.41.8	N	133 40.3	W	CTD stn 429 in	67
		23:54	70 41.68	N	133 40.31	W	CTD out	67
30-Jun-08	430	0:45	70 36.13	N	133 39.14	W	rosette stn 430 in	70
		1:06	70 36.09	N	133 39.1	W	rosette out	70
	431	2:00	70 29.57	N	133 37.66	W	CTD in	67
		2:09	70 29.56	N	133 37.59	W	CTD out	66
	432	2:57	70 24.49	N	133 36.42	W	rosette in	62
		3:18	70 24.59	N	133 36.64	W	rosette out	62
	433	4:16	70 17:29	N	133 34.79	W	CTD in	54
		4:25	70 17.28	N	133 35.04	W	CTD out	54
	434	5:10	70 10.65	N	133 32.8	W	secchi in	45
		5:17	70 10.63	N	133 32.88	W	secchi out	45
		5:18	70 10.62	N	133 32.88	W	PNF/UV in	45
		5:30	70 10.59	N	133 32.99	W	PNF/UV out	45
		5:26	70 10.62	N	133 33.14	W	lawas out	39
		6:09	70 10.67	N	133 33.25	W	rosette in	40
		6:48	70 10.93	N	133 33.52	W	rosette out	40
		7:06	70 10.99	N	133 33.7	W	monster + small nets in	40
		7:12	70 11.04	N	133 33.92	W	monster + small nets out	40.4
		7:00	70 10.98	N	133 33.68	W	64 micron in	40
		7:03	70 10.98	N	133 33.68	W	64 micron out	40
		7:41	70 11.0	N	133 33.5	W	tucker in	40
		7:49	70 10.9	N	133 33.9	W	tucker out	40
		8:13	70 10.6	N	133 33.2	W	rosette 2 in	45
		8:36	70 10.7	N	133 33.1	W	rosette 2 out	45
		10:11	70 10.6	N	133 33.2	W	box core in	45
		10:14	70 10.6	N	133 32.2	W	box core au fond	45
		10:16	70 10.6	N	133 32.2	W	box core out	45
		9:52	70 10.6	N	133 33.2	W	EK 60 in	45
		11:10	70 10.7	N	133 33.1	W	agassiz in	45

		11:22	70 10.9	N	133 33.0	W	agassiz out	45
		11:05	70 10.8	N	133 33.1	W	echantillons surface	45
		16:45	71 10.5	N	133 49.0	W	rosette in	595
		17:58	71 49.7	N	133 49.8	W	rosette out	584
	423	18:35	71 16.3	N	133 50.9	W	rosette CTD in	802
		19:25	71 16.3	N	133 50.0	W	rosette CTD out	802
	422	20:15	71 22.4	N	133 52.7	W	rosette in	1080
		21:45	71 22.5	N	133 52.2	W	rosette out	1080
		21:50	71 22.5	N	133 52.2	W	lawas in	1080
	421	23:15	71 28.2	N	133 55.6	W	trappes sediments in	1184
		23:43	71 28.1	N	133 54.6	W	MOB in	1154
1-Jul-08	421	0:20	71 28.2	N	133 54.0	W	rosette in	1138
		1:25	71 27.9	N	133 54.1	W	rosette out	1080
		1:51	71 28.18	N	133 54.4	W	RMT in	1148
		2:03	71 27.9	N	133 53.8	W	RMT out	1123
		2:37	71 28.5	N	133 53.6	W	tucker in	1138
		2:51	71 28.4	N	133 53.8	W	tucker out	1136
		3:42	71 28.3	N	133 54.6	W	rosette in	1164
		5:10	71 28.5	N	133 55.0	W	rosette out	1164
		5:30	71 28.0	N	133 54.8	W	thorium pump in	1160
		7:26	71 28.7	N	133 47.2	W	thorium pump out	930
		7:45	71 28.1	N	133 54.4	W	secchi/PNF/UV in	1145
		8:15	71 28.2	N	133 54.7	W	secchi/PNF/UV out	1146
		9:13	71 28.1	N	133 54.7	W	rosette 3 in	1142
		10:17	71 28.3	N	133 54.4	W	rosette 3 out	1154
		10:50	71 28.1	N	133 55.3	W	monster net in	1180
		12:02	71 28.3	N	133 54.3	W	monster net out	1148
		12:12	71 28.3	N	133 54.3	W	net 64 microns in	1148
		12:15	71 28.3	N	133 54.3	W	net 64 microns out	1148
		12:29	71 28.3	N	133 54.2	W	rosette 4 in	1146
		13:40	71 28.03	N	133 53.8	W	rosette 4 out	1125
		13:53	71 27.9	N	133 53.8	W	hydrobios in	1123
		15:12	71 27.8	N	133 53.9	W	hydrobios out	1104
		15:47	71 27.4	N	133 54.5	W	rosette 5 in	1140
		16:38	71 27.64	N	133 54.78	W	rosette out	1168
		17:46	71 30.42	N	133 38.61	W	recover sed traps	1001
		18:10	71 30.59	N	133 38.49	W	trappes sediments out	1007
		19:30	71 22.01	N	133 51.14	W	lawas in	1051
		19:40	71 21.75	N	133 52.73	W	MVP in 5kn	1050
		21:20	71 14.1	N	133 50.7	W	lawas out	705
2-Jul-08	421	1:39	70 52.57	N	133 43.17	W	MPV out	80
	435	4:47	71 04.84	N	133 48.40	W	MOB in	315
		5:17	71 04.45	N	133 47.24	W	rosette in	299
		6:17	71 04.77	N	133 47.68	W	rosette out	310
		6:30	71 04.82	N	133 48.04	W	secchi/PNF/UV in	311
		6:45	71 04.96	N	133 48.58	W	secchi/PNF/UV out	319
		7:25	71 05.67	N	133 49.11	W	monster net in	337
		7:50	71 05.37	N	133 48.66	W	monster net out	337
		8:07	71 05.37	N	133 48.66	W	64 microns in	337
		8:09	71 05.37	N	133 48.66	W	64 microns out	337
		8:53	71 04.16	N	133 47.00	W	rosette 2 in	287
		9:44	71 04.29	N	133 47.21	W	rosette 2 out	294
		10:00	71 04.48	N	133 47.54	W	hydrobios in	300
		10:28	71 04.46	N	133 47.08	W	hydrobios out	300
		11:10	71 04.76	N	133 47.99	W	rosette 3 in	310
		11:50	71 05.02	N	133 47.92	W	rosette 3 out	310
		12:20	71 04.34	N	133 47.56	W	tucker in	295
		12:33	71 04.23	N	133 48.39	W	tucker out	295

		12:52	71 04.45	N	133 49.43	W	tucker in	307
		13:00	71 04.41	N	133 50.19	W	tucker out	309
		15:08	71 04.26	N	133 47.13	W	rosette in	289
		15:32	71 04.21	N	133 47.44	W	rosette out	290
		16:00	71 04.46	N	133 48.06	W	thorium pump in	301
		17:28	71 04.63	N	133 47.81	W	thorium pump out	300
		17:50	71 04.89	N	133 48.83	W	agassiz in	315
		18:30	71 04.22	N	133 51.97	W	agassiz montant	312
		18:35	71 04.21	N	133 52.31	W	agassiz out	312
		18:53	71 04.23	N	133 52.55	W	box core in	313
		19:04	71 04.30	N	133 52.58	W	box core out	318
3-Jul-08	1526	6:40	72 00.78	N	131 19.51	W	rosette in	1057
		7:53	72 00.54	N	131 19.17	W	rosette out	1051
	1525	11:00	72 09.27	N	129 45.76	W	rosette in	366
		11:52	72 09.40	N	129 45.66	W	rosette out	364
	6012	14:30	72 39.5	N	130 00.12	W	rosette in	1238
		16:07	72 38.68	N	130 01.116	W	rosette out	1215
	6010	17:26	72 39.68	N	129 26.31	W	CTD in	610
		17:56	72 39.53	N	129 26.23	W	CTD out	609
	6009	19:15	72 39.674	N	128 54.169	W	CTD in	293
		19:37	72 39.78	N	128 54.02	W	CTD out	294
3-Jul-08	Full 6006	21:05	72 39.78	N	128 22.07	W	Sediment traps in	224
		22:17	72 30.57	N	128 19.75	W	MOB in	217
		22:30	72 39.57	N	128 20.87	W	MHAS in	216
		22:33	72 39.56	N	128 20.86	W	rosette 1 in	216
		23:13	72 39.25	N	128 21.04	W	rosette 1 out	216
		23:46	72 39.57	N	128 21.15	W	monster net in	218
4-Jul-08		0:03	72 39.59	N	128 21.16	W	monster net out	221
		0:05	72 39.59	N	128 21.17	W	Ring net in	221
		0:18	72 39.56	N	128 21.24	W	Ring net out	223
		0:24	72 39.51	N	128 21.36	W	tucker in	222
		0:37	72 39.44	N	128 20.75	W	tucker out	218
		0:52	72 39.37	N	128 21.09	W	64 microns in	221
		0:55	72 39.34	N	128 21.13	W	64 microns out	221
		1:48	72 39.49	N	128 21.12	W	rosette 2 in	221
		2:34	72 39.27	N	128 21.46	W	rosette 2 out	225
		2:55	72 39.47	N	128 21.56	W	hydrobios in	222
		3:10	72 39.51	N	128 21.71	W	hydrobios out	222
		3:46	72 39.52	N	128 21.66	W	rosette 3 in	222
		4:13	72 39.5	N	128 39.55	W	rosette 3 out	224
		4:57	72.39.59	N	128 21.69	W	RMT in	224
		5:12	72 39.31	N	128 22.24	W	RMT out	225
4-Jul-08	Full 6006	6:02	72 39.61	N	128 20.78	W	secchi disk in	221
		6:05	72 39.67	N	128 20.84	W	secchi disk out	218
		6:07	72 39.68	N	128 20.86	W	PNF in	218
		6:11	72 39.68	N	128 20.91	W	PNF out	218
		6:17	72 39.68	N	128 21.04	W	UV cage in	219
		6:46	72 39.80	N	128 21.58	W	UV out	223
		7:03	72 39.48	N	128 21.66	W	Rosette in	222
		7:41	72 39.59	N	128 19.98	W	rosette out	220
		8:10	72 39.60	N	128 20.75	W	thorium pump in	220
		10:00	72 39.60	N	128 20.75	W	thorium pump out	220
		10:15	72 39.78	N	128 21.29	W	monster net in	220
		10:30	72 39.79	N	128 21.31	W	monster net out	220
		11:43	72 39.20	N	128 19.39	W	box core in	219
		11:48	72 39.2	N	128 19.39	W	box core au fond	219

		11:53	72 39.15	N	128 19.4	W	box core out	218
		13:05	72 39.35	N	128 20.76	W	trappes sediments out	221
		13:21	72 39.35	N	128 20.92	W	trappes a bord	221
4-Jul-08	6004	14:15	72 39.54	N	127 56.04	W	CTD in	157
		14:30	72 39.47	N	127 56.25	W	CTD out	164
	6002	15:21	72 39.55	N	127 30.42	W	rosette in	150
		15:54	72 39.51	N	127 30.79	W	rosette out	146
5-Jul-08	McLure W.	7:00	74 35.76	N	121 26.16	W	MVP west of McLure in	447
		15:58	75 37.73	N	120 28.62	W	MPV west of Mclure out	373
	2005	17:14	75 26.47	N	120 25.99	W	rosette in	417
		18:11	75 26.30	N	120 26.35	W	rosette out	417
	2010	20:00	75 07.34	N	120 26.28	W	MOB in	424
		20:22	75 07.65	N	120 23.84	W	rosette 1 out	421
		21:13	75 07.46	N	120 24.15	W	rosette 1 out	422
		20:55	75 07.55	N	120 24.10	W	lawas in	422
		21:00	75 07.55	N	120 24.10	W	MHAS in	422
		21:45	75 07.65	N	120 24.09	W	monster net in	421
		22:10	75 07.59	N	120 24.50	W	monster net out	422
		22:30	75 07.6	N	120 24.7	W	RMT	422
		22.45	75 07.24	N	120 24.0	W	RMT out	422
		23:25	75 07.67	N	120 23.8	W	rosette 2 oin	421
6-Jul-08	2010	0:15	75 07.47	N	120 23.53	W	rosette 2 out	420
		0:59	75 07.48	N	120 22.89	W	hydrobios in	418
		1:24	75 07.25	N	120 22.59	W	hydrobios out	416
		1:45	75 07.15	N	120 22.54	W	rosette 3 in	417
		2:20	75 07.12	N	120 22.18	W	rosette 3 out	417
		2:59	75 07.84	N	120 24.23	W	tucker in	423
		3:11	75 07.82	N	120 23.47	W	tucker out	421
		3:20	75 07.74	N	120 23.89	W	ring net in	422
		3:24	75 07.69	N	120 23.87	W	ring net out	422
		4:15	75 07.71	N	120 23.58	W	secchi/PNF/UV	421
		4:50	75 07.50	N	120 24.68	W	secchi/PNF/UV	421
		5:12	75 07.51	N	120 24.94	W	rosette in	423
		6:17	75 07.59	N	120 24.86	W	rosette out	423
		6:20	75 07.56	N	120 25.01	W	thorium pump in	422
		7:56	75 07.95	N	120 25.85	W	thorium pump out	430
		9:16	75 07.57	N	120 23.85	W	rosette 5 in	421
		10:00	75 07.45	N	120 24.35	W	rosete 5 out	420
		10:16	75 07.75	N	120 26.14	W	agassiz in	427
		11;10	75 06.65	N	120 24.43	W	agassiz out	420
		14:20	75 06.34	N	120 19.84	W	ice team in	420
		16:12	75 06.34	N	120 19.84	W	ice team out	420
		17:28	75 03.39	N	120 42.99	W	recupe buoy + MHAS	493
	2015	18:48	74 49.38	N	120 36.61	W	rosette in	495
		19:47	74 49.40	N	120 36.80	W	rosette out	495
		22:15	74 39.6	N	122 27.76	W	lawas in	416
7-Jul-08	9002	3:00	74 19.98	N	125 30.30	W	rosette in	288
		4:00	74 19.64	N	125 30.16	W	rosette out	274
		4:33	74 17.85	N	125 22.53	W	box core in	219
		4:40	74 17.86	N	125 22.46	W	box core out	219
8-Jul-08	410	1:54	71 42.3	N	126 30.40	W	trappes sediment in	400
		3:14	71 42.93	N	126 28.98	W	rosette 1 in	400
		4:05	71 42.03	N	126 29.29	W	rosette 1 out	410
		4:31	71 42.04	N	126 29.64	W	RMT in	413
		4:46	71 41.72	N	126 29.37	W	RMT out	4115
		5:04	71 41.69	N	126 29.41	W	tucker in	417

		5:17	71 41.36	N	126 29.62	W	tucker out	429
		6:48	71 42.11	N	126 29.60	W	rosette 2 in	410
		7:27	71 42.05	N	126 29.20	W	rosette 2 out	408
		8:13	71 41.96	N	126 29.18	W	hydrobios in	404
		8:40	71 41.96	N	126 29.18	W	hydrobios out	404
		9:20	71 41.71	N	126 29.49	W	MOB in	410
		9:21	71 41.71	N	126 29.49	W	surface + light profile	410
		9:25	71 41.68	N	126 29.68	W	rosette 3 in	423
		10:10	71 41.65	N	126 29.43	W	rosette 3 out	411
		10:50	71 42.05	N	126 29.37	W	monster net in	403
		10:20	71 41.65	N	126 29.43	W	MOB + light profile out	415
		11:13	71 42.11	N	126 29.27	W	monster net out	403
		11:15	71 42.11	N	126 29.27	W	20 microns	403
		11:42	71 41.98	N	126 29.43	W	secchi/ PNF/UV in	403
		12:15	71 42.12	N	126 29.37	W	secchi/PNF/UV out	400
		13:00	71 42.35	N	126 29.28	W	rosette 4 in	395
		13:53	71 42.46	N	126 28.88	W	rosette out	390
		14:14	71 42.52	N	126 28.74	W	thorium pump in	383
8-Jul-08	410	15:43	71 42.70	N	126 29.13	W	thorium pumps out	384
		16:07	71 42.701	N	126 29.826	W	Agassiz net in	398
		16:55	71 42.09	N	126 28.94	W	Agassiz out. nothing in it	404
		17:11	71 42.235	N	126 29.14	W	Box Core in. 17:20 bottom	402
		17:28	71 42.28	N	126 29.14	W	Box Core out	394
		18:01	71 42.53	N	126 29.04	W	Agassiz no2 in	388
		18:34	71 42.4	N	126 30.19	W	Agassiz out	407
		19:30	71 43.895	N	126 18.89	W	Sediment traps in	297
	411	21:00	71 37.79	N	126 42.58	W	Rosette stn 411 in	443
		21:25	71 37.78	N	126 42.41	W	Rosette out	440
		21:25	71 37.78	N	126 42.41	W	Lawas in	440
	412	22:19	71 33.81	N	126 55.37	W	Rosette in	413
		23:13	71 33.84	N	126 55.33	W	Rosette out	413
9-Jul-08	413	0:01	71 29.78	N	127 08.18	W	CTD rosette in	373
		0:18	71 29.77	N	127 08.37	W	CTD rosette out	373
	414	1:06	71 25.26	N	127 21.85	W	rosette in	305
		1:49	71 25.35	N	127 22.0	W	rosette out	305
	415	02.58	71 21.63	N	127 33.44	W	CTD rosette in	239
		3:12	71 21.62	N	127 33.66	W	CTD rosette out	239
	420	5:39	71 02.85	N	128 30.677	W	rosette 1 in	34
		6:00	71 03.13	N	128 31.067	W	rosette 1 out	34
		6:12	71 03.28	N	128 31.51	W	tucker in	35
		6:18	71 03.17	N	128 31.2	W	tucker out	36
		6:42	71 03.26	N	128 30.74	W	rosette in	34
		7:00	71 03.53	N	128 30.7	W	rosette out	37
		7:12	71 03.69	N	128 30.84	W	Monster net in	37
		7:17	71 03.75	N	128 30.91	W	Monster net out	37
		7:33	71 03.96	N	128 31.16	W	64 microns in	35
		7:40	71 04.021	N	128 31.1	W	64 microns out	35
		7:58	71 02.97	N	128 30.58	W	secchi/PNF/UV in	41
		8:25	71 03.09	N	128 31.2	W	secchi/PNF/UV out	39
		8:43	71 03.06	N	128 31.55	W	MOB/light profile/surface water	34
		9:01	71 03.04	N	128 30.64	W	rosette 2 in	43
		9:24	71 03.26	N	128 30.72	W	rosette 2 out	43
		9:40	71 03.59	N	128 31.10	W	MOB/light+surface out	43

		9:45	71 03.59	N	128 31.10	W	benne 1 in	43
		9:47	71 03.59	N	128 31.10	W	benne out	43
		9:53	71 03.60	N	128 31.13	W	benne 2	43
		10:10	71 03.60	N	128 31.13	W	benne 3	43
		10:30	71 03.03	N	128 30.65	W	hypersass in	43
		11:15	71 03.03	N	128 30.65	W	hypersass out	43
		11:33	71 04.33	N	128 26.25	W	lawas out	47
	419	12:35	71 06.31	N	128 20.89	W	CTD in	51
		12:44	71 06.32	N	128 21.14	W	CTD out	52
	418	13:56	71 09.73	N	128 10.18	W	rosette in	65
		14:17	71 10.00	N	128 10.45	W	rosette out	65
	417	15:26	71 13.34	N	127 58.49	W	CTD in	83
		15:38	71 13.42	N	127 58.44	W	CTD out	84
	416	16:52	71 17.75	N	127 46.21	W	sediment traps in	160
		17:13	71 17.86	N	127 46.50	W	sediment trap final deploy	160
		17:29	71 17.4	N	127 45.57	W	MHAS in	158
		18:38	71 17.65	N	127 45.92	W	rosette in	158
		19:17	71 17.80	N	127 45.79	W	rosette out	159
		19:30	71 17.83	N	127 45.65	W	RMT in	160
		19:48	71 17.64	N	127 44.47	W	RMT out	161
		20:10	71 17.38	N	127 45.73	W	tucker in	157
		20:21	71 17.38	N	127 45.73	W	tucker out	157
		21:46	71 17.44	N	127 45.45	W	rosette in	161
		22:27	71 17.32	N	127 45.00	W	rosette out	161
		23:15	71 17.36	N	127 45.50	W	monster in	157
		23:27	71 17.35	N	127 45.48	W	monster out	158
		23:10	71 17.36	N	127 45.50	W	lawas out	157
		23:48	71 17.30	N	127 45.41	W	rosette in	157
10-Jul-08	416	0:11	71 17.27	N	127.45.47	W	rosette out	158
		0:47	71 17.25	N	127 46.06	W	hydrobios in	154
		0:59	71 17.22	N	127 46.28	W	hydrobios out	155
		1:01	71 17.21	N	127 46.31	W	ring net in	154
		1:08	71 17.21	N	127 46.54	W	ring net out	153
		2:01	71 17.40	N	127 46.01	W	rosette 4 in	156
		2:20	71 17.35	N	127 46.21	W	rosette out	155
		2:47	71 17.38	N	127 47.57	W	thorium in	151
		4:21	71 17.91	N	127 48.65	W	thorium out	155
		4:45	71 17.96	N	127 49.44	W	secchi/PNF/UV in	152
		5:15	71 18.16	N	127 50.65	W	secchi/PNF/UV out	154
		5:46	71 17.06	N	127 45.05	W	rosette 4 in	155
		6:21	71 17.20	N	127 45.77	W	rosette out	155
		7:02	71 18.68	N	127 49.76	W	agassiz in	160
		7:28	71 18.61	N	127 49.07	W	agassiz out	159
		8:42	71 17.36	N	127 45.64	W	MOB/light+surface in	158
		9:03	71 17.36	N	127 45.64	W	box core in	158
		9:08	71 17.35	N	127 45.69	W	box core out	158
		9:43	71 17.35	N	127 45.69	W	MOB/light+surface out	158
		11:00	71 18.13	N	127 46.74	W	sediment trap out	160
		10:30	71 17.74	N	127 47.86	W	lawas in	160
		10:50	71 17.74	N	127 47.86	W	hypersass in	160
		11:05	71 17.74	N	127 47.86	W	MHAS out	160
		11:30	71 18.21	N	127 46.56	W	hypersass + lawas out	160
	1900	15:37	71 42.15	N	126 07.42	W	CTD in	235
		15:56	71 42.09	N	126 07.43	W	CTD out	237
	1901	16:47	71 37.86	N	125 53.79	W	rosette in	356
		17:42	71 37.72	N	125 54.78	W	rosette out	354

	1902	18:27	71 33.81	N	125 39.68	W	CTD in	347
		18:45	71 33.88	N	125 39.49	W	CTD out	345
	1903	19:24	71 29.81	N	125 26.44	W	rosette in	327
		20:10	71 29.72	N	125 26.79	W	rosette out	325
		20:07	71 29.72	N	125 26.76	W	lawas out	325
	1904	21:08	71 25.75	N	125 12.65	W	CTD in	275
		21:25	71 25.67	N	125 12.87	W	CTD out	278
	1905	22:05	71 21.55	N	125 00.13	W	rosette in	246
		22:46	71 21.47	N	125 00.72	W	rosette out	246
	1906	23:35	71 17.44	N	124 45.74	W	CTD in	248
		23:51	71 17.44	N	124 45.74	W	CTD out	248
11-Jul-08	1907	0:34	71 13.06	N	124 32.59	W	rosette in	278
		1:12	71 13.1	N	124 32.86	W	rosette out	283
		1:20	71 12.60	N	124 31.83	W	lawas in	283
		1:50	71 10.31	N	124 20.07	W	lawas out	255
	1908	2:08	71 08.84	N	124 19.23	W	CTD in	290
		2:26	71 08.86	N	124 19.32	W	CTD out	293
	1909	3:06	71 04.83	N	124 06.63	W	rosette in	416
		3:54	71 04.79	N	124 07.19	W	rosette out	370
	1910	4:36	71 00.53	N	123 53.95	W	CTD in	321
		4:53	71 00.44	N	123 54.01	W	CTD out	323
	1911	5:36	70 57.17	N	123 37.93	W	rosette in	350
		6:20	70 57.03	N	123 38.99	W	rosette out	345
	1100	7:26	71 02.72	N	123 15.57	W	rosette in	267
		8:15	71 02.63	N	123 16.14	W	rosette out	267
		8:25	71 02.62	N	123 15.94	W	monster in	267
		8:57	71 02.63	N	123 16.51	W	monster out	267
		9:16	71 02.57	N	123 17.98	W	MOB in	267
		9:22	71 02.57	N	123 17.98	W	lawas in	267
		9:34	71 02.80	N	123 15.83	W	tucker in	267
		9:45	71 02.61	N	123 16.74	W	tucker out	267
		10:02	71 02.55	N	123 18.55	W	light+surface profile in	267
		10:35	71 02.80	N	123 16.26	W	secchi/pnf/uv in	265
		10:55	71 02.80	N	123 16.26	W	secchi/pnf/uv ouy	265
		11:57	71 02.65	N	123 16.14	W	MOB+light+surface out	265
		12:25	71 02.66	N	123 16.35	W	rosette 3 in	267
		13:05	71 02.65	N	123 17.42	W	rosetteout	269
		13:22	71 02.58	N	123 15.58	W	hydrobios in	270
		13:42	71 02.52	N	123 16.25	W	hydrobios out	269
		14:25	71 02.73	N	123 18.94	W	rosette in	265
		15:06	71 02.82	N	123 20.12	W	rosette out	249
		15:44	71 03.07	N	123 15.02	W	MVP in	252
		19:40	70 36.58	N	124 13.26	W	mvpout	446
		20:40	70 37.66	N	124 10.64	W	mvp in	496
		23:33	70 18.98	N	124 50.00	W	mvp out	91
	1110	23:51	70 19.33	N	124 50.40	W	rosette in	96
12-Jul-08		0:26	70 19.25	N	124 50.10	W	rosette out	90
		0:38	70 19.16	N	124 50.00	W	monster in	92
		0:45	70 19.14	N	124 50.11	W	monster out	92
		1:08	70 18.94	N	124 49.64	W	tucker in	95
		1:16	70 19.06	N	124 49.27	W	tucker out	95
		1:44	70 19.48	N	124 50.52	W	secchi/pnf/uv in	95
		2:05	70 19.46	N	124 50.48	W	secchi/pnf/uv out	95
		2:33	70 19.39	N	124 50.39	W	rosette 2 in	96
		3:00	70 19.3	N	124 50.55	W	rosette out	96
		3:32	70 19.16	N	124 50.9	W	agassiz in	91

		3:44	70 19.04	N	124 50.26	W	agassiz out	93
		3:22	70 19.21	N	124 50.79	W	bettle grab in	92
		3:25	70 19.20	N	124 50.80	W	bettle grab fond	93
		3:27	70 19.19	N	124 50.82	W	bettle grab out	93
	1108	5:04	70 27.96	N	124 31.56	W	rosette in	204
		5:47	70 27.89	N	124 30.80	W	rosette out	202
	1106	7:00	70 36.78	N	124 12.84	W	rosette in	446
		8:03	70 36.65	N	124 12.57	W	rosette out	432
	1104	9:10	70 45.25	N	123 53.45	W	rosette oin	425
		10:05	70 44.92	N	123 52.77	W	rosette out	425
	1102	11:16	70 54.00	N	123 34.71	W	rosette in	390
		12:05	70 53.85	N	123 35.02	W	rosette out	388
	1912	12:40	70 53.95	N	123 22.47	W	ctd in	417
		13:06	70 53.81	N	123 22.72	W	ctd out	420
	1913	13:45	70 53.96	N	123 04.88	W	rosette in	470
		14:37	70 53.91	N	123 05.92	W	rosette out	466
		14:00	70 53.94	N	123 05.79	W	lawas in	466
	1914	15:20	70 53.98	N	122 45.84	W	ctd in	389
		15:42	70 53.94	N	122 46.08	W	ctd out	392
	1915	16:26	70 53.99	N	122 27.11	W	rosette in	415
		17:20	70 54.07	N	122 28.04	W	rosette out	413
	1916	18:05	70 54.03	N	122 08.53	W	ctd in	424
		18:25	70 54.05	N	122 08.86	W	ctd out	423
	1917	19:07	70 54.01	N	122 49.88	W	rosette in	386
		19:55	70 53.87	N	121 50.07	W	rosette out	380
	1918	20:35	70 54.04	N	121 32.42	W	ctd in	350
		20:35	70 54.04	N	121 32.42	W	lawas in	350
		20:56	70 54.04	N	121 32.58	W	ctd out	350
	1919	21:51	70 53.98	N	121 13.68	W	rosette in	303
		22:37	70 53.98	N	121 13.68	W	rosette out	303
	1920	23:45	70 54.03	N	121 04.10	W	ctd in	295
		0:00	70 53.97	N	121 04.10	W	ctd out	295
13-Jul-08	D34 full	2:04	71 04.77	N	121 49.86	W	trappe a sediments in	181
		3:00	71 04.3	N	121 49.17	W	rosette 1 in	185
		3:40	71 04.15	N	121 49.28	W	rosette out	184
		3:37	71 04.16	N	121 49.27	W	MHAS in	184
		4:04	71 04.43	N	121 48.36	W	RMT in	184
		4:17	71 04.02	N	121 47.61	W	RMT out	186
		4:45	71 03.78	N	121 48.08	W	Tucker in	188
		4:55	71 03.38	N	121 48.08	W	Tucker out	192
		6:15	71 04.63	N	121 49.02	W	rosette 2 in	182
		6:50	71 04.58	N	121 50.06	W	rosette 2 out	183
		7:16	71 04.74	N	121 49.98	W	MOB in	181
		7:36	71 04.62	N	121 48.93	W	Monster net in	182
		7:45	71 04.68	N	121 49.24	W	Monster net out	181
		7:46	71 04.68	N	121 49.24	W	20 microns in. out at 07:49	181
		8:05	71 04.73	N	121 49.49	W	64 microns in. out at 08:10	181
		9:00	71 04.6	N	121 48.76	W	rosette 3 in	183
		9:10	71 04.6	N	121 48.76	W	hyperSAS in	183
		9:30	71 04.5	N	121 49.08	W	Lawas in	183
		9:30	71 04.5	N	121 49.08	W	rosette 3 out	183
		9:42	71 04.5	N	121 49.08	W	MOB out	183
		10:29	71 04.65	N	121 48.76	W	hydrobios in	182
		10:32	71 04.63	N	121 48.86	W	hydrobios out	183
		11:10	71 04.7	N	121 48.53	W	secchi/PNF/UV in	183

		11:49	71 04.66	N	121 48.7	W	secchi/PNF/UV out	182
13-Jul-08	D34 full	12:00	71 04.65	N	121 48.79	W	rosette 4 in	182
		12:40	71 04.72	N	121 49.05	W	rosette 4 out	181
		13:06	71 04.59	N	121 48.77	W	Agassiz in	183
		13:28	71 04.41	N	121 49.3	W	Agassiz out	184
		13:00	71 04.61	N	121 48.8	W	Lawas out	183
		14:30	71 04.18	N	121 49.4	W	Box Core in	186
		14:33	71 04.18	N	121 49.37	W	Box Core bottom. out at 14:37	186
		16:22	71 03.69	N	121 00.03	W	recover sed traps. on deck at 16:36	233
		16:37	71 03.67	N	122 00.12	W	64 microns in. out at 16:39	234

The general schedule of leg 9A was 2 to 3 days in each bay, followed by an open water station. The open water stations sampled during leg 9A include mooring station 405b and hotspot station 1216 east of Cape Bathurst. On the week of June 14, the science steering committee opted to sample along a transect perpendicular to the ice edge instead of a dedicated full open water station. The transect is plotted in Figure 1b. The decision to sample this transect was made in response to an observation of a spring freshet plume from the Horton River extending along the ice edge (observed on MODIS satellite imagery) and the appearance of numerous whales along the ice edge (observed during aerial mammal surveys) during the same time period. The transect was positioned to start in open water unaffected by the river plume (station FB00) cross the river plume (stations FB1 ï FB3) and end into the ice edge (stations FB4 ï FB7; Figure 1b).

During leg 9B, we were also able to begin operations with the moving vehicle profiler (MVP), a towable instrument that monitors conductivity, temperature, depth, fluorescence and dissolved oxygen. The MVP was used for surface water profiles near the ice edge during the ice edge transect on 14-15 June and during 2 short (20 ï 30 km) transects. The first of these transects was across the shelf break from the tip of Cape Bathurst and east, whereas the second transect was from the south to north exiting from Darnley Bay.

During leg 9B, operations were shifted from in the ice to open water. In order to maximize productivity, this meant switching from moonpool to on-deck operations. Furthermore, science and logistics were changed from days to 24-hour operations. As a result we were able to sample important transect lines throughout the entire polynya. During leg 9B we sampled 9 full stations (adding to the 4 full stations sampled during leg 9A), 4 basic stations, 4 MVP transects and numerous nutrient and CTD stations completing CFL transect lines 1200, 421-435, 6000 (west of Banks Island), 2000 (MðClure Strait), 410-420, 1900 and 1100. We also sampled water from the Mackenzie and Horton rivers via helicopter as well as a full station at D33/34 (a drifting ice station sampled for more than 2 weeks during leg 7).

Scientific operations ended the evening of 13 July, 2008. On 14 July we visited the community of Ulukhaktok (Holman). The schedule of the community visit is provided below. During the visit we presented on the science and logistics of CFL to 4 school groups of 15 ï 20 students each during the day. At night we invited 16 members from the Ulukhaktok HTC, Elders Committee and Community Corporation to join us for a science tour, supper and a formal presentation followed by a culture exchange and informal discussions.

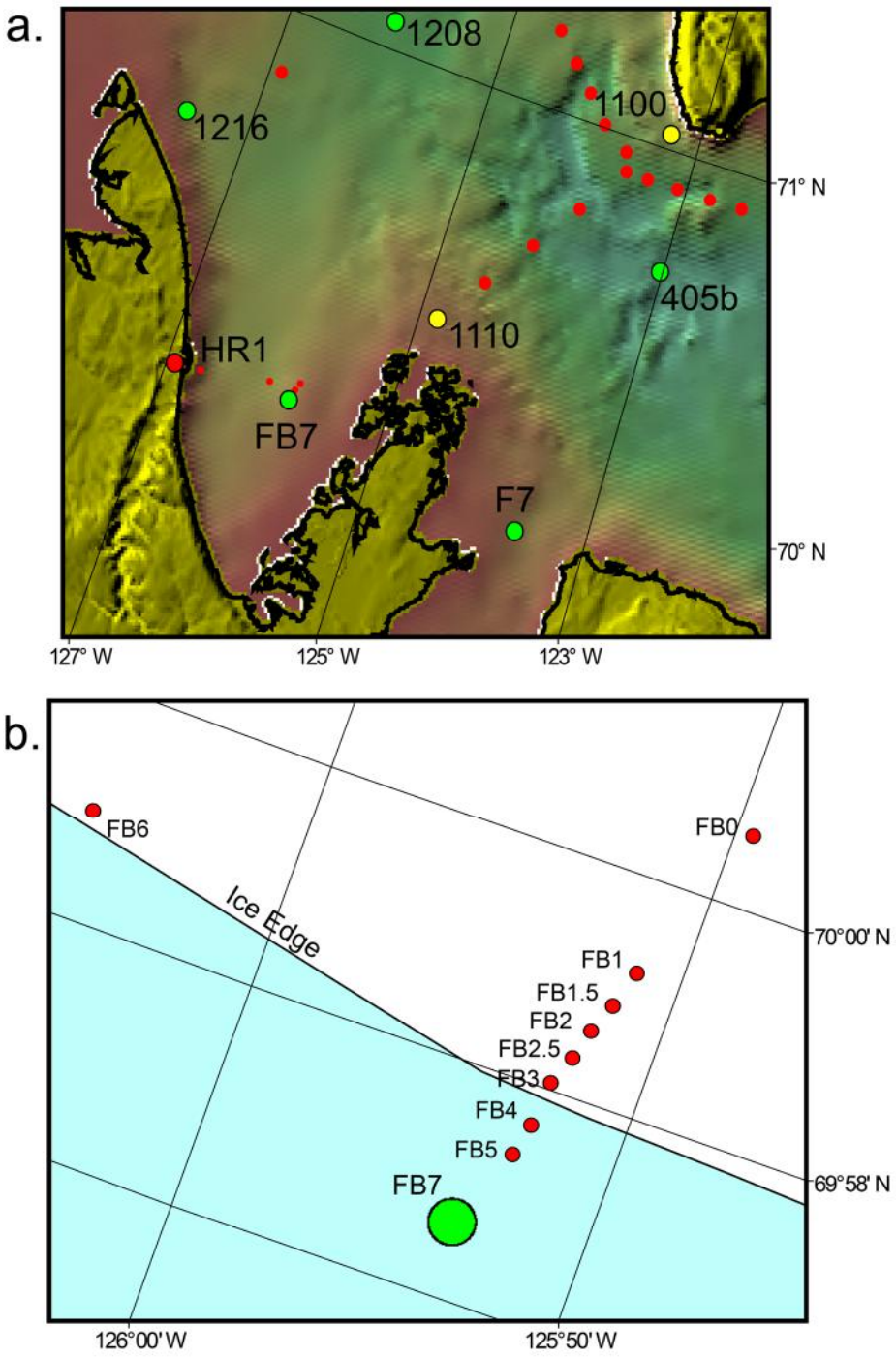


Figure 1. (a) Map of Franklin Bay and Darnley Bay highlighting the location of stations sampled during leg 9A (Sta. FB0 ï FB7, 405b, F7, HR1 and 1216) ï red dots are CTD and Nutrient stations, yellow dots are basic stations and green dots are full stations. (b) Close up of ice edge transect accomplished in Franklin Bay on 14-16 June, 2008 ï red dots are Basic stations, green dot is the full station, FB7.

Schedule of Ulukhaktok Community Visit, 14 July, 2008

1st school group
picked up from Ulukhaktok at 9:15 am
dropped off at 12:40 pm

2nd school group
picked up from Ulukhaktok at 10:20 am
dropped off at 1:40 pm

3rd school group
picked up from Ulukhaktok at 12:40 pm
dropped off at 2:50 pm

4th school group
picked up from Ulukhaktok at 1:40 pm
dropped off at 3:50 pm

3:50 pm ï 16 members of the HTC, Community Corporation and Elders
embark from Ulukhaktok
4:20 pm ï 5:30 pm ï Ship tour
5:30 pm ï 6:30 pm ï Supper
6:45 pm ï 7:00 pm ï CFL presentation
7:00 pm ï 8:00 pm ï ñice breakerò gathering
8:00 pm ï 9:00 pm ï Community members disembark

From 15 -17 July, we transited to Kugluktuk and accomplished the crew exchange for the start of leg 10.

2. Team reports

2.1. Team 1

PI: Yves Gratton (INRS-ETE, 490, Rue de la Couronne, Québec)
Participants: Véronique Lago, Sarah Dyck, Charles Brouard and Yves Gratton (INRS-ETE, 490, Rue de la Couronne, Québec)

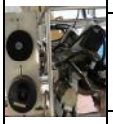
2.1.1. CTD/Rosette

Objective
Description of water masses and general circulation over a year in the Beaufort Sea and Amundsen Gulf.

CTD-rosette

Materials
Physical parameters were recorded using a ship mounted RDI Ocean Surveyor ADCP (150kHz), and a rosette frame equipped with 24 bottles of 12 L and the following sensors:

Table 1: Sensors used on the Rosette

Photo	Item	Manufacturer	Type & Properties	Serial Number
	CTD	SeaBird	SBE-911 Sampling rate : 24 Hz	
	Temperature	SeaBird	SBE 3plus Range: -5°C to + 35°C Accuracy: 0.001	4204
	Pressure	SeaBird	Accuracy: 0.015% of full range	90584
	Conductivity	SeaBird	SBE 4C Range: 0 to 7 S/m Accuracy: 0.0003	2696
	Oxygen	SeaBird	SBE-43 Range: 120% of saturation Accuracy: 2% of saturation	casts 001 to 117: 0420 casts 118 to 180: 0427

	pH	SeaBird	SBE-18 Range: pH from 0 to 14 Accuracy: pH 0.01	0444
	Nitrates	Satlantic	MBARI ISUS Range: 0.5 to 200 µM Accuracy: ± 2 µM	134
	PAR	Biospherical		4664
	SPAR	Biospherical		20147
	Fluorometer	Sea Point		2465
	Transmissometer	WetLab	Path length: 25 cm	CST-558DR
	Altimeter	Benthos		1061

Table 2: Sensor specifications.

Parameter	Sensor		Range	Accuracy	Resolution
	Compagny	Instrument Type			
Attached to the Rosette					
CTD	SeaBird	SBE-9plus [1]			
Temperature	SeaBird	SBE-03 [1]	-5°C à +35°C	0.001°C	0.0002°C
Conductivity	SeaBird	SBE-4C [1]	0-7 S/m (0-70mmho/cm)	0.0003 S/m (0.003mmho/cm)	0.00004 S/m (0.0004 mmho/cm)
Pressure	Paroscientific	410K-105	up to 10 500m (15 000psia)[2]	0.015% of full scale	0.001% of full scale
Dissolved oxygen	SeaBird	SBE-43 [3]	120% of surface saturation[4]	2% of saturation	unknown
pH	SeaBird	SBE-18-I [5]	0-14 pH units	0,1 pH unit	unknown
Nitrates concentration	Satlantic	MBARI-ISUS 5T [6]	0.5 to 2000 µM	±2 µM	±0.5 µM
Light intensity (PAR)	Biospherical	QCP2300	1.4×10^{-5} to 0.5 εE/(cm^2·sec)		
sPAR	Biospherical	QCP2200	1.4×10^{-5} to 0.5 εE/(cm^2·sec)		
Fluorescence	Seapoint	Chlorophyll-fluorometer	0.02-150 µg/l	unknown	30
Transmissiometer	Wetlabs	C-Star	0-5 V	unknown	1.25 mV
Altimeter	Benthos	PSA-916 [7]	0 - 100 m	unknown	0.01 m

Notes: [1] Maximum depth of 6800m

[2] Depending on the configuration

[3] Maximum depth of 7,000m

[4] In all natural waters, fresh and marine

[5] Maximum depth of 1,200m

[6] Maximum depth of 1,000m

[7] Maximum depth of 6,000m

Methods

Due the continuation of the ice program and heavy ice conditions at the start of the leg, the rosette was deployed from the moonpool for the first portion of the leg and switched to boat deck operations at the mid leg scientific crew exchange. A set of open water stations was also visited throughout the entire leg. CTD or Rosette casts were usually performed four times a day while stationed in the ice at 07h00, 11h00, 15h00 and 19h00. Once, a 13-hour, hourly CTD sampling has been done. Water was sampled according to each team requests. Here are examples of usual depths collected.

- *Nutrients* (Team 7; PI: Jean-Éric Tremblay): salinity of 33.1, chlorophyll maximum, 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300 and every 100 m up to the bottom.
- *DIC* (Team 6; PI: Lisa Miller): salinity of 33.1, 5, 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300 and every 100 m up to the bottom.
- *Mercury*(Team 8; PI: Gary Stern): salinity of 33.1, 5, 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300 and every 100 m up to the bottom.
- *DOC/DON* (Team 7; PI: Christine Michel): salinity of 33.1, 5, 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300 and every 100 m up to the bottom.
- *Contaminants* (Team 8; PI: Gary Stern): chlorophyll maximum, 10, 25, 50 m and every 50 m up to the bottom.
- *DNA* (Team 7; PI: Connie Lovejoy)
- *Microbes and Virus* (Team 7; PIs: Carlos Pedros and Roxanne Maranger): ñinterestingò features in the O_2, NO_3, fluorescence, temperature and salinity profiles.
- *CDOM* (Team 3 ; PI: Pierre Larouche): 10, 25 m and chlorophyll maximum while in the ice and 50%, 20% of light, chlorophyll maximum and 60 m while in open water.
- *Pigment* (Team 3; PI: Suzanne Roy): 10, 25 m and chlorophyll maximum while in the ice and 50%, 15% of light and chlorophyll maximum while in open water.
- *Primary production* (Team 3; PI: Michel Gosselin): 10, 25 m and chlorophyll maximum while in the ice and 50%, 30%, 15%, 5%, 1%, 0.2% of light, chlorophyll maximum, 75 and 100 m while in open water.

Sampling locations

During leg 9, our focus was on the Amundsen Gulf, Franklin and Darnley Bay, the MacKenzie river and west and north of Banks island.

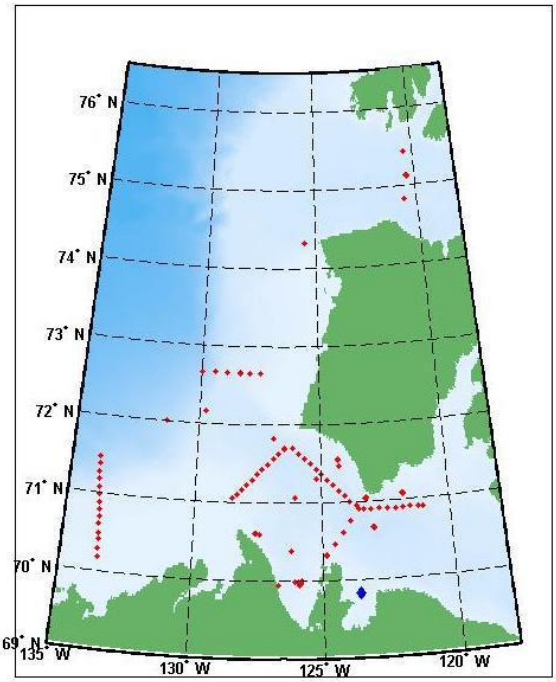


Figure 1: Positions of Rosette casts are shown as red dots and station of 13 hours sampling is blue diamond.

Probes calibration

Salinity: Samples were taken on many casts with small bottles of 200 mL. They were analysed with an autosal GuildLine, model 8400B. Its range goes from 0.005 to 42 and its accuracy is < 0.002. The results were satisfying. The difference between the salinity probe recordings and the samples was around 0.07. A few samples were very dissimilar (by almost 2), but this may be because they have been contaminated during sampling.

pH: Tests were done twice using two buffers.
The sensor is quite stable. Results are as follow:
Buffer 4.01 gave 4.23 and 4.25
Buffer 7.00 gave 7.42 and 7.51
Sea water is usually around pH=8, we can expect pH data to be a little over estimated.

Oxygen: Oxygen sensor calibration was performed using Winklerôs method and a Mettler Toledo titration machine. Reagent Blanks was performed once, results show that chemicals are still good (m<4). Oxygen have been sampled on six casts. Each time, we choose five depths of different oxygen concentration and sampled it three times. The results are not satisfying; the slope of comparison between the sensor and the samples was varying from 0.89 to 0.96. To rectify this problem, we changed the sensor between casts 117 and 118. However, after the change the slope of comparison was still unsatisfactory ranging from 0.85 to 0.91 which led us to surmise that the error could come from the titration machine or the chemical product used. A deeper investigation will be done on next leg.

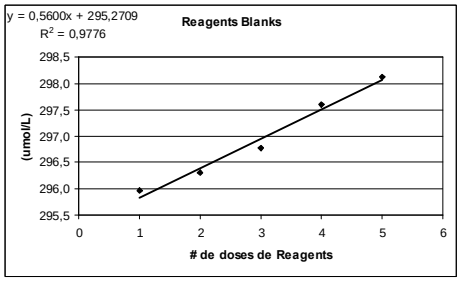


Figure 2: Reagents Blanks (m=0.56) measured during leg 0803 with the same chemicals on cast 061.

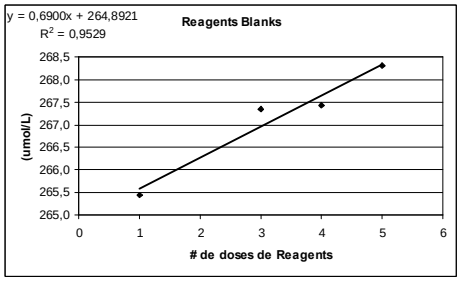


Figure 3: Reagents Blanks (m=0.69) measured on cast 148.

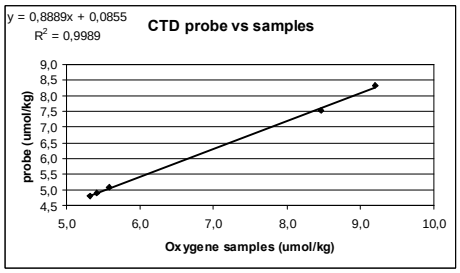


Figure 4: Relation between samples and probe recordings during cast #078 (m=0.8889).

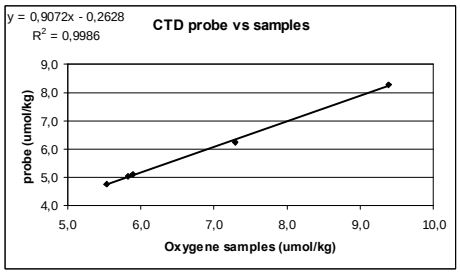


Figure 5: Relation between samples and probe recordings during cast #180 (m=0.9072).

Problems

- **Sensors**
  We had problems with the nitrates sensor for the first few casts after the rosette was moved from the moonpool to the boat deck.
  The oxygen probe may have an offset, it has been changed for a probe that has been calibrated on April 26th 2008 and the difference between Winklerôs method measures and the sensor was still present. Consequently, the problem could come from the sampling or the titration of oxygen.
- **Deck material (winch, A-frame, etc.)**
  The winch on the open deck overheated. Attaching an additional cooling hose rectified this problem.
- **ADCP**
  The currents were only measured sporadically during the leg. The ADCP could not determine the middle range of the water column currents for a still unknown reason. The ADCP also stopped receiving information a few times due to ice under the ship blocking the signal.

Available data

All information concerning the Rosette casts are summarized in the CTD Logbook. It includes cast and station numbers, date and time of sampling in UTC, latitude and longitude, bottom and cast depths, as well as the cast name and comments concerning the cast. A Rosette sheet was also created for every single cast. Information on this sheet includes the type of parameter sampled and weather information. For every cast, data recorded at the moment of bottle closure were averaged and recorded in the so-called ôbottle filesô. Averaged data are those recorded between 3 seconds before bottle closure and 7 seconds after the closure. It includes the bottle number, time and date, pressure, temperature, salinity, transmissivity, chlorophyll, oxygen, irradiance and pH measurements. All those files are available on the ôSharesô.

- Rosette sheets and the CTD logbook : Shares\Leg9\Rosette_CTD\logs
- Bottles files : Shares\Leg9\Rosette_CTD\bottle_data
- Plots of every cast including salinity, temperature, oxygen, transmissometer, nutrients, fluorometer and irradiance : Shares\Leg9\Rosette_CTD\plots

A total of 180 casts were performed between June 5th, 2008 and July 17th, 2008.

Preliminary Results
The ñ13 hour marathonsò were performed at station F7 from the moonpool.

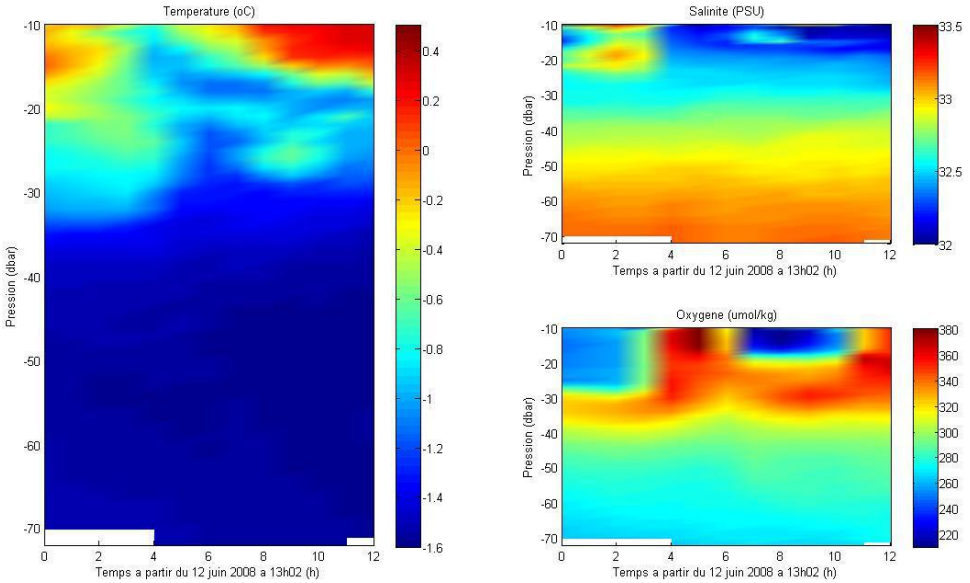


Figure 6: Temperature, salinity and oxygen data recorded on the 13 hour sampling done on station 2008-F7 on June 12th.

Self Contained Autonomous MicroProfiler (SCAMP)

Unfortunately the SCAMP was out of commission in leg 9.

MVP (Moving Vehicle Profiler)

The Moving Vehicle Profiler (MVP) is basically a towed CTD (with fluorescence and dissolved oxygen sensors). It was removed from its winter storage and used first as a CTD (ship stopped) in Darnley and Franklin Bays to provide profiles of the first 10 meters of the water column. The objective was to obtain a section of the Horton River plume (Franklin Bay) perpendicular to the ice edge. When the MVP is used in automatic profile mode, we loose the first 10 and last 10 meters. After the rosette operations were moved to the outside location, it was used in the towed mode only. Figure 7 gives an overview of the MVP sections / profiles in CFL leg 9 (cruise 0804).

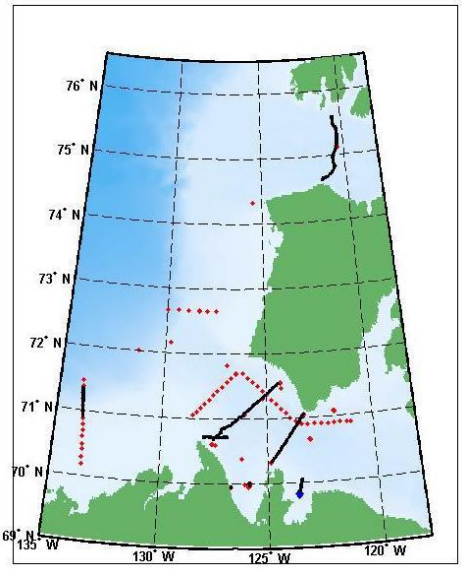


Figure 7: Positions of MVP casts and transects are shown as black dots and lines and rosette stations are shown as red dots.

Problems

Along the MacKenzie transect, the amplitude of surface waves created some difficulty to catch the bottom depth with the EK60 which forced the MVP to end a cast and recover as an automatic security. Thus, the data for this transect had sporadic maximum depths.

Preliminary Results

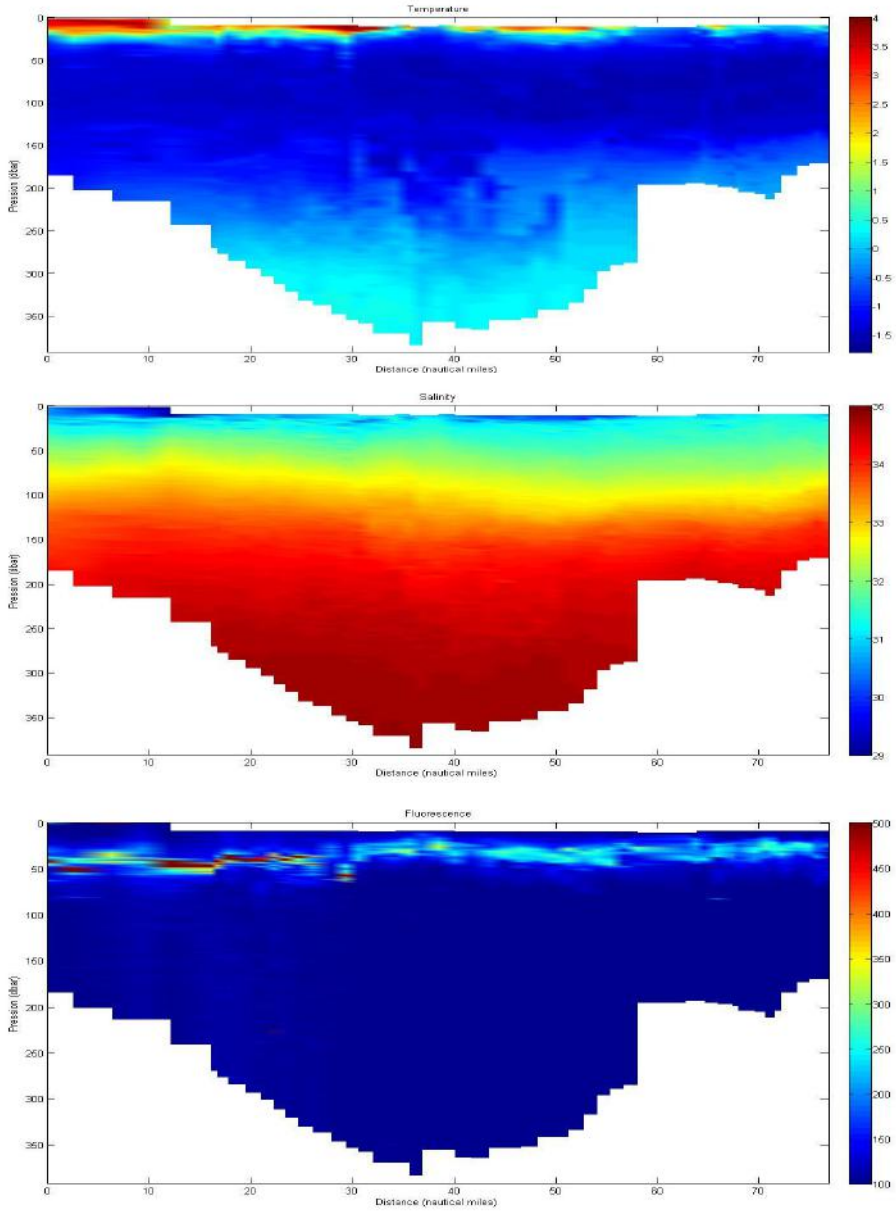


Figure 8: Temperature, salinity and fluorescence data recorded on the MVP transect done along line 1200, across the Amundsen Gulf.

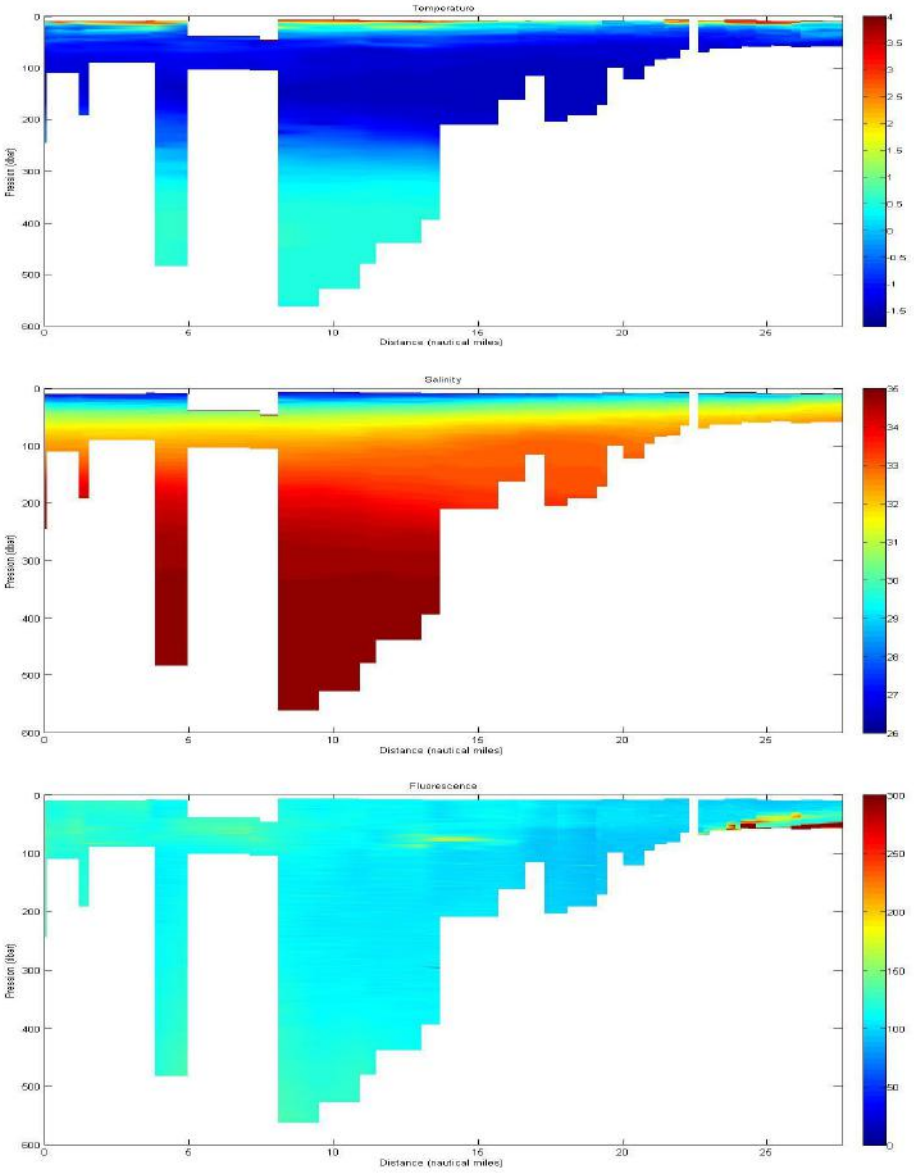


Figure 9: Temperature, salinity and fluorescence data recorded along the MVP transect done between stations 423 and 428, perpendicular to the MacKenzie River at the shelf break.

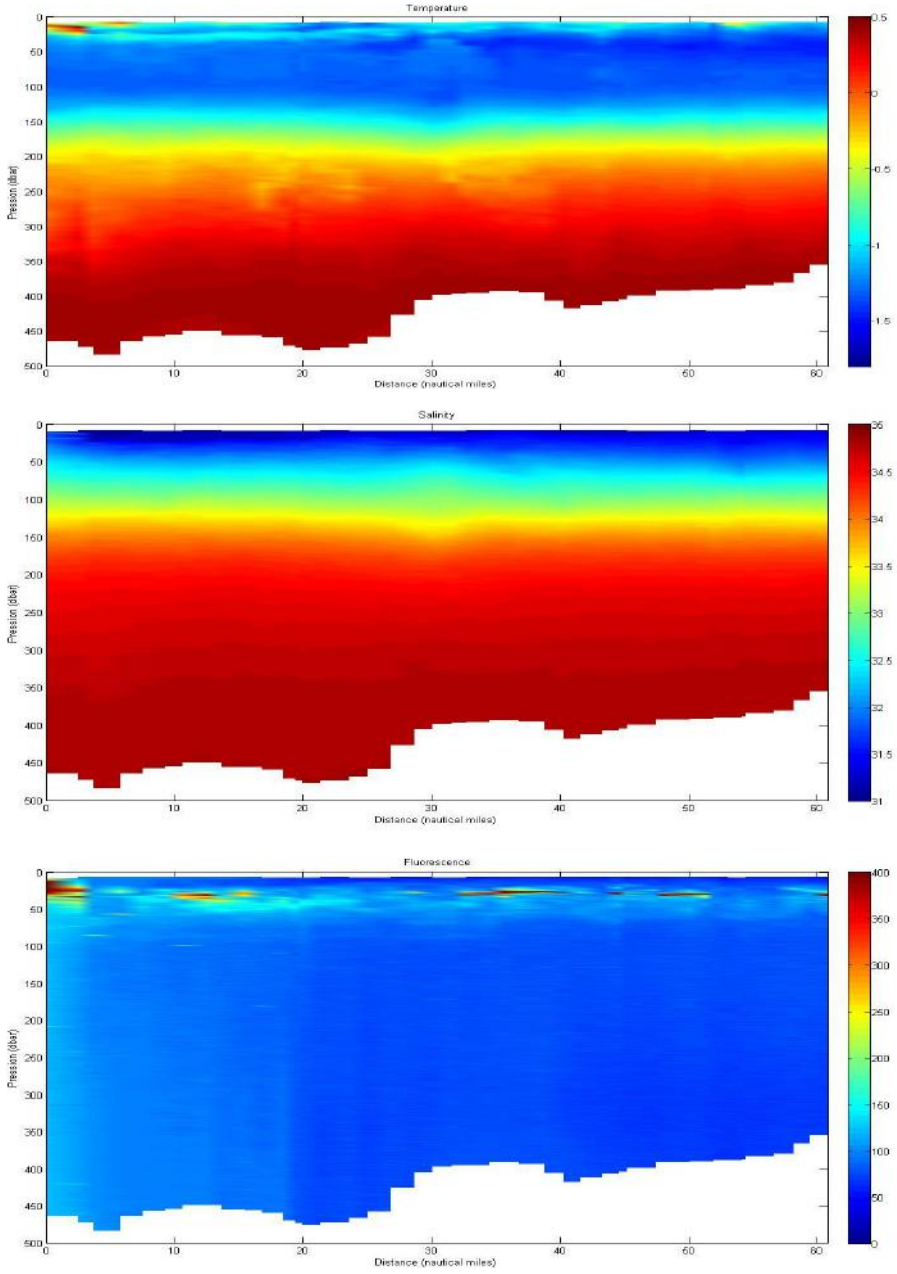


Figure 10: Temperature, salinity and fluorescence data recorded along the MVP transect done between stations 2005 and 2015, across McClure Strait.

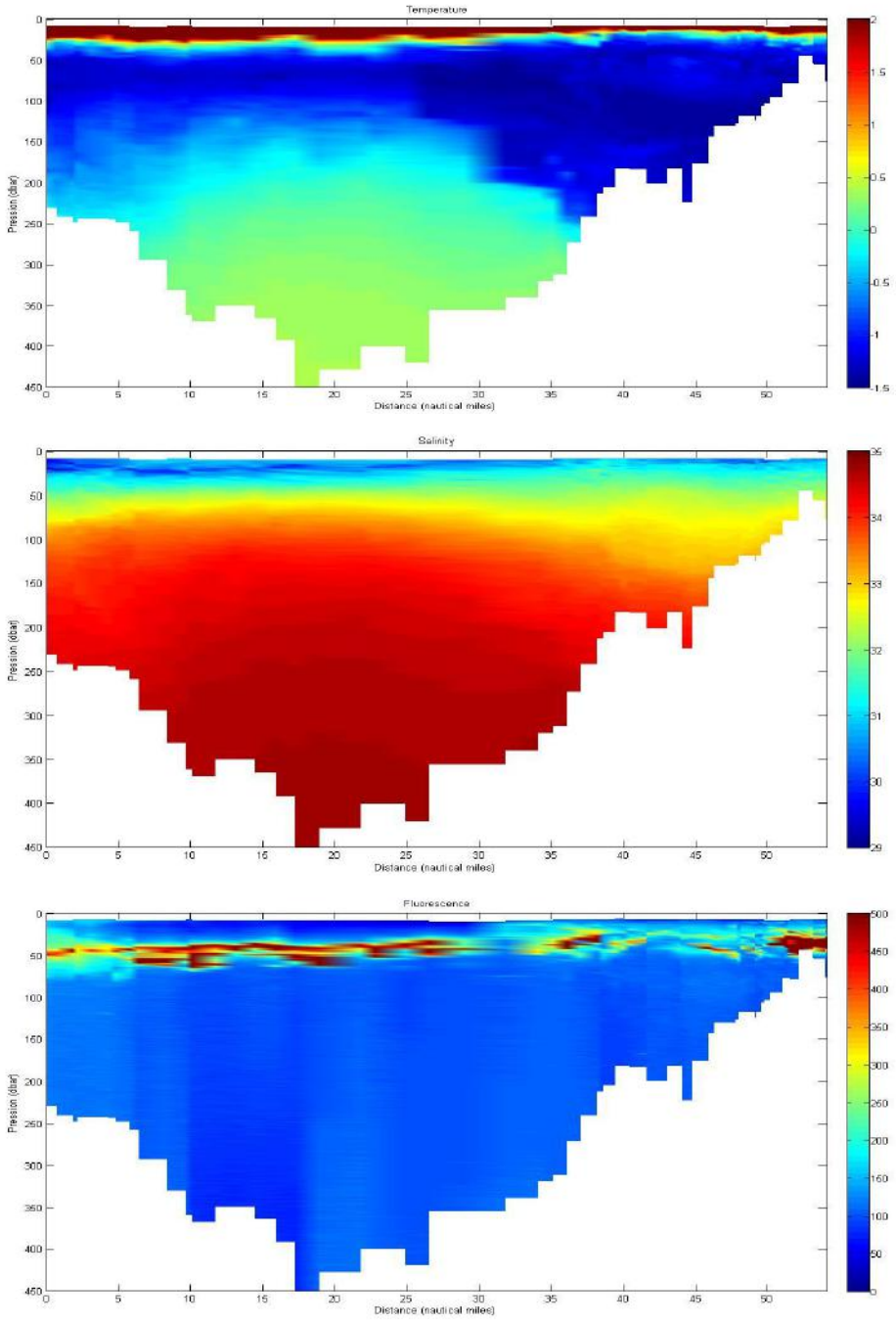


Figure 11: Temperature, salinity and fluorescence data recorded on the MVP transect done along line 1100 between stations 1100 and 1110, across the Amundsen Gulf.

Ice Camp

No long-term turbulence ice camp was deployed due to the poor ice conditions.

Moonpool operations

Moonpool operations were conducted until June 22nd. After that date, the rosette was operated from the outside, starboard ñshackò.

Open water operations

Open water operations began on June 23rd at Full Station 1216 (cast 063).

2.2. Team 2

PI: David Barber (CEOS, University of Manitoba)
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2.2.1. Ice Dynamics

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Colored Dissolved Organic Matter (CDOM), Fluorescence of Dissolved Organic Matter (FDOM), Salinity and Oxygen Isotope (δ18O)

Dissolved organic matter (DOM) plays a major role in the ocean as carbon and energy sources for the microbial food web, and for consumers at higher trophic levels that feed on microbes or on DOM directly. The coloured fraction of this dissolved organic matter is a complex pool of autochthonous materials, derived from in situ photosynthetic activity and processed microbially, and allochthonous materials, that are rich in humic substances and largely derived from terrestrial environments.

Fig.1. CDOM sampling

This coloured dissolved organic matter (CDOM) is photochemically active and also influences the spectral underwater regime that in turn affects primary production. The composition and reactivity of CDOM in aquatic ecosystems are still poorly understood. The sources and dynamics of DOM are of special interest in the coastal Arctic Ocean. These environments receive inputs of freshwater from large rivers that drain arctic tundra and peatlands as well as subarctic boreal forest. To increase the understanding of this tracer we are coupling the sampling with $\delta^{18}O$ which is a conservative tracer of freshwater masses. It has been estimated that more than 25% of the worldôs soil carbon lies in these catchments, and there is concern about how ongoing climate change may mobilize these stocks and transport them to arctic seas. The carbon derived from arctic rivers appears to be a major source of terrigenous DOM to the deep ocean, and changes in the magnitude and composition of this material therefore have broader oceanographic implications.

Global circulation models predict that the arctic basin will experience greater and more rapid warming than elsewhere over the course of this century, and there is increasing evidence that global climate change has already begun to have significant impacts on permafrost degradation and terrestrial vegetation dynamics at high northern latitudes.

Water was collected onboard using the rosette from the moonpool and off the ship from the zodiac.

Due to problems with the spectrophotometer Cary 50, the CDOM samples were stored at 4^{o}C and measurements of CDOM will be completed at University of Manitoba.

Preliminary Results:
CDOM and FDOM analysis will be performed after the cruise in laboratories at the University of Manitoba. Stable isotope analysis of water samples will be analyzed outside of the university.

Table 1. CDOM and FDOM sample locations.

Date (mm/dd/yy)	Station (#)
14/06/08	FB1
14/06/08	FB1.5
14/06/08	FB2
14/06/08	FB2.5
14/06/08	FB3
14/06/08	FB6
15/06/08	FB4
15/06/08	FB5
16/06/08	FB0
17/06/08	HR1

CTD and Optical Measurements
The objectives of this experiment are to examine potential impacts of sea ice (and related environmental parameters) on light intensity under various sea ice, snow and solar zenith angle regimes during the spring transition period (Legs 7, 8b and 9a). To address this objective we will be measuring light fields (PAR) above and under the ice down to 60 m, albedo, snow properties (temperature, grain size, salinity) and upper ocean properties (conductivity and temperature) along with other relevant surface validation data. These measurements will be done in fast ice floes, landfast ice as well as in leads and the marginal ice zone. The ultimate intent is to extrapolate these observations/results to regional scales.

Fig. 2. A CTD and PAR profile through the ice

CTD (Conductivity, Temperature, and Depth) and PAR (Photosynthetically Active Radiation) profiles were done opportunistically with a focus on different snow and ice, and meltpond conditions as well as different times of the day. This is to see the effect of different snow and ice regimes on PAR in the water column below the ice. Profiles were also done through melt ponds, thin ice as well as open water between floes from the skippy boat. Transects from open water to the ice edge and across floes were also done when possible. Sampling was done at different times of the day to see the effect of solar zenith angle.

Snow pits including a vertical pit photo, and snow grain photos, density and salinity were done for the top, middle and bottom of each snow pack when possible.

Table 2. PAR/CTD profile and albedo sample locations.

STATION	DATE	Alec PAR	ASD DW & UW	SNOW/ACTIVE LAYER	ICE THICKNESS	CTD
F7_1	07/06/08	Yes	Yes	Dep, T	Yes	Yes
F7_2	07/06/08	Yes	Yes	Melt Pond, Dep	Yes	Yes
F7_3	07/06/08	Yes	Yes	Melt Pond	Yes	Yes
F7_3b	07/06/08	No	Yes	Melt Pond, Dep, T	No	No
F7_4	07/06/08	Yes	Yes	Dep, T	Yes	Yes
F7_5	09/06/08	Yes	Yes	Dep, T	Yes	Yes
F7_6	09/06/08	Yes	Yes	Melt Pond, Dep	Yes	Yes
F7_7	09/06/08	Yes	Yes	Dep, SGA	Yes	Yes
F7_8	09/06/08	Yes	Yes	Dep, T	Yes	Yes
F7_9	09/06/08	Yes	Yes	Melt Pond, Dep	Yes	Yes
F7_10	11/06/08	Yes	Yes	Dep, T	Yes	Yes
F7_11	11/05/08	Yes	Yes	Melt Pond, Dep, T	Yes	Yes
F7_T1	12/06/08	Yes	No	Dep	Yes	Yes
F7_T2	12/06/08	Yes	No	Dep	Yes	Yes
F7_T3	12/06/08	Yes	No	Dep	Yes	Yes
F7_T4	12/06/08	Yes	No	Dep	Yes	Yes
F7_T5	12/06/08	Yes	No	Dep	Yes	Yes
F7_T6	12/06/08	Yes	No	Dep	Yes	Yes
F7_T7	12/06/08	Yes	No	Dep	Yes	Yes
F7_T8	12/06/08	Yes	No	Dep	Yes	Yes
F7_T9	12/06/08	Yes	No	Dep	Yes	Yes
F7_T10	12/06/08	Yes	No	Dep	Yes	Yes
F7_T11	12/06/08	Yes	No	Dep	Yes	Yes
F7_T12	12/06/08	Yes	No	Dep	Yes	Yes
F7_13	13/06/08	No	Yes	No	No	No
FB6_1	15/06/08	Yes	No	Dep	Yes	Yes

FB5_1	16/06/08	Yes	Yes	Melt Pond, Dep, T	Yes	Yes
FB5_2	16/06/08	Yes	Yes	Dep, T	Yes	Yes
FB5_3	16/06/08	Yes	No	Melt Pond, Dep	Yes	Yes
FB5_4	16/06/08	Yes	No	Dep	Yes	Yes
FB5_5	16/06/08	Yes	No	Dep	Yes	Yes
FB5_6	16/06/08	Yes	No	Melt Pond, Dep	Yes	Yes
FB5_7	16/06/08	Yes	No	Melt Pond, Dep	Yes	Yes
HR1	17/06/08	Yes	No	Dep, T	Yes	Yes
HR2	17/06/08	Yes	No	Open Water, between floes	No	Yes
FB5_8	18/06/08	No	Yes	Melt Pond, Dep, T	No	No
FB5_9	18/06/08	No	Yes	Melt Pond, Dep, T	No	No
FB5_10	18/06/08	No	Yes	Melt Pond, Dep, T	No	No
FB7_1	20/06/08	Yes	No	Dep	Yes	Yes
FB7_2	20/06/08	Yes	No	Melt Pond, Dep	Yes	Yes
FB7_3	21/06/08	Yes	Yes	Melt Pond, Dep, T	Yes	Yes
FB7_4	21/06/08	Yes	No	Dep	Yes	Yes
STN1216	23/06/08	Yes	No	Open Water	No	Yes

Snow Pits: T = temperature profile, Cap = capacitance plate, SGA = snow grain analysis, D = density
Dep = Depth
ASD: DW = Downwelling, UW = Upwelling

Fig. 3. Setting up the ASD to collect downwelling irradiance.

Downwelling and upwelling irradiance measurements were done at most ice stations with an extended range radiometer from ASD. If there were different surface types at one site downwelling and upwelling irradiance was measured with the ASD at more than one location for each site.

Two 4 km transects perpendicular to the ice edge were completed on June 12 at F7 in Darnley Bay. One transect was 1 km east of the ship and the other was 1 km west of the ship. There were six sites on each transect and at each site a PAR and CTD profile were done down to 60 m. These transects were completed to look at the melt layer and light in from the ice edge in conjunction with the EM researchers in Team 2.

The Satlantic HyperOCR profiler was used for profiles down to 50 m along the Franklin Bay transect. These were done at FB1, FB1.5 , FB2, FB2.5, FB3, and FB3.5, and FB4.

Dive Program
During the first half of leg 9 there was a dive program that Team 2 was involved in. Team 2 was involved in two parts of the dive program which were a bio-optics dive program in conjunction with Team 3 and an ice edge dive.

During each bio-optics dive, measurements were made in a north-south transect under the ice every meter starting under a snow area then under a melt pond and then under the snow on the other side of the pond. These optical measurements were made with the Satlantic HyperOCR hyperspectral radiometer. It has 255 channels with wavelengths ranging from 300 to 1200 nm and integrates Wet Labs ECO series sensors which include sensors to measure concurrent conductivity, temperature, pressure, chlorophyll fluorescence and optical backscattering. At the end of each transect the diver dropped the profiler and a profile down to 50 m was completed. A rope was tied from the starting point to the end above the ice and below. Measurements of the distance from the rope to the upper surface and rope to the bottom of the ice were made along with pond depth and snow depth at each meter where the optical measurements had been made. When the optical measurements were made, the diver wore a re-breather to reduce the amount of bubbles.

Table 3. Bio-optics dive locations.

Date (mm-dd-yyyy)	Station (#)
08/06/08	F7
11/06/08	F7
13/06/08	F7
16/06/08	FB5
18/06/08	F7
20/06/08	FB7
21/06/08	FB7

During the dive program Team 2 also led an ice edge dive. These dives were to investigate the differences in light from the open water to the ice edge and then from the ice edge under the ice. The profiler was carried by the diver along a transect and was also dropped for a profile down to 50 m under the ice and in the open water by the ice. The surface along the dive transect was characterized.

Table 4. Ice edge dive locations.

Date (mm/dd/yy)	Station (#)
13/06/08	F7
18/06/08	F7

Ice physical-microstructure (Ice Raid)

General ice conditions:
During first half of Leg 9 we encountered FYI melt ponds and snow patches frequently mainly in Darnley Bay and Franklin Bay. The ice was ablating and breaking up at a rapid rate during this time period. By the end of Leg 9A, there was no fast ice left, though there were small ice floes around. Leg 9B was conducted in open waters except for a single stop in MðClure Strait where we were able to sample the fast ice on July 6. Therefore, the ice raids pertain to fast ice in Darnley Bay, Franklin Bay and MðClure Strait.

Physical sampling:
A field program (Ice Raid) was designed to obtain the physical-microstructure properties of sea ice. To access the ice surface during Leg 9, we landed on ice, lowered from the starboard and port side of the ship by gangway and sometimes by crane. Air and ice temperatures were measured by a hand-held temperature probe.

Ice surface condition (i.e., snow patches, melt ponds, thaw holes) was recorded. We took ice cores: one for temperature measurement, a second was cut in 10 cm pieces and put into whirlpack bags for the salinity measurement, and a third core was taken for micro-structure. At all stations, the ice thickness was found to be more than 1 m. Each 10 cm piece of ice core was melted to room temperature before measuring the salinity using a conductivity meter.

We set up the cold lab (-20°C) to take ice microstructure photography including thick and thin sections. We note the temperature of the cold lab varied between -11°C and -20°C, but occasionally increased up to -8.0°C. The temperature in the lab sometimes fell to -23 degrees. To take thick section (5 mm) photography, we cut an ice core into pieces and attached the piece on a glass plate, and fixed the ice piece by applying three layers of freshwater around the piece. Once, the ice piece firmly fixed on the plate, we prepared a thick section by shaving down the ice piece to about 5-10 mm thick using Bandsaw and Microtome. Then, we took pictures of the thick section by a digital camera (Canon, PowerShot G2) to see air bubble or brine pocket/tube distribution. Once thick section pictures were taken, we shaved down the ice piece to a millimeter thick (called a thin section). Then, we took cross- and parallel-polarization images from the thin section by putting polarized sheets under the ice section and between the ice section and the digital camera.

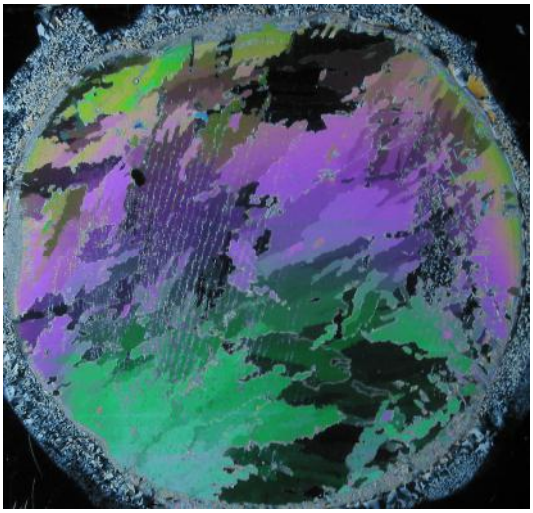


Fig. 4. Horizontal cross-polarized ice microstructure (130-140 cm) from MõClure Strait on July 6, 2008.

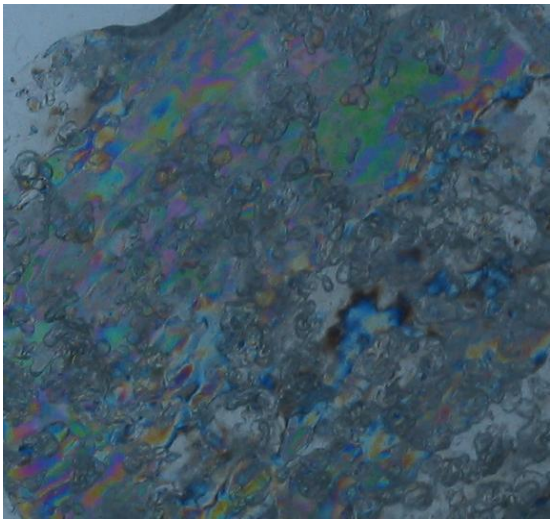


Fig. 5. Vertical co-polarized ice microstructure (0-10 cm) on June 13, 2008.

Sometimes we faced the difficulty in fixing the ice core onto the glass plate which made it difficult to make 1 mm sections. Therefore, some of the sections are 1.5 to 2 mm thick. Horizontal microstructure picture were also taken for MõClure Strait fast ice.

The light table stopped functioning at the end of Leg 9A. We used external flash light to illuminate light table. This brought difficulty in maintaining proper light conditions in the pictures.

Surface EM measurements

Objectives:
Ship-based ice-EM measurements were conducted to investigate the interactions between microwave signatures (both active and passive) and sea ice thermo-physical properties. The observed data will be used to calibrate sea-ice products from the satellite sensors and to evaluate the theoretical microwave emission/scattering models. This result will provide more advanced knowledge of how microwave signature reacts to the evolution of sea ice thermo-physical properties on small scales during the fall freeze-up period.

Instrumentation and methods:

The radiometers are dual polarized (vertical and horizontal) radiometers at 37 and 89 GHz with 6° beamwidth antennas (Radiometrics). The radiometers were mounted about 12 m above the sea surface on the portside of the ship. During transect, the radiometers were fixed at the incident angle of 55°. Whenever the ship was stationary, we changed the incident angle of the radiometers from 30° to 150° at a 5° interval. The SBR position stopped functioning since June 24th; therefore data was acquired only in fixed mode at 55 degree elevation angle. On July 12 the UPS battery in the SBR box died, therefore no SBR data is available between July 12 and July 17 (Crew change). A network camera (Cannon, VB-C10R) was mounted on a rail right beside the wheelhouse. The initial set-up for the camera was pan=0.00°, tilt=-25.00° and zoom=43.40° and was changed to tilt=-40.00° from Nov. 1. The pictures were taken every 10 sec to 1 min depending on surface conditions. A hand-held digital camera was also used to record the visual surface condition.

A C-band polarmetric (VV, VH, HV, HH) scattereometer system (PROSENSING) was deployed about 7.56 m above the sea surface (Figure 6). Whenever the ship was stationary, measurements from the ship were done from -30° to 30° in the azimuth, with the 0° reference at a perpendicular line to the ship side and from 20° to 60° in elevation at 5° increment. An infrared transducer (Everest, 4000L) was mounted on a rail in the shed for the C-band scattereometer system (Figure 6). Ice thickness camera was set up on the main deck at the port side. The scatterometer positioner from University of Calgary was used after June 26th onwards and data was acquired as originally planned.

Infrared Transducer back up was taken on weekly basis. At a couple of occasions the instrument was taken off for Beluga surveys.

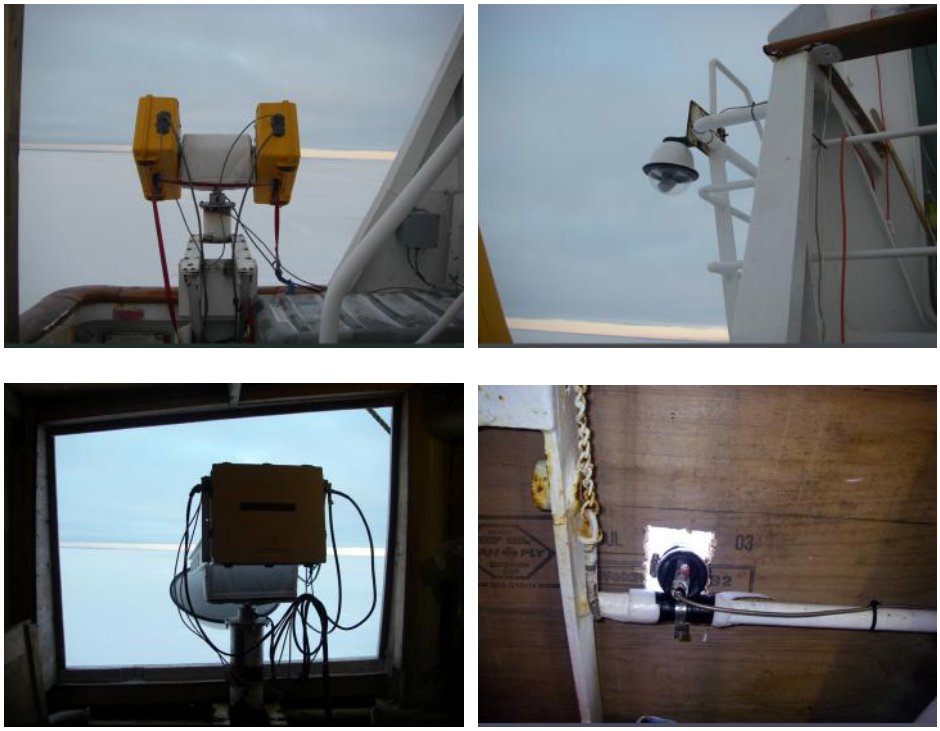


Fig. 6. Microwave radiometer system (top left), webcam (top right), scatterometer (bottom left) and infrared transducer (bottom right).

Meteorological Ocean Buoy (MOB)

The Meteorological Ocean Buoy (MOB) is comprised of a Data Well DWR-G4 buoy, modified to provide the additional functionality of a wind speed and direction sensor and an RF locating beacon. The Datawell DWG-4 buoy acquires and logs wave height data from a stabilized accelerometer, and wave direction data derived from GPS signals. To supplement this data, a number of additional parameters are collected and logged by the Metocean electronics (Metocean stack).

The Metocean stack includes an Ultrasonic Wind Sensor and a TCM2 compass that accurately measures the compass heading, buoy pitch and roll. Metocean stack also measures the battery voltage of the battery pack.

While the Datawell stack logs data into a flash card on the data logger on its stack, in order to store results from the Metocean Sensor stack, a second flash card is used with the Persistor CF-1 CompactFlash® datalogger module as part of the Metocean stack. Data from these flash cards can be saved on a hard drive independently and decoded using Metocean and datawell supplied decoding programs.

Once activated, the battery pack provides 25 days of continuous operation of the buoy. The Metocean stack samples various sensors connected to it once every 15 minutes and logs the results accordingly.

Deployment:
The buoy was deployed at every full station for minimum of 2 hours and maximum of 15 hours. It was deployed most of the time by zodiac 100 m away from the ship. At many occasions it was deployed by line from the front deck. Help from the crew in deployment and recuperation is highly appreciated. Once it was deployed using the barge.

Recuperation:
The buoy was recovered using either the zodiac, cage or barge. The ship heading and buoy bearing on ship DF was matched and the ship was sailed towards the buoy and a team with binoculars started finding the little yellow dot right in front of the ship. As soon as the buoy was spotted, the zodiac was deployed to retrieve it. This operation was done whenever the buoy was invisible and drifted quite far from the point of deployment otherwise only the zodiac was deployed with direction instructions on wireless to find the buoy.

Fig. 7. Meteorological Ocean Buoy (MOB) deployment by line (left) and data acquisition (right).

Data acquired:

Table 6. MOB data acquisition dates.

Met Ocean Buoy s/no.	Date
E54020-02	June 16
	June 23
	June 27
	June 28
	June 29
	June 30
E54021-02	June 10
	June 11
	June 14
	June 15
	June 16
	June 17
	June 18
	July 1
	July 2
	July 4
	July 6
	July 8
	July 9
	July 10
	July 11
	July 13

Preliminary results:

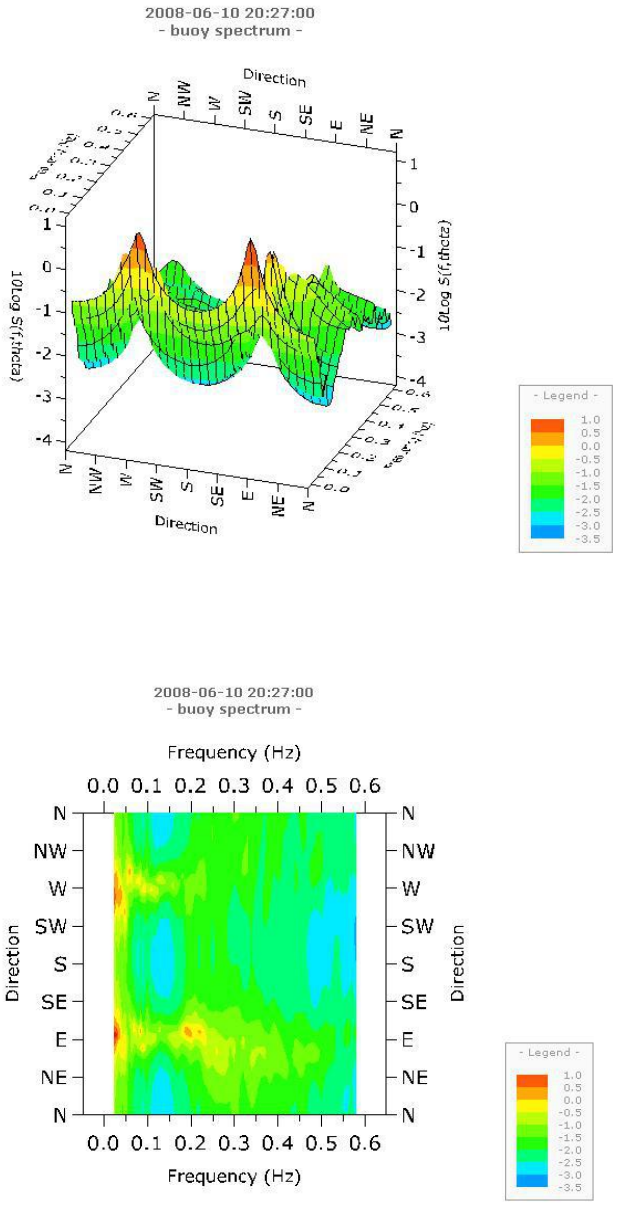


Fig. 8. MOB spectrum preliminary results.

Performance of buoys:
The buoy worked very well during most of the deployments; however, the radio beacon did not work a couple of times. The buoy was recuperated using zodiac with a hand held DF. High quality DF on ship was also used in parallel to track the buoy.

Vaisala wind sensors record data quite irregularly. Therefore, the surface wind data is not available for many stations. The reason behind the irregular functioning of wind sensor is as of yet unknown.

Laser Wave Slope (LAWAS)

Lawas was operated at every station when ship was at stop and sometimes during motion. At the fast ice stations the LAWAS data over melt pond waves was also acquired. At fast ice stations LAWAS was used as a mobile laser profiler to walk on the snow patch and melt pond in series.

Deployment:
LAWAS was deployed on fast ice melt ponds using tetra pods (Fig. 9) to measure the waves in the melt ponds and roughness over the snow patches. It was also used in profiling mode over the snow patches and melt ponds with two persons holding the system and one person towing the unit from behind. For all open water stations, the LAWAS was deployed on the foredeck on the beam (see picture).

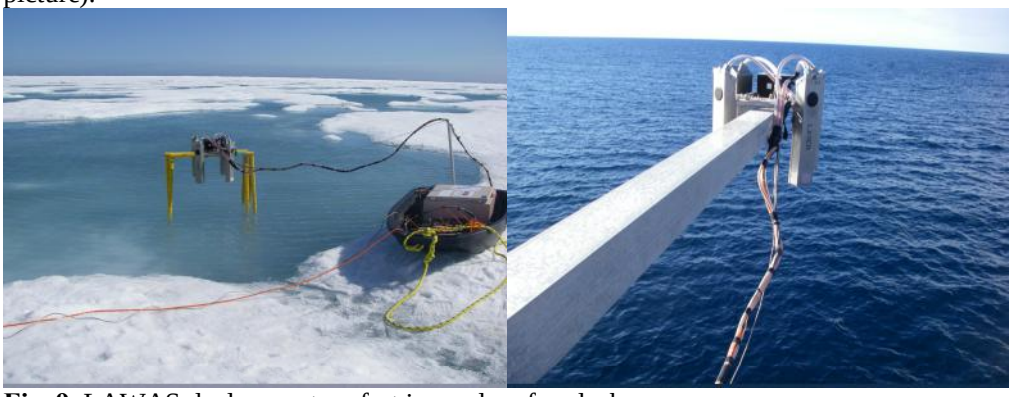


Fig. 9. LAWAS deployment on fast ice and on foredeck.

The wind direction was noted at every deployment and picture of the wind tower was taken every time.

Table 7. LAWAS dates of data acquisition and station numbers.

Station	Folder name
F7	June8_deployment1
F7	June9_deployment1
F7	June9_deployment2
405B	June10_deployment1
F7	June11_deployment1
F7	June12_deployment1
F7	June12_deployment2
F7	June13_deployment1
FB6	June15_deployment1
FB0	June16_deployment1
HR1	June17_deployment1
FB5	June17_deployment2
F7	June18_deployment1
FB7	June20_deployment1
FB7	June21_deployment1
1216	June23_deployment1
1216	June23_deployment2
F7	June24_deployment1
F7	June24_deployment2
F7	June24_deployment3
FB7	June25_deployment1
1200	June27_deployment1
1208	June28_deployment1
434	June30_deployment1
423	June30_deployment2
421	July1_deployment1
410	July8_deployment1
410	July8_deployment2
420	July9_deployment1

416	July9_deployment2
416	July10_deployment1
1100	July11_deployment1
1100	July11_deployment2
D34	July13_deployment1

Ice beacons

Two ice beacons were deployed (Table 8).

Table 8. Ice beacon deployment details.

Ice beacon number	Station/ location	Date
#703026/ (15320)	MõClure Strait (MYI floe)	July 5, 2008
#703027	MõClure Strait (FYI Middle of ice edge)	July 6, 2008

Fig. 10. Ice beacon deployment on MYI floe (left) and FYI edge (right) in the middle of Mõclure Strait.

Beluga Surveys

During the Leg 9A, extensive Beluga surveys were conducted. The surveys were conducted using the helicopter and charter planes (Fig. 11). The video shooting of Beluga whales was also made. A few surveys were done near the fast ice edge in the Darnley and Franklin bays.

Fig. 11. Beluga whales observed from the helicopter.

2.2.2. Optical Observation

By Shaojun Zheng and Zhihua Chen

Key Lab for Polar Oceanography and Global Ocean Change
Ocean University of China

Ocean Profiler II

Purpose:

The Profiler II design builds on the experience gained by Satlantic on previous generations of profiling instruments. It offers researchers the unique opportunity to use the system as a free-fall profiling device or in conjunction with a detachable float for near-surface measurements. The system is also available mounted on a lowering frame.

The Profiler II is specifically designed to allow the interchangeable use of Satlanticôs high-resolution multispectral OCR-500 series optical sensors and hyperspectral HOCR (or OCR-3000) sensors1. Optional features include a conductivity sensor and integration of up to two non-Satlantic instruments into the instrument package, making this system the most versatile platform for measuring the apparent optical properties of the ocean. The system addresses the issues of self-shadowing and ship induced disturbances while offering a wide dynamic range in an easy to deploy package.

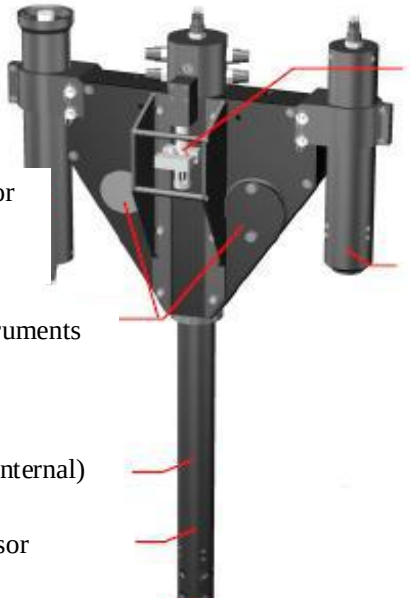
Background:

The Profiler II is Satlanticôs next-generation profiling instrument, building upon the very successful MicroPro design. The primary goal of this design was to allow data to be collected with a high spatial resolution in the regions around a field station on a typical oceanographic cruise. A secondary goal for the instrument was to support experiments in the case-2 waters that are often found in the nearshore and littoral environments. Water conditions in these areas are such that light levels below 100 meters depth (generally below six optical depths) are extremely low, difficult to measure, and provide little significant information in terms of the satellite validation mission being performed. In addition, attenuation levels are high enough that it becomes important to have downwelling irradiance and upwelling radiance sensors located close to the same depth.

The Profiler II design builds on the experience gained by Satlantic on previous generations of profiling instruments. Designing the Profiler II with the capability to operate in both free-fall and at-surface modes, the ability to interchange hyperspectral and multispectral sensors, and the seamless integration of two foreign sensors such as a fluorometer and backscatter meters, has resulted in an outstanding instrument package.

Instrument:

Profiler II major components:



Reference Sensor:

Cable:

Deployment Procedure (free-fall deployment):
The primary advantage of the free-fall deployment technique is that it provides a straightforward method of making measurements away from a vessel in such a way as to drastically reduce or completely avoid ship induced perturbations. In this way clean passive optical sensor data can be collected.

Table 9. Station information

Station	Longitude	Latitude	Date(UTC)
1216	127.6630W	70.6092N	2008-06-23
1200	124.2973W	71.5413N	2008-06-27 22:46
1208	126.1203W	71.0668N	2008-06-28 21:23
434	133.5821W	70.1748N	2008-06-30 16:19
6006	128.3481W	72.6702N	2008-07-04 16:40
2010	120.3640W	75.0790N	2008-07-06 19:30
410	126.5279W	71.6924N	2008-07-08 15:48
420	128.5454W	71.0543N	2008-07-09 15:00
416	127.8070W	71.2994N	2008-07-10 15:25
1100	123.2991W	71.0652N	2008-07-11 17:59
D34	121.8177W	71.0569N	2008-07-13 15:20

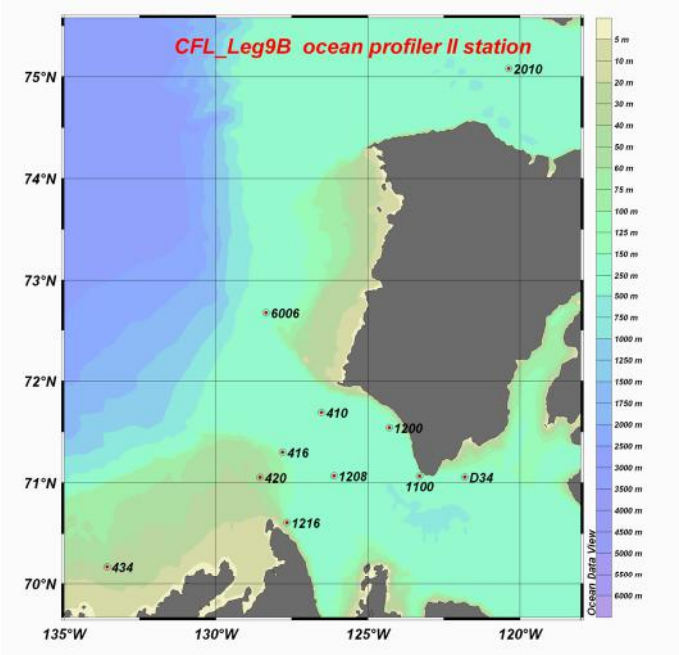


Fig. 12. Station locations mapped in the study area.

HyperSAS

Purpose:

The HyperSAS remote sensing system is designed for above-water measurements of ocean color using Satlanticôs OCR-3000 (MiniSpec) series of digital optical sensors. The primary purpose of the HyperSAS is to allow the user to obtain high-precision, high-resolution hyperspectral measurements of water-leaving spectral radiance and downwelling spectral irradiance.

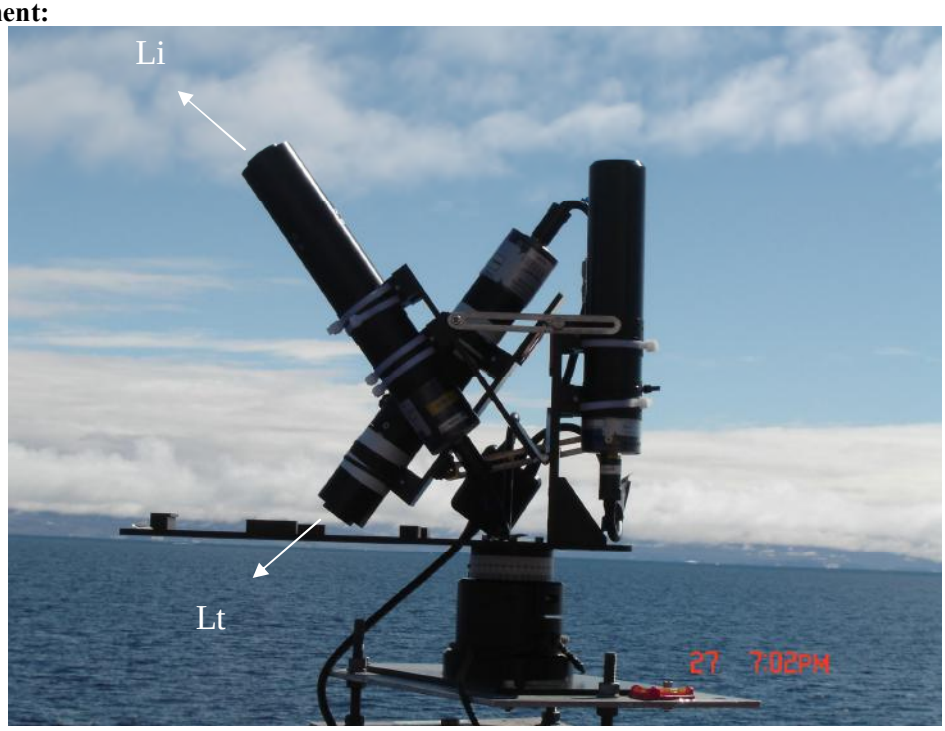
Background:

The HyperSAS system normally consists of two radiance sensors and one irradiance sensor. One radiance sensor is pointed to the ocean to measure the sea surface signal (LT), while the other (Li) is pointed to the sky to provide information necessary for sea-surface glint correction. The irradiance sensor (Es) is used to monitor the downwelling light field and is required for computing remote sensing reflectance.

The HyperSAS can be mounted on a variety of vessels to provide continuous monitoring of ocean color along the shipôs track, on towers or other platforms to provide time series observations, or on aircraft to allow airborne remote sensing of ocean color. The system is small, light, and compact, making it very easy to deploy.

The spectral water-leaving radiance and remote sensing reflectance obtained from HyperSAS data are used to derive the concentrations of sea-water constituents such as dissolved organic matter, suspended sediments, and chlorophyll concentration in the surface layer. Since chlorophyll is an indicator of algal biomass, this information is utilized to estimate phytoplankton abundance and marine productivity, to detect phytoplankton blooms, and to monitor organic pollution through its influence on these blooms. The HyperSAS also provides valuable surface truth for calibration and validation of satellite ocean color products. If surface water samples are obtained simultaneously with HyperSAS measurements, the combined data set can be utilized for biooptical modeling

Instrument:



HyperSAS

Irradiance sensor

Note
The Es or irradiance sensor is a Satlantic OCR-3000 series irradiance sensor. The Es sensor should be mounted high on the ship to minimize errors due to ship shading, stack gases, and so on.

The observation geometry is a crucial part of the SAS measurement protocol. The sea and sky radiance sensors must be pointed at the same nadir and zenith angles respectively. This angle is usually chosen to be between 30° and 50° with an optimum angle of 40°.At this angle the sea surface reflectance for the skylight does not depend greatly on the wind speed and the constant value of 0.028 can be used in sky glint correction. To avoid the direct sun-glint the sensors should be pointed at the azimuth angle between 90° and 180° away from solar plane, with an optimum angle of 135° away from sun. With this orientation the glint effect will be minimized and water-leaving radiance will dominate the total signal.

Table. 10. Stations sampled with HyperSAS.

Station	Lat	Lon	Date	Time□UTC□
FB7	69.560°N	125.530°W	2008-Jun25	16:11
1200	71.546°N	124.342°W	2008-Jun27	18:45
1200	71.539°N	124.331°W	2008-Jun27	19:45
1208	71.071°N	126.079°W	2008-Jun28	17:15
1208	71.065°N	126.049°W	2008-Jun28	18:04
1208	71.071°N	126.053°W	2008-Jun28	18:25
421	71.471°N	133.907°W	2008-July01	15:45
421	71.470°N	133.914°W	2008-July01	16:41
421	71.471°N	133.905°W	2008-July01	18:02
435	71.073°N	133.794°W	2008-July02	15:55
435	71.076°N	133.793°W	2008-July02	16:35
6006	72.662°N	128.331°W	2008-July04	15:35
6006	72.662°N	128.331°W	2008-July04	16:20
6006	72.662°N	128.331°W	2008-July04	17:11
2010	75.125°N	120.404°W	2008-July06	15:40
2010	75.118°N	120.415°W	2008-July06	16:41
2010	75.125°N	120.347°W	2008-July06	18:15
410	71.701°N	126.489°W	2008-July08	15:07
410	71.701°N	126.491°W	2008-July08	18:10
410	71.708°N	126.484°W	2008-July08	19:40

410	71.708°N	126.480°W	2008-July08	20:00
420	71.049°N	128.511°W	2008-July09	16:38
420	71.050°N	128.512°W	2008-July09	16:50
416	71.293°N	127.760°W	2008-July10	00:10
416	71.293°N	127.760°W	2008-July10	00:30
416	71.303°N	127.779°W	2008-July10	16:58
1100	71.043°N	123.275°W	2008-July11	14:45
1100	71.043°N	123.275°W	2008-July11	15:15
D34	71.075°N	121.816°W	2008-July13	15:17
D34	71.075°N	121.816°W	2008-July13	15:34
D34	71.075°N	121.816°W	2008-July13	15:52
D34	71.075°N	121.816°W	2008-July13	16:10

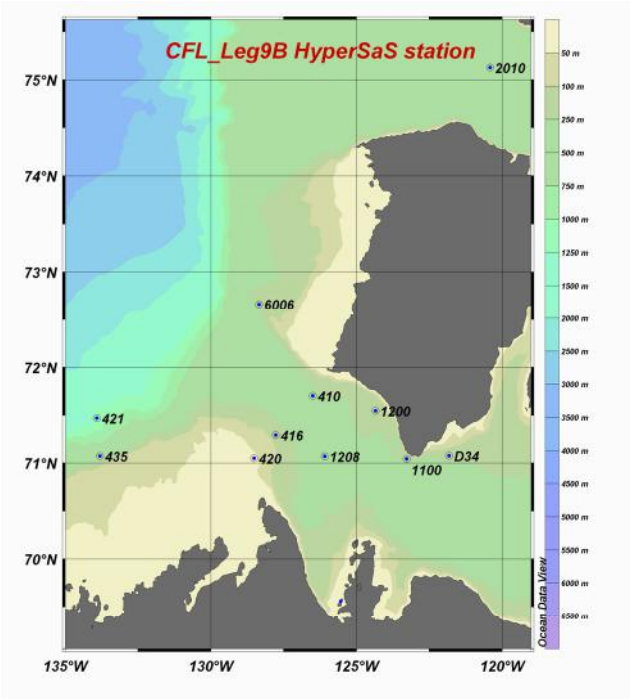


Fig. 13. Station locations mapped in the study area.

2.3. Team 3

PI: Michel Gosselin

Participants: C.J. Mundy (Postdoctoral Fellow), Claire Evans (Postdoctoral Fellow), Thomas Brown (PhD student), Eva Alou Font (PhD student), Molly Palmer (PhD student), Benoît Philippe (Masters student), Mathieu Ardyna (Masters student), Kevin Randall (Masters Student), Amélie Sallon (Masters student)

Primary producers fuel nearly all of the Earthôs ecosystems by converting the sunôs energy to an available food source through a process called photosynthesis. During photosynthesis, primary producers fix carbon dioxide, an important greenhouse gas, into food molecules connecting them, albeit indirectly, to our global climate. In this project we have focused our efforts to better understand physical (e.g., light) and chemical (e.g., nutrients) factors affecting primary production within the Beaufort Sea and Amundsen Gulf.

In seasonally ice-covered seas, primary producers can be found in two generalized environments (habitats): (1) associated with sea ice (ice algae) and (2) suspended in the upper water column (phytoplankton). The timing, intensity and duration of primary production in these two environments

are different. Both habitats play a very important and integrated role within the ecosystem. In a typical Arctic marine ecosystem, the relative importance of sea ice algae and phytoplankton follow a seasonal progression, with sea ice algae providing an initial food source for heterotrophs in early spring when the region is ice-covered, followed by a shift to phytoplankton production as the ice melts away during summer months. However, in the flaw lead system where open water can exist even in winter, the general location of primary producers is understandably much more complex. Contrasting the environments of primary producers in the flaw lead with the surrounding ice cover is a driving goal of our research. Furthermore, we have not had the opportunity to examine this dynamic region throughout the entire year, until now with the Circumpolar Flaw Lead System Study.

2.3.1. Ecology of algae associated with ablating landfast first-year sea ice

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Logistical constraints have limited the number of biophysical studies focused on sea ice ablation in the Arctic. The study of the algal community associated with melting sea ice is no exception to this statement. Only a handful of studies exist that examine the ecology of algae associated with ablating sea ice and these studies have largely involved multiyear sea ice. In this project we had the unique opportunity to sample first-year landfast sea ice from the beginning of melt through to break-up in both Franklin and Darnley Bay. It is noted that this sub-project was accomplished in close collaboration with team 2 who focused on physical aspects of the environment.

As melt progresses in sea ice, an intricate surface of melt ponds and ice patches form, while on the bottom surface domes can form beneath melt ponds. The different surfaces of the sea ice in addition to the interior ice matrix were assumed to be different environments for colonization of algae and therefore were each sampled during this study. Figure 1 shows a schematic of melting sea ice depicting the different regions sampled. Regions A through E were obtained via slurp guns and under ice samples were obtained with the assistance of SCUBA divers. Region F was collected via ice core extraction using a 9 cm core barrel (Kovacs© Mark II Coring System). The ice core was further separated into sections starting from the bottom 0-3 cm, 3-10 cm, 10-20 cm and then 20 cm sections until the surface of the ice.

Ice core sections needed to be melted prior to analysis. To minimize osmotic shock, core sections were melted in 0.2 µm filtered seawater (FSW) at a dilution of 100 ml FSW per 1 cm of core prior to melting. Once melted, nutrient (Nut) samples were taken, followed by a measurement of the salinity and total volume of the samples. It is noted that nutrient samples for FSW were collected as well as nutrient samples for additional core sections (i.e., no FSW added) which were stored in whirl-pack bags and placed in darkness to melt. Nut samples were also collected for slurp gun samples.

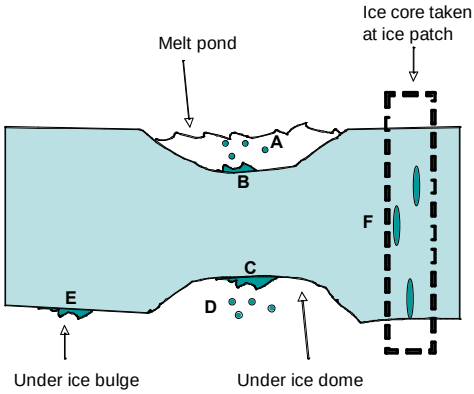

Figure 1. Schematic of the different regions sampled for analsysis. A = meltpond water, B = meltpond bottom surface, C = under ice dome surface, D = under ice dome water, E = under ice bulge surface, F = ice core taken at an ice patch

All water (collected via slurp guns) and melted ice core samples were filtered for determination of size fractionated chlorophyll *a* (chl *a*), particulate organic carbon and nitrogen (POC/N), spectral absorption of particulate matter (Ap), high performance liquid chromatography pigment analysis (HPLC), general cell identification (Cells; fixed in Lugol Acid and Formalin and to be counted via inverted microscopy), cell identification of autotrophs and heterotrophs via epifluorescence microscopy (Epi), and abundance and size class of pico/nanoalgae and bacteria via flow cytometry (Cyto) (Table 1). It is noted that above the bottom 10 cm of the ice core only Chl *a*, Cells, Cyto, Ap and HPLC were analyzed.

The water column under the ice was also sampled coincident with the rest of the data collection. Water was generally sampled from 2, 5, 10 and 25 m depths. The water was analyzed for Chl *a*, Nuts, Cells and Cyto. However, an intense under-ice bloom was observed in Darnley Bay (Sta. F7) on 11 to 18 June, 2008 and therefore, more depths were sampled and are included in the next section on ñphytoplankton communityò.

Table 1. Data collection locations sampled during leg 9.

Station	Date	Location	Latitude (N)	Longitude (W)
F7	08/06/08	Darnley Bay	69.827	123.631
F7	11/06/08	Darnley Bay	69.827	123.631
FB05	16/06/08	Franklin Bay	69.956	125.875
F7	18/06/08	Darnley Bay	69.815	123.652
FB07	21/06/08	Franklin Bay	69.947	125.900

2.3.2. Phytoplankton Community

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Kevin Randall
Université Laval

Phytoplankton, referring to algae suspended in the water column, represent the major primary food source of the oceanic food web. Growth largely depends upon access to light or nutrients. Light profiles of the water column were conducted with a Natural Fluorescence profiler (PNF 300) and the atmosphere irradiance with a Li-cor quantum sensor. The water samples were collected with niskin bottles mounted on a CTD (conductivity, Temperature, Depth) rosette. Seven optical depths were sampled (100%, 50%, 30%, 15%, 5%, 1% and 0.2%), and 75m, 100m, 200m, 400m and maximum chlorophyll were also sampled when available.

Samples were filtered for size fractionated chlorophyll *a* (chl *a*) (>0.7 µm, >5 µm and >20µm), particulate organic carbon and nitrogen (POC/N), dissolved organic carbon and total organic carbon (TOC/DOC), high performance liquid chromatography pigment analysis (HPLC), general cell identification (cells fixed in Lugol Acid and Formalin and to be counted via inverted microscopy), abundance and size class of pico/nanoalgae and bacteria via flow cytometry (Cyto).

During leg 9B we were able to collect 11 samples for determination of size fractioned (>0.7 εm and >5 εm) primary production to estimate daily primary production at 7 photic depths (depths corresponding to 100%, 50%, 30%, 15%, 5%, 1%, and 0.2% of the surface irradiance) following JGOFS protocol for simulated in situ incubation. A radioactive tracer (Carbon 14) was used to determine the phytoplankton carbon uptake rate. An incubator installed on the foredeck was used to control the different environmental light conditions with different filters wrapping plexiglass tubes, one for each depth. The major issue was the temperature of the incubator, which was fluctuating a lot

and was always 5 degrees Celsius above the surface temperature of the Arctic Ocean. The main purpose of this incubator was to create the same environmental conditions found in the water column for *in situ* experiments.

Table 2. Number of depths sampled for each variable collected from the rosette during open water casts.

Station	Date	DOC/ DON	DOC/ TOC	Chl	POC/N	HPLC	Cells (Lugol & formol)	Bacteria	Pico- and nano-plankton
F7	09/06/08			5					
405B	10/06/08	4	4	10	4		3	6	6
F7	12/06/08			5			2		
FB1	14/0608	4	4	4	4		2	4	4
FB 1.5	14/06/08	1	1	1	1			1	1
FB 2	14/0608			3	3			4	4
FB 2.5	14/06/08			1				1	1
FB 3	14/06/08	4	4	4	4		2	4	4
FB5	15/06/08	4	4	4	4		2	4	4
FB 6	15/06/08			4	4				4
F8	18/06/08			4	4		4	4	4
FB07	21/06/08			4	4		4	4	4
1216	23/06/08	4	4	9	4	-	4	5	5
F7-69	24/06/08	4	4	9	4	-	4	6	6
070-FB7	25/06/08	4	4	8	4	-	4	5	5
1200	27/06/08	4	4	10	4	2	3	6	6
1208	28/06/08	4	4	10	4	1	3	6	6
434	29/06/08	4	4	7	3	2	2	5	5
421	01/07/08	4	4	12	4	2	3	6	6
435	02/07/08	4	4	11	4	2	3	6	6
6006	04/07/08	5	5	9	4	2	3	5	5
2010	05/07/08	4	4	12	4	2	3	6	6
410	08/07/08	4	4	11	4	2	3	6	6
420	09/07/08	3	3	6	3	2	3	4	4
416	10/07/08	4	4	11	4	2	3	6	6
1100	11/07/08	4	4	11	4	2	3	5	5
1110	12/07/08	3	3	9	3	2	3	5	5
D34	13/07/08	4	4	10	4	2	3	6	6

Table 3. Rate measurements: number of depths at which experiments were conducted.

Station	Date	Primary production
1208	28 June 2008	7
421	1 July 2008	7
435	2 July 2008	7
6006	4 July 2008	7
2010	6 July 2008	7
410	8 July 2008	7
416	10 July 2008	7
1110	12 July 2008	7
D-34	13 july 2008	7

2.3.3. Ice Algae Biomarkers

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Objective:
An investigation into the use of compound specific biomarkers from sea ice diatoms to determine the presence of past Arctic sea ice.

Background:
Previously, the Plymouth team (Guillaume Masse, Simon Belt, Lindsay Vare and Thomas Brown) have demonstrated that an unusual chemical biomarker, derived from sea ice diatoms, can be detected in sediments below sea ice, thus providing a proxy measure for sea ice cover in the past. Analysis of sediment material collected with the help of Dr. A Rochon (UQAR) and his colleagues during the 2005 ArcticNet cruise revealed the presence of this biomarker across the entire Canadian Arctic Archipelago from the NOW region through to the Beaufort Sea. Notably, analysis of extracted sediments showed significant temporal and spatial variations in the concentration of the sea ice biomarker, indicating variations in sea ice cover in the past and between different locations. The aim of the current fieldwork was to obtain a series of sea ice cores encompassing various physical, temporal and spatial variations in order to investigate factors affecting biomarker concentration. These data would then be calibrated against satellite records of sea ice over the region.

A further aim of the current fieldwork was to collect sufficient amounts of representative species of the Arctic ecosystem in order to be able to perform analyses of their lipid contents and study the transfer of sea ice biomarkers across food chains. Planktonic specimens were collected using nets. Box core sediments were also obtained from stations relating to ice covered regions.

Sampling:
Box core sediments were collected from a range of locations in the Amundsen Gulf. Sampling consisted of both bulk homogenised surface sediments and high resolution (2 mm) sectioning over 20 cm cores.

Plankton net tows were collected at every opportunity throughout the cruise with samples from vertical tows (40 m water column ï 20 um) being stored separately and frozen (-20^{o}C) for later analysis in the UK to establish null results of biomarker content relating to open water conditions.

Sea ice cores were collected regularly until the ice melted in an attempt to capture the period of sea ice decay and the end of the spring bloom. Cores were sampled in triplicate to determine local variability in algal and biomarker production as well as from areas of low snow (~2 cm) and high snow (~30 cm) where possible to determine irradiance effects. Opportunistic cores were also sampled in interesting features such as pressure ridges, frozen cracks, lead edges, new ice (~10cm) and thin ice (~50 - 70cm). Cores were melted (bottom 10cm) and filtered (0.7 GF/F). Samples were frozen (-20^{o}C) and taken back to the UK for analysis. Dive samples were obtained from the onboard dive team. A scraping device previously manufactured on board to remove and collect the bottom 2~3 cm was used for bulk sampling. Slurp guns were also used to sample the under ice community. Samples were filtered (0.7 GF/F) and frozen (-20^{o}C).

Our analysis, briefly, consists of solvent extraction, open column chromatography and Gas Chromatography - Mass Spectrometry.

2.3.4. Inherent Optical Properties

PI: Pierre Larouche, Institut Maurice-Lamontagne (Pierre.Larouche@dfo-mpo.gc.ca)
Participant: Molly Palmer, Stanford University (mapalmer@stanford.edu)

Introduction:
The goal of this subproject of Team 3 was to investigate and explore the inherent optical properties of the Beaufort Sea and Amundsen Gulf region, in an effort to expand upon a database of measurements that began with the CASES project. Optical properties in this region show a strong terrestrial influence from the Mackenzie River, which severely biases the estimation of phytoplankton biomass obtained from remote sensing data. Satellite-based data is crucial to our ability to monitor and understand the complex biophysical processes in these remote coastal waters where other methods are often unavailable. Thus, the over-arching hope for these measurements is to develop specific methods and algorithms that will improve our ability to remotely sense biological properties in these high latitude, river-influenced areas, particularly in regards to the ocean color satellites SeaWiFS and MODIS.

Specific objectives for the 2007-08 CFL cruise are:

- The estimation of the ability of current bio-optical algorithms to measure chlorophyll-a concentration and species discrimination;
- The development of specific algorithms for a variety of ocean color sensors which will in turn provide a better understanding of the Beaufort Sea and the Baffin Sea physical and biological processes;
- The analysis of light absorption properties of arctic phytoplankton.

To reach these objectives, we will measure throughout the program the following parameters whenever possible:

(1) the transparency of the water with a Secchi disk;
(2) vertical profiles of inherent optical properties (light absorption and transmission, backscatter light, volume scattering function, particle size spectra, phytoplankton fluorescence, CDOM fluorescence, temperature and salinity using a custom built optical profiler system;
(3) the pigment composition of phytoplankton with the high performance liquid chromatography method (HPLC);
(4) the algal pigments light absorption;
(5) the total suspended matter and its partition into organic and inorganic matter;
(6) the chromophoric dissolved organic matter concentration (CDOM).

Methods:
Water samples were taken to measure inherent optical properties from June 7 to July 6. During leg 9A (June 7 - June 26), stations were predominantly in the ice; leg 9B was mainly open-water stations. The ice stations focused primarily on Darnley Bay and Franklin Bay, and included a unique transect from the ice pack in Franklin Bay out to the ice edge and then through to open water. As part of this transect, samples were collected remotely from the Horton River, which influences Franklin Bay, and these samples were analyzed as part of the regular dataset. The open-water stations were more variable both spatially and temporally, sometimes with multiple stations per day, and sometimes with several days between stations. The open water stations ranged from the southern tip of Banks Island, up to MðClure Straight, and out to the Mackenzie River, where samples were collected remotely and analyzed as well. See Table 3 for more information.

While at the ice stations, water was typically collected at 4 depths. Samples were taken at 2 and 5 m through a small hole cut into the ice (usually about 300-1000 m from the ship to avoid influence) using a pump and hose lowered into the hole. Ice thickness during this time ranged from a maximum of 180 cm in early June in Darnley Bay, decreasing to roughly 120 cm by the time we left Franklin Bay

directly ahead of the annual break-up. The ice during this time was relatively stable but covered with meltponds. Two other samples were taken using the rosette through the moon pool at 10 and 25 m.

During open-water stations, water was typically collected at 6 depths, which were optically determined where feasible. Thus, prior to each rosette, the Secchi disk was used in conjunction with UVA, UVB, PAR (all three with Eva Alou-Font) and PNF sensors to approximate optical depths of 50%, 10%, and 1%. The other depths collected from the rosette were the chlorophyll maximum, as indicated by the CTD; and 60 m depth. Finally, a surface water sample was taken either by dropping a bucket over the side of the boat, from the zodiac, or from the rosette (as a last-choice when no other alternatives were available).

Filtrations were performed for HPLC, a_{ph}, total suspended matter (TSM), and CDOM. For HPLC and algal pigments, water samples (up to 2.5 L) were filtered through 25 mm GF/F filters, flash-frozen, and stored in liquid nitrogen on the ship. CDOM samples were filtered using 0.2 ε m Anotop® syringe filters (Whatman) and collected into 60 ml acid-cleaned clear or amber glass bottles. The bottles were stored frozen (-20 ęC) in the dark on the ship. Total suspended matter was measured by filtering up to 2 L of water using pre-weighted 25 mm GF/F filters. The filters were stored on the ship at ï 80 ęC to arrest pigment degradation (Sosik 1999). The AC-9 was used for a few vertical profiles (contact Jens Ehn for details); more often, the PNF was used. Sample buckets and filtration towers were rinsed with 70% ethanol once a week; syringes for CDOM filtration were rinsed in a hydrochloric acid bath prior to use.

2.3.5. Rates of Carbon Fixation by Marine Phytoplankton

PI: Kevin Arrigo, Stanford University (arrigo@stanford.edu)
Participant: Molly Palmer, Stanford University (mapalmer@stanford.edu)

Introduction:
The goal of this subproject of Team 3 is to explore the relationship between photosynthesis and light in marine phytoplankton. Photosynthesis-irradiance curves provide a now-standard tool for understanding photosynthetic mechanisms and characterizing the response of microalgae to varying environmental conditions. Given the complex nature of the flaw-lead system and the sensitivity of this area to global change, these types of measurements are crucial for building a baseline database of knowledge for which to assess and predict future changes in the biological system.

Photosynthesis-irradiance curves rely on the precise measurement of radio-labeled carbon assimilation. The physiological response of phytoplankton to light saturation can be used to assess algal photoacclimation and maximum rates of carbon fixation (P_{max}) per unit chlorophyll *a* biomass. In this technique, a single, continuous function is used to describe the initial linear response (α, the photochemical reactions of photosynthesis) through to photoinhibition (β) (Platt et al. 1980; Jassby and Platt 1976).

Methods:
To determine rates of carbon fixation, we sampled phytoplankton assemblages from the ice, meltponds, and open water stations throughout Leg 9 of the CFL cruise. At most stations, only the chlorophyll max was sampled; one meltpond sample was also analyzed. Whenever possible, samples were pre-screened through 450 μm mesh.

Samples were incubated in a ñPhotosynthetronò at 19 light levels ranging from 6 μE/m^2/s to 900 μE/m^2/s, the majority of irradiances focused between 0-100 μE/m^2/s to characterize the initial linear response and P_{max} of the *P* vs. *E* curve (Figure 2). Approximately 235 mL sample was gently combined and stirred by hand with 12 mL 20 μCi $NaH^{14}CO3$ and added in 10 mL aliquots to 17 pre-chilled plastic scintillation vials (Wheaton) to obtain a final activity of 1 μCi in each sample. Light

Table 4. Location, date, and information of inherent optical property sampling.

Station	Date	Time (UT)	Latitude	Longitude	HPLC	Algal pigments	TSM	CDOM	Rosette	Notes
F7 - ice	6/7/08	17:02-17:32	69,49.64	123,37.852	4 (8130-8133)	4 (8130-8133)	4 (B382-B385)	4 (8130-8131)	R0804005	
F7 - ice	6/8/08	21:34-21:46	69,49.643	123,37.848	4 (8134-8137)	4 (8134-8137)	4 (B386-B389)	4 (8134-8137)	R0808010	dense bloom
405B - ow	6/10/08	19:51-20:59	70,39.846	123,0.044	6 (8138-8143)	6 (8138-8143)	6 (B390-B395)	6 (8138-8143)	R0804014	
F7 - ice	6/12/08	16:37-16:56	69,49.456	123,37.966	4 (8144-8147)	4 (8144-8147)	4 (B396-B399)	4 (8144-8147)	R0804022	dense bloom
FB01 - ow	6/14/08	22:41-22:58	69,59.015	125,51,132	Eva Alou took these	4 (8148-8151)	4 (B400-B403)	4 (8148-8151)	R0804039	Team 3 standard depths: surface, 50%, 30m, chl max (22m)
FB03 - ice edge	6/14/08	01:36-02:03	69,58.069	125,52.192	Eva Alou took these	4 (8152-8155)	4 (B404-B407)	4 (8152-8155)	R0804040	switched surface and 50% order
FB05 - ice	6/15/08	20:07-20:33	69,57.389	125,52.501	Eva Alou took these	4 (8156-8159)	4 (B408-B411)	4 (8156-8159)	R0804044	very thick with particulates
HR - river	6/17/08	12:11-12:51	69,56.447	126,41.72	0	0	0	2 (8160-8161)	R0804047	
F7 - ice	6/18/08	17:04-17:23	69,48.884	123,39.085	4 (8162-8163)	4 (8162-8163)	4 (B412-B415)	4 (8162-8163)	R0804050	dense bloom
FB07	6/21/08	13:02-12:21	69,56.818	125,53.46	3 (CJ has data)	3 (CJ has data)	3 (CJ has data)	3 (CJ has data)	R0804059	2 chl max (35m, 52m)
1216 - ow	6/23/08	17:43-18:19	70,36.71	127,35.456	4 (8166-8170)	6 (8166-8171)	6 (B416-B421)	6 (8166-8171)	R0804065	
F7 - ice	6/24/08	21:27-21:56	69,49.297	123,39.68	1 (8174; Eva has others)	4 (8172-8175)	4 (B422-B425)	4 (8172-8175)	R0804069	fairly dense
1200 - ow	6/27/08	23:43-0:20	71,32.448	124,19.818	3 (8176-8178)	6 (8176-8181)	6 (B426-B431)	6 (8176-8181)	R0804074	
1208 - ow	6/28/08	22:22-23:06	71,3.872	126,4.34	3 (8179-8181)	6 (8182-8187)	6 (B432-B437)	6 (8182-8187)	R0804080	
434 - ow/river	6/30/08	12:12-12:51	70,10.672	133,33.254	2 (8182-8183)	4 (8188-8191)	4 (B438-B441)	4 (8188-8191)	R0804093	near Mackenzie
421 - ow	7/1/08	15:11-16:18	71,28.163	133,54.283	3 (8184-8186	4 (8192-8195)	4 (B442-B445)	4 (8192-8195)	R0804100	
435 - ow	7/2/08	14:55-15:47	71,4.168	133,47.024	1 (8199)	1 (8200)	1 (B450)	1 (8200)	R0804104	sea sick - rough
6006 - ow	7/4/08	13:03-13:41	72,39.497	128,20.675	1 (8197)	1 (8196)	1 (B446)	1 (8197)	R0804115	sick
2010 - ow/ice	7/6/08	11:12-12:06	75,7.499	120,24.946	3 (8200-8202)	5 (8201-8206)	5 (B451-B456)	5 (8201-8206)	R0804122	McLure Straight

levels were measured prior to and after the experimentation period using a Biospherical Instruments scalar PAR sensor. Samples were incubated for 2-hrs at -1.5°C. Immediately after incubation, samples were split into 5 mL subsamples and filtered through 5 μm polycarbonate filters and 25 μm GF/F (Whatman). The filters were then placed in plastic scintillation vials, and 100 μL 6N HCl and 1 mL milli-Q water was added to each vial. The vials were allowed to shake overnight in a fume hood. The following day, 100 μL of 6N NaOH was added to each vial, followed by 5 mL scintillation cocktail (Ecolume) was added. Each vial was shaken and left to sit for at least 3 hours and then counted in a scintillation counter.

In total, 15 P vs. E curves were completed from June 8 to July 4, 2008 (Table 5, Figure 3). Early curves focus on the ice algae community and follow the progression of a fairly large bloom in phytoplankton biomass (primarly dominated by diatoms such as *Thalassiosira* spp., as indicated by epifluorescence microscopy). Later in the sampling period, as the fast ice began to break-up, more open water stations were sampled, including near the south of Banks Island (Sachs Harbor), near the mouth of the Mackenzie River, and near Cape Bathurst.

Table 5. Sample locations and notes for *P* vs. *E* curves

Date	Station	Location	Notes	Name	Rosette
6/8/08	F7	69,49.64; 123,37.852	ice; 2m (CJ collect)	A-B	R0804010
6/9/08	F7	same	ice; chl max	C-D	
6/10/08	405B	70,39.846; 123,0.044	open water; chl max; pre-filter	E-F	R0804014
6/12/08	F7-1	69,49.456; 123,37.966	ice; chl max; 10 mL scint cocktail	G-H	R0804022
6/14/08	FB01	69,59.015; 125,51.132	Franklin Bay Transect; open water; chl max	I-J	R0804039
6/14/08	FB03	69,58.069; 125,52.192	Franklin Bay Transect; ice edge; chl max	K-L	R0804040
6/15/08	FB05	69.57.389; 125,52.501	Franklin Bay Transect; ice; chl max	M-N	R0804044
6/16/08	FB05/ MPUI-B	same	ice algae-meltpond/slurp at dive hole	O-P	
6/17/08	F8		ice, chl max	Q-R	
6/23/08	1216 - Cape Bathurst	70,36.71; 127,35.456	open water; chl max; 100uL out of to's for totals; totals in large plastic scint vials for counter; 6mL 14C; probably missed main bloom	S-T	R0804065
6/27/08	1200 (Sachs harbor)	71,32.448; 124,19.818	open water, chl max	U-V	R0804074
6/30/08	434 - Mackenzie	70,10.672; 133,33.254	open water/river	W-X	R0804093
7/1/08	421	71,28.163; 133,54.283	open water, chl max	Y-Z	R0804100
7/2/08	435	71,4.168; 133,47.024	open water, chl max	AA-BB	R0804104
7/4/08	6006	72,39.497; 128,20.675	2.5 hr incubation	CC-DD	R0804115

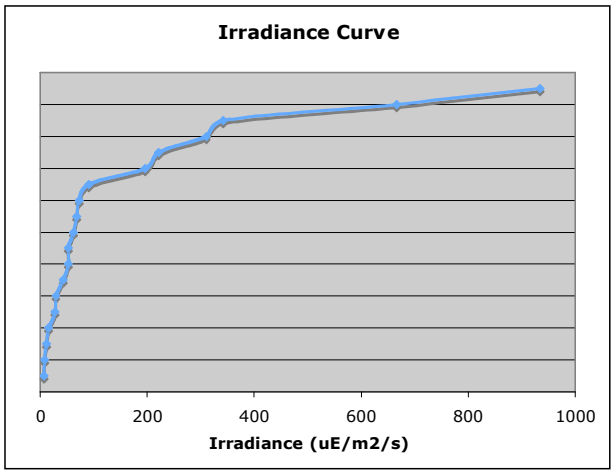

Figure 2. Calibrated irradiances for photosynthetron.

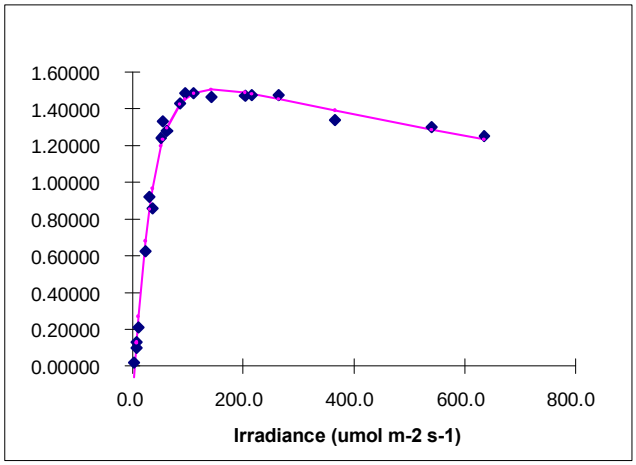

Figure 3. An example photosynthesis vs. irradiance curve.

2.3.6. Viability and Photoprotection

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Introduction:
Cell viability is a poorly known process in the ocean. Viruses and bacteria are implicated in cell mortality but cell death (e.g. apoptosis) can also be important. Recent work suggests than cell viability is strongly determined by the level of photo-protection in phytoplankton (Van del Poll et al., 2005).

With rapid global warming in polar environments ice reduction and melting should lead to increased irradiance in surface waters. Phytoplankton cells previously acclimated to lower light levels may then have insufficient photo-protection and consequently suffer significant mortality. Recent work linked cell survival with nutrient depletion in oligotrophic waters (Agusti et al., 2006).

Principal objective:
The objective of the project is to examine the flaw lead system and land fast ice in the Canadian Arctic during Spring time focusing on the following specific hypothesis:

1) To test whether photo-protection is a major determinant in changes in cell viability and this will contribute to difference between the composition of phytoplankton population from the flaw lead system and the land-fast regions.
2) To test whether cells from the more nutrient-limited regions show lower viability compared to nutrient-rich regions, when exposed to high surface irradiance.

Objectives:

1) Cell viability quantification.
2) Test cell photoprotection (Pigments, D1 protein cycle) vs. changes in viability.
3) Test nutrients vs changes in viability.
4) Test UV radiation vs changes in viability

To reach these objectives we measured the following parameters whenever possible:

1) Transparency of the water with a Secchi disk (to choose the right depths in the rosette).
2) Downwelling irradiance vertical profiles (UVb, UVa, PAR).
3) The pigment composition of phytoplankton with the high performance liquid chromatography method (HPLC).
4) Cell viability (Enzymatic technique and stain).
5) D1 protein.
6) Photosynthetic response (Xe-PAM).
7) Ratio of variable to maximum fluorescence Fv/Fm as a measure of the cell physiology activity (fluorometer).

Methods:

- Water samples were taken from June 6th until July 14th. Under the thin ice on the flaw lead system and in the water column in Open water stations. Samples under the ice were taken using a pump and a hose lowered through a small hole perforated in the thin ice with a handheld ice auger at surface level and 5 meters. Other samples under the ice where taken with the rosette, at 10 meters, 25 meters and depth of maximum chlorophyll when it was present until the mid leg change. In leg 9B all the stations where open water.
- In open water stations water samples where taken with the rosette according to the transparency of the water measured with the Secchi disk, normally at 50 % irradiance, 15% 1% and chlorophyll maximum when was present.
- Samples for HPLC technique were filtered through 25 mm GF/F filters with a maximum of 2 L each depth and then stored in liquid nitrogen on board.
- Samples for protein D1 were filtered through 25 mm GF/F filters with a maximum of 2 L each depth and then stored in liquid nitrogen on board.
- Cell viability was measured for each depth for posterior epifluorescence microscopy (microphytoplankton) and flow cytometry (Pico, nanophytoplankton) analysis.
- Vertical UV radiation profiles were done at each open water station.

Conclusions:

The CFL leg 9 operations where completed during 5th June to 13th July. We particularly thank the crewmembers and the rest of the members of team 3 who helped with operations.

References:

Van de Poll W.H., Van Leeuwe M.A., Roggeveld J., Buma A.G.J., (2005) Nutrient limitation and high irradiance acclimatation reduce PAR and induce UV viability loss in the Antartic diatom *Chaetoceros brevis* (Bacillariophyceae). Journal of phycology 41:840-850.

Agusti S., Alou E, Hoyer M.V., Frazer T.K., Canfield D.E.,(2006) Cell death in lake phytoplankton communities. Freshwater biology 51: 1496-1506.

Table 6. Number of depths sampled for each variable.

Station	Date	Cast	HPLC	D1	Viability Micro	Viability Nanopico	Xe-PAM	Fluoro	Radiometer Profile (UV, PAR)
F7	07/06/08	05	4	4	4	-	4	4	-
F7	09/06/08	08	4	4	4	-	4	4	-
405b	10/06/08	14	4	4	4	-	-	4	X
F7	11/06/08	16	4	4	4	-	3	5	-
F7	13/06/08	35	4	4	4	-	4	4	-
FB01	14/06/08	39	4	4	3	-	4	4	-
FB03	14/06/08	40	4	4	3	-	4	4	-
FB05	15/06/08	44	4	4	4	-	4	4	
HRO I	17/06/08	-	1	-	-	-	-	-	-
HR River	17/06/08	-	1	-	-	-	-	-	-
F7	18/06/08	49	4	3	3	-	3	3	-
F3	19/06/08	54	2	2	2	-	-	2	-
F3	20/06/08	-	-	-	-	-	-	-	X
FB07	21/06/08	59	4	4	4	4	4	4	-
1216	23/06/08	045	4	4	4	4	3	3	X
F7	24/06/08	069	5	5	4	5	-	5	-
FB07	25/06/08	070	5	5	4	5	5	5	-
1200	27/06/08	074	4	-	3	4	-	4	X
1208	28/06/08	80	4	-	3	4	-	4	X
434	30/06/08	93	3	-	3	4	-	4	X
421	1/07/08	100	5	2	3	5	1	3	X + Experiment
435	2/07/08	104	4	1	2	4	-	4	-
6006	4/07/08	115	5	-	-	5	-	4	X
2010	6/7/08	122	-	-	-	4	-	1+ Experiment	X + Experiment
410	8/07/08	129	-	-	-	4	-	4+ Experiment	X + Experiment
420	9/07/08		-	-	2	4	-	4	X
416	10/07/08	146	-	-	2	4	-	4	X
1100	11/07/08	160	3	-	2	3	-	3	X
1100	12/07/08		-	-	2	4	-	4	X
D34	13/07/08	180	-	-	2	4	-	4	X

2.3.7. The significance of viruses for polar marine ecosystem functioning

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Background and Objectives:
Microbial communities (phytoplankton, bacteria, Achaea, heterotrophic protozoa and viruses) comprise the majority of the biomass in the oceans and drive nutrient and energy cycling, and are thereby important components of polar food webs. With the emergent awareness that viruses are major players influencing biodiversity and biogeochemical processes the need to elucidate their role in polar ecosystems has been underlined as, despite their likely importance, their quantitative significance has barely been studied. We aimed to complete a comprehensive study of the viruses and viral mediated processes of the Arctic marine habitats encountered during legs 8 and 9 of the Circumpolar Flaw Lead Study. Samples will be taken and experiments performed on organisms from both the water column and the sea ice. The objectives of this study are: 1) To examine the abundance and composition of viruses and their prokaryotes and eukaryotic hosts (In collaboration with Prof. C Lovejoy University of Laval, 2) To determine viral induced mortality on both prokaryotic and eukaryotic microbial hosts alongside host growth rates and mortality due to grazing. 3) To gather a data set allowing comparison of the viruses and viral mediated processes of the Southern and Northern Polar regions. 4) To collect sample from which viruses might be isolated and therefore available for laboratory experiments.

Work onboard:
A range of sampling was completed at four different station types which were; óLevel Oneô stations, óBacterialô water column stations, óAlgalô water column stations and óIceô stations. During the former RNA, DNA and pigments were sampled as part of a suite of other microbiologically-relevant measurements in collaboration with the other Microbiologist onboard (Mr D Nguyen University of Montreal). For more details see report of Mr D Nguyen. On bacterial water column stations measurements of abundance, diversity, grazing rate and viral-induced mortality were performed on the bacterial community at surface and/or chlorophyll maximum and bottom. On algal water column stations abundance, diversity, growth rate, viral lysis rate and grazing rate was determined on those algae present at the chlorophyll maximum. Finally at ice stations measurements were made to determine the abundance and diversity of the viruses and bacteria and the frequency of virus-infected bacteria. Details of the stations sampled are given in Table 7. At all experimental stations, samples were taken for viral diversity by concentrating 10 l volumes by 30 kDa ultrafiltration. These samples will be stored at -80 ºC until analysis by pulse field gel electrophoresis at the NIOZ. Samples for viral and bacterial abundance were fixed with glutaraldehyde, snap frozen and stored at -80 ºC for later analysis at NIOZ by flow cytomtery and SYBR Green.

Growth rates, viral lysis and grazing of the cyanobacteria, picoeukaryote, and nanoeukaryote communities present were determined by a dilution technique whereby whole water is combined with either 30 kDa filtered water (virus and grazer-free) or 0.4 um filtered water (grazer-free) in triplicate over a dilution series and incubated at *in situ* temperature and light conditions (environmental chamber). Fixed samples for algal enumeration were taken from all incubations at the start of the assay and after 24 h, allowing the calculation of growth rate. By plotting observed growth rate against the level of dilution the theoretical growth rate in the absence of mortality was calculated along with coefficients of grazing and viral induced mortality.

Rates of viral induced mortality of bacteria were determined by viral reduction assay. Briefly, the bacterial community was concentrated by tangential flow filtration and resuspended in viral free water generated by 30 kDa ultrafiltration. The production of viruses was followed by sampling for bacterial and viral abundance over a 12 h period (subsampling every 3 h). Rates of lysogenic infection of the bacteria were determined in identical experiments with the addition of Mitomycin C, inducing lytic production of any lysogenic phage. In addition, rates of viral infection of bacteria will be elucidated by determining the frequency of infected cells which will be performed at the NIOZ on samples preserved with glutaraldehyde. Grazing of bacteria was assessed by an exclusion assay whereby bacterial numbers within incubations filtered to remove grazers 0.8 um were compared with whole water incubations containing grazers. Samples for virus isolation were collected from the chlorophyll maximum and will be screened against potential hosts at the NIOZ.

Table 7. Stations Sampled during leg 9.

Station Designation	Date	UTC	Lat	Long	Sampling
F7	7/6/2008	13:14	69º 50.226	123º 37.466	Bacterial
F7	9/6/2008	13:08	69º 49.64	123º 37.85	Level One
405b	10/6/2008	12:36	70º 39.697	123º 1.006	Algal
F7	11/6/2008	13:19	69º 49.46	123º 37.969	Bacterial
F7	12/6/2008	13:02	69º 49.548	123º 37.974	Algal
Ice transect-open water	14/06/08	22:41	69º 59.016	125º 51.132	Level One
Ice transect-ice edge	14/06/08	1:36	69º 58.069	125º 52.192	Level One
Ice transect-in ice	15/06/08	20:07	69º 57.389	125º 52.501	Level One
FB07	16/06/08	20:23	70º0.649	125º 49.566	Algal
F7	18/06/08	15:06	69º 48.887	123º 39.092	Bacterial
F7	19/06/08	14:10	69º 48.551	123º 36.811	Algal
fb07	21/06/08	13:02	69º 56.818	125º 53.46	Bacterial
F7	24/06/08	18:49	69º 49.375	123º 38.856	Level One + Algal
FB7	25/06/08	5:37	65º 56.808	125º 53.562	Algal
1200	27/06/08	23:43	71º 32.448	124º 19.818	Bacterial
1280	28/06/08	22:22	71º 3.872	126º 4.34	Bacterial
1208	28/06/08	3:51	71º 3.889	126º 2.807	Level One
434	30/06/08	14:12	70º 10.646	133º 33.192	Bacterial
421	1/7/2008	18:28	71º 28.351	133º 54.175	Algal
435	2/7/2008	21:07	71º 4.256	133º 47.105	Algal
6006	4/7/2008	9:45	72º 39.526	128º 21.628	Level One
2010	5/7/2008	12:16	75º 7.681	120º 23.796	Algal
410	8/7/2008	15:22	71º 41.681	126º 29.698	Bacterial
420	9/7/2008	15:00	71º 3.038	128º 30.647	Algal
416	10/7/2008	5:46	71º 17.303	127º 45.406	Level One

Preliminary Results:
All measurements will be performed on preserved samples either at NIOZ for, flow cytometry of viruses, bacteria and phytoplankton, pulse field gel electrophoresis of the viral community, and transmission electron microscopy to determine levels of infected cells and at University of Laval for DNA, RNA and pigment samples.

2.4. Team 4

2.4.1. Pelagic Food web

Zooplankton, Fish Acoustic and Ecology

PI: Louis Fortier
Participants: Hélen Cloutier (U. Laval), Gérald Darnis (U. Laval), Samuel Lauzon (U. Laval), and Stéphane Thanassekos (U. Laval), and with the help of Alexis Burt (U. Manitoba)
Written by: Gérald Darnis and Stéphane Thanassekos and tables by Hélen Cloutier and Samuel Lauzon

Introduction
The fragmented, thin, and often absent ice cover in the flaw lead allows solar radiation to reach the surface layer of the ocean where it triggers photosynthesis by microscopic algae. Team 4, Pelagic and Benthic Food Web, investigates how and to what extent microalgae growing in the flaw lead are consumed by the zooplankton and reach the benthos and how physical processes affect the abundance, physiology and community structure of zooplanktonic organisms. Our simple hypothesis is that, relative to adjacent ice-covered regions, enhanced algal production in the flaw lead translates into biological hot spots where higher zooplankton and benthos production prevail. We also investigate how the Arctic cod, a central species in the Arctic food web, uses the flaw lead for feeding, overwintering, reproduction, and as a nursery ground for their young stages (http://www.ipy-cfl.ca/page1/page1.html).

General objectives
Our sampling program is derived from that of ArcticNet project 1.4 led by Dr. J.-É. Tremblay (U. Laval), ôMarine productivity and sustained exploitation of emerging fisheriesô, whose overarching goal is to assess the impact of sea-ice cover reduction and increasing sea temperatures on biological productivity, fisheries resources and marine mammal populations of the coastal Canadian Arctic. Since the beginning of the CFL field program last October, we focus on how physical processes moderate biogeochemical processes within the changing northern flaw lead ecosystem in the Amundsen Gulf - Banks Island area. The objectives of team 4 for leg 9 were to continue the work conducted during previous legs from the moon pool and to initiate the open water season by deploying zooplankton nets from the front deck (double (horizontal), quadruple (vertical) 1-m^2 nets, hydrobios and Rectangular Midwater Trawl) and from the zodiac (horizontal 1-m diameter ringnet) along the ice edge. We concentrated our sampling efforts on pelagic secondary producers as well as on larval, and juvenile Arctic cod. Our multidisciplinary ArcticNet-CFL team is strongly linked with Team 7 (Carbon Fluxes ï Tremblay) of the CFL program.

The primary objectives of our team during CFL leg 9 were:
1- To assess zooplankton / fish abundance and diversity by using various sampling devices.
2- To track zooplankton / fish biomass and distribution with the EK60 Echo sounder, and nets.

Our secondary field objectives were to collect and use zooplankton samples to:
1- investigate the cycling of contaminants by zooplankton and fish (G. Stern, U. Manitoba);
2- identify the sources and pathways of omega-3 in the Arctic marine food web (J. Michaud, E. Dewaily and L. Fortier, U. Laval). This project is linked to the CFL-URSUK program and ArcticNet theme 1.5, focusing on the importance of omega-3 fatty acids in the traditional diet of Inuit communities;
3- assess the biomass and respiration rates of the zooplankton community by the Electron Transfer System (ETS) activity at specific stations (G. Darnis and L. Fortier);
4- collect samples for stable isotope analysis of the food web structure and carbon fluxes; this is a joint project between Teams 4 and 7 of CFL (A. Forest, L. Fortier, J-E. Tremblay);

5- measure copepod *in-situ* egg production (EPR) and gonad maturation of *Calanus glacialis*, *C. hyperboreus* and *Metridia longa* (G. Darnis, L. Fortier);
6- validate the daily increment deposition on the otoliths of larval Arctic cod using a fluorescent marker (C. Bouchard, L. Fortier ï conducted by Helen Cloutier during LEG 9).
7- Increase the size of arctic cod larval dataset (length-at-age) in order to validate an individual-based model designed to calculate growth and survival of this species (S. Thanassekos, L. Fortier ï Measurements by Hélen Cloutier and Samuel Lauzon during LEG 9).

Sampling program

Leg 9 started at a landfast ice site in Darnley Bay. This period was devoted to moon pool sampling with at least one 1-m^2 vertical net cast per day and one Hydrobios every three days (Table 1 and 2). While the ship was static in the ice, the team used the hole prepared by the diving team to deploy the 1-m diameter ring net, in order to sample surface water that is typically inaccessible from the moon-pool (Table 3a). This net was also trawled twice during leg 9a and once during leg 9b, horizontally from the zodiac, as close as possible to the marginal ice zone with the objective to catch arctic cod larvae (Table 3b).

Every three-four days, the ship made excursions out of the ice, in open water and open deck activities started on June 10th with a vertical monster net tow (Table 4) and an oblique double Tucker net tow (Table 5). As the Rectangular Midwater Trawl was deployed for the first time after winter during CFL, its preparation delayed its deployment to the 16th of June (Table 6).

Real open water operations began on June 23rd at Full Station 1216, after the installation of the Hydrobios on the front deck. We also had the opportunity to sample for the first time in MôClure strait on July 6th at station 2010.

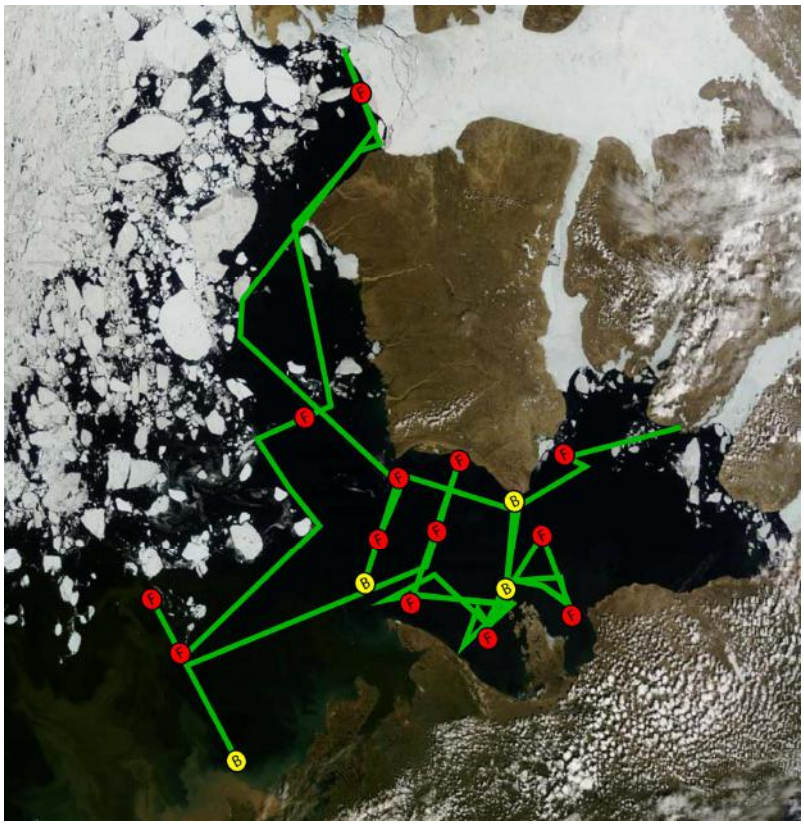

Figure 1. Location of stations (F: Full, B: Basic) visited during CFL leg 9.

Description of the sampling devices used during leg 9

a) **Rosette**. Samples to investigate the vertical distribution of the micro-zooplankton were collected from the rosette twice during leg 9.

b) **1-m² square net**. A 1-m^2 square metal frame rigged with a 200 µm mesh plankton net, an external 10 cm diameter 50 µm net and equipped with a TSK flow meter. This instrument is used to obtain integrated water column samples. Downward and upward winch speeds are 40 and 30 m/min respectively. Quantitative samples from both nets for taxonomy and abundance estimates are preserved in formaldehyde. Qualitative samples (i.e. "live tows") are also collected to obtain animals for contaminants, lipids, EPR and ETS studies.

c) **Hydrobios** (Fig. 2a). Multi-depth plankton profiler equipped with nine 200 µm-mesh nets (opening 0.5 m^2) for depth specific sampling of the water column. The Hydrobios is also equipped with a CTD to record water column properties while collecting biological samples. Downward and upward winch speeds are 40 and 30 m/min respectively. For most casts, the net collection was preserved in formaldehyde for taxonomic analysis. However, the content of each net from some deployments was divided 50% for taxonomy (4% buffered formaldehyde), 25% for biomass estimates and 25% for ETS analysis.

d) **1-m diameter ring net** (Fig. 2b). A 1 m diameter metal ring equipped with a 200 µm mesh net, an external 10 cm diameter 50 µm net, and central G.O. flow. This net was deployed from a hole in the ice at proximity of the ship but at a site not influenced by its presence during LEG 9A. The net was lowered and pulled up manually. The ring net was also trawled horizontally along the ice edge, as close as possible, with a zodiac at a 2 knot speed.

e) **Monster net** (Fig. 2c). Four 1-m^2 metal frames attached together, one rigged with a 1-m^2 500 µm mesh net and a G.O. flow meter for contaminant sampling, one with a 1-m^2 200 µm mesh net and a TSK flow meter for abundance measurements, two with a 1-m^2 200 µm mesh net without a flow meter for "live" sampling, and an external 10 cm diameter 50 µm net. The gear is deployed vertically from 10 meters off the bottom to the surface. Downward and upward winch speeds are 40 and 30 m/min respectively.

f) **Tucker net** (Fig. 2d). Two 1-m^2 metal frames attached together each rigged with a 1-m^2 500 µm mesh net, an external 10 cm diameter 50 µm net and equipped with a TSK flow meter. The gear is deployed obliquely to 90 meters or less (depth determined by cable length and angle). Downward and upward winch speeds are 30 and 20 m/min respectively.

g) **Rectangular Midwater Trawl (RMT,** Fig. 2e**).** Trawl with an opening of 9 m^2 fitted with a 1600 µm mesh-net. When towed, ship speed was typically 2-3 knots; and winch speed down was 30 m/min and around 20 m/min on the way up. This net, only deployed at full stations, was used to catch larval and juvenile fish. Collected zooplankton was equally divided for taxonomic and contaminant studies.

h) **64 µm ring net** (Fig. 2f)**.** This 50-cm diameter aperture net was essentially used to collect live organisms as food for the cod larvae that were incubated for the otolith marking experiment (Helen Cloutier). It was deployed from 30m to surface by hand from either the moonpool or the front deck in open water. It was also used on ice from the dive hole (hole prepared by the diving team during LEG 9A).

Sampling events during leg 9

Overall, 131 sampling events occurred from which 72 samples were preserved for taxonomy. Samples from the "dive tows", were used for further analyses and laboratory experiments as described below. Samples for lipid and stable isotopes analyses were placed in cryovials and stored at -80°C. Other samples were preserved as a *bulk* at -80°C for later gut fluorescence measurements. All these samples will be sorted and analysed at Laval University. Samples for contaminants were sorted and preserved by Alexis Burt (Dr. Stern's team, U. Manitoba).

The first three weeks of leg 9 were spent in the decaying landfast ice in either Darnley or Franklin Bay. The fragility of the ice prevented the deployment of motorised vehicles that would have permitted to pull the nets from ice holes. As a consequence the zooplankton team work on the ice was limited to the deployment of shallow ringnets trawled by hand. Furthermore, when checked the EK 60 recordings did not show any significant presence of fish and fish cage deployment from the moonpool

was therefore cancelled. The few spotted echosounder targets actually proved to be amphipods aggregations as validated by the nets and the diversô observations under the ice. No aggregations were seen at the bottom of the water column. The two landfast ice sites displayed different ecosystem structures. The water column in Darnley bay was characterised by huge sticky aggregates of algae that clogged the nets and suffocated the zooplankton in the samples. Very few Arctic cod larvae were collected at this site. The two fast ice sites were too shallow to give interesting estimates of zooplankton vertical distribution with the Hydrobios. Therefore, the only interesting vertical profiles were limited to the three excursions in deeper waters that were made once a week during leg 9A. Our first significant collection of cod larvae occurred on the 14 June while transiting to Franklin Bay (Table 7). A total number of 1351 larvae were caught during LEG 9, 610 where measured (and around half of these were frozen to measure their fresh un-preserved weight back at university), and 741 were preserved in ethanol. 564 larvae were captured with the double Tucker, 228 with the Monster net and 519 with the RMT. The 200 khz transducer could not be deployed for most of leg 9A because its cable broke and rust built up in the tube to the bottom of the hull before the cable could be changed. As a consequence, data for the 200 khz wavelength of the EK60 could not be recorded for this period.

Leg 9B was mostly devoted to open water sampling. Thirteen Full stations and 4 Basic stations were visited. At a typical full station, the Hydrobios, Monster, Oblique tucker, RMT and 64 µm ringnet were deployed whereas only the Monster, 64 µm ringnet and the Oblique tucker were used at a Basic station. Time between stations was short and the variety of gears, experiments and processing of fish larvae made this sampling period intensive. Thanks to the good weather conditions and the professionalism of crew, team members and chief scientist, all the deployments were made easy and successful. We were able to deploy the Hydrobios below 1000 m (Station 421) for the second time since it is part of the scientific equipment of the Amundsen.

Figure 2. Sampling gear used during CFL leg 9.

a) Hydrobios

b) 1-m^2 ring net, from the dive hole and from the zodiac.

c) 4 x 1-m^2 Monster net

d) 2 x 1-m^2 Tucker net


e) Rectangular Midwater Trawl

f) 64 εm ring net from the dive hole.

Table 1: Summary of sampling activities with the 1-m^2 square net in the moon pool during leg 9.

Date (UTC)	Station	LAT	LONG	Depth	Contaminants	Taxonomy	Lipids	Stable Isotopes Gut fluo	EPR	Respirométry	Live tow
2008-06-07	2008-F7	69°49,45	123°37,97	74		X					
2008-06-07	2008-F7	69°49,46	123°37,98	70							X
2008-06-07	2008-F7	69°49,47	123°37,99	70	X						
2008-06-08	2008-F7	69°49,48	123°37,100	70			X	X			
2008-06-08	2008-F7	69°49,49	123°37,101	70	X						
2008-06-08	2008-F7	69°49,50	123°37,102	70	X						
2008-06-08	2008-F7	69°49,51	123°37,103	70						X	
2008-06-09	2008-F7	69°49,52	123°37,104	70				X			
2008-06-09	2008-F7	69°49,53	123°37,105	70		X					
2008-06-09	2008-F7	69°49,54	123°37,106	30							X
2008-06-09	2008-F7	69°49,55	123°37,107	50							X
2008-06-11	2008-F7	69°49,45	123°37,97	70		X					
2008-06-11	2008-F7	69°49,45	123°37,97	70							
2008-06-11	2008-F7	69°49,45	123°37,97	70							X
2008-06-11	2008-F7	69°49,45	123°37,97	70							X
2008-06-12	2008-F7	69°49,45	123°37,98	70					X		
2008-06-12	2008-F7	69°49,45	123°37,98	70	X						
2008-06-12	2008-F7	69°49,45	123°37,98	70	X						
2008-06-13	2008-F7	69°49,45	123°37,96	70							
2008-06-13	2008-F7	69°49,46	123°37,97	70							X
2008-06-13	2008-F7	69°49,47	123°37,98	70		X					
2008-06-15	FB05	69°57,38	125°52,5	95	X						
2008-06-15	FB05	69°57,38	125°52,5	95				X		X	
2008-06-15	FB05	69°57,38	125°52,5	95		X					
2008-06-18	2008-F7	69°48,9	123°39,0	67		X					
2008-06-18	2008-F7	69°48,9	123°39,0	67			X				
2008-06-18	2008-F7	69°48,9	123°39,0	67				X			
2008-06-19	2008-F7	69°48,9	123°39,0	11	X				X		
2008-06-19	2008-F7	69°48,9	123°39,0	115		X					

2008-06-20	FB07	69°56,72	125°53,36	100							X
2008-06-20	FB07	69°56,72	125°53,36	100	X						
2008-06-21	FB07	69°57,05	125°53,69	100		X					
2008-06-21	FB07	69°57,05	125°53,69	100	X						
2008-06-21	FB07	69°57,05	125°53,69	100					X	X	
2008-06-21	FB07	69°57,05	125°53,69	100							X

Table 2: Summary of sampling activities with the Hydrobios during leg 9.

Date (UTC)	Station	LAT	LONG	Depth	Taxonomy	Lipids	Biomass and ETS
2008-06-07	F7	69°49,45	123°37,97	68	X		X
2008-06-10	405B	70°39,7	122°129,7	560	X		X
2008-06-12	F7	69°49,45	123°37,97	70	X		
2008-06-16	FB06	69°58,836	126°05,295	190	X		X
2008-06-20	FB07	69°56,7	125°53,3	100	X		
2008-06-23	1216	70°36,69	127°25,13	225	X		X
2008-06-28	1200	71°32,72	124°20,30	185	X		X
2008-06-28	1208	71°03,84	126°02,66	395	X		X
2008-07-02	421	71°27,95	133°53,78	1180	X		
2008-07-02	435	71°04,48	133°47,54	285	X		X
2008-07-04	6006	72°39,47	128°21,56	210	X		X
2008-07-06	2010	75°07,28	120°22,89	405	X		X
2008-07-08	410	71°41,96	126°29,18	390	X		X
2008-07-10	416	71°17,25	127°46,06	144	X	X	
2008-07-11	1100	71°02,58	123°15,58	260	X		X
2008-07-13	D34	71°04,65	121°48,76	173	X		

Table 3a: Summary of sampling activities through the ice with the 1-m diameter ring net during leg 9, from the ice.

Date (UTC)	Station	LAT	LONG	Depth	Contaminants	Taxonomy	Live Tow
2008-06-09	F7	69°48,924	123°40,931	20		X	
2008-06-09	F7	69°48,924	123°40,931	20			X
2008-06-09	F7	69°48,924	123°40,931	20			X
2008-06-09	F7	69°48,924	123°40,931	20			X
2008-06-09	F7	69°48,924	123°40,931	20			X
2008-06-12	F7	69°49,45	123°37,98	20		X	
2008-06-12	F7	69°49,45	123°37,98	20			X
2008-06-12	F7	69°49,45	123°37,98	20			X
2008-06-13	F7	69°49,45	123°37,96	20		X	
2008-06-13	F7	69°49,45	123°37,96	20			X
2008-06-20	FB07	69°56,72	125°53,36	20		X	
2008-06-20	FB07	69°56,72	125°53,36	20	X		

Table 3b: Summary of sampling activities through the ice with the 1-m diameter ring net during leg 9, from the zodiac.

Date (UTC)	Station	LAT	LONG	Depth	Taxonomy	Live Tow
2008-06-15	2008-Z1	69°57,38	125°52,5	Surface	X	
2008-06-15	2008-Z1	69°57,38	125°52,5	Surface		X
2008-06-15	2008-Z1	69°57,38	125°52,5	Surface		X
2008-06-15	2008-Z1	69°57,38	125°52,5	Surface		X
2008-06-16	2008-Z2	70°00,76	125°49,55	Surface	X	
2008-06-16	2008-Z2	70°00,76	125°49,55	Surface		X
2008-06-16	2008-Z2	70°00,76	125°49,55	Surface		X
2008-07-06	2008-Z3	74°52,69	120°25,05	Surface		X
2008-07-06	2008-Z3	74°52,69	120°25,05	Surface		X
2008-07-06	2008-Z3	74°52,69	120°25,05	Surface	X	
2008-07-06	2008-Z3	74°52,69	120°25,05	Surface		X
2008-07-06	2008-Z3	74°52,69	120°25,05	Surface		X

Table 4: Summary of open water sampling activities from the front deck with the 4 x 1-m^2 Monster net during leg 9.

Date (UTC)	Station	LAT	LONG	Depth	Contaminants	Taxonomy	Lipids	Stable Isotopes Gut fluo	EPR	Respirometry
2008-06-10	405B	70°39,28	123°00,75	600	X	X	X	X		
2008-06-14	FB01	69°58,963	125°51,080	85	X	X				
2008-06-15	FB03	69°58,033	125°51,880	90	X	X	X	X		X
2008-06-16	FB00	70°00,66	125°50,09	80	X	X				
2008-06-17	HR01	69°56,349	126°41,778	96	X	X				
2008-06-19	F7	69°48,8	123°39,04	113	X	X				
2008-06-23	1216	70°36,9	127°35,2	163	X	X	X	XX		
2008-06-24	F7	69°49,30	123°40,24	69	X	X				
2008-06-25	FB07	69°57,3	125°53,1	98	X	X		X		
2008-06-27	1200	71°32,657	124°19,657	197	X	X				
2008-06-28	1208	71°03,448	126°05,827	393	X	X	X	X		
2008-06-30	434	70°10,998	133°33,710	32	X	X			X	
2008-07-01	421	71°28,1	133°55,3	1165	X	X	X	XX		
2008-07-02	435	71°05,369	133°49,107	328	X	X				
2008-07-04	6006	72°39,57	128°21,15	208		X				
2008-07-04	6006	72°39,78	128°21,29	216	X	X		XX		
2008-07-05	2010	75°07,65	120°24,09	411		X		X		
2008-07-08	410	71°42,11	126°29,27	393	X	X	X	XX	X	
2008-07-09	420	71°03,692	128°30,847	28		X		X		
2008-07-10	416	71°17,36	127°45,50	148	X			X	X	
2008-07-11	1100	71°02,62	123°15,94	270	X	X	X	X		
2008-07-12	1110	70°19,16	124°50,00	82		X		X		
2008-07-13	D34	71°04,628	121°48,931	172		X	X	XX		

Table 5: Summary of open water sampling activities from the front deck with the 2 x 1-m^2 Tucker net during leg 9.

Date (UTC)	Station	LAT	LONG	Depth	Contaminants	Taxonomy	Lipids	Stable Isotopes	EPR	Respirométry
2008-06-10	405B	70°39,32	23°00,38	90		X				X
2008-06-14	FB01	69°59,07	125°51,51	90	X	X				
2008-06-19	F7	69°48,46	123°36,26	90	X	X				
2008-06-23	1216	70°37,08	127°34,97	90	X	X	X	X		
2008-06-24	F7	69°48,924	123°40,931	70	X	X				
2008-06-25	FB07	69°56,05	125°53,7	80	X	X				
2008-06-27	1200	71°32,260	124°19,044	90	X	X				X
2008-06-28	1208	71°03,7	126°05,6	90	X	X				
2008-06-30	434	70°11,007	133°33,509	90	X	X				
2008-07-01	421	71°28,5	133°53,84	90		X			X	
2008-07-02	435	71°04,34	133°47,56	90	X	X				
2008-07-02	435	71°04,45	133°49,43	35	X	X				
2008-07-04	6006	72°39,51	128°21,36	90		X	X	X		X
2008-07-06	2010	76°07,84	120°24,23	90	X	X				
2008-07-08	410	71°41,692	126°29,407	90	X	X				X
2008-07-09	420	71°03,284	128°31,510	25	X	X				
2008-07-10	416	71°17,38	127°45,73	92	X	X				
2008-07-11	1100	71°02,80	123°15,83	92		X				
2008-07-12	1110	70°18,94	124°49,64	64		X				
2008-07-13	D34	71°03,788	121°48,083	92		X				X

Table 6: Summary of sampling activities with the RMT during leg 9.

Date (UTC)	Station	LAT	LONG	Depth	Live Tow
2008-06-16	FB00	70°00,59	125°50,26	60	**X**
2008-06-17	HR01	69°56,1	126°39,6	90	**X**
2008-06-23	HR01	69°58,4	126°37,4	90	**X**
2008-06-18	F7	69°50,312	123°40,798	30	**X**
2008-06-23	1216	70°36,69	127°25,13	90	**X**
2008-06-28	1208	71°32,62	124°19,43	90	**X**
2008-06-28	1200	71°03,6	126°06,5	90	**X**
2008-07-01	421	71°28,18	133°54,44	90	**X**
2008-07-04	6006	72°39,594	128°21,690	90	**X**
2008-07-06	2010	75°07,6	120°24,7	90	**X**
2008-07-08	410	71°42,048	126°29,642	90	**X**
2008-07-10	416	71°17,827	127°45,648	90	**X**
2008-07-13	D34	71°04,437	621°48,368	92	**X**

Table 7: Summary of larval arctic cod captures during LEG 9 (610 measured, 741 preserved, 1351 total).

Station	Date	Net	mesh	n measured	n preserved
F7	07-06-2008	ringnet 64µ	64	1	x
FB01	14-06-2008	2x1m2 Otow	500	51	51
FB01	14-06-2008	4x1m2 Vtow	200	3	x
FB03	15-06-2008	4x1m2 vtow	200	55	115
FB05	15-06-2008	1m2 vtow	200	8	x
2008-Z1	15-06-2008	Ringnet Zodiac	200	16	x
FB00	16-06-2008	4x1m2 vtow	200	7	x
2008-Z2	16-06-2008	Ringnet Zodiac	200	6	x
FB00	16-06-2008	RMT	1600	10	x
HR01	17-06-2008	RMT	1600	25	17
F7-Ice Edge	19-06-2008	2x1m2 Otow	500	26	37
F7-Ice Edge	19-06-2008	4x1m2 Vtow	200	25	6
2008-FB7	20-06-2008	4x1m2 Vtow	200	6	x
1216	23-06-2008	2x1m2 Otow	500	12	x
1216	23-06-2008	RMT	1600	1	x
2008-F7	24-06-2008	4x1m2 Vtow	200	3	x
2008-F7	24-06-2008	2x1m2 Otow	500	22	x
FB07	25-06-2008	4x1m2 Vtow	200	10	x
FB07	25-06-2008	2x1m2 Otow	500	18	x
1200	27-06-2008	2x1m2 Otow	500	25	x
1200	28-06-2008	RMT	1600	28	58
1208	29-06-2008	2x1m2 Otow	500	25	20
1208	29-06-2008	RMT	1600	5	x
434	30-06-2008	2x1m2 Otow	500	1	x
421	1-07-2008	RMT	1600	18	226
421	1-07-2008	2x1m2 Otow	500	17	x
421	1-07-2008	hydrobios	200	1	x
435	2-07-2008	hydrobios	200	1	x
435	2-07-2008	4x1m2 Vtow	64	1	x
435	2-07-2008	2x1m2 Otow	500	25	151
6006	4-07-2008	RMT	1600	9	x
410	8-07-2008	RMT	1600	16	4
410	8-07-2008	2x1m2 Otow	500	4	x
420	9-07-2008	2x1m2 Otow	500	23	5
420	9-07-2008	4x1m2 Vtow	200	1	x
416	10-07-2008	RMT	1600	26	x
416	10-07-2008	2x1m2 Otow	500	7	x
1100	11-07-2008	2x1m2 Otow	500	10	x
1100	11-07-2008	4x1m2 Vtow	200	3	x
1110	12-07-2008	2x1m2 Otow	500	10	x
D34	13-07-2008	RMT	1600	25	51

D34	13-07-2008	2x1m2 Otow	500	24	x

Laboratory analyses

1) **Egg production rate experiments (EPR)**
   Copepod *in-situ* egg production rate (EPR) were monitored by incubating the females of two species (*Calanus glacialis* and *Metridia longa*) at 0°C, a temperature similar to that they experience in their environment. The results from the experiments conducted during leg 8 showed that the egg production season is over for *C. hyperboreus* but still underway for *C. glacialis* and *Metridia longa* and continued on leg 9. Often, poor abundance of females *C. glacialis* and the high concentration of algae in the zooplankton samples limited our capacity to sort enough organisms for the EPR experiments. Thus the number of experiments is lower than for the previous legs for this species.
2) **Biomass and Transfer System (ETS) activity**
   Samples were sorted for biomass and ETS activity assays at 11 Hydrobios stations (Table 2). At these stations, each Hydrobios net was subdivided: 50% for taxonomy (i.e. preserved in formol), 25% for population biomass estimates and 25% for ETS activity measurements. For biomass estimates, the sub-sample (i.e. 25% of total sample) was fractionated with sieves in > 1000 µm and < 1000 µm size classes; these fractions were preserved at -0ęC. Sub-samples for zooplankton population ETS activity assays (i.e. 25% of the total sample) were also sieved through the same two size fractions. As no Sanyo incubator was available for the ETS experiments, samples were incubated in a Pyrex plate filled with water and heated to 40ęC on a hot plate. Temperature of this ôhot tubô proved to remain constant during the required incubation time. ETS experiments were also performed on individual copepods (females and copepodite stage 5) of *Calanus glacialis*, *C. hyperboreus* and *Metridia longa*.
3) **Respiration experiments**
   To derive respiration from the activity of the Electron Transfer System (ETS), a ratio of respiration on ETS activity is required. Thus eight incubations were carried out to measure oxygen consumption of zooplankton assemblages and selected copepods species in sealed chambers.

Acoustic monitoring

The Simrad EK-60 Echosounder of the Amundsen allows our group to continuously monitor the spatial and vertical distribution of zooplankton and fish, the later mostly represented by Arctic cod (*Boreogadus saida*). The hull-mounted transducers are in operation 24h a day and will provide an extensive mapping of where the fishes are within the region of interest over a yearly cycle.

General Recommendations:

For an unknown reason, the lab incubator had a warming episode (up to 16°C) despite regular defrosts and no door opening (that happened early in the morning before anybody had come to the lab for that day). Continual monitoring of the incubator and defrosting every day, especially if the door is opened often, should be accomplished.

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2.4.2. Benthic Food web

PIs: *Team 4* (Food webs): Philippe Archambault (University of Quebec at Rimouski, Canada) and Dieter Piepenburg, (University of Kiel, Germany); *Team 7* (Carbon and Nutrient Fluxes): Paul Renaud, (Akvaplan-niva, Norway), and Tobias Tamelander (University of Tromsø, Norway)

Participants: Heike Link (9A and 9B), University of Quebec at Rimouski, Mylène Bourque (9B), University of Quebec at Rimouski

Background

On leg 9, the benthic work was continued according to the activities of the team from legs 3, 7, and 8 as part of Team 4 (Food webs) and Team 7 (Carbon and nutrient fluxes). This included deployments of the box corer and grab for retrieving seafloor sediments and the Agassiz trawl for sampling epibenthic communities.

The research is based on the hypothesis that sea ice dynamics control the trophic structure and vertical fluxes and, hence, the 1) strength of pelagic-benthic coupling as well as 2) abundance, composition, diversity, and carbon demand of the benthic communities, which should therefore differ between the flaw lead polynya and the (ice-covered) rest of the shelf. This means, vice versa, that a comparative quantitative inventory of the benthic community structure and metabolism under the flaw lead and the land-fast ice will allow for assessing the effect of the ice regime on pelagic-benthic coupling. Furthermore, the work will contribute to the overarching objective to describe and compare the biodiversity and secondary productivity of benthic communities in areas of enhanced and reduced (ñhot spotsò and ñcold spotsò) productivity and diversity in the Canadian Arctic.

The spatial distribution and seasonal dynamics of the benthic community structure and metabolism is planned to be characterized by repeated sampling over a pre-defined sampling grid throughout a large part of the CFL study period. Samples have been collected during leg 3 in October/November 2007, and since leg 7, starting in March 2008. The field work will be continued during the following leg 10, thus covering a period of time from March to August 2008 and forming a time series of the seasonal patterns of benthic community structure and metabolism. As the sampling is intended to embrace a broad range of benthic size groups (to describe the benthos as comprehensive as possible), a variety of sampling gear will be employed (box corer, grab, Agassiz trawl, epibenthic sled, ROV).

The **box corer** is deployed to quantitatively sample macrobenthic infauna (team 4) and obtain sediment cores which are used to determine sediment properties and the carbon utilization and nutrient recycling by the benthic community (team 7). The second objective contributes to the overall team 7 goal to comparatively quantify major fluxes and pathways of carbon and nutrients over the annual cycle in the flaw lead and fast-ice regions. Within this context, the contribution of the benthos in the overall marine carbon flux will be estimated by determining the carbon demand of the seabed fauna. This, in turn, will be assessed by measuring the sediment oxygen uptake, i.e. by incubating sediment cores and following the decrease of dissolved oxygen in the ambient overlying water with time. These measurements provide a bulk parameter, commonly termed the 'sediment oxygen demand' (SOD), integrating total aerobic respiration of the community of benthic organisms contained in the core.
At the same time, changes in nutrient concentration for ammonia, nitrate, nitrite, silicate and phosphate in the ambient water are measured, to gain first knowledge on the role of benthic activity for the nutrient cycles in Arctic waters.

The **Agassiz trawl** is used to survey epibenthic diversity and abundance of species. Where possible, this data should be compared to visual surveys conducted by the ROV.

The **ROV** work is aimed on an analysis of the epibenthic macro- and megafauna, in order to complement concomitant survey work, using the box corer, targeting other smaller size groups of the benthic assemblages (e.g., endobenthic macrofauna).

Material and Methods

The box corer was deployed at 14 stations (Table 1) between MðClure Strait and the Amundsen Gulf south-east of Banks Island at water depths ranging from 45 to 563 m between 10 June and 13 July 2008.

From 12 box corers, seafloor sediments were collected with a total of five replicate sub-cores (with a diameter of 11.5 cm, i.e., an area of 0.1 m^2 each, down to sediment depths of 15 to 20 cm) for subsequent on-board SOD incubations. Three sediment cores with a 10.0 cm diameter, 15 cm depth, were collected for onboard bioturbation experiments. In addition, three sub-cores for chlorophyll *a* (diameter of 5 cm each) and three sub-cores for CN analyses (2.54 cm diameter each) were taken from each box core. Sub-cores for chlorophyll *a* were sliced in 1 cm sections to 10 cm depth. For CN, the top 2 cm were collected. These samples were frozen and transported off the ship for analyses in the home lab. (Fig. 1)

From two box corers and four grabs, sediments of a surface area of 0.125 m^2, varying 10-15 cm in depth were collected and passed through a 500 mesh sieve and preserved in a 10% buffered seawater formalin solution for further identification in the laboratory.

Incubations of sediment sub-cores were performed in a dark and temperature controlled room (ca. 3 °C) in the zooplankton container (front deck, port side). The decrease in oxygen concentrations in the water overlying the sediment (bottom water collected from rosette water samples obtained at the same station) in the incubation cores was measured periodically (6-8 h intervals) over 1-3 days to assess SOD.

Nutrient samples from the ambient water were taken at the start of incubations (ca. 100 % oxygen in the water), at midway (ca. 90 % oxygen), and at the end of incubations (ca. 80 % oxygen). Except ammonia, nutrient concentration was analysed by Jean-Eric Tremblayôs Team onboard.

Fig. 1: Boxcore with SOD/Nutrient cores (grey), bioturbation cores (white), Chlorophyll a cores (orange), CN cores (syringes), and a biomarker core (black).

Three incubation cores containing water only acted as controls. At the end of the incubations (after 15 to 20% of the oxygen has been consumed), the sediment in the cores was sieved on a 0.5 mm mesh sieve, and the sieve residue, including fauna, was preserved in a 10% buffered seawater-formalin solution for later analyses of species composition, abundance and biomass.
For bioturbation experiments, luminophores were added to the sediment surface and then cores were held with oxygen saturated overlying water for 10 days in the incubation room. At the end, cores were sliced in 0.5 cm slices for the first 3 cm, and the 1 cm slices until the bottom of the core. Samples were frozen and transported to the home lab for further analyses.

Table 1: Benthic sampling stations during leg 9, with number of cores collected for Sediment Oxygen Demand (SOD), bioturbation experiments, Chlorophyll a (Chl), CN, number of samples for diversity, and type of samples for other groups (Biomarkers, Contaminants).

Station	Date	Depth	Position				Equipment	SOD/Nutrients	Bioturbation	Chl	CN	Diversity	Biomarkers	Contaminants	Comment
405B	10.06.2008	563	70°39.8	N	123°00.5	W	Box corer		4		3		core	surface	
		546	70°40	N	123°00.6	W	Box corer	5			3			surface	
1116	14.06.2008	230	70°02.5	N	126°16.6	W	Box corer	5	3	3	3			surface	
FB3	16.06.2008	97	69°58.08	N	125°51.71	W	Box corer	5	3	3	3		core	surface	
		97	69°58.30	N	125°51.41	W	Agassiz trawl					1			10 min
DB01	19.06.2008	95	69°49.61	N	123°36.25	W	Box corer	5	3	3	3		core	surface	
1216	23.06.2008	151	70°36.89	N	127°36.95	W	Box corer	5	3	3	3		core	surface	
F7		83	69°49.54	N	123°37.93	W	Agassiz trawl					1			9 min
1200	27.06.2008	207	71°32.6	N	124°19.5	W	Agassiz trawl					1			5 min
		207	71°31.9	N	124°17.8	W	Box corer	5	3	3	3		surface	surface	
1208	28.06.2008	400	71°03.79	N	126°11.12	W	Agassiz trawl					1			9 min
434	30.06.2008	45	70°10.6	N	133°32.2	W	Box corer	5	3	3	3		surface	surface	
		45	70°10.7	N	133°33.1	W	Agassiz trawl					1			5 min
435	02.07.2008	312	71°04.89	N	133°48.83	W	Agassiz trawl								empty
		318	71°04.30	N	133°52.58	W	Box corer	5	3	3	3		surface	surface	
6006	04.07.2008	219	72°39.2	N	128°19.39	W	Box corer					1	core	surface	
2010	06.07.2008	420	75°07.75	N	120°26.14	W	Agassiz trawl					1			10 min
9002	07.07.2008	219	74°17.85	N	125°22.53	W	Box corer	5		3	3		surface	surface	
410	08.07.2008	402	71°42.235	N	126°29.14	W	Box corer					1	core	surface	
		388	71°42.53	N	126°29.04	W	Agassiz trawl					1			10 min
420	09.07.2008	43	71°03.59	N	128°31.10	W	Grab					3		surface	
416		160	71°18.68	N	127°49.76	W	Agassiz trawl					1			7 min
		158	71°17.36	N	127°45.64	W	Box corer	5	3	3	3		core	surface	
1110	12.07.2008	92	70°19.16	N	124°50.9	W	Agassiz trawl					1			5 min
		93	70°19.20	N	124°50.80	W	Grab					1	surface		
D34	13.07.2008	183	71°04.59	N	121°48.77	W	Agassiz trawl					1			10 min
		186	71°04.18	N	121°49.37	W	Box corer	5		3	3		core	surface	

The **Agassiz trawl** was successfully deployed at a total of 10 stations between Mc Lure Strait and the Amundsen Gulf south-east of Banks Island at water depths ranging from 45 m to 420 m. Species were counted or estimated in abundance and identified to the lowest possible taxonomic level. Some specimens were preserved for further identification in the home lab.
The **ROV** was not deployed during leg 9.

Preliminary Results
Benthic communities showed a generally higher SOD than in leg 7 and 8. During this leg, we revisited and sampled the stations D34, 9002, and 405B for SOD. At all three stations, oxygen consumption had strongly increased compared to the results at these stations from leg 7 or 8. These results reflect the increase in benthic metabolic activity after the algal bloom and the associated sinking of organic material to the seafloor. However, data still need to be analysed more thoroughly, taking temperature and benthic biomass changes into account.
Diversity and abundance of epibenthic communities sampled by the Agassiz trawl varied between sites. At 2 rocky sites, crinoids (*Heliometra sp.*) were dominating, whereas several species of ophiurids predominated on homogenous soft-bottom sediments. At the rocky but deep (420 m) station 2010, *Ophiura sarsi* was the most abundant species.
Beside other polychaetes, molluscs, pycnogonids, sipunculids, decapods, amphipods, holothuroids, asteroids, and bryozoans, *Ctenodiscus crispatus* (Asteroidea), *Mesidothea sp.* (Isopoda) and *Astarte sp.* (Bivalvia) were found at several sites. Closer identification and analyses of assemblage composition will be conducted after the end of the field work.

2.5. Team 6

Participants: *(in alphabetical order)* Brent Else (U of M, Canada), Silvia Gremes-Cordero (RSMAS, UM, USA), Nicolas-Xavier Geilfus (Ulb ï Belgium)

2.5.1. Surface Meteorology and Flux Project

Introduction
The surface meteorology and flux program (CFL Team 6) is designed to record basic meteorological conditions and to study exchanges of momentum, heat and mass across the atmosphere-sea ice-ocean interface. The main value of this program to the overarching objectives of Team 6 is the direct measurement of CO_2 fluxes.

Turbulent fluxes of CO_2 are measured by the eddy covariance technique, which is dependent only on atmospheric measurements. Although measurement of these fluxes is extremely useful information, it is essentially meaningless without an understanding of the processes (physical, biological and chemical) that drive gas exchange. In an open-ocean situation this context is largely provided by measurement of sea-surface pCO_2, but the situation becomes much more complex when a sea ice cover is included in the equation.

This section of the CFL Team 6 cruise report reviews the atmospheric and sea surface pCO_2 measurements that were made during Leg 9. Other sections of the annual report will deal with the sea ice measurements that were made in support of the CO_2 flux measurements.

Amundsen Micrometeorology and Eddy Covariance Flux Tower

Methods
The micrometeorological tower located on the front deck of the Amundsen (Figure 1) provided continuous monitoring of meteorological variables and eddy covariance parameters. The tower consists of slow response sensors that record bulk meteorological conditions (air temperature, humidity, wind speed/direction, surface temperature) and fast response sensors that record the eddy

covariance parameters (CO_2/H_2O concentration, 3D wind velocity, 3D ship motion, air temperature) (Table 1). In addition, radiation sensors (Figure 1, Table 1) were installed on the roof of the wheelhouse to provide information on incoming longwave, shortwave and photosynethetically active radiation. All data was logged to Campbell Scientific dataloggers; a model CR5000 logger was used for the eddy covariance data, a CR1000 logger for the slow response met data, and a CR23X for the radiation data. All loggers were synchronized to UTC time using the shipôs GPS system as a reference.

The eddy covariance system on the tower makes use of two separate gas analyzers and a single 3D sonic anemometer. The dual gas analyzers system allows us to make use of both closed path and open path eddy covariance systems. The open path gas analyzer has the benefit of making measurements concurrently with the sonic anemometer, but the closed path gas analyzer is not as easily disturbed by adverse weather conditions.

In order to make sure that the two systems are comparable, careful calibrations were performed on both instruments. The closed path system is based on a LI-7000 gas analyzer which employs two optical cells, one of which was used to monitor the drift of the instrument by constantly passing a stream of ultra-high purity N_2. In addition, the sample cell of the instrument was calibrated daily using the ultra-high purity N_2 to zero the CO_2 and H_2O measurements, and a reference gas of known CO_2 to span the instrument. Occasionally, a span calibration of the H_2O sensor was performed using a dew point generator (model LI-610).

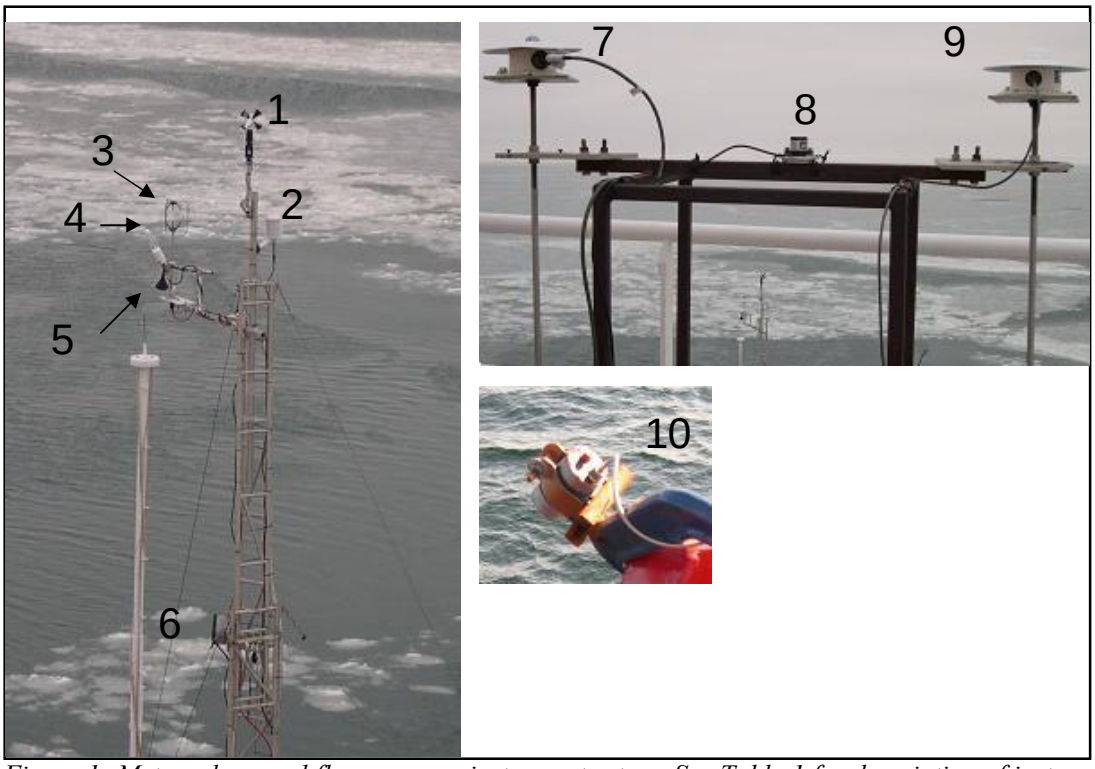

Figure 1: Meteorology and flux program instrument setup. See Table 1 for description of instruments based on the numbers. Note that on Nov. 18 the Motion Pak (6) was moved to the rear face of the tower to facilitate easier motion correction.

Table 1: Description of instruments shown in Fig. 1.

Fig 1	Sensor	Variables	Units	Ht from deck (m)	Scan (s) / Ave (min)	Specs
1	wind monitor (RMYoung 05103)	wind speed/ direction	m/s; º	8.45	2/1	±0.6 m/s ±3º deg
2	temperature/relative humidity probe (Vasailla HMP45C212)	T and RH	ºC; %	7.53	2/1	Humidity ±2% 0-90% @ 20ºC ±3% 90-100% @ 20ºC 0.05% RH/ºC Temperature ± 0.1 ºC
3	3D wind velocity (Gill R3 ultra-sonic anemometer)	u,v,w, speed of sound (SOS)	m/s	7.1	10 Hz	RMS noise <1% offset <0.01 m/s SOS < 0.5% accuracy
4	LI7500 open path gas analyzer	CO_2/H_2O	µmol/ m^3 mmol/ m^3	7.1	10 Hz	RMS noise ±0.1 µmol/mol zero drift 0.1 µmol/mol/ºC gain drift 0.1%/ºC
5 (inlet, analyzer not show	LI7000 closed path gas analyzer	CO_2/H_2O	µmol/ m^3 mmol/ m	inlet at 7.1	10 Hz	RMS noise ±0.1 µmol/mol zero drift 0.3 µmol/mol/ºC gain drift 0.2%/ºC
6	multi-axis inertial sensor (MotionPak, Systron Donner)	rate x,y,z accel x,y,z	º/s; g	6.48	10 Hz	rate <0.004º/s acc <10 µg
7	pyranometer (Eppley, model PSP)	SW_in	W/m^2	7.0	2/1	~±5%
8	quantum sensor (Kipp & Zonen, PARLite	PAR	µmol/ m^2/s^1	7.6	2/1	~±5%
9	pyrgeometer (Eppley, model PIR)	LW_in	W/m^2	7.0	2/1	~±10%
10	surface temperature (Everest infrared transduc model 4000.44ZL)	Tsrfc	ºC	1.6 m	3/1	±0.5 ºC accuracy
not show	pressure transducer (RM Young, 61205V)	Patm	kPa		2/1	

Notes

The meteorological tower ran consistently for the duration of the leg (June 5 ï July 16) with the exception of brief periods when the tower was taken down for maintenance. However, for significant periods of time during the leg certain sensors were inoperable due to atmospheric conditions. The most common problem encountered during this leg was riming due to the cold, moist conditions. The extent of data lost due to atmospheric conditions cannot be estimated at this time, and will only be known once post processing is complete.

Ice-Based Micrometeorology and Eddy Covariance Flux Tower

Methods

A portable 2m tower was deployed on the ice in close proximity to the ship to measure meteorological data in conjunction with the data collected on the ship-based tower (Figure 2). The tower consisted of slow response meteorological instruments (wind speed/direction, air temperature, relative humidity, surface temperature, upwelling and downwelling shortwave and longwave radiation) and fast response flux instruments (3 dimensional wind velocity, sonic temperature, CO_2/H_2O fluctuations from open and closed path sensors). All data was logged using a Campbell Scientific CR3000 datalogger that was synchronized to UTC time using the shipôs GPS system.

Figure 2: The portable ice meteorology/flux station. For this deployment, the closed path sensor and radiation sensors were not included. They were included in later deployments (see Table 2).

Deployments

Table 2: Site and deployment information for ice-based meteorology tower

Deployment Date (UTC)	Removal Date (UTC)	Notes
Jun. 11, 20:50	Jun. 14, 03:35	No radiation sensors. Closed path eddy covariance system installed June 12, 15:40.
Jun. 18, 17:50	Jun. 19, 12:00	Tower located ~150m southeast of ship (shipôs heading 90º); radiation sensors located ~8m west of main tower; sonic anemometer pointing to east

On-track pCO2 System

Methods

A custom-built pCO_2 system was utilized on this leg to measure dissolved CO_2 at the sea surface in near real time. The system (Figure 3) is located in the engine room of the Amundsen, and draws sample water from the shipôs clean water intake. The water is passed into a sealed container through a shower head, maintaining a constant headspace. This set up allows the air in the headspace to come into equilibrium with the CO_2 concentration of the seawater, and the air is then cycled from the container into a LI-7000 gas analyzer in a closed loop. Thermocouples are used to measure water temperature immediately before entering the equilibration chamber, and to measure the temperature of the air in the chamber. All data is logged to a Campbell Scientific CR1000 datalogger.

The LI-7000 gas analyzer was calibrated daily using ultra-high purity N_2 as a zero gas, and a gas with known CO_2 concentration as a span gas. Spanning of the H_2O sensor was not necessary because a desiccant column removes H_2O from the air stream before passing into the sample cell. As with the closed path system, a stream of N_2 is constantly cycled through the reference cell of the LI-7000 to monitor and correct for drift of the instrument.

Figure 3: The on-track pCO_2 system located in the engine room of the Amundsen. The equilibration chamber is the clear cylinder (left bottom) and the gas analyzer is the box with the digital display.

Notes
The on-track pCO_2 system was active for the duration of the leg, with some minor interruptions for maintenance. Major interruptions in data collection were experienced when the ship was breaking ice, which either reduced the flow of water into the equilibration tank, or completely blocked it. In the case of blocked flow, the data is lost, but tests will have to be conducted to determine if data obtained with low water flow is useful.

During this leg, we expanded testing of the accuracy of the system by drawing samples from the water inlet line for DIC analysis. This was conducted 4 times throughout the cruise. Preliminary results suggest that the pCO_2 values calculated from the DIC samples match very well with the equilibrator values.

2.5.2. Sea Ice Biogeochemistry

In-Situ measurements and Ice Core Collection

In order to get a set of biogeochemical variables that will help us understand the dynamics of processes happening in sea ice and seawater, we collected ice cores for further analysis in both Winnipeg, Brussels and Liege labs. Basically, we took between 10 and 12 cores at each station. A major concern throughout the whole sampling procedure has been to prevent contamination of trace metal samples, especially iron. We followed the trace metal clean procedures proposed by Lannuzel et al. (2007). Nitrile gloves were used for handling the iron dedicated samples, and items used for sample collection and storage were acid-cleaned and sealed in plastic bags. The electropolished stainless steel core barrel (Lichtert Industries, Brussels, Belgium) has been specially designed and tested to be non-contaminant for iron. Seawater was pumped up with a portable peristaltic pump (Cole-Parmer, Masterflex E/P). Finally, the sea ice cores dedicated to iron determination were immediately packed in cleaned plastic bags and stored at minus 25 degrees Celsius.

Additionally, we measured a couple of standard variables in the field (e.g., freeboard, snow thickness, snow temperature). A complete list of the variables for the leg 9 is presented in Table 3.

Table 3: Summary of variables collected from snow/sea ice/brine/seawater samples

Fluxes	Bell	7-juin	9-juin	12-juin	19-juin
Snow	T/S/Chl	DM	DM	DM	DM
	O18	AO	AO	AO	AO
Ice Cores	Temperature/ salinity/18O/Chl	ULB			
	Fabrics	AO	AO	AO	AO
	Nutrients	UoM	UoM	UoM	UoM
	Iron		ULB	ULB	ULB
	Trace Metals		ULB	ULB	ULB
	DMS,P,O (ULB)		ULB	ULB	ULB
	Total gas: O2, N2, CH4, Ar, CO2	ULB	ULB	ULB	ULB
	pCO2 of bulk ice	ULB	ULB	ULB	ULB
	TA & DIC (centrifugation)		ULB	ULB	ULB
	CaCO3		ULB	ULB	ULB
	DMS,P,O (UoM)	ULB	ULB	ULB	ULB
	Brine composition	ULB	ULB	ULB	ULB
Brine Sack holes	direct pCO2		ULB	ULB	ULB
	TA/DIC (Vindta)	DM	DM	DM	DM
	pCO2/DIC (Stenton Method)	AO	AO	AO	AO
	O18	UoM	UoM	UoM	UoM
	T/S/Chl	ULB	ULB	ULB	ULB
	DMS	AO	AO	AO	AO
Sea Water	direct pCO2	ULB	ULB	ULB	ULB
	TA/DIC (Vindta)	DM	DM	DM	DM
	pCO2/DIC (Stenton Method)	AO	AO	AO	AO
	T/S/Chl/O18	UoM	UoM	UoM	UoM
	DMS	AO	AO	AO	AO
	O18	ULB	ULB	ULB	ULB
		ULB	ULB	ULB	ULB

DM	Direct measurement
AO	Analyzed onboard
UoM	Ice cores /liquid phase sampled for subsequent analysis at the University of Manitoba
ULB	Ice cores / liquid phase sampled for subsequent analysis at the Université Libre de Bruxelles
Ulg	Ice cores sampled for subsequent analysis at the Universite de Liège
OG	measurements carried by other groups

Table 4: List of the different station sampled during leg 9.

7-juin	Darnley Bay F6
9-juin	Darnley Bay F6
12-juin	Darnley Bay F6
18-juin	Darnley Bay F7

Brine and Seawater Samples

Sampling of brine from the sea ice was conducted by drilling shallow sackholes (ranging from 20 cm down to almost full ice thickness) through the surface of the ice sheet. The brine from adjacent brine channel and pockets was allowed to seep into the sackhole for 15-120 min (depending on ice temperature), with the hole covered with a plastic lid (Gleitz et al., 1995), reportedly the best current method to sample brines for chemical studies (Papadimitriou et al., 2004). Brine and sea water were pumped from the hole using a peristaltic pump (Masterflex® - Environmental Sampler).

Samples for alkalinity (TA), dissolved inorganic carbon (DIC), chlorophyll (chl), pCO_2, temperature, salinity, O^{18}, and DMS were taken.

Analysis for DIC and TA was performed using the VINDTA 3C (Versatile Instrument for the Determination of Titration Alkalinity) developed by Marianda (see section 4).

Chlorophyll, temperature and salinity were also measured immediately onboard (AO).

The samples for O^{18} and DMS will be sent back to Brussels and analyzed.

The pCO2 was measured directly on the field using the Sea Ice Equilibrator System (SIES). This device allows measurement of pCO_2 by utilizing a membrane contractor equilibrator (Membrana® Liqui-cell) coupled to an infrared gas analyzer (IRGA, Li-Cor® 6262). All instrumentation of the SIES unit were enclosed in an insulated box that contained a 12V power source and was warmed to keep the inside temperature just above 0°C. Seawater flow through the equilibrator at a rate of 1 L min^{-1} and a closed air loop ensures circulation through the equilibrator and the IRGA at a rate of 3 L min^{-1}. Temperatures were measured in situ simultaneously in the brine sackhole and at the outlet of the SIES unit. A temperature correction of the pCO_2 was applied assuming that the relation from Copin-Montégut (1988) is valid at low temperatures and high salinities. The IRGA was calibrated using CO_2-in-air standards with mixing rations of 0 ppm and 369.4 ppm of CO_2 supplied by Air Liquide Belgium® shortly after returning to the ship (while the IRGA was still cold). Stable field pCO_2 readings could take considerable time to obtain (up to 1 hour from turning on the flow of gas) especially when pCO_2 values were low in the brine.

Gas chamber measurements

A chamber coupled to the SIES was used to measure air-ice CO_2 fluxes. The accumulation chamber (West system®) is a metal cylinder closed at the top (internal diameter 20 cm; internal height 9.7 cm). A rubber seal surrounded by a serrated-edge iron ring ensured an air-tight connection between the base of the chamber and the ice. For measurement over snow, an iron tube was mounted at the base of the chamber to enclose the sampled snow down to the ice and to prevent lateral advection of air through the snow. The chamber was connected in a closed loop between the air pump (3 L min^{-1}) and the IRGA of the SIES. The measurement of pCO_2 in the chamber was recorded every 30 sec for at least 10 min. The flux was computed from the slope of the linear regression of pCO_2 against time (r^2 Ó~ 0.99) according to Frankignoulle (1988). The uncertainty of the flux computation due to the standard error on the regression slope is on average ±3%. CO_2 fluxes values correspond to the average of three measurements. The idea is to look at the changes in the pCO_2 between the beginning and the end of the

gas chamber deployment. Any increase in this pCO_2 can then be understood as a positive flux from the ice ï any decrease as a negative flux.

We did several gas chamber measurements during the main coring stations but also during small punctual stations. In order to investigate the influence of the ice properties on the fluxes, we put the chamber on different ice types and thicknesses.

Ice Cores

All the ice cores are stored in a freezer container onboard.

In the field temperature of the ice is taken directly after the extraction of an ice core. After, on the same ice core we cut it each 5 cm to measure salinity but also chlorophyll, and to take samples for O^{18}. Towards the end of the leg, when the sea ice was warm and significant brine drainage occurred after sample removal from the core hole, ice cores were cut into 5 cm segments and placed in buckets immediately in the field.

Onboard, the ice core was melted in a cold room at +4°C for the study of minerals of $CaCO_3$ and ikaite. The melt water was filtrated on a GF/F and the filter was stored in the freezer container for further analysis back in Belgium.

DMS/P/O contents in sea ice, brine and water

Material and methods
The purpose of the DMS/P/O project is to measure the DMS/P/O contents in sea ice, brine and water during leg 8 and 9a in order to determine the dynamics of those compounds in the ice and between the mediums. Another point of interest is to follow the evolution of those concentrations over time and to look at the potential interactions and influences of the biogeochemistry of sea ice on DMS/P/O. The work is undertaken in collaboration with Dr. Maurice Levasseur (U.Laval).

Basically, we took ice cores, brine and water samples at different locations representing different ice types and thicknesses. Ice samples were taken using a electropolished stainless steel corer and liquid samples were put into air tight vials with the help of a peristaltic pump or syringes. The vials were stored in the dark at 4 ºC before analysis to minimize biological activity.

Liquid samples (DMSP and water/brines samples) were analyzed with the Purge and Trap system and the GC. This system uses helium as a carrier gas to remove all the DMS from the container and to accumulate it into a teflon loop immerged into liquid nitrogen in order to capture the DMS. When all the DMS is trapped the loop is put into hot water and all the gas is released into a gas chromatography system (GC Varian with a six way valve, a column specific for sulfur and a PFPD detector).

During leg 9a, all the liquid samples from brine and sea water were analyzed on the ship.

2.5.3. Laser Wave System (LAWAS) Project

The University of Miami LAWAS consists of 4 Riegl LD90-3 laser altimeters mounted in a square array of 0.3m diameter. LAWAS is mounted on a boom near the bow on the port side (see Fig. 4). A Systron Donner MotionPak is mounted at the center of the array to measure all six components of motion of the laser array.

Fig. 4 Photographs showing LAWAS position near bow of Amundsen.

The LAWAS system is designed to measure time series of wave slope in two directions, from which rms slope of the sea surface can be calculated. Of particular interest are measurements coincident with Quiksat overpasses. Typically eight overpasses occur each day, between 01 ï 13 UTC. The project objective is to relate CO2 gas transfer to Quikscat derived backscatter measurements. LAWAS deployments took place on June 27th, 28th,30th , July 2nd, 6th ,7th , 8th, 9th , 10th , and 12th during several satellite passages each time. Data was obtained during stations, but also at full ship speed and at 7 knots (maximum ship speed before bow-generated wake appears).

2.6. Team 7

The Arctic climate displays high inter-annual variability and decadal oscillations that modulate growth conditions for marine primary producers. Much deeper perturbations recently became evident in conjunction with globally rising CO_2 levels and temperatures (ACIA 2004; Comiso 2003). The thickness and extent of Arctic sea-ice decrease rapidly (Johannessen et al. 1999; Rothrock et al. 1999) and the ice-free season is extending both in the Arctic (Laxon et al. 2003) and subarctic (Stabeno & Overland 2001). Models predict further reductions in ice cover (ACIA 2004). These changes entail a greater penetration of light into surface waters, which is expected to bolster phytoplankton production (Rysgaard et al. 1999), food web productivity and CO_2 drawdown by the ocean. At present, phytoplankton production varies by two orders of magnitude across the Canadian Arctic, but the forcing mechanisms are poorly understood and quantified. In the Canadian Archipelago, the productivity of phytoplankton is likely to be limited by light or the supply of allochtonous nitrogen, depending on ice conditions. The supply of allochtonous nitrogen is influenced by climate-driven processes, mainly the large-scale circulation, river discharge, upwelling and regional mixing processes. Over most of the western Arctic, and especially the Beaufort Sea, the concentrations of inorganic nitrogen (i.e. nitrate, nitrite and ammonia) at surface remain low throughout the year and the phytoplankton possibly depend on local recycling and the dissolved organic nitrogen (DON; e.g. urea, amino acids and primary amines) supplied by rivers. A large portion of the phytoplankton biomass is typically located within subsurface chlorophyll maxima (SCM). SCM productivity is possibly in balance with the episodic supply of nitrate across the halocline and/or the supply of ammonium and nitrate by local recycling and nitrification, respectively. Despite the importance of SCM for the food web and CO_2 fluxes, little is known about their structure, turnover and susceptibility to environmental variability and change.

2.6.1. Phytoplankton dynamics and nutrient fluxes

PI: Jean-Éric Tremblay (Department of Biology, Laval University)
Participants: Johannie Martin (9A and 9B) and Simon Pineault (9B) (Department of Biology, Laval University)

Objectives
The main goals of our subproject for leg 9 were to **(1)** establish the horizontal and vertical distributions of phytoplankton nutrients and the influence of different processes (e.g. mixing, upwelling and biological processes) on these distributions, **(2)** characterize the detailed vertical structure of chlorophyll-*a* with respect to irradiance, nutrient supply and physical structure, **(3)** experimentally assess causal relationships between phytoplankton productivity and the availability of light **(4)** determine the utilisation of different sources of inorganic and organic nitrogen by phytoplankton, and **(5)** assessed the role of the ice algae during the initiation of the primary production in the water column. Ancillary objectives were to calibrate the *SeaPoint* fluorometer and *ISUS* nitrate probe attached to the Rosette.

Methods
Samples for inorganic nutrients (ammonium, nitrite, nitrate, orthophosphate and orthosilicic acid) and urea were taken at all rosette stations (see Table 1) to establish detailed vertical profiles. Ammonium was determined immediately after collection using modifications of the manual fluorometric method (e.g. Holmes et al. 1999). Urea samples were either frozen or analyzed fresh using the method of Mulveena & Savidge 1992. The concentrations of nitrate, nitrite, orthophosphate and orthosilicic acid were determined on fresh samples using an Autoanalyzer 3 (Bran+Luebbe) with colorimetric methods adapted from Grasshof (1999).

Samples for the natural abundance (Table 1) of ^{15}N and ^{13}C in particulate organic matter were taken from ice-core (bottom part; 10 cm), ice-water interface, at 5 m and at the chlorophyll maximum (30 m if no maximum were observed). Volumes ranging from few millilitres (for ice samples) to 12 to 20 litres (for water samples) were filtered onto 24 or 47 mm pre-combusted GF/F filters and the filters were desiccated at 60°C in a drying oven. These data will be used for nitrogen uptake calculations and to assess the nitrogen status of phytoplankton communities.

The relationship between light and the uptake of C and N by phytoplankton (light-gradient incubation in Table 1) from the chlorophyll maximum was assessed using dual labelling with stable isotopes of C and N in four light-gradient modules (10 light intensities). Temperature was maintained at *in situ* levels with a chilling circulator. Samples from all modules were spiked with ^{13}C-bicarbonate; two modules received saturating additions of ^{15}N-nitrate, ^{15}N-ammonium (or ^{15}N-urea, or ^{15}N-nitrite), and the other two trace additions. Incubations were terminated by filtration onto 24-mm GF/F filters. All filters were desiccated at 60°C and stored dry for post-cruise determination of isotopic enrichment and particulate organic carbon and nitrogen.

SetCol protocol (Bienfang 1981) was carried out on water collected at the chlorophyll maximum (or 30 m) at the stations where incubations were performed to measure the sinking rate of the micro algae cells. Fractions from the top, the middle and the bottom part of the column were filtered on GF/F filter and extracted with acetone to determine the chlorophyll concentrations. Samples for the taxa composition were taken in the top, the middle and the bottom fraction in a second column and were stored with acid lugol for a post-cruise analysis.

The effects of incubation treatments (variable nutrient additions and light conditions) on the photosynthetic characteristics of phytoplankton were assessed by Pulse Amplitude Modulated fluorometry (PAM; Heinz-Walz). Nitrate data were used to calibrate the ISUS nitrate probe. Calibration of the Rosette fluorometer was achieved by comparing the instrumentôs output with extracted chlorophyll *a* and PAM data.

Table 1. List of sampling stations and measurements during leg 9 of CFL.

Station	Cast	Date	Nuts	PAM	Light-gradient incubation	Natural Abundance (water)	Natural Adundance (ice)
F7	005	06/06/08	X	X	X	X	
F7	-	08/06/08					X

405 B	013	10/06/08	X	X	X	X	
F7	017	11/06/08	X	X		X	X
FB01	038	14/06/08	X	X			
FB03	040	15/06/08	X	X			
FB05	043	15/06/08	X	X		X	
FB08	-	16/06/08					X
FB00	046	16/06/08	X	X		X	
HR01	047	17/06/08	X	X		X	
F7	054	19/06/08	X	X	X	X	
FB07	060	21/06/08	X	X	X	X	X
1216	064	23/06/08	X	X	X	X	
F7	068	24/06/08	X	X	X	X	
FB07	071	25/06/08	X	X	X	X	
1200	073	27/06/08	X	X	X	X	
1204	078	28/06/08	X				
1208	079	28/06/08	X	X	X	X	
434	094	30/06/08	X	X			
421	099	01/07/08	X	X	X	X	
435	103	02/07/08	X	X			
1526	107	03/07/08	X				
1525	108	03/07/08	X				
6012	109	03/07/08	X				
6006	112	04/07/08	X	X	X	X	
6002	117	04/07/08	X				
2005	118	05/07/08	X				
2010	119	06/07/08	X	X	X	X	X
2015	124	07/07/08	X				
9002	125	07/07/08	X				
410	126	08/07/08	X	X	X	X	
412	131	09/07/08	X				
414	133	09/07/08	X				
420	137	09/07/08	X	X		X	
418	140	09/07/08	X				
416	142	10/07/08	X	X	X	X	
1901	148	10/07/08	X				
1903	150	11/07/08	X				
1905	152	11/07/08	X				
1907	154	11/07/08	X				
1911	158	11/07/08	X				
1100	159	11/07/08	X	X			
1110	162	12/07/08	X	X			
1108	164	12/07/08	X				
1106	165	12/07/08	X				
1104	166	12/07/08	X				
1913	169	12/07/08	X				

1915	171	12/07/08	X				
1917	173	13/07/08	X				
1919	175	13/07/08	X				
D34	177	13/07/08	X	X	X	X	

Preliminary Results
No preliminary results are available because post-runs corrections arenôt done at this time.

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2.6.2. Dissolved Inorganic Carbon System

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The oceanôs exchange of carbon dioxide with the atmosphere is governed by the biogeochemical cycling of carbon and physical processes throughout the water column, which determine the concentration of dissolved inorganic carbon in the surface waters. Of the seven relevant carbon system parameters, a minimum of two are needed to calculate the others and fully describe the inorganic carbon chemistry, over-determination of the system being beneficial. During CFL Leg 9, roughly 450 samples were analyzed for dissolved inorganic carbon (DIC) and total alkalinity (TA), yielding two of the relevant parameters.

Water samples were collected at full, basic and mooring stations in parallel with nutrients rosette. DIC and TA were sampled using 500 mL glass bottles which were rinsed and filled using a plastic tube. DIC samples were first to be taken from the Niskin bottles, (preceded only by dissolved oxygen). These samples were either analyzed immediately following sampling, or spiked with $HgCl_2$ and stored in the dark at 4°C to await analysis.

Since we were using the moon pool for rosette sampling during Leg 9A, the top 10 meters of the water column were missed. In addition to this, we found that the 10 meter samples were often contaminated. As a result, the final rosette sample was taken at depth of 12 meters, and surface water sampling took place on the ice at roughly the same time as the rosette sampling. Surface water samples were collected from a hole in the ice, at fast ice and drift stations. Water was collected using a small battery operated pump which was lowered hand to 7, 5, and 1 meter below the surface. Bottles were filled using standard methods on the ice and returned to the ship for analysis. A CTD cast to a depth of 12 meters was taken at surface water sampling sites.

At open water stations, surface water samples were collected from the zodiac at some nominal distance from the ship, with the location determined by the direction of the current. Water samples were collected using either the pump, or a small Niskin bottle. A CTD cast was also done either with a small Sea-Bird CTD, or using the light-profiler in co-operation with Team 2. These water samples

were analyzed and results compared with the 5 and 2.5 meter depth samples taken from the rosette to determine the effect of the ship on the surface water sampling from the rosette with respect to DIC and TA analysis. Broadly speaking, we observed a disturbance of the mixed layer by the repositioning of the ship ï affecting mainly the temperature and salinity of near surface samples ï apparent by a discrepancy in these parameters between the ship and zodiac values.

DIC and TA were analyzed on board using a VINDTA 3C (Versatile Instrument for the Determination of Titration Alkalinity) by Marianda. Total alkalinity was determined by titrating a volumetrically accurate sub-sample of seawater using HCl as a titrant. In the case of dissolved inorganic carbon, a volumetrically determined sub-sample of sweater was acidified with 8.5% H_3PO_4 to convert all inorganic carbon into gaseous CO_2. The CO_2 is then stripped out of the sample using ultra-pure N_2 gas, followed by transfer into the titration cell where total inorganic carbon is then detected using the coulometric method (Johnson et al., 1993).

In addition to water column sampling, an attempt was made to continue (to a lesser extent) the ice core and brine sampling work initiated by team 6 in Leg 4 and 5. To this end, one core was collected at each fast ice and drift station. The top, middle, and bottom 10 cm of the core were cut and placed in plastic Tedlar bags ï gas impermeable, with a clamp type seal and small spigot for withdrawing air or water. The core sections were laid out to thaw, then analyzed for DIC, TA, and conductivity. Brine was collected using a peristaltic pump, from core holes drilled to 4 different depths relative to the ice surface. Standard methods were used to fill 500 mL bottles which were then analyzed for DIC and TA.

River water samples were collected at both the MacKenzie and the Horton Rivers, and analyzed for DIC and TA. This was of particular interest, since TA can be used as a fresh water tracer. ï Measurements of alkalinity from these two different (end-member) freshwater sources should allow us to distinguish between freshwater input from sea ice melt and freshwater input from the Horton and MacKenzie rivers to the Arctic Ocean in the CFL sampling region.

Table 2: Water column sampling for DIC, TA

STATION	LAT °N min	LON °W min	CTD CAST	DATE
F7	69° 49.64ô	-123° 37.85	0804006	08/06/08
405B	70° 39.508ô	-122° 59.872ô	0804013	10/06/08
F7	69° 49.64ô	-123° 37.85ô	0804017	11/06/08
F7	69° 49.462ô	-123° 37.957ô	0804035	13/06/08
FB01	69° 59.214ô	-125° 51.121	0804038	14/06/08
FB03	69° 58.069ô	-125° 52.192ô	0804040	14/06/08
FB05	69° 57.394ô	-125° 52.493ô	0804043	15/06/08
FB00	70° 0.649ô	-125° 49.566ô	0804046	16/06/08
HR01	69° 56.41ô	-126° 41.79ô	0804047	17/06/08
F7	69° 48.36ô	-123° 35.908ô	0804054	19/06/08
FB07	69° 57.446ô	-125° 54.028ô	0804060	21/06/08
1216	70° 36.76ô	-127° 34.646ô	0804064	23/06/08
F7	69° 49.462ô	-123° 37.957ô	0804068	24/06/08
1200	71° 32.755ô	-124° 20.53ô	0804073	27/06/08
1208	71° 3.852ô	-126° 3.146ô	0804079	28/06/08
434	70° 10.646ô	-133° 33.192ô	0804094	30/06/08
421	71° 28.267ô	-133° 54.652ô	0804099	01/07/08
435	71° 4.446ô	-133° 47.237ô	0804103	02/07/08
6006	72° 39.54ô	-128° 20.872	0804112	03/07/08
2005	75° 26.399ô	-120° 25.951ô	0804118	05/07/08
2010	75° 7.651ô	-120° 23.83ô	0804119	05/07/08
410	71° 41.929ô	-126° 28.992ô	0804126	08/07/08
420	71° 3.277ô	-128° 30.734ô	0804137	09/07/08
1100	71° 2.757ô	-123° 15.634ô	0804159	10/07/08
1110	70° 19.333ô	-124° 50.401ô	0804162	12/07/08

D34	71° 4.26ô	-121° 49.151	0804177	13/07/08

Table 3: Stations where ice, brine and interface water was sampled for DIC and TA.

STATION	LAT °N min	LON °W min	SAMPLES TAKEN	DATE
F7	69° 49.64ô	-123° 37.85	Ice, Brine, Interface Water	08/06/08
F7	69° 49.64ô	-123° 37.85ô	Ice, Brine, Interface Water	11/06/08
F7	69° 49.462ô	-123° 37.957ô	Ice, Brine, Interface Water	13/06/08
FB05	69° 57.394ô	-125° 52.493ô	Ice, Brine, Interface Water	15/06/08
F7	69° 48.36ô	-123° 35.908ô	Ice, Brine, Interface Water	19/06/08

References:

Johnson, K. M., K. D. Wills, D. B. Butler, W. K. Johnson and C. S. Wong. Coulometric total carbon dioxide analysis for marine studies: maximizing the performance of an automated gas extraction system and coulometric detector. Marine Chemistry, Vol. 44, pp. 167-187, 1993.

2.6.3. Sediment traps and water column DOC and EPS

PI: Christine Michel (Freshwater Institute)
Participants: Amélie Sallon[1] (9A and 9B) and Rodd Laing[2] (9B)
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[2] University of Manitoba

Objective:

To quantify organic material sinking export processes under the ice and open water.

Sinking export processes were estimated with the **particle interceptor traps** method. Short-term traps were deployed in open water and under ice. Trap contents were used to analyze elements such as: pigments (chl a + pheopigments), POC, PIC, PON, EPS, biogenic silica (BioSi), stable isotopes. Thorium measurements were done in collaboration with Kirk Cochran in the open water stations. Trap contents were used for identification and enumeration of phytoplankton cells and estimation of the number and the size of fecal pellets.

Water-column measurements of dissolved organic carbon (DOC) and EPS were accomplished as part of this sub-project as well.

Sampling :

Table 4. Under ice sediment trap deployments.

UT #	Station #	Trap depth (m)	Date deployed (mm/dd/yy)	Duration	Nb traps deployed
UT 1	F6	1-15-25-50	06-05-08	24h	2 per depth
UT 2	F7	1-15-25-50	06-12-08	24h	2 per depth
UT 3	FB5	1-15-25-50	06/16/08	24h	2 per depth
UT 4	FB7	1-15-25-50	06/20/08	24h	2 per depth

Table 5. Open water sediment trap deployments.

FST #	Station # Full station	Trap depth (m)	Date deployed (mm/dd/yy hh:mm)	Duration (h)	Nb traps deployed
FST 1	405B	50	06-10-08 08:30	12:00	5
		100			5
		150			5
FST 2	1216	50	06/23/08 09:00	12:00	5
		100			5
FST 3	1200	50	06/27/08 11:54	16:30	5
		100			5
		150			5
FST 4	1208	50	06/28/08 11:30		5
		100			5
		150			5
FST 5	421	50	06/30/08 23:15	19:00	2
		100			5
		150			5
FST 6	6006	50	07-03-08 21:05	16:00	5
		100			5
FST 7	410	50	07-08-08 01:54	16:30	5
		100			5
		150			5
FST 8	416	50	07-09-08 17:13	18:00	5
		100			5
FST 9	D34	50	07/13/08 02:04	14:32	5
		100			5

2.6.4. Barium

PI: Helmuth Thomas
Participant: Elizabeth Shadwick, Department of Oceanography, Dalhousie University, Halifax, NS, Canada, elizabeth.shadwick@dal.ca

In the Canadian Arctic, barium (Ba) is mainly released from the North American continent and can therefore be used as a tracer for terrestrial freshwater input. Together with ^{18}O, a tracer for freshwater input from precipitation and ice melt, all freshwater sources to the Arctic can be quantified.

Throughout Leg 9, samples for barium were taken from the rosette parallel to samples for ^{18}O, at approximate depths 5, 10, 20, 50, 70, 100, 140, 200 and 300 m. Small plastic bottles (15 mL) were rinsed three times, then filled and spiked with 15 µl concentrated HCl. Sample bottles were then sealed with parafilm and kept for later analysis using isotope dilution mass spectrometry.

Table 6: Stations sampled for Barium

STATION	LAT °N min	LON °W min	CTD CAST	DATE
405B	70° 39.508ô	-122° 59.872ô	0804013	10/06/08
FB01	69° 59.214ô	-125° 51.121	0804038	14/06/08
HR01	69° 56.41ô	-126° 41.79ô	0804047	17/06/08
1216	70° 36.76ô	-127° 34.646ô	0804064	23/06/08
434	70° 10.646ô	-133° 33.192ô	0804094	30/06/08
421	71° 28.267ô	-133° 54.652ô	0804099	01/07/08
435	71° 4.446ô	-133° 47.237ô	0804103	02/07/08
2005	75° 26.399ô	-120° 25.951ô	0804118	05/07/08
2010	75° 7.651ô	-120° 23.83ô	0804119	05/07/08
1100	71° 2.757ô	-123° 15.634ô	0804159	10/07/08
1110	70° 19.333ô	-124° 50.401ô	0804162	12/07/08

2.6.5. Bacterial and Archaeal diversity and enzymatic activity

PI: Jody Deming
Participants: Colleen T. E. Kellogg, ctebean@u.washington.edu and Shelly D. Carpenter, seashell@u.washington.edu; School of Oceanography, University of Washington, Seattle WA 98195

Introduction and Background

Our work on board the NGCC Amundsen during Leg 9 of the CFL project consisted of two parts ï one focusing on Bacterial and Archaeal diversity and enzymatic activity associated with particles in the photic zone (Part 1; in collaboration with Kirk Cochranôs lab at Stony Brook University in New York) and the second focusing on these particle-associated microbes and associated enzymatic activities once they leave the photic zone, with particular interest in nepheloid layers (Part 2).

Our collaboration with the Cochran lab seeks to examine the export of carbon in two polynyas on river-impacted Arctic shelves and, for comparison, with a non-river impacted polynya. The North Water was our river-free control (sampled in 2006 during the ArcticNet cruise) for both the Cape Bathurst Polynya (sampled this cruise as well as during the ArcticNet cruise in 2006) and the Laptev Sea Polynya off the Lena River (sampled in 2005 as part of the NABOS expedition). Climate warming may alter the cycling of carbon on Arctic shelves through permanent reductions in ice cover and increases in riverine discharge. These changes may lead to, at least initially, increases in the export of carbon to the slope and deep Arctic basins. As a result, it is critical to characterize present carbon cycling in these, and other, polynyas. In order to do this, we will be coupling geochemical and microbiological analyses in a joint effort to examine particle flux, the diversity of the microbes associated with these particles and their extracellular enzymatic activity (i.e. the rates at which certain components of the particles are being hydrolyzed). In each polynya, patterns in the vertical particle flux will be measured by Dr. J. Kirk Cochranôs group using a radionuclide approach employing the natural radionuclide, ^{234}Th. Samples for this analysis were collected using large volume in situ pumps fitted with a 70 εm and 1 εm filter to represent the ósinkingô and ósuspendedô particle fractions, respectively. These filters will be also used by the Deming Lab Group to measure the extracellular enzymatic activity (EEA) associated with the different size fractions and the associated microbial diversity. Ultimately, this collaboration will allow for a better understanding of the different particle fluxes in river-impacted and river-free polynyas, the diversity of microbial communities associated with these different particle size fractions and origins (terrestrial versus marine), and the associated microbial enzymatic activity. Since all work is being done on the same filter set we expect to better understand the export of carbon in the aforementioned Arctic polynyas and which microbes contribute to its attenuation with depth. This knowledge will better equip us to understand and predict how carbon export may change as the Arctic continues to warm.

The second part of our project examines microbial diversity and particulate organic matter (POM) composition as it leaves the photic zone and its eventual fate. We are interested in how POM composition is transformed after it leaves the photic zone as well as how microbial diversity and enzymatic activity change below the photic zone, thereby examining the importance of microorganisms in altering sinking POM in the Arctic Ocean. By altering POM composition and concentration, microbes affect the food source for the benthic communities and the amount of carbon eventually available for sequestration in the deep Arctic Ocean. We have a particular interest in nepheloid layers as mechanisms for transport of POM off Arctic shelves and sampled them whenever observed in the water column. Nepheloid layers may provide a second chance for microbial degradation of recently deposited POM before it is sequestered in the deep ocean, ultimately affecting the extent of carbon sequestration in the Arctic Ocean. As this part of our project focuses on POM after it leaves the photic zone, we sampled at the chlorophyll max, the bottom and at one or two depths in between these two depths (generally approximately halfway between the chlorophyll max and the bottom). Again, as described above, we were interested in comparing microbial activity and diversity on terrestrially-derived and marine-derived particles and we believe that the samples taken during CFL

Leg 9 will allow us to adequately address this question. We believe this important as Arctic shelves, especially the Mackenzie Shelf, are commonly a mix of these two types of particles and microbial degradation of these particles types likely differs, affecting the composition of material eventually sequestered in the deep ocean.

Methods

Part 1:

In-situ pump samples ï Following deployment and recovery of in situ pumps by the Cochran lab, the pump heads from each depth containing one large 70 εm Polypropelene filter and one 1 εm microquartz filter were immediately taken to the 2°C cold room. They were first halved, with one half used by the Deming lab and the other by the Cochran lab. The Deming lab half was cut in half again (two quarters of the total). One quarter was used for extracellular enzymatic activity (EEA) measurements, described in greater detail below, and the other was sectioned into five parts. One filter piece was placed into a microcentrifuge tube and stored at -80°C for DNA analyses upon return to Seattle. The remaining four pieces were frozen for analyses of particulate lipids, amino acids and carbohydrates as well as ŭ^{13}C of POM.

Part 2:

Size fractionation of water samples ï In order to obtain different size fractions of particles and associated Bacteria and Archaea, 10 L of water, collected from niskin bottles, were filtered via a peristaltic pump through an in-line, size-fractionation set-up in a 2°C cold room. The water was first passed through a 60 εm nylon mesh filter, then through a 1 εm polycarbonate filter and finally through 0.22 εm durapore Sterivex filter. The >60 εm fraction is operationally defined as the ósinkingô particulate fraction. The 60-1 εm fraction contains the ósuspendedô particles and the 1-0.22 εm fraction contains free-living Bacteria and Archaea. Samples will be analyzed for Bacterial and Archaeal diversity in the University of Washington School of Oceanography labs upon completion of Leg 9.

In addition to size fractionation for examination of Bacterial and Archaeal diversity, we also size fractionated 4ï 10 L of water for measurements of extracellular enzymatic activity (see below) and for analyses of particulate organic matter components (particulate carbohydrates, amino acids and lipids) as well as stable carbon isotopic analyses (ŭ^{13}C). For each of these samples, only the >60 εm and 60ï 1 εm fractions were collected for analyses, with the exception of particulate lipids, where the free-living fraction (1ï 0.2 εm) was also collected. Due to limitations in the amount of water we could take, only single samples were taken for each of these analyses.

Extracellular enzymatic activity (EEA) - To estimate enzymatic hydrolytic rates of organic matter, extracellular enzymatic activity was measured using fluorescently tagged substrate analogs (Huston and Deming, 2002). Protease, chitobiase and carbohydrase activities were estimated using L-leucine 7-amindo-4-methylcourmarin (MCA-Leucine), 4-methylumbelliferyl-*N*-acetyl-ß-D-glucosaminide (MUF-G), and 4-methylumbelliferyl-ß-D-glucoside (MUF-B) respectively. Lipase activity was also estimated on some samples using MUF-oleate. Substrates were added to samples at saturating concentrations, determined on board using water from different sampling locations. At each station, 10 L of water from each depth was size-fractionated as described above. Following filtration, filters were resuspended in 40ï 50 ml of 0.2 εm filtered seawater from the same depth and station. This solution was then aliquoted into glass culture tubes for each enzyme type and respective substrates were added to a final concentration of 200ï 250 εM. Fluorescence was measured using a Turner Fluorometer over a series of time points to estimate EEA (change in fluorescence over time): with greater EEA, more fluorescent tags are released from the substrate analogs. EEA was measured at each station and depth sampled, and results were obtained shipboard.

Bacterial abundance estimates ï From each depth sampled, duplicate 15ï 50 ml samples were fixed with 0.2 um-filtered 37% formaldehyde to a final concentration of 2% formaldehyde. In order to estimate bacterial abundance associated with different size fractions of POM (discussed above) samples fixed were either whole seawater, <60 εm or <1 εm filtered. Fixed samples were stored at

2ï 4°C and will be stained with DAPI and acridine orange and analyzed microscopically upon return to the University of Washington.

Water column chemistry ï Water from the Niskin bottles was also collected to estimate chlorophyll *a* concentrations, particulate organic carbon and nitrogen and suspended particulate matter (SPM) to obtain a better understanding of particle-related characteristics of the water column. Following sample collection, water was brought back to the 2°C cold room. Duplicate samples of 500 ml from each size fraction discussed above were filtered onto precombusted GF/F filters for both chlorophyll *a* and POC/PON samples. These filtered were folded and placed in precombusted foil pouches, frozen at -20°C and will be analyzed back at the University of Washington labs. Duplicate 2 l samples were filtered onto precombusted, preweighed GF/C filters for estimation of SPM. These filters were placed in small 47 mm Petri dishes and stored at -20°C. They will be dried and reweighed back at the University of Washington for an estimation of SPM.

All of these analyses will allow for a comparison between EEA and community diversity obtained via large volume (in situ pump) and small volume (in-line, peristaltic pump) filtration. The in situ pump samples focuses on material in the photic zone while our smaller volume filtration focuses on the changes in this material and the microbial community associated with it once it leaves the photic zone and reaches the seafloor. As the bulk of our measurements are done back at our labs at the University of Washington, we do not have any results to report at this time.

Sample Stations and Collections

Figure 1. Map shows stations sampled by the Deming lab. At stations denoted by the white placemark, only samples for Part 2 of our project were collected. At stations denoted by the yellow placemark, samples for both Part 1 and 2 of our project were taken. At stations denoted by the orange placemark, only samples for Part 1 of our project were collected. Note: not *all* station labels are shown on this map, see following map for more detail.

Figure 2. Map zoomed in on stations visited by the Deming lab in Franklin and Darnley Bay. Station placemarkers denote the same meanings as described in Fig. 1.

2.6.6. ^{234}Th-derived POC fluxes and extracellular enzymatic activitiy

Participants: J. Kirk Cochran, Alisha Renfro (Leg 9B) and David Hirschberg (Leg 9A), Marine Sciences Research Center, School of Marine and Atmospheric Science, Stony Brook University, Stony Brook, New York 11794-5000 USA

Project Overview:
This project is collaborative with Jody Deming (University of Washington; represented by Colleen Kellogg and Shelly Carpenter on Leg 9). We are using the natural radionuclide ^{234}Th to determine POC fluxes in the water column and Demingôs group is measuring extracellular enzyme activities on particles collected with our in situ pumps (see Deming cruise report for more details).

Sampling:
After setting up our gear, sampling began on leg 9A. We collected samples of two types: 1) Small volume (2 L) water samples from rosette casts for measurement of total ^{234}Th (generally sampled at 0, 10, 25, 50, 75, 100, 125, 150 m) and 2) Particulate samples (>70 µm and 1-70 µm) obtained by deployment of four in situ pumps that filter 150-450 L of water at depths of 25, 50, 75 and 100 m. Table 7 shows the stations that were sampled.

Table 7. Stations sampled during leg 9.

Station	Date (mm/dd/yy)	Small Volume Samples	In situ pump
405B	06/10/08	X	X
FB5	06/18/08	X (Ice core)	
FB6	06/15/08	X	X
1216	06/23/08	X	X
1208	06/28/08	X	X
421	07/01/08	X	X

435	07/02/08	X	X
6006	07/04/08	X	X
2010	07/05/08	X	X
410	07/08/08	X	X
416	07/09/08	X	
	07/10/08		X

Sample Processing:
Thorium was co-precipitated with manganese oxide from water samples and the precipitate was filtered onto 25 mm microquartz filters. The filters were counted for ^{234}Th beta activity using a low background beta counter. Particulate samples from in situ pumps were split with Demingôs group (50/50). For the >70 µm fraction (collected on polypropylene mesh filters), particles were rinsed off the filter, re-filtered onto microquartz filters, dried and mounted for beta counting. The 1 µm microquartz filter was dried and ten 20 mm punches were taken and mounted for beta counting. All samples were counted at least twice during the cruise to monitor the decay of ^{234}Th (half-life = 24 .1 days). Final work-up of ^{234}Th data will take place at Stony Brook University.

2.6.7. Marine microbiology group

Participants: Dan Nguyen, Maranger team ï Université de Montréal (leg 9a) and Gabriel Maltais-Landry, Maranger team ï Université de Montréal (leg 9b)

Introduction
Microorganisms are a heterogeneous group that include representatives of the three kingdoms of live, Archaea, Bacteria and Eukarya. These organisms drive biogeochemical processes in the ecosystem. Autotrophic microorganisms are the base of the Arctic trophic web, which comprises 7 orders of size magnitude, ranging from the smallest cell of less than 1 µm to the largest mammals. All of these organisms are strongly influenced by annual cycles of light, temperature and ice cover in terms of the composition and activity of the species present.

How microbes use organic and inorganic matter and how this influences other components of the food web? This knowledge is needed to better predict the consequences of natural or anthropogenic changes on these trophic dynamics. This will also help us to evaluate the systemôs ability to buffer these changes at short and long timescales.

Objectives
The measurements completed during this leg covered the work of 4 teams headed by Corina Brussard, Connie Lovejoy, Roxane Maranger and Carles Pedrós-Alió. We aimed to determine the diversity of species present and the importance of the biogeochemical processes driven by these organisms during the spring season.

The first specific objective of leg 9 was to maintain the intensive sampling for bacterial respiration started during leg 8b, to confirm the results obtained during leg 8 for both water column and ice cores. Secondly, we intensified nitrous oxide measurements to gain a better spatial resolution of the production of this gas. We focused on these two aspects (bacterial respiration, N_2O) as they are the most novel of our sampling protocols.

Sampling
The details of the stations sampled and measurements performed can be found in Table 8. The following variables were measured:

1. **Molecular genetics and gene expression:** Samples for DNA and RNA were collected once a week at 4 different depths. Six l seawater samples were prefiltered through a 50 µm mesh and then separated into ólargeô and ósmallô DNA fractions by filtration through a 3 µm and then a

0.2 µm polycarbonate filter. After collection samples were stored at -80 ºC until processing in the Lovejoy laboratory in Université Laval.

2. **Chlorophyll concentration:** Samples for chlorophyll analyses were taken once during leg 9. For each sample, one liter of water was filtered through a Whatman GF/F filter for microorganisms larger than the nominal pore size of 0.7 µm. In addition, 3 µm prefiltered obtain the small fraction, which was finally filtered through a Whatman GF/F filter. After filtration, the filters were stored overnight at -20ºC. Subsequently, the filters were introduced in acetone 90% and placed in a refrigerator, in the dark. After 24 hours, the fluorescence of the extracts, before and after acidification with 3 drops of 5% HCl, was determined by means of a Turner TD-700 fluorometer.

3. **HPLC:** Samples for High Pressure Liquid Chromatography (HPLC) analyses were taken once during leg 9. Two fractions were collected, one for the total fraction (down to 0.7 µm) and one for the small fraction (from 3 µm to 0.7 µm). Samples were stored at -80 ºC and will be analyzed at Laval University.

4. **Virus:** See report of Evans and Brussaard leg 9.

5. **Organic matter:** Using pre-combusted GF/F filters (47 mm diameter) in a passive filtration system (by gravity) samples for dissolved organic carbon (DOC), total organic carbon (TOC), amino acids and carbohydrates were taken once during leg 9a. Samples without filtration for total phosphorus determination were also collected.

6. **Bacteria and Archaea abundance:** Microscope preparations for bacterial abundance estimations were prepared by filtering a small volume of water (20ml) fixed with formaldehyde and staining with DAPI. Microscopy slides were prepared once a week at 6 different depths. Slides were frozen (-20°C) until counting on a epifluorescence microscope. Bacterial preparations were also obtained throughout the cruise on a less regular basis (e. g. ice cores). Slides for heterotrophic nanoflagellates (fixed with glutaraldehyde) were also prepared on a weekly basis.

7. **Ciliates:** Samples for ciliates abundance and diversity were collected during protocol 10, preserved using a Lugol acid solution, and will be analyzed off the ship.

8. **FISH – eukaryotes & CARD-FISH – Bacteria and Archaea:** Fluorescent In Situ Hybridization samples were collected once a week at 6 different depths, and on a less regular basis for other stations. Samples were stored at -80 ºC until analysis off the ship.

9. **MarFISH – bacteria and archaea:** Incubations with ^{3}H-labeled leucine and ^{14}C-labeled bicarbonate were carried out to detect active prokaryotes in the uptake of these substrates at two depths (surface and base of the nitrocline). Leucine incubations lasted for 8 hours and bicarbonate incubations lasted for 24h always in the dark. After fixation, samples were filtered and filters stored at ï 80 to be analyzed on land. In combination with the FISH technique this can give information on the phylogenetic identity of these active microorganisms. Besides the MarFISH incubations, samples were incubated with ^{14}C-labeled bicarbonate (at a lower concentration) to measure bulk bicarbonate uptake by bacteria and archaea in the dark. These samples were incubated for 24 hours and subsequently filtered. The filters were exposed to HCl fumes overnight, and embedded in cocktail for the scintillation counter measurement. This measurement was only carried out for leg 9a as we ran out of ^{14}C labeled bicarbonate.

10. **Bacterivory – FLBs grazing**: In order to acquire values of ingestion rates of bacteria by heterotrophic eukaryotes, Fluorescent Labelled Bacteria (FLB) obtained from a culture of *Brevundimonas diminuta* were used on bacterial grazing experiments. Triplicates and a 0.2 µm seawater filtered control with 10^5 cells/ml added were used. Samples for flagellates and

bacterial microscopy observation and for bacterial production were collected at the beginning and after 48 hours of incubation at seawater temperature (cold-room). This experiment was conducted once during leg 9.

12. **Bacterial production:** Bacterial production rates were measured at six depths once a week using the leucine incorporation method (^{3}H labelled leucine) with 4 hours incubation at in-situ temperature followed by readings on the shipôs scintillation counter. Samples were also taken on an irregular basis for other stations and projects (e. g. ice cores).

13. **Respiration:** Bacterial/community respiration rates were measured using the FIBOX, which measures O_2 depletion in time using sensors glued in 500ml Erlenmeyers. The consumption of O2 in time can be converted in CO2 production to compare carbon respiration rate to bacterial carbon production rates. Each experiment lasted for about 15 days and oxygen measurements were made every 1-2 days. The erlenmeyers were kept in the dark inside a cooler in a cold room.

14. **ETS:** Due to the low respiration rates in Arctic waters, a back-up method was also used to obtain respiration rate surrogates via ETS (Electron transport system activity). This is achieved by filtering a large quantity (8L-10L) of water on GF/F filters to collect live cells and freeze them (-80°C) as quick as possible. These will be analyzed (enzymatic activity) off the ship.

15. **N_2O in the upper water column:** Dissolved N2O measurements were carried out using the headspace equilibration method with 1.1 L of seawater. 3 samples were taken from 3 to 8 depths on a more or less daily schedule. These will be analyzed off the ship for N2O on an electron capture detector (GC).

Table 8. Sampling locations and activities (numbers in columns = number of depths sampled)

Date of start	Station ID	Cast #	Latitude (north)	Longitude (west)	Bacterial production	ETS	Bacterial respiration	N_2O	Bacteria/archaea	Virus abundance	Organic matter and TP	Ciliates	FISH	MARFISH	Algivory	Bacterivory	DNA	RNA	HPLC	Algal abundance	Chl a	HNF	Biolog
2008/06/07	F7	2/8	69°49,6	123°37,85	4	2	2	3	4	4		4	4			1	7	4		4		4	
2008/06/10	405b	12	70°39,697	123°1,006				4									1						
2008/06/11	F7	18/25/ice hole	69°49,6	123°37,85				8															
2008/06/14	FB1	39	69°59,026	125°51,159	4			3	4	4			4				4	4		4		4	3
2008/06/14	FB3	40	69°58,077	125°52,191	4		2	3	4	4			4				4	4		4		4	3
2008/06/15	FB5	44	69°57,38	125°52,5	4	2	2	3	4	4	4		4	2			3	3		4		4	3
2008/06/16	FB0	46	70°0,699	125°49,566	1			3	1								1						
2008/06/17	HR1	47	69°56,447	126°41,72	1			3	1														
2008/06/18	FB5 Ice	Ice station	69°48,9	123°39,0	3		3		3													3	
2008/06/19	F7	54	69°48,36	125°35,908				3															
2008/06/23	1216	65	70°36,71	125°35,456				3															
2008/06/24	F7	69	69°49,297	123°39,68				4									4	4					
2008/06/25	HR							3															
2008/06/28	1200	76	71°32,79	124°20,488				8															
2008/06/28	1208	82	71°3,889	126°2,807	6	2	3	3	6				6				4	4				6	
2008/06/30	434	93	70°10,672	133°33,254	2		2	2	2				2				2					2	
2008/06/30	421	101	71°28,351	133°33,254	4	1	2	3	4				4				1					4	
2008/07/02	435	105	71°4,735	133°47,975	4	1	2	3	4				4				1					4	
2008/07/04	6006	114	72°39,526	128°21,605	6	2	2	6	6	6			6				4	4		6		6	
2008/07/05	2005	118	75°26,399	120°25,951				3															
2008/07/05	2010	120	75°7,681	120°23,796	6		2	6	4														
2008/07/07	9002	125	74°19,976	125°30,272				4															
2008/07/08	410	128	71°41,681	126°29,687	4			8	4				4				3					4	
2008/07/08	420	138	71°3,038	128°30,647	2			3	2				2										

2008/07/10	416	144	71°17,303	127°45,406	6	2	3	3	6	6			6				4	4	4	6	2	6	3
2008/07/10	1903	150	71°29,8	125°26,45				3															
2008/07/11	1100	161	71°2,726	123°18,925	4			4	4														
2008/07/12	1110	162	70°19,333	124°50,401				3															
2008/07/12	1106	165	70°36,774	124°12,832				4															
2008/07/12	1915	171	70°54	122°27,422				3															
2008/07/12	1919	175	70°53,986	121°13,668				3															
2008/07/13	D34	178	71°4,72	121°49,157	4			4	4														

2.7. Team 8

PI: Gary Stern (DFO, Freshwater Institute)
Participants: Debbie Armstrong (University of Manitoba), Alexis Burt (MSc student, University of Manitoba), Jeff Latonas (MSc student, University of Manitoba), Fiona Wong (Environment Canada, Toronto), Allison MacHutchon (DFO, Freshwater Institute), Joanne Delaronde (DFO, Freshwater Institute)

General objective
The question this project hopes to answer is how climate variability in physical forcing and the biogeochemical response to this primary forcing will affect hexachlorocyclohexane (HCH) and mercury (Hg)/methyl mercury (MeHg) contaminant cycling. Ultimately, we propose to relate changes in delivery and biogeochemical cycling of these contaminants to their levels in fish, marine mammals and the people who consume these tissues as part of their traditional diets.

An additional sampling campaign was undertaken during ArcticNet and CFL 2007-2008. The program is designed to obtain a detailed picture of PFOA (perfluorooctanoic acid) and PFOS (perfluorooctane sulfonic acid) concentrations in near shore and open ocean sites in the Canadian arctic.

2.7.1. Organic Contaminants

Hexachlorocyclohexane (HCH)

Technical HCH is a mixture of several isomers, the most abundant being α-HCH (60-70%), γ-HCH (5-12%) and β-HCH (10-15%). Technical HCH and pure γ-HCH (lindane, pesticide active isomer) have been used for over 50 years and are now ubiquitous in water throughout the northern hemisphere with the highest levels found in the surface water layers near pack ice in the Arctic Ocean.

Technical HCH was banned or heavily restricted by China, the former Soviet Union and India between the mid-1980s and 1990. Concentrations of α-HCH in arctic air responded quickly to these large-scale usage changes and declined by an order of magnitude from the early 1980s to mid-1990s in steps that closely matched global usage and emission estimates. As a consequence, the direction of net gas exchange in arctic waters reversed from deposition in the 1980s to air-water equilibrium or volatilization in the mid-1990s.

The α-isomer is the prominent in Arctic air, water, biota and soil, and moves northward via cold-condensation, a process whereby the contaminant evades into the atmosphere, drifts with atmospheric currents, and condenses in colder climates where at colder temperatures increasingly favours the water and extensive ice cover inhibit further evasion. Hence the contaminant accumulates disproportionately in the Arctic.

HCH water sampling
Water (4L) was collected using the rosette and using a pail or Niskin sampler for surface water collection at several stations. Where feasible, transects across water bodies were collected. In the aft lab, water was pumped through a glass-fibre filter followed by an ENV+ solid-phase extraction (SPE) cartridge using peristaltic pumps. Filters and cartridges were frozen and shipped to Fisheries and Oceans Canada, Winnipeg (DFO-Winnipeg). Salinity and ^{18}ŭO samples were also collected at each site and depth where HCH samples were taken. Salinity samples were analyzed onboard using the salinometer. ^{18}ŭO samples were stored at 2ºC and shipped to DFO-Winnipeg. ^{18}ŭO analysis will be performed at Fisheries and Oceans Canada, Sidney.

During Leg 9, water profiles (depths of, generally, surface, 5m, 10m, 25m, 50m, 100m, 200m, bottom) were sampled at stations D45, D34, F7, F8, FB01, FB05, HR01, 405B, 410, 416, 420, 421, 434, 435, 1100, 1110, 1200, 1208, 1216, 2010, 6006.

Surface water only was sampled at the Horton River delta, Mackenzie River delta and two meltponds at F8.

HCH air sampling
The air sampler was set up on the bow of the ship on the starboard side of the foredeck. Air sample collection coincided with water profile and zooplankton collection stations. Samples were collected on a glass fibre filter and polyurethane foam (PUF) for analysis of organic contaminants. Air sample collection times ranged between 4 and 7 hours. Filters and PUFs were frozen at -20°C and shipped to the Fisheries and Oceans Canada, Winnipeg for HCH analysis.

During Leg 9, air was sampled at stations D45, D34, F7, F8, FB01, FB05, HR01, 405B, 410, 416, 420, 421, 434, 435, 1100, 1110, 1200, 1208, 1216, 2010, 6006.

HCH biotic sampling
The main purpose of this study is to link physical and biological processes to mercury/HCH levels in the food web and to target the pelagic food web biomagnification and bioaccumulation of HCH and mercury with stable isotopes and fatty acids. Thus, all biological samples collected will be measured for HCHs, total mercury and MeHg along with stable isotopes to place organisms into their associated trophic levels.

Zooplankton
Zooplankton samples were collected at open water and ice stations in conjunction with water and air sample collection. Zooplankton was sorted into families, or to genus and species where possible, placed in scintillation vials and Whirlpak bags and frozen for HCH, stable isotopes and fatty acids analyses. See data report subsection for teams 4 for information on zooplankton species collected, stations sampled and collection methods.

Polychlorinated biphenyls (PCBs)

General Objective
As a result of extensive studies over the past 30 years, much has been learned about traditional contaminants like PCBs and their pathways, processes and effects in the Canadian Arctic. One of the only areas remaining as a major knowledge gap is Arctic seawater. PCB concentration data for Arctic seawaters are rare, largely because opportunities to collect the samples are rare, and also because it is challenging to sample and analyze PCBs at the low concentrations that occur in Arctic seawater without contamination or other biases. As we learn more about these challenges, increasingly it looks like some of the data collected in the past ï including some in the Canadian Arctic ï may be incorrect.

The goal of this project is to obtain new, trustworthy measurements of dissolved PCB concentrations in Canadian Arctic Ocean seawater, guided by recent developments in our understanding of the challenges associated with this work, and how they can be overcome.

Equipment preparation and sampling techniques
Our groupôs experience with sampling Arctic seawater for contaminants in the course of the Canadian Arctic Shelf Exchange Study (CASES) and ArcticNet cruises has made us very cognizant of the challenges of this kind of sampling generally and also more specifically, for the conditions aboard Canadian Arctic research vessels.

Ultra-clean procedures were considered from the time that sampling materials (XAD-2 resin and glass fiber filters) were first prepared, through their storage and handling in the field and during and after sample collection. In preparation for sampling, XAD-2 resins were rigorously cleaned, proofed and

packaged at AXYS Analytical Services Ltd. The filters were pre-combusted, stored in baked aluminum envelopes and vacuum sealed in plastic. New Teflon tubing and connectors as well as the pump filter plates were cleaned with hexane and vacuum sealed in plastic. These components were prepared at the Freshwater Institute, DFO, Winnipeg. The cleaned materials were stored on the ship in a vacuum seals bags inside a clean cooler to minimize their contact with the shipôs atmosphere and other potential contamination sources.

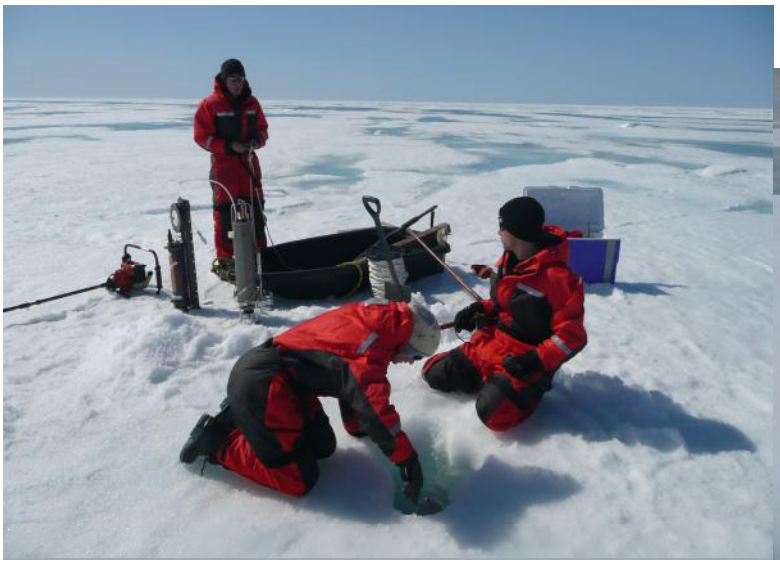
Two in situ pump systems (Infiltrex and SeaStar) were deployed beneath the sea ice to a depth of 15 m thus sampling Arctic Ocean seawater from the sea ice (rather than a ship) as a platform. The sampling area was upwind and approximately 500 m away of the ship to reduce the effects of the ships atmosphere.

The systems are equipped with glass fibre filters to collect suspended particulates (and associated PCBs) and stainless steel columns containing XAD-2 resin, which extract dissolved PCBs. During leg 9A the project was limited by the number of pre-cleaned columns available. Of the five columns, two were treated as procedural blanks and three as samples.

Two blanks were obtained by passing approximately 1-L of seawater through each pumping system. The expected blank levels for filters and XAD-2 resin columns are in the order of 3-8 pg absolute.

Samples consist of between 250-400 L of seawater**.** (400-600 L would have been preferred.) Assuming that PCB concentrations in Canadian Arctic seawater are similar to recently reported values for the European Arctic (e.g., $\Sigma PCBs_{15}$=0.54-1.96 pg/L, PCB congener 52 concentrations = 0.10-0.24 pg/L; (Gustafsson et al., 2005)), sample volumes of 400-600 L should produce readily quantifiable PCB congener concentrations (40-120 pg absolute).

After the required volume of water was sampled, the columns and GF/F were placed in ziploc bags, sealed and returned to the ship where they were vacuum sealed. The columns were stored at 2ºC and the GF/F at -24ºC.



Preparing pumps and site for deployment.

SeaStar high volume pump with XAD column and filter attached.

Samples collected

Date begin	Total pumping time (hours)	Sample code	Column ID	Station	Total Volume (L)	Pump type	Location	
							Lat (N)	Long (W)
08-Jun-08	0.12	CFL08-HV-0005	4415-31	F7	2.35	Infiltrex	69º 49.63	123º 37.85
08-Jun-08	29.83	CFL08-HV-0006	4415-33	F7	180.6	SeaStar	69º 49.63	123º 37.85
11-Jun-08	59.13	CFL08-HV-0007	4415-32	F7	493.51	SeaStar	69º 49.45	123º 37.97
12-Jun-08	0.12	CFL08-HV-0008	4415-34	F7	1.54	SeaStar	69º 49.45	123º 37.97
15-Jun-08	59.17	CFL08-HV-0009	4415-35	FB05	529.81	SeaStar	69º 57.38	125º 52.01

All samples and blanks pumped at a rate of 150 mL min^{-1}.

PCB congeners will be analyzed at AXYS Analytical Services Ltd. by high-resolution gas chromatography/mass spectrometry (US EPA method 1668A). Samples are analyzed in batches of 12-15 or less and a blank, spike and/or duplicate is analyzed with each batch.

Currently Used Pesticides (CUPs) and Perfluoro Compounds in the Atmosphere

The fate of pesticides applied to agricultural fields is of great interest because they are manufactured to be toxic to biota and some organisms. Currently used pesticides (CUPs) are generally more volatile and less persistent than the older style organochlorine pesticides, such as HCHs, but they can still undergo atmospheric transport through volatilization and deposition followed by reemissions. They ultimately make their way to sensitive ecosystems including the Canadian Arctic. CUPs include: dacthal, chlorothalonil, endosulfan and Chlorpyrifos, which have been reported in Arctic air (Hung et al., 2005; Jantunen et al., 2007, Shen et al., 2005; Pozo et al., 2006; Chernyak et al., 1996), seawater (Jantunen et al., 2007; Chernyak et al., 1996; Weber et al., 2006), sub-arctic/arctic lake water (Muir et al., 2004), snow (Hermanson et al., 2005; Chernyak et al., 1996) and fog (Chernyak et al., 1996). Perfluoro chemicals are emerging persistent organic pollutants which are found in a wide range of applications such as paints, packaging, lubricants, firefighting foams, stain repellents and cookware. They are found in Arctic where they accumulated in the food chain and in the atmosphere (Butt et al., 2007; Shoeib et al., 2006). There are is little known about their atmospheric levels in the Arctic.

During Leg 9B, air (~1200m^3, n=8) were continuously collected to determine occurrence and levels of CUPs. Air was drawn at a flow rate of 0.5 m^3/min, through a glass fiber filter (Whatman, Maidstone, England, 20.3 x 25.4 cm, EPM 2000, collects 99% of particles >0.3µm) followed by two plugs of polyurethane foam (PUF), each 8 cm diameter x 7.5 cm tall, that collect the gaseous phase. Surface water samples (n=8) of 30-40L were collected by using a bucket dropped to the side of the boat. The water is passed through a glass fibre filter (GFF, 142mm) followed by a column of XAD-2 resin (Amberlite, macroreticular styrene divinylbenzene copolymer, 20-60 mesh size, Rohm and Haas, Supelco, Bellefonte PA, USA, 1.5 cm i.d., 75 mL settled volume) to concentrate the dissolved fraction.

A separate set of air samples were collected for perfluoro compounds. Three ~350 m^3 air samples were taken with a PS-1 (Tisch Environmental, Village of Cleves, OH, U.S.A.) sampler, consisting of 7.6 cm diameter GFF followed by PUF-XAD-2-PUF plug sandwaich (6.8 cm diameter). These were collected for Mahiba Shoeib at Environment Canada, Toronto. Sampling will be continued in Leg 10.

α-HCH Flux Experiments

Hexachlorocyclohexanes (HCHs) are the most abundant organochlorine pesticides in Arctic air due to their facile atmospheric deposition in the cold environment and slow degradation rates. In the past two decades, there has been a reduction in primary emissions of technical HCH with an accompanying decline in atmospheric HCHs concentrations. As a result, a reversed direction of air-water flux from net deposition to net volatilization has been observed in some arctic regions. This study was carried out to determine the gas exchange of HCHs using gradients of HCH concentrations and enantiomer fractions (EF) of α-HCH, where EF = concentrations of (+)/[(+) + (ï)] enantiomers.

Air samples were collected at three heights above the surface water, at ~1m, ~6m and ~12m to determine the flux of α- HCH and its enantiomers. These samples were collected during full stations and at the community visit at Holman. There were a total of 8 sampling events. A modified PS-1 (Tisch Environmental, Village of Cleves, OH, U.S.A.) sampler was used consisting of 7.6 cm diameter GFF followed by one PUF plug (6.8 cm diameter x 4.2 cm). Sampling rate ranged from 70-115 ml/min which gave a sample volume of 60-100 m^{-3}. Parallel low volume water samples of 4L were also collected in duplicates. These low volume water samples were passed through a glass fibre filter (47mm) followed by a ENV+ (200mg, Jones Chromatography) SPE cartridge.

It is expected that α-HCH levels in air collected near the water surface is higher than those collected at 12 m above water. Similarly, EFs of α-HCH in air sampled closest to the water are expected to approach the nonracemic EFs in the surface water and tend toward more nearly racemic values with height.

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2.7.2. Mercury

Rationale

Mercury (Hg) levels in marine mammals and fish are an ongoing concern in Arctic regions because of their inclusion in traditional subsistence diets among indigenous peoples in northern regions. Successful strategies to mitigate health impacts related to Hg in human diets require an understanding of both the social and cultural perspective of northern communities, as well as the natural environmental processes that lead to Hg in food resources. Our research on Hg in the Arctic is focused on determining the environmental processes responsible for the distribution and speciation of Hg in Arctic marine ecosystems, for the purpose of supporting the development of strategies to lessen the impact of Hg on human and ecosystem health.

Marine Water Column Sampling

During Leg 9 of the CFL Study, the Team 8: Contaminants group collected samples from the marine water column in Amundsen Gulf from 24 locations within the Amundsen Gulf and the Beaufort sea as well as three rivers: Horton River Estuary, Horton River and the MAcKenzie River (Table 1). Samples from the 10 m depth to the seafloor were collected with the ship-based Rosette sampling equipment in PVC ôNiskin-styleô sample bottles remotely operated from onboard the ship. Supplementary ôSurfaceô samples from 0 to 10 m in depth were collected by a PVC Niskin water sampling bottle (General Oceanics, Miami, Florida) from a hole or open lead within a few hundred meters of the ship and within three hours of the Rosette collection (Table 1). Within each profile, 11 to 20 different depths were sampled (including Niskin sampling), producing high resolution profiles for ótotal Hgô (Hg_T) and methyl Mercury (MeHg). At each depth sampled for Hg_T, water was also collected for ŭ^{18}O analysis in tightly sealed glass scintillation vials. After collection of ŭ ^{18}O samples, bottles were further sealed with parafilm and stored at 4°C.

Preliminary Results

Hg_T levels in the Amundsen Gulf measured during Leg 9 were very low, averaging roughly 1 pM (0.2 ng/L) throughout the water column. These values are comparable with the lowest concentrations of Hg_T observed in the global oceans (e.g., the Pacific and North Atlantic Oceans), and somewhat lower than those observed in coastal oceans and regional seas (e.g., the Baltic and the Celtic Seas, Hudson Bay). However, we were able to observe changes in the concentrations caused by the final ice /meltbreakup and influence of river inputs from the Horton and the Mackenzie River systems.

Table 5. Sampling Location and Date for Marine Water HgT Measurements During CFL Leg 9

Station	Date	Location	Bottom Depth (m)	Cast #
405b	June 10	Amun. Gulf	590	13
F7	June 11, June	Darnley B.	80	17
	13,		80	35
	June 19,		110	54
	June 24		74	68
FB01	June 14	Frank. B	98	38
FB03	June 14	Frank. B	98	40
FB05	June 15	Frank. B	98	43
FB00	June 16	Frank. B	89	46
HR01	June 17	Horton E	100	47
FB07	June 21	Frank. B	115	60
	June 25		106	71
1216	June 23	Beaufort	166	64
1200	June 27		207	68
1208	June 28		400	79
434	June 30	Beaufort	47	94
421	July 1	Beaufort	1180	99

435	July 2	Beaufort	300	103
410	July 8	Beaufort	414	126
420	July 9	Beaufort	42	137
416	July 9	Beaufort	159	142
6006	July 4	Amun. G	224	112
2005	July 5	McClure	418	118
2010	July 5	McClure	412	119
1100	July 11	Amun. G	268	159
1110	July 12	Amun. G	94	162
D34	July 13	Amun. G	185	177

At open water stations, surface water samples were taken with the zodiac to avoid contamination from the ship. It was quite evident that the results from the Niskin sampling were lower in THg concentration. Of course, the Niskin must be cleaned and tested at both the spigot and the top of the Niskin before use.

Atmospheric Mercury

Three systems have been running constantly during Leg 9 for real-time atmospheric mercury speciation monitoring in the air. On Leg 9, these systems were monitored and operated by Jeff Latonas.

Mercury Speciation System (SN323)
This system includes a Tekran 1135, a Tekran 1130, a Tekran 1130 Pump, and a Tekran 2537B (SN323). It provides real-time atmospheric Hg measurements for gaseous elemental mercury (GEM; every 5 min), particulate mercury (Hg_P; every 2 hours) and reactive gaseous mercury (RGM; every 2 hours). The system was installed in Leg 5 and has been continuously working without major problems. There were no major interruptions of the instruments operation in Leg 9.

No Mercury depletion events were observed during leg 9; GEM, RGM, and Hg_p remained fairly constant throughout the period. The last of the depletion events were observed on leg 8 with the last one occurring on may 29th near the north eastern point of Banks Island. The predominant Hg 2+ species has continued to be RGM since May 6th.

The glassware in the 1130/1135 speciation unit was changed on June 20th including the RGM denuder, particulate mercury filter, and intake glassware. The unit was shut down on the 11th of July and the speciation unit was dismantled. A series of standard injections was performed on the 8th of July to confirm proper calibration of the instrument and results were good (within 5%). The 2537B (SN323) was then converted to sample only GEM for the remainder of the cruise. GEM sampling with this instrument began on July 12th.

Total Atmospheric Mercury System (SN051)
We are also monitoring Total mercury (Hg_t) through a Tekran 1105 arctic pyrozlyzer unit which heats the sample to 900°C before analysis by another Tekran 2537A (SN051). This unit was operating normally throughout leg 9. Total mercury concentrations remained fairly constant throughout the leg due to the absence of depletion events. Measurements were stopped on the 11th of July and the system

was dismantled. A series of standard injections was performed on July 8th to confirm calibration and the results were good.

Gaseous Elemental Mercury (SN071)
Alongside the speciation unit an additional Tekran 2537 was monitoring GEM (SN071). This unit was installed on May 20th during leg 8 and was operational until the 11th of July after which the Tekran 2537B (SN323) took over GEM measurements. GEM concentrations were constant throughout leg 9 and consistent with the total atmospheric mercury measurements from SN051. On June 20th the unit underwent maintenance which included replacing both gold cartridges and heaters. A series of standard injections was performed on July 8th to confirm calibration and the results were good.

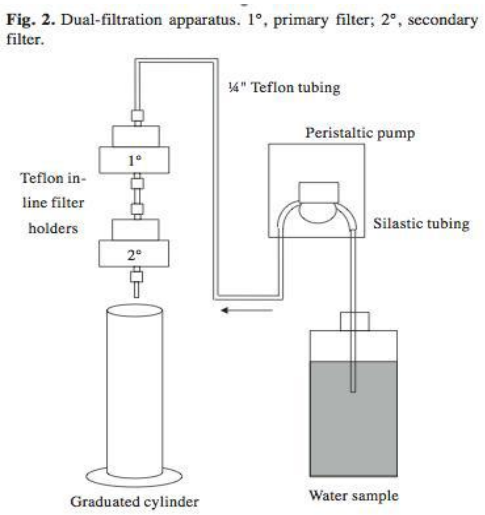
Mercury in Phytoplankton and Zooplankton

Algae (Hg, MeHg)
Phytoplankton samples were taken in conjunction with zooplankton tows. Samples were sieved through 710µm, 350µm, 150µm, 50µm and 20µm mesh and frozen. Samples were also preserved with lugolôs for speciation.

Phytoplankton was collected at stations F7, HR01, F7 open water, and 2010. At open water stations, phytoplankton was collected with a 20um mesh net (stations 405B, 1216, F7 open water, FB07 open water, 1200, 1208, and 6006). The rosette was used to collect phytoplankton at the chlo max (stations 405B, FB03, HR01, 1216, 1208, 6006, and 2010) these samples were filtered as below.

Under-ice algae was collected from the ice-water interface with a battery powered pump on a metre long under ice arm (stations F7 (x2), and 2010). These samples were filtered onto pre-combusted and weighed glass fibre filters (GF/F) for chlorophyll *a*, dry mass, and filtered in series with a clean set up for mercury, with a blank (see figure). The filters were frozen, and will be shipped to Winnipeg for further analysis.

Under-ice algae was also collected during the dive program using slurp guns and the same 20µm mesh net at stations F7 (x2), FB03, FB05, and FB07. These samples were also filtered as described. Ice algae was not collected as there was no more ice algae.



Filtration set up for algal Hg (exception: the peristaltic pump is between the filters and the waste container)

Sarah and Alexis collecting slurp gun samples at the dive program (photo by Shelly Carpenter)

Zooplankton

Zooplankton samples were collected during the leg. Various zooplankton families were collected using horizontal/oblique tows on the foredeck with a double Tucker net (500µm mesh) and vertical tows done with the monster net (4x200µm mesh nets). Samples were also collected from the using the zodiac at the ice edge, and from the dive hole with a ring net (200µm mesh), and from under the ice using a vacuum during the dive program (H. Hop).

Zooplankton was sorted into families, or to genus and species where possible, placed in scintillation vials and Whirlpak bags and frozen until they can be analyzed for THg, MeHg, stable isotopes and fatty acids. Common species found were *Calanus hyperboreus*, *Calanus glacialis, Paraeuchaeta glacialis*, *Sagitta elegans, Sagitta maxima*, *Themisto abyssorum*, *Themisto libellula*, Cnidarians, and Ctenophores. Some less common species found were *Cleone limacina*, *Limacina helicina*, *Hyperoche* sp., *Gammarus* sp., *Onisimus* sp., Euphasiids and one unidentified fish.

Zooplankton was collected at station F7 (x12), 405B, FB01, FB03, FB05 (x2), FB00 (x2), HR01 (x2), FB07, 1216, 1200 (x2), 1208 (x2), 434, 421, 435, 6006, 2010, and 410 for a total of 34 zooplankton hauls leg 9.

Tucker 2x1m^2 200µm mesh
oblique tow
(photo by Samuel Lauzon)

Monster 4x1m^2 200µm mesh
vertical tow

Special thanks to the Zooplankton Team members (Gerald, Stéphane, Samuel, and Helen) for hours of collecting and help sorting, and to the crew for their tireless support and encouragement. This project wouldn't be complete with out you!

Mercury in Ice, Brine and Snow

In order to study the cycling of Mercury in the Arctic environment, we need to understand how it moves through the barrier separating the atmosphere and ocean known as ice. Movement through ice is thought to be carried through the network of brine channels that are formed within the ice and the interaction of that brine with the water column with the onset of spring. Another important factor to consider is the impact of snow or deposition as a source from the atmosphere to the snowpack, ice column and directly into the ocean.

On leg 9 we collected ice cores, snow samples and brine/melt pond samples as much as possible to track the movement of mercury with these media. Samples of each were collected over varying time series at stations: F7, FB04, FB07 and 2010. The ice cores from stations FB07

and 2010 were processed, the remaining cores from stations D34 (leg 8), F7 and FB04 are in the portside chest freezer. These were not sampled due to a limited number of falcon tubes onboard.

All ice cores were cut into duplicates and each duplicate was scrapped with a freshly cleaned and tested ceramic blade. Both pieces were placed into separate zip lock bags and then stored in one larger bag to melt. When sampling, each individual zip lock bag was rinsed with MQ water over the area that would be cut and then sampled. A small amount was rinsed out and then the sample was collected. For example, a 5 cm piece of ice split would yield two 25 mL samples of water in the end. The scrapping was very clean, and the gloves were changed between each section of the core to be scrapped. This is essential to good reproducible results.

Snow samples and melt ponds were collected on a daily basis when possible.

Methyl Mercury

The form of mercury that accumulates within the foodweb is the organic form of mercury known as methyl mercury. We are interested in determining the pathways in which mercury (Hg) becomes methylated and to study the levels in the abiotic and biotic environments. We are up and running Methyl Mercury samples with our new and improved BrooksRand Automated system. The detector lamp needs to be changed at the beginning of each leg and possibly after travelling through heavy ice. The detector was quite stable this leg and we were able to analyse samples collected on leg 7: D29b as well as collect and analyse samples from nine stations including the Horton and MacKenzie rivers. We were able to reach the detection limit of the instrument in our sensitivity to 0.01 ng/L. Analysis time is approximately two days for 30 samples.

Sample depths are chosen based on the CTD profile from the rosette at the time of deployment. As the CTD goes down, it maps out the characteristics of the water column and the ñinterestingò depths are those where salinity, temperature and chlorophyll differ to identify different water masses of the water column. At all sampling events, both δO18 and THg samples were collected.

BrooksRand Automated MeHg system.

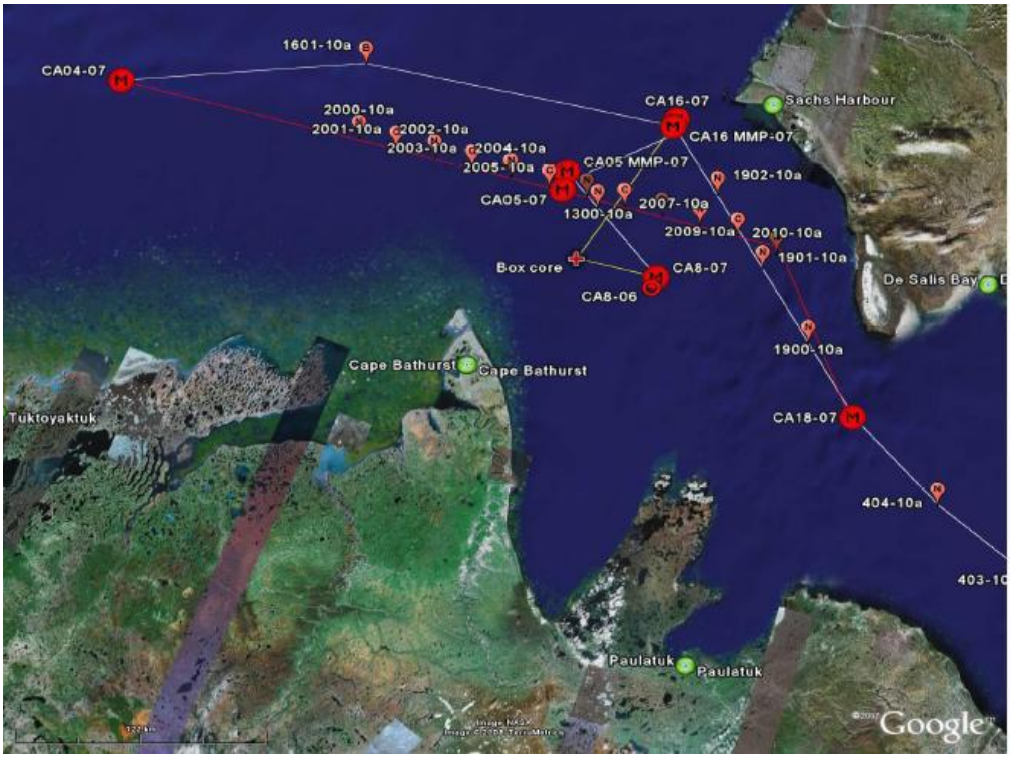
Leg 10

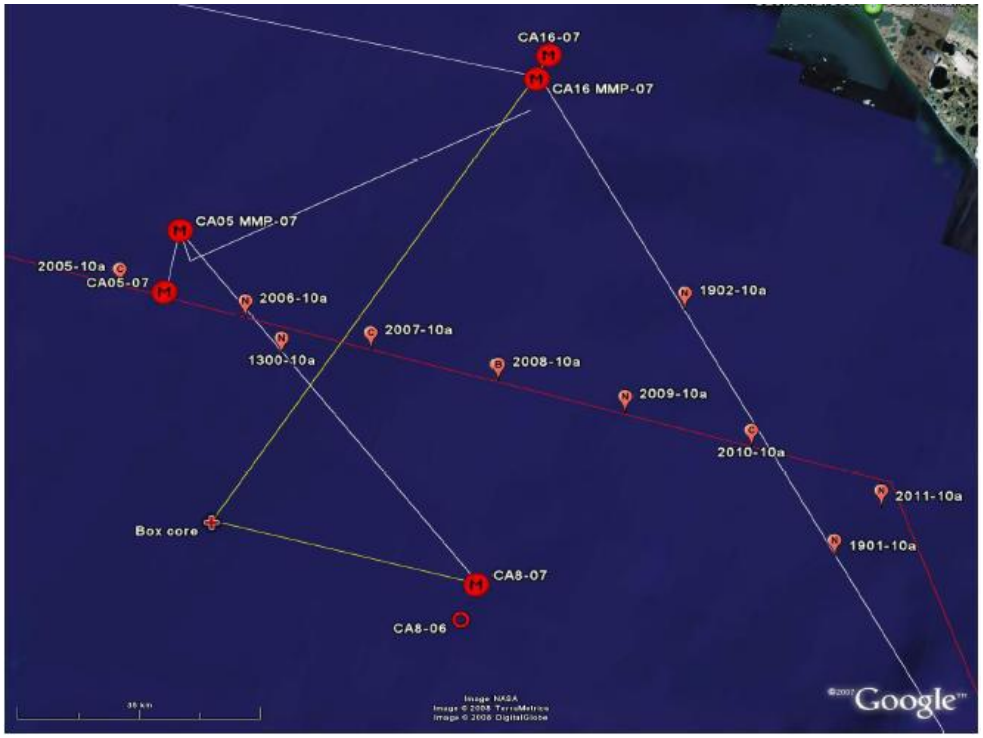
18 July – 7 August 2008

edited and compiled by Gary Stern
(Chief Scientist)

1. General overview

1.1. Cruise maps

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CA05 MMP-07
2005-10a
CA05-07
2006-10a
1902-10a
2007-10a
1300-10a
2008-10a
2009-10a
2010-10a
2011-10a
Box core
1901-10a
CA8-07
CA8-06
Image NASA
Image © 2008 TerraMetrics
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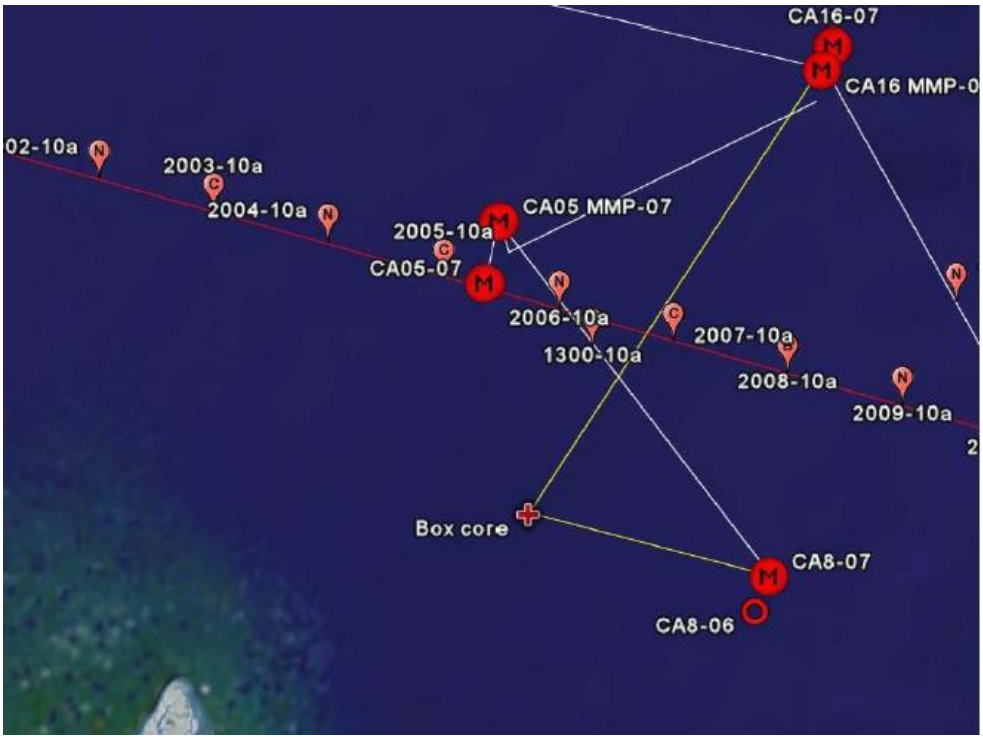
Google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02-10a
2003-10a
2004-10a
CA05 MMP-07
2005-10a
CA05-07
2006-10a
2007-10a
1300-10a
2008-10a
2009-10a
Box core
CA8-07
CA8-06

1.2. Ship Log of Science Activities

Scientific log recorded by the CCGS Amundsen officer-on-watch.

Date	Hre	Latitude		Longitude		Cap	Activités	Prof (M)	T° Air ©
18-jul-2008	20h45	67*59,67	°N	114*40,25	°W	064	LAWAS on	155	6.4
19-jul-2008			□		□		**----------Stn 400-10A----------**		
19-jul-2008	07h20	69*06,41	°N	114*47,45	°W	063	Rosette in - **cast 001**	138	5.6
19-jul-2008	07h50	69*06,43	°N	114*47,49	°W		Rosette out	138	5.8
19-jul-2008			□		□		**----------Stn 401-10A----------**		
19-jul-2008	11h10	69*14,27	°N	116*36,26	°W	090	Rosette in - **cast 002**	176	6.6
19-jul-2008	11h50	69*14,46	°N	116*36,09	°W	082	Rosette out	179	6.2
19-jul-2008			□		□		**----------Stn 402-10A----------**		
19-jul-2008	15h05	69*36,17	°N	118*07,82	°W	095	Rosette in - **cast 003**	433	7.3
19-jul-2008	15h59	69*36,64	°N	118*07,14	°W	100	Rosette out	430	6.6
19-jul-2008	20h00	70*05,8	°N	120*06,3	°W	090	LAWAS on	426	7.6
19-jul-2008	20h30	70*06,12	°N	120*00,71	°W	090	LAWAS out	426	7.5
			□		□		**----------Stn 403-10A----------**		
19-jul-2008	21h41	70*05,36	°N	120*09,38	°W	075	PNF in	420	6.8
19-jul-2008	21h47	70*05,45	°N	120*09,29	°W	032	PNF out	419	6.5
19-jul-2008	22h22	70*05,46	°N	120*08,90	°W	089	Rosette in - **cast 004**	410	6.6
19-jul-2008	23h08	70*05,65	°N	120*09,52	°W	096	Rosette out	411	6.6
19-jul-2008	23h30	70*05,45	°N	120*08,66	°W	092	Vertical Net in	411	6.6
19-jul-2008	23h59	70*05,54	°N	120*08,87	°W	092	Vertical Net out	411	6.6
20-jul-2008	00h18	70*05,19	°N	120*08,77	°W	150	Tucker in	412	6.5
20-jul-2008	00h32	70*04,72	°N	120*08,71	°W	222	Tucker out	413	6.5

			°N		W	°			
20-jul-2008	01h10	70*05,48	°N	120*05,62	W	084	Rosette in - **cast 005**	412	6.8
20-jul-2008	01h52	70*05,52	°N	120*05,60	W	084	Rosette out	412	6.6
20-jul-2008	02h09	70*05,53	°N	120*05,58	W	092	Phytoflash in	412	6.5
20-jul-2008	02h30	70*05,50	°N	120*05,59	W	100	Phytoflash out	412	6.5
20-jul-2008	03h05	70*05,47	°N	120*05,60	W	089	Rosette in - **cast 006**	411	6.5
20-jul-2008	04h07	70*05,52	°N	120*05,87	W	078	Rosette out	419	6.4
			□		□		**----------Stn 404-10A----------**		
20-jul-2008	06h59	70*20,99	°N	121*36,24	W	091	Rosette in - **cast 007**	479	6.4
20-jul-2008	07h58	70*21,14	°N	121*36,34	W	085	Rosette out	473	6.3
			□		□		**----------Stn 405-10A----------**		
20-jul-2008	14h58	70*41,500	°N	122*57,925	W	052	Sediment traps in	584	6.2
20-jul-2008	15h00	70*41,712	°N	122*57,946	W	073	Balloon launch	590	6.4
20-jul-2008	21h40	70*41,50	°N	122*51,52	W	086	PNF in	597	7.4
20-jul-2008	21h45	70*41,53	°N	122*51,62	W	086	PNF out	598	7.4
20-jul-2008	21h45	70*41,54	°N	122*51,74	W	078	Secchi disk	597	7.4
20-jul-2008	21h45	70*41,54	°N	122*51,74	W	078	Secchi disk	597	7.4
20-jul-2008	22h39	70*41,16	°N	122*54,13	W	090	Rosette in - **cast 008**	584	7.5
20-jul-2008	23h44	70*41,61	°N	122*55,01	W	098	Rosette out	597	7.4
20-jul-2008	23h58	70*41,64	°N	122*55,33	W	103	Monster Net in	598	7.4
21-jul-2008	00h37	70*41,68	°N	122*55,47	W	103	Monster Net out	598	7.5
21-jul-2008	00h51	70*41,70	°N	122*55,47	W	108	Monster in	599	7.6

21-jul-2008	01h29	70*41,75	°N	122*55,58	°W	108	Monster out	599	7.7
21-jul-2008	01h58	70*41,80	°N	122*55,81	°W	099	Rosette in - **cast 009**	599	7.7
21-jul-2008	02h35	70*41,86	°N	122*55.96	°W	102	Rosette out	598	7.8
21-jul-2008	03h04	70*41,92	°N	122*55,91	°W	105	Hydrobios in	599	7.9
21-jul-2008	03h44	70*41,97	°N	122*56,03	°W	102	Hydrobios out	599	8.1
21-jul-2008	04h04	70*41,97	°N	122*55,74	°W	095	Tucker in	599	8.1
21-jul-2008	04h17	70*42,22	°N	122*55,89	°W	270	Tucker out	598	8
21-jul-2008	04h35	70*42,04	°N	122*56,14	°W	126	RMT in	598	7.7
21-jul-2008	04h56	70*42,07	°N	122*56,22	°W	104	RMT out	599	8
21-jul-2008	05h15	70*42,12	°N	122*56,26	°W	101	Rosette in - **cast 010**	599	8.1
21-jul-2008	06h21	70*42,28	°N	122*56,12	°W	128	Rosette out	598	7.8
21-jul-2008	07h15	70*42,40	°N	122*56,33	°W	335	Box Core in	596	7.2
21-jul-2008	07h28	70*42,41	°N	122*56,34	°W	311	Box Core bottom	596	7
21-jul-2008	07h39	70*42,44	°N	122*56,37	°W	304	Box Core out	596	7
21-jul-2008	09h27	70*42,93	°N	123*06,22	°W	070	Sediment traps out begin	491	6.5
21-jul-2008	09h37	70*42,94	°N	123*06,14	°W	070	Sediment traps out end	491	6.5
21-jul-2008	10h02	70*41,18	°N	123*13,02	°W	203	RMT in	517	7.1
21-jul-2008	10h15	70*40,93	°N	123*12,40	°W	056	RMT out	515	7.2
			□		□		**----------Stn 1900-10A----------**		
21-jul-2008	23h02	70*56,95	°N	123*51,93	°W	287	Rosette in - **cast 011**	350	6.7
21-jul-2008	23h25	70*57,00	°N	123*52,50	°W	298	Rosette out	352	6.7

22-jul-2008	00h10	71*02,4057	°N	124*08,3323	°W	280	LAWAS on	401	6.9
22-jul-2008	00h48	71*03,2451	°N	124*18,5544	°W	280	LAWAS out	453	6.6
			□		□		**----------Stn 1901-10A----------**		
22-jul-2008	01h59	71*13,45	°N	124*42,18	°W	263	Rosette in - **cast 012**	275	6.4
22-jul-2008	02h44	71*13,26	°N	124*41,82	°W	247	Rosette out	271	6.4
			□		□		**----------Stn 1902-10A----------**		
22-jul-2008	04h58	71*29,91	°N	125*36,53	°W	221	Rosette in - **cast 013**	358	3.5
22-jul-2008	05h16	71*29,89	°N	125*36,17	°W	227	Rosette out	357	3.8
			□		□		**----------Stn CA16-07 / 437----------**		
22-jul-2008	13h56	71*47,55	°N	126*29,47	°W	309	Mooring recovery CA16-07	301	4.8
22-jul-2008	14h15	71*47,59	°N	126*29,19	°W	249	Rosette in - **cast 014**	296	4.9
22-jul-2008	14h16	71*47,59	°N	126*29,19	°W	249	Balloon launch	296	4.9
22-jul-2008	14h28	71*47,61	°N	126*29,11	°W	256	Rosette out	294	5.3
22-jul-2008	14h48	71*47,62	°N	126*29,13	°W	257	Hydrobios in	293	6.2
22-jul-2008	15h00	71*47,63	°N	126*29,10	°W	261	Hydrobios out	294	6.5
22-jul-2008	15h12	71*47,64	°N	126*28,95	°W	292	LAWAS on	293	6.3
22-jul-2008	15h48	71*44,16	°N	126*30,23	°W	006	Sediment traps in begin	364	5.5
22-jul-2008	16h20	71*44,17	°N	126*29,76	°W	002	Sediment traps in end	363	5.2
			□		□		**----------Stn CA16MMP-07----------**		
22-jul-2008	18h42	71*45,134	°N	126*29,898	°W	310	CA16MMP-07 begin recovery	352	6
22-jul-2008	19h20	71*44,81	°N	126*28,83	°W	032	CA16MMP-07 end recovery	349	5.7
22-jul-2008	19h35	71*44,239	°N	126*28,69	°W	275	Rosette in - **cast 015**	351	5.8
22-jul-2008	19h53	71*44,594	°N	126*28,737	°	275	Rosette out	353	5.8

			°N		W°				
22-jul-2008	20h15	71*42,27		126*32,76	W	280	LAWAS on	360	4.7
			°N		W°				
22-jul-2008	23h00	71*42,96		126*42,81	W	280	LAWAS out	360	4.7
			□		□		**----------Stn CA16-07 / 437----------**		
			°N		W°				
22-jul-2008	23h07	71*43,00		126*43,23	W	280	PNF in	438	4.7
			°N		W°				
22-jul-2008	23h10	71*42,99		126*43,24	W	274	PNF out	439	4.5
			°N		W°				
22-jul-2008	23h39	71*42,41		126*37,56	W	288	Rosette in - **cast 016**	437	4.4
			°N		W°				
23-jul-2008	00h34	71*42,27		126*37,72	W	286	Rosette out	439	4
			°N		W°				
23-jul-2008	00h45	71*42,23		126*37,60	W	288	Vertical Net in	439	3.9
			°N		W°				
23-jul-2008	01h16	71*42,24		126*37,54	W	299	Vertical Net out	439	3.6
			°N		W°				
23-jul-2008	01h32	71*42,22		126*37,44	W	257	Hydrobios in	439	3.4
			°N		W°				
23-jul-2008	02h05	71*42,08		126*37,26	W	266	Hydrobios out	440	3.5
			°N		W°				
23-jul-2008	02h30	71*42,03		126*37,01	W	266	Rosette in - **cast 017**	440	3.5
			°N		W°				
23-jul-2008	03h03	71*41,94		126*36,87	W	266	Rosette out	440	3.6
			°N		W°				
23-jul-2008	03h16	71*41,88		126*36,69	W	265	Phytoflash in	440	3.7
			°N		W°				
23-jul-2008	03h41	71*41,79		126*36,34	W	269	Phytoflash out	440	3.7
			°N		W°				
23-jul-2008	04h20	71*41,63		126*36,03	W	261	Rosette in - **cast 018**	441	3.9
			°N		W°				
23-jul-2008	05h12	71*41,36		126*35,62	W	257	Rosette out	441	3.9
			°N		W°				
23-jul-2008	05h22	71*41,37		126*35,74	W	310	Tucker in	441	3.9
			°N		W°				
23-jul-2008	05h34	71*41,68		126*36,44	W	28	Tucker out	441	3.8
			°N		W°				
23-jul-2008	12h52	71*50,90		125*35,26	W	262	MOB buoy in	162	3.9
23-jul-2008	13h56	71*51,23	°N	125*34,15	°	86	Weather balloon launch	127	5.1

			°N		W °				
23-jul-2008	15h31	71*50,53		125*28,51	W	316	MOB buoy out	67	3.1
			°N		°				
24-jul-2008	08h30	71*41,43		126*26,86	W	306	Sediment traps recovery begin	391	3.2
			°N		°				
24-jul-2008	08h53	71*41,51		126*26,85	W	306	Sediment traps recovery end	391	3.2
			°N		°				
24-jul-2008	09h21	71*41,42		126*27,21	W	284	Rosette in - **cast 019**	395	3.4
			°N		°				
24-jul-2008	09h40	71*41,33		126*27,19	W	288	Rosette out	398	3.4
			°N		°				
24-jul-2008	09h53	71*41,82		126*26,60	W	0	Zodiac in	398	3.4
			°N		°				
24-jul-2008	10h12	71*41,822		126*26,589	W	8	Zodiac out	398	
			□		□		**----------Stn 411-10A----------**		
			°N		°				
24-jul-2008	11h07	71*37,81		126*42,50	W	285	Rosette in - **cast 020**	435	3.1
			°N		°				
24-jul-2008	11h25	71*37,74		126*42,56	W	289	Rosette out	434	2.8
			□		□		**----------Stn 412-10A----------**		
			°N		°				
24-jul-2008	12h08	71*33,84		126*55,02	W	285	Rosette in - **cast 021**	415	2.7
			°N		°				
24-jul-2008	13h05	71*33,52		126*55,00	W	326	Rosette out	415	3
			□		□		**----------Stn 413-10A----------**		
			°N		°				
24-jul-2008	14h24	71*29,58		127*08,29	W	278	Rosette in - **cast 022**	371	2.6
			°N		°				
24-jul-2008	14h27	71*29,58		127*08,27	W	277	Weather balloon launch	371	2.6
			°N		°				
24-jul-2008	14h40	71*29,55		127*08,24	W	278	Rosette out	371	2.5
			°N		°				
					W		**----------Stn 414-10A----------**		
			°N		°				
24-jul-2008	15h25	71*25,35		127*21,98	W	28	Rosette in - **cast 023**	305	2.4
			°N		°				
24-jul-2008	16h09	71*25,27		127*21,75	W	265	Rosette out	306	2.5
			°N		°				
24-jul-2008	16h45	71*24,205		127*37,633	W	270	LAWAS on	237	2.4
24-jul-2008	16h55	71*24,187	°N	127*38,207	°	270	Mooring CA05MMP-07 recovery begin	236	2.5

			°N		W °				
24-jul-2008	17h17	71*24,320		127*38,283	W	300	Mooring CA05MMP-07 recovery end	234	2.5
			°N		°				
24-jul-2008	18h09	71*24,39		127*38,00	W	270	Rosette in - **cast 024**	237	2.6
			°N		°				
24-jul-2008	18h22	71*24,37		127*37,99	W	270	Rosette out	235	2.6
			°N		°				
24-jul-2008	18h22	71*24,37		127*37,99	W	270	LAWAS out	235	2.6
			°N		°				
24-jul-2008	19h06	71*18,790		127*36,060	W	280	LAWAS on	204	3.8
			□		□		**----------Stn 408-10A----------**		
			°N		°				
24-jul-2008	19h12	71*18,771		127*36,036	W	260	Mooring CA05-07 recovery begin	200	3.8
			°N		°				
24-jul-2008	19h51	71*18,712		127*35,355	W	285	Mooring CA05-07 recovery end	200	4.1
			°N		°				
24-jul-2008	20h16	71*18,78		127*36,15	W	272	Rosette in - **cast 025**	200	4.2
			°N		°				
24-jul-2008	20h20	71*18,78		127*36,15	W	275	LAWAS out	200	4.1
			°N		°				
24-jul-2008	20h32	71*18,66		127*36,10	W	269	Rosette out	200	4.1
			°N		°				
24-jul-2008	21h12	71*18,29		127*34,80	W	280	Hydrobios in	203	4.1
			°N		°				
24-jul-2008	21h23	71*18,19		127*34,43	W	282	Hydrobios out	203	4.1
			°N		°				
24-jul-2008	22h05	71*17,74		127*32,87	W	277	Monster Net in	205	4.3
			°N		°				
24-jul-2008	22h20	71*17,67		127*32,63	W	325	Monster Net out	206	4.3
			°N		°				
24-jul-2008	22h42	71*17,80		127*28,68	W	8	Tucker Net in	220	4.1
			°N		°				
24-jul-2008	22h53	71*18,15		127*28,62	W	338	Tucker Net out	225	4.2
			°N		°				
24-jul-2008	23h18	71*18,35		127*27,65	W	276	Hydrobios in	232	4.3
			°N		°				
24-jul-2008	23h34	71*18,21		127*27,56	W	268	Hydrobios out	229	4.3
			°N		°				
25-jul-2008	00h36	71*18,89		127*35,44	W	24	RMT in	205	4.1
25-jul-2008	00h48	71*19,27	°N	127*35,17	°	334	RMT out	208	4.1

			°N		W	°				
25-jul-2008	02h08	71*19,19	°N	127*35,49	W	°	328	Sediment traps in	207	3.7
25-jul-2008	02h37	71*19,38	°N	127*36,34	W	°	280	Box Core in	206	4
25-jul-2008	02h51	71*19,37	°N	127*36,34	W	°	276	Box Core out	206	3.9
25-jul-2008	05h31	71*21,370	°N	127*30,586	W	°	345	Weather balloon launch	250	3.1
25-jul-2008	09h17	71*21,895	°N	127*20,933	W	°		Rosette in - **cast 026**	288	
25-jul-2008	09h43	71*21,720	°N	127*19,969	W	°		Rosette out		
25-jul-2008	10h20	71*21,45	°N	127*18,95	W	°	11	MOB buoy in	292	2.3
25-jul-2007	13h17	71*20,866	°N	127*17,231	W	°	8	Weather balloon launch	288	2.9
25-jul-2008	13h25	71*20,868	°N	127*17,226	W	°	9	MOB buoy out	288	2.9
25-jul-2008	15h56	71*18,81	°N	127*36,25	W	°	280	Secchi disk in	200	3.4
25-jul-2008	15h59	71*18,81	°N	127*36,26	W	°	276	Secchi disk out	200	3.4
25-jul-2008	16h00	71*18,81	°N	127*36,26	W	°	276	PNF in	200	3.4
25-jul-2008	16h09	71*18,83	°N	127*36,23	W	°	260	PNF out	200	3.8
25-jul-2008	16h27	71*18,83	°N	127*36,15	W	°	207	Rosette in - **cast 027**	200	4
25-jul-2008	17h01	71*18,76	°N	127*36,06	W	°	249	Rosette out	199	4.8
25-jul-2008	18h08	71*18,69	°N	127*35,89	W	°	253	Rosette in - **cast 028**	201	5.4
25-jul-2008	18h40	71*18,53	°N	127*35,74	W	°	233	Rosette out	200	5.4
25-jul-2008	19h16	71*18,80	°N	127*35,90	W	°	335	Mooring CA05-08 deployement begin	201	4.4
25-jul-2008	19h50	71*18,71	°N	127*35,15	W	°	45	Mooring deployement end	205	4.1
25-jul-2008	21h09	71*19,47	°N	127*44,51	W		232	Rosette in - **cast 029**	179	4.9

25-jul-2008	21h30	71*19,32	°N	127*44,74	°W	293	Rosette out	177	6.7
25-jul-2008	21h49	71*19,24	°N	127*44,77	°W	332	MVP in	176	5.6
25-jul-2008	22h19	71*19,11	°N	127*44,87	°W	316	MVP out	175	4.9
25-jul-2008	22h36	71*19,12	°N	127*44,76	°W	98	Phytoflash in	176	5
25-jul-2008	23h05	71*18,94	°N	127*45,19	°W	154	Phytoflash out	172	4.4
26-jul-2008	00h34	71*24,397	°N	127*38,43	°W	118	Mooring CA05MMP-08 deployement end	235	4.5
26-jul-2008	01h29	71*23,65	°N	127*43,00	°W	354	Rosette in - **cast 030**	215	4.6
26-jul-2008	01h41	71*23,62	°N	127*43,35	°W	326	Rosette out	214	4.8
26-jul-2008	02h20	71*18,98	°N	127*45,14	°W	61	Rosette in - **cast 031**	173	4.6
26-jul-2008	03h01	71*18,99	°N	127*45,29	°W	70	Rosette out	173	4.8
26-jul-2008	03h52	71*15,13	°N	127*30,45	°W	61	Sediment traps recovery begin	187	5.3
26-jul-2008	04h21	71*15,12	°N	127*30,43	°W	107	Sediment traps recovery end	187	5.4
			□		□		**----------Stn 1300-10A----------**		
26-jul-2008	05h15	71*16,81	°N	127*04,39	°W	44	Rosette in - **cast 032**	304	5.5
26-jul-2008	05h56	71*16,77	°N	127*04,76	°W	4	Rosette out	302	6.6
			□		□		**----------Stn 1301-10A----------**		
26-jul-2008	07h12	71*09,58	°N	126*30,74	°W	38	Rosette in - **cast 033**	390	5.6
26-jul-2008	07h38	71*09,60	°N	126*30,95	°W	9	Rosette out	389	6.1
26-jul-2008	08h05	71*06,88	°N	126*18,94	°W		LAWAS on	411	6.1
26-jul-2008	08h36	71*06,764	°N	126*12,236	°W		LAWAS out	411	6.1
			□		□		**----------Stn 407-10A----------**		
26-jul-2008	09h37	71*00,09	°N	126*02,24	°W	169	Sediment traps deployement begin	393	5.8

26-jul-2008	10h12	71*00,18	°N	126*02,62	°W	229	Sediment traps deployement end	391	5.9
26-jul-2008	10h23	71*00,30	°N	126*02,09	°W	234	MOB buoy in	393	5.8
26-jul-2008	10h49	70*59,37	°N	125*56,58	°W	74	Monster Net in	398	6
26-jul-2008	11h15	70*59,31	°N	125*57,32	°W	125	Monster Net out	397	6.1
26-jul-2008	14h00	71*06,243	°N	126*08,117	°W	19	Balloon launch	408	7
26-jul-2008	14h38	71*08,732	°N	126*14,347	°W	68	Hydrobios in	404	7.3
26-jul-2008	15h05	71*08,79	°N	126*14,61	°W	71	Hydrobios out	403	6.2
26-jul-2008	15h27	71*08,86	°N	126*14,81	°W	67	Rosette in - **cast 034**	403	6.2
26-jul-2008	15h38	71*08,91	°N	126*14,88	°W	63	Rosette out	403	6.2
26-jul-2008	16h44	71*00,63	°N	126*10,94	°W	344	Zodiak water sampling	385	7.8
26-jul-2008	17h14	71*00,78	°N	126*11,64	°W	1	MOB buoy out	383	7.7
26-jul-2008	18h11	71*02,109	°N	126*06,284	°W	58	Rosette in - **cast 035**	388	7.5
26-jul-2008	18h27	71*02,104	°N	126*06,27	°W	70	Rosette out	388	7.5
26-jul-2008	18h55	71*03,191	°N	126*01,80	°W	90	Mooring CA08-07 recovery begin	395	7.5
26-jul-2008	19h52	71*03,07	°N	126*01,80	°W	223	Mooring CA08-07 recovery end	395	6.9
26-jul-2008	20h15	71*02,91	°N	126*01,41	°W	83	Hydrobios in	395	7
26-jul-2008	20h23	71*02,88	°N	126*01,47	°W	33	Hydrobios out	394	7.1
26-jul-2008	20h55	71*03,20	°N	126*01,23	°W	204	Tucker Net in	396	8.2
26-jul-2008	21h06	71*02,86	°N	126*01,57	°W	177	Tucker Net out	394	7
26-jul-2008	21h21	71*02,30	°N	126*01,56	°W	165	Tucker Net in	393	6.9
26-jul-2008	21h32	71*01,93	°N	126*01,33	°W	156	Tucker Net out	390	6.9

26-jul-2008	22h27	70*58,93	°N	126*05,52	°W	94	Sediment traps recovery begin	390	7
26-jul-2008	23h24	70*58,83	°N	126*05,50	°W	118	Sediment traps recovery end	391	7.2
27-jul-2008	03h53	70*56,964	°N	126*18,228	°W	181	Balloon launch	373	7
27-jul-2008	10h09	70*53,25	°N	126*38,97	°W	90	Rosette in - **cast 036**	310	7.8
27-jul-2008	10h27	70*53,25	°N	126*38,65	°W	92	Rosette out	309	7.8
27-jul-2008	12h44	71*01,70	°N	127*05,28	°W	100	Box Core in	245	8.2
27-jul-2008	12h58	71*01,66	°N	127*05,50	°W	84	Box Core out	245	7.8
							----------Stn CA16-07----------		
27-jul-2008	20h05	71*47,24	°N	126*29,80	°W	93	Mooring deployement begin	314	7.31
27-jul-2008	20h20	71*47,31	°N	126*29,92	°W	130	LAWAS on	314	8.1
27-jul-2008	20h31	71*47,31	°N	126*29,89	°W	130	Mooring deployement end	314	8.1
27-jul-2008	21h23	71*48,29	°N	126*25,21	°W	51	Rosette in - **cast 037**	235	8.2
27-jul-2008	21h37	71*48,33	°N	126*25,16	°W	55	Rosette out	233	8.3
27-jul-2008	22h18	71*45,33	°N	126*29,79	°W	25	MOB buoy in	350	8
27-jul-2008	22h26	71*45,16	°N	126*29,71	°W	237	LAWAS out	348	8.3
28-jul-2008	00h15	71*45,139	°N	126*30,356	°W	334	Mooring CA16MMP-08 deployement begin	353	9.3
28-jul-2008	00h20	71*45,323	°N	126*30,505	°W	349	MOB buoy out	351	9.2
28-jul-2008	01h15	71*44,61	°N	126*33,44	°W	98	Rosette in - **cast 038**	381	8.7
28-jul-2008	01h20	71*44,61	°N	126*33,38	°W	108	Rosette out: configuration problems	380	8.6
28-jul-2008	01h29	71*44,61	°N	126*33,19	°W	105	Rosette in - **cast 038 prise 2**	380	8.6
28-jul-2008	01h50	71*44,63	°N	126*33,10	°W	105	Rosette out	379	8.5

28-jul-2008	02h19	71*43,54	°N	126*44,68	°W	111	LAWAS on	436	8.1
28-jul-2008	03h00	71*42,4	°N	126*35,9	°W	110	LAWAS out	433	7.9
			□		□		**----------Stn 1601-10A----------**		
28-jul-2008	09h01	71*33,93	°N	130*42,35	°W	90	Rosette in - **cast 039**	330	6.9
28-jul-2008	09h41	71*34,25	°N	130*41,53	°W	90	Rosette out	345	6.9
28-jul-2008	10h02	71*33,91	°N	130*42,33	°W	86	Secchi disk in	332	7
28-jul-2008	10h05	71*33,94	°N	130*42,26	°W	90	Secchi disk out	330	7
28-jul-2008	10h07	71*33,95	°N	130*42,21	°W	90	PNF in	331	7
28-jul-2008	10h15	71*34,01	°N	130*42.03	°W	84	PNF out	330	7.1
28-jul-2008	10h57	71*34,39	°N	130*40,81	°W	88	Rosette in - **cast 040**	345	7
28-jul-2008	11h43	71*34,65	°N	130*40,40	°W	92	Rosette out	342	7.1
28-jul-2008	12h35	71*33,80	°N	130*42,66	°W	109	Monster and small Vertical Net in	326	7.3
28-jul-2008	12h56	71*33,79	°N	130*42,92	°W	100	Monster and small Vertical Net out	329	7.3
28-jul-2008	13h04	71*33,77	°N	130*42,96	°W	106	LAWAS on	329	7.3
28-jul-2008	13h19	71*33,60	°N	130*43,10	°W	189	Tucker in	325	7.3
28-jul-2008	13h31	71*33,18	°N	130*43,93	°W	179	Tucker out	328	7.2
28-jul-2008	13h51	71*33,92	°N	130*42,40	°W	104	Phytoflash in	334	7.3
28-jul-2008	14h04	71*33,91	°N	130*42,64	°W	97	Balloon launch	331	7.2
28-jul-2008	14h22	71*33,91	°N	130*42,80	°W	105	LAWAS out	334	7.3
28-jul-2008	14h23	71*33,90	°N	130*42,80	°W	105	Phytoflash out	334	7.3
28-jul-2008	14h36	71*33,91	°N	130*42,82	°W	96	Rosette in - **cast 041**	333	7.3

28-jul-2008	15h25	71*34,01	°N	130*43,12	° W	104	Rosette out	341	7.7
28-jul-2008	21h18	71*04,69	°N	133*35,87	° W	103	Hydrobios in	316	7.8
28-jul-2008	21h31	71*04,79	°N	133*36,30	° W	95	Hydrobios out	317	7.8
28-jul-2008	23h02	71*04,861	°N	133*38,433	° W	99	Mooring recovery CA04-07 bottom part begin	301	7.7
28-jul-2008	23h41	71*04,955	°N	133*37,948	° W	33	Mooring recovery CA04-07 bottom part end	313	7.7
29-jul-2008	01h41	71*05,39	°N	133*40,96	° W	103	Rosette in - **cast 042**	310	7.6
29-jul-2008	01h55	71*05,45	°N	133*41,08	° W	105	Rosette out	312	7.7
			□		□		**----------À l'ancre au nord de Tuktoyaktuk----------**		
29-jul-2008	13h40	69*49,192	°N	133*20,71	° W	160	LAWAS on	11.9	16.1
29-jul-2008	14h18	69*49,19	°N	133*20,68	° W	163	Balloon launch	12.2	17.5
29-jul-2008	16h25	69*49,192	°N	133*20,653	° W	210	LAWAS out	11.5	17.9
29-jul-2008	23h25	70*11,73	°N	133*32,68	° W	340	Tucker Net in	43.2	8.6
29-jul-2008	23h37	71*11,85	°N	133*33,69	° W	277	Tucker Net out	42.5	8.5
29-jul-2008	23h55	70*13,96	°N	133*34,20	° W	15	LAWAS on	51.3	8.6
30-jul-2008	00h20	70*15,204	°N	133*31,708	° W	40	LAWAS out	51	8.4
			□		□		**----------Stn 435----------**		
30-jul-2008	04h46	71*04,37	°N	133*45,27	° W	125	Sediment traps deployement begin	294	5.1
30-jul-2008	05h11	71*04,33	°N	133*45,47	° W	154	Sediment traps deployement end	292	5
30-jul-2008	05h49	71*04,54	°N	133*45,89	° W	143	MOB buoy in	300	5.1
30-jul-2008	06h15	71*05,98	°N	133*44,16	° W	48	Secchi disk in	354	5.4
30-jul-2008	06h18	71*05,98	°N	133*44,16	° W	48	Secchi disk out	354	5.4
30-jul-2008	06h21	71*05,98	°N	133*44,16	° W	99	PNF in	352	5.3

			°N		W				
30-jul-2008	06h26	71*05,98	°N	133*44,15	W	122	PNF out	352	5.3
30-jul-2008	06h53	71*06,01	°N	133*44,32	W	304	Rosette in - **cast 043**	356	5.3
30-jul-2008	07h21	71*05,90	°N	133»*44,35	W	324	Rosette out	344	5.3
30-jul-2008	08h03	71*05,57	°N	133*45,24	W	356	Hydrobios in	338	5.4
30-jul-2008	08h29	71*05,42	°N	133*45,19	W	270	Hydrobios out	335	5.8
30-jul-2008	09h29	71*06,27	°N	133*42,66	W	325	Rosette in - **cast 044**	379	3
30-jul-2008	10h15	71*05,82	°N	133*43,44	W	332	Rosette out	340	2.9
30-jul-2008	11h09	71*00,04	°N	133*41,72	W	211	MOB buoy out	121	3.5
30-jul-2008	13h38	71*01,15	°N	133*45,05	W	228	Sediment traps out	177	2.6
30-jul-2008	18h50	71*08,107	°N	133*38,491	W	172	Mooring recovery CA04-07 begin	487	4.5
30-jul-2008	19h05	71*08,129	°N	133*37,427	W	172	Mooring recovery CA04-07 end	478	5.2
31-jul-2008	05h51	71*10,317	°N	133*33,656	W	200	LAWAS on	511	6.2
31-jul-2008	06h35	71*07,48	°N	133*37,091	W	200	LAWAS out	443	6.3
31-jul-2008	13h57	71*04,51	°N	133*38,02	W	220	Mooring deployement CA04-08 begin	320	5.3
31-jul-2008	14h28	71*04,89	°N	133*38,00	W	220	Balloon launch	310	5.3
31-jul-2008	14h37	71*04,880	°N	133*37,959	W	220	Mooring deployement end	310	5.3
31-jul-2008	15h28	71*04,37	°N	133*34,62	W	225	Rosette in - **cast 045**	300	5.7
31-jul-2008	16h09	71*04,23	°N	133*34,11	W	236	Rosette out	288	5
31-jul-2008	16h35	71*04,22	°N	133*33,84	W	249	Monster Net in	289	4.9
31-jul-2008	16h55	71*04,25	°N	133*33,77	W	264	Monster Net out	288	4.7

31-jul-2008	17h16	71*05,623	°N	133*34,680	°W	310	Tucker Net in	361	4.5
31-jul-2008	17h28	71*05,952	°N	133*35,029	°W	315	Tucker Net out	377	4.3
31-jul-2008	18h58	71*05,011	°N	133*38,529	°W	245	ROV deploy	316	4.3
31-jul-2008	22h22	71*04,88	°N	133*39,40	°W	270	transect ROV begin	294	4.1
31-jul-2008	22h45	71*04,90	°N	133*39,88	°W	270	transect ROV end	294	4
01-aug-2008	00h38	71*04,84	°N	133*39,27	°W	249	Box Core in	294	4.3
01-aug-2008	01h00	71*04,85	°N	133*39,29	°W	261	Box Core out	294	4.4
01-aug-2008	01h21	71*04,88	°N	133*39,27	°W	251	Benthic trawl in	295	4.5
01-aug-2008	01h40	71*04,946	°N	133*39,842	°W	253	Benthic trawl stop	295	4.7
01-aug-2008	01h50	71*05,00	°N	133*39,89	°W	253	Benthic trawl out	297	4.8
01-aug-2008	02h23	71*05,60	°N	133*40,46	°W	239	Secchi disk in	324	4.8
01-aug-2008	02h25	71*05,59	°N	133*40,48	°W	236	Secchi disk out	324	4.8
01-aug-2008	02h27	71*05,58	°N	133*40,50	°W	231	PNF in	322	4.8
01-aug-2008	02h33	71*05,53	°N	133*40,53	°W	227	PNF out	318	4.8
			□		□		**----------Stn 2000-10a----------**		
01-aug-2008	02h20	71*13,85	°N	130*22,48	°W	174	Rosette in - **cast 046**	56	5.3
01-aug-2008	09h40	71*13,99	°N	130*22,28	°W	178	Rosette out	56	5.3
			□		□		**----------Stn 2001-10a----------**		
01-aug-2008	10h44	71*14,54	°N	129*50,83	°W	175	Rosette in - **cast 047**	46	5.1
01-aug-2008	10h56	71*14,53	°N	129*50,57	°W	177	Rosette out	47	5
			□		□		**----------Stn 2002-10a----------**		
01-aug-2008	11h56	71*15,88	°N	129*19,88	°W	190	Rosette in - **cast 048**	48	5

01-aug-2008	12h09	71*15,88	°N	129*19,69	°W	190	Rosette out	49	5
			□		□		**----------Stn 2003-10a----------**		
01-aug-2008	13h06	71*16,75	°N	128*49,76	°W	190	Rosette in - **cast 049**	54	4.9
01-aug-2008	13h14	71*16,.73	°N	128*49,71	°W	178	Rosette out	54	4.7
			□		□		**----------Stn 2004-10a----------**		
01-aug-2008	14h18	71*17,75	°N	128*17,21	°W	186	Rosette in - **cast 050**	70	5.3
01-aug-2008	14h40	71*17,77	°N	128*17,23	°W	188	Rosette out	70	5.3
01-aug-2008	14h48	71*17,43	°N	128*17,76	°W	243	Rosette in - **cast 051**	70	5.3
01-aug-2008	15h08	71*17,39	°N	128*17,50	°W	318	Rosette out	70	5.4
			□		□		**----------Stn 2005-10a----------**		
01-aug-2008	16h21	71*18,14	°N	127*46,60	°W	200	Rosette in - **cast 052**	163	6.4
01-aug-2008	16h32	71*18,09	°N	127*46,36	°W	166	Rosette out	162	5.8
			□		□		**----------Stn 2006-10a----------**		
01-aug-2008	17h34	71*18,95	°N	127*15,56	°W	257	Rosette in - **cast 053**	273	6
01-aug-2008	18h15	71*19,03	°N	127*15,15	°W	34	Rosette out	275	7
			□		□		**----------Stn 2007-10a----------**		
01-aug-2008	19h21	71*19,53	°N	126*44,54	°W	192	Rosette in - **cast 054**	416	6.6
01-aug-2008	19h39	71*19,540	°N	126*44,498	°W	194	Rosette out	418	6.5
01-aug-2008	20h41	71*19,85	°N	126*13,63	°W	195	LAWAS on	448	6.7
01-aug-2008	21h22	71*16,84	°N	126*16,32	°W	190	LAWAS out	448	6.9
			□		□		**----------Stn 2008-10a----------**		
01-aug-2008	21h40	71*18,03	°N	126*15,71	°W	193	Secchi disk in	442	7.5
01-aug-2008	21h42	71*18,03	°N	126*15,71	°W	193	Secchi disk out	442	7.5

01-aug-2008	21h42	71*18,06	°N	126*15,69	° W	189	PNF in	442	7.5
01-aug-2008	21h48	71*18,12	°N	126*15,66	° W	190	PNF out	442	7.5
01-aug-2008	21h13	71*19,95	°N	126*13,07	° W	198	Rosette in - **cast 055**	442	8
01-aug-2008	22h58	71*20,04	°N	126*12,24	° W	164	Rosette out	442	7.1
01-aug-2008	23h12	71*19,98	°N	126*11,79	° W	210	Monster Net in	441	7.2
01-aug-2008	23h40	71*20,-8	°N	126*11,52	° W	226	Monster Net out	441	7.1
02-aug-2008	00h03	71*20,33	°N	126*11,03	° W	277	Tucker Net in	431	7.3
02-aug-2008	00h15	71*20,42	°N	126*12,14	° W	256	Tucker Net out	441	7
02-aug-2008	00h22	71*20,43	°N	126*12,40	° W	228	Phytoflash in	442	7
02-aug-2008	00h48	71*20,37	°N	126*12,07	° W	227	Phytoflash out	441	7
02-aug-2008	01h31	71*19,98	°N	126*13,15	° W	239	Rosette in - **cast 056**	442	6.8
02-aug-2008	02h27	71*19,66	°N	126*12,45	° W	271	Rosette out	437	6.7
02-aug-2008	04h00	71*19,83	°N	126*13,57	° W	305	Rosette in - **cast 057**	443	6.6
02-aug-2008	04h22	71*19,72	°N	126*13,80	° W	342	Rosette out	442	7
			□		□		**----------Stn 2009-10a----------**		
02-aug-2008	05h29	71*20,39	°N	125*42,38	° W	25	Rosette in - **cast 058**	434	7.4
02-aug-2008	06h15	71*20,42	°N	125*43,09	° W	23	Rosette out	433	8.6
			□		□		**----------Stn 2010-10a----------**		
02-aug-2008	07h24	71*20,68	°N	125*10,83	° W	84	Rosette in - **cast 059**	299	8
02-aug-2008	07h38	71*20,78	°N	125*10,95	° W	70	Rosette out	302	7.9
			□		□		**----------Stn 2011-10a----------**		
02-aug-2008	08h47	71*18,65	°N	124*35,97	° W	140	Rosette in - **cast 060**	243	7.9

02-aug-2008	09h30	71*18,946	°N	124*35,966	°W	140	Rosette out	248	8.3
02-aug-2008	10h09	71*19,05	°N	124*35,68	°W	140	Box Core in	251	8.3
02-aug-2008	10h26	71*19,22	°N	124*35,77	°W	140	Box Core out	250	8.4
02-aug-2008	15h53	70*40,17	°N	123*00,05	°W	118	ROV deployement	549	9.9
02-aug-2008	16h29	70*40,164	°N	122*59,938	°W	145	ROV transect begin	549	9.7
02-aug-2008	16h59	70*40,82	°N	123*01,81	°W	145	ROV transect end	549	9
02-aug-2008	21h50	70*39,98	°N	122*59,42	°W	110	Secchi disk	537	9
02-aug-2008	21h53	70*39,98	°N	122*59,42	°W	103	PNF in	537	9
02-aug-2008	21h58	70*39,99	°N	122*59,32	°W	110	PNF out	537	9
			□		□		**----------Stn 405----------**		
02-aug-2008	22h21	70*40,03	°N	122*58,97	°W	111	Rosette in - **cast 061**	536	9.1
02-aug-2008	23h09	70*40,14	°N	122*58,83	°W	111	Rosette out	547	9.3
02-aug-2008	23h37	70*41,74	°N	122*54,92	°W	115	Monster Net in	599	9.3
03-aug-2008	00h19	70*41,76	°N	122*55,74	°W	109	Monster Net out	599	9.1
03-aug-2008	01h06	70*42,07	°N	123*02,47	°W	180	Tucker Net in	554	12.08
03-aug-2008	01h19	70*41,65	°N	123*02,88	°W	177	Tucker Net out	551	9.3
03-aug-2008	01h31	70*41,54	°N	123*02,78	°W	93	Rosette in - **cast 062**	543	9
03-aug-2008	02h12	70*41,70	°N	123*02,77	°W	103	Rosette out	554	9.1
03-aug-2008	09h56	70*39,99	°N	122*59,58	°W	90	ROV in	510	8.2
03-aug-2008	12h30	70*39,90	°N	123*00,40	°W	90	ROV out	510	7.8
03-aug-2008	15h09	70*40,00	°N	122*59,60	°W	75	ROV in	510	7.8

03-aug-2008	17h20	70*39,98	°N	122*59,58	° W	73	ROV out	536	8.1
04-aug-2008	11h33	70*49,59	°N	123*31,12	° W	257	Rosette in - **cast 063**	505	6.5
04-aug-2008	11h46	70*49,59	°N	123*31,09	° W	259	Rosette out	505	6.4
04-aug-2008	11h52	70*49,59	°N	123*31,14	° W	259	Rosette in - **cast 063 prise 2**	505	6.4
04-aug-2008	11h57	70*49,59	°N	123*31,13	° W	267	Rosette out	505	6.4
04-aug-2008	18h21	70*39,941	°N	122*59,529	° W	250	Mooring deployement CA18-08 begin	540	6.6
04-aug-2008	19h13	70*39,935	°N	122*59,536	° W	255	Mooring deployement CA18-08 end	540	6.6
04-aug-2008	19h59	70*40,35	°N	122*55,85	° W	247	Rosette in - **cast 064**	542	6.4
04-aug-2008	20h30	70*40,21	°N	122*55,43	° W	237	Rosette out	535	6.4
04-aug-2008	20h45	70*40,11	°N	122*55,23	° W	257	Hydrobios in	527	6.5
04-aug-2008	20h55	70*40,07	°N	122*55,03	° W	250	Hydrobios out	523	6.5

2. Team reports

2.1. Team 1

PI: Yves Gratton (INRS-ETE, 490, Rue de la Couronne, Québec)
Participants: Véronique Lago, Antoine Roy-Gobeil (INRS-ETE, 490, Rue de la Couronne, Québec)

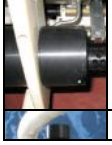
2.1.1. CTD/Rosette

Objectives
Description of water masses and general circulation over a year in Beaufort Sea and Amundsen Gulf. Physical parameters were recorded using a ship mounted RDInstruments Ocean Surveyor ADCP (150kHz), and a rosette frame equipped with 24 bottles of 12 L.

CTD-rosette

Materials
The rosette frame is equipped with 24 bottles of 12 L and the following sensors:

Table 1: Sensors used on the Rosette

Photo	Item	Manufacturer	Type & Properties	Serial Number
	CTD	SeaBird	SBE-911 Sampling rate : 24 Hz	
	Temperature	SeaBird	SBE 3plus Range: -5°C to + 35°C Accuracy: 0.001	4204
	Pressure	SeaBird	Accuracy: 0.015% of full range	90584
	Conductivity	SeaBird	SBE 4C Range: 0 to 7 S/m Accuracy: 0.0003	2696
	Oxygen	SeaBird	SBE-43 Range: 120% of saturation Accuracy: 2% of saturation	0427
	pH	SeaBird	SBE-18 Range: pH from 0 to 14 Accuracy: pH 0.01	0444
	Nitrates	Satlantic	MBARI ISUS Range: 0.5 to 200 µM Accuracy: ± 2 µM	134
	PAR	Biospherical		4664

	SPAR	Biospherical		20147
	Fluorometer	Sea Point		2465
	Transmissometer	WetLab	Path length: 25 cm	CST-558DR
	Altimeter	Benthos		1061
	ECO fluorometer (CDOM)	Wet Labs	FL(RT)D Digital output resolution : 14 bit Analog output signal: 0-5V Range: 0.09-500ppb Ex/Em: 370/460nm	

Table 2: Sensors specifications

Parameter	Sensor		Range	Accuracy	Resolution
	Compagny	Instrument Type			
Attached to the Rosette					
CTD	SeaBird	SBE-9plus [1]			
Temperature	SeaBird	SBE-03 [1]	-5°C à +35°C	0.001°C	0.0002°C
Conductivity	SeaBird	SBE-4C [1]	0-7 S/m (0-70mmho/cm)	0.0003 S/m (0.003mmho/cm)	0.00004 S/m (0.0004 mmho/cm)
Pressure	Paroscientific	410K-105	up to 10 500m (15 000psia)[2]	0.015% of full scale	0.001% of full scale
Dissolved oxygen	SeaBird	SBE-43 [3]	120% of surface saturation[4]	2% of saturation	unknown
pH	SeaBird	SBE-18-I [5]	0-14 pH units	0,1 pH unit	unknown
Nitrates concentration	Satlantic	MBARI-ISUS 5T [6]	0.5 to 2000 µM	±2 µM	±0.5 µM
Light intensity (PAR)	Biospherical	QCP2300	1.4×10^{-5} to 0.5 εE/(cm^2·sec)		
sPAR	Biospherical	QCP2200	1.4×10^{-5} to 0.5 εE/(cm^2·sec)		
Fluorescence	Seapoint	Chlorophyll-fluorometer	0.02-150 µg/l	unknown	30
Transmissiometer	Wetlabs	C-Star	0-5 V	unknown	1.25 mV
Altimeter	Benthos	PSA-916 [7]	0 - 100 m	unknown	0.01 m
CDOM fluorescence	Wet Labs	FL(RT)D [7]	0.09-500ppb	unknown	14 bit

Notes: [1] Maximum depth of 6800m
[2] Depending on the configuration
[3] Maximum depth of 7,000m
[4] In all natural waters, fresh and marine
[5] Maximum depth of 1,200m
[6] Maximum depth of 1,000m
[7] Maximum depth of 6,000m

Method
Water was sampled according to each team requests. Here are examples of usual depths collected by them.

- *Nutrients* (Team 7; PI: Jean-Éric Tremblay): salinity of 33.1, chlorophyll maximum, 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300 and every 100 m up to the bottom.
- *Nitrogen* (Team 7; PI: Jean-Éric Tremblay): surface and chlorophyll maximum.
- *DIC* (Team 6; PI: Lisa Miller): salinity of 33.1, 5, 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300 and every 100 m up to the bottom.
- *Mercury*(Team 8; PI: Gary Stern): salinity of 33.1, 5, 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300 and every 100 m up to the bottom.
- *doc/don* (Team 7; PI: Christine Michel): salinity of 33.1, 5, 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300 and every 100 m up to the bottom.
- *DNA* (Team 7; PI: Connie Lovejoy): surface and chlorophyll maximum
- *CDOM* (Team3 ; PI: Pierre Larouche): 10, 25m and chlorophyll maximum while in the ice and 50%, 20% of light, chlorophyll maximum and 60m while in open water on primary production rosettes; 5m and middle of water column for other sampling.
- *Primary production*(Team 3; PI: Michel Gosselin): 10, 25m and chlorophyll maximum while in the ice and 50%, 30%, 15%, 5%, 1%, 0.2% of light, chlorophyll maximum, 75 and 100m while in open water.

Sampling locations
We focus on the Amundsen Gulf and the Mackenzie River.

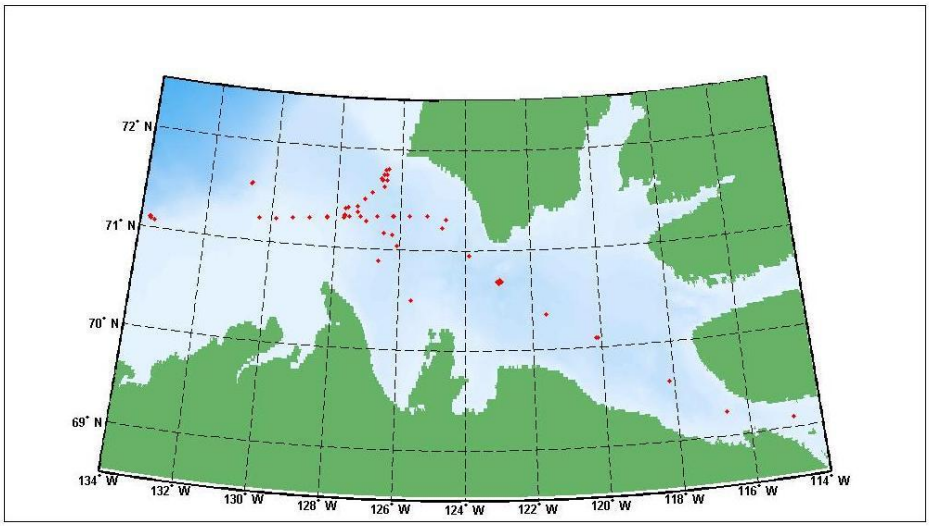


Figure 1: Positions of Rosette casts are shown as red dots.

Probes calibration

Salinity: Samples were taken on many casts with small bottles of 200 mL. They were analysed with an autosal GuildLine, model 8400B. Its range goes from 0.005 to 42 and its accuracy is < 0.002. The results were not really satisfying. The difference in between the salinity probe recordings and the samples was around 0.09. However, the conductivity probe has been changed a few times during the leg as a reaction to the bad results of the CTD

pH: Tests were done a few time using two buffers. The results are not satisfying. Results are as follow:
Buffer 4.01 gave from 7.68 to 6.07
Buffer 7.00 gave 7.13 and 6.91
Sea water is usually around pH=8, we can expect pH data to be over estimated.

Oxygen: Oxygen sensor calibration was performed using Winklerôs method and a Mettler Toledo titration machine. Reagent Blanks was performed once, results show that chemicals are still good (m<4). Oxygen have been sampled on three casts. Each time, we choose five depths of different oxygen concentration and sampled it three times. The results are not satisfying; the slope of comparison between the sensor and the samples was varying from 0.76 to 1.04. The results are nonetheless similar to what we got on leg 8 and 9 even after the oxygen probe has been changed during leg 9. Thus, the oxygen probe might have an offset that will need to be corrected.

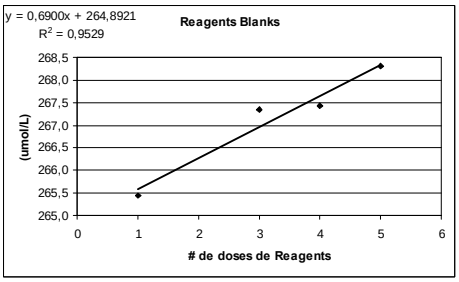


Figure 2: Reagents Blanks (m=0.69) measured during leg 0804 with the same chemicals on cast 148.

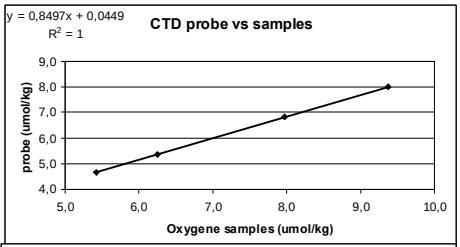


Figure 3: Relation between samples and probe recordings during cast #016 (m=0.8497).

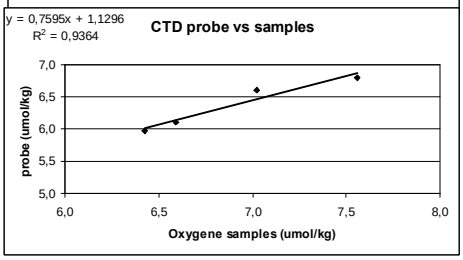


Figure 4: Relation between samples and probe recordings during cast #041 (m=0.7595).

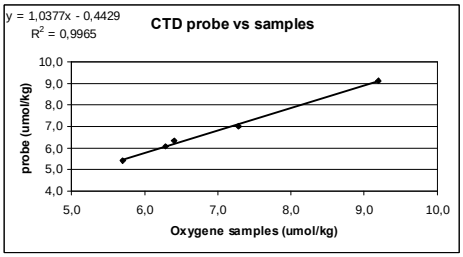


Figure 5: Relation between samples and probe recordings during cast #053 (m=1.0377).

Problems

- **Sensors**
  The sensors started to act strangely after a new fluorometer for CDOM has been installed on the rosette for cast 0805011. Then many tentative have been done to solve the problems, until all the communications with the CTD shut down. Then all the sensors and cables have been changed. Once the signal passed again, the pump stopped working deeper to 270m. The problems have been satisfyingly solved for cast 0805044, except for a few more problems with the carrousel for the bottles closure.
  The oxygen probe may have an offset.
- **Deck material (winch, A-frame, etc.)**
  No problem reported.

Available data

All information concerning the Rosette casts are summarized in the CTD Logbook. It includes cast and station numbers, date and time of sampling in UTC, latitude and longitude, bottom and cast depths, as well as the cast name and comments concerning the cast. A Rosette sheet was also created for every single cast. Information on this sheet includes the type of parameter sampled and weather information. For every cast, data recorded at the moment of bottle closure were averaged and recorded in the so-called ôbottle filesô. Averaged data are those recorded between 3 seconds before bottle closure and 7 seconds after the closure. It includes the bottle number, time and date, pressure, temperature, salinity, transmissivity, chlorophyll, oxygen, irradiance and pH measurements. All those files are available on the ôSharesô.

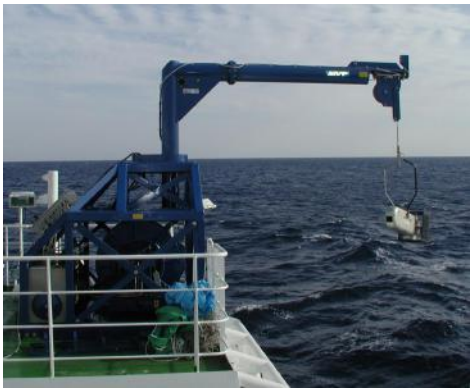
- Rosette sheets and the CTD logbook : Shares\Leg10\Rosette_CTD\logs
- Bottles files : Shares\Leg10\Rosette_CTD\bottle_data
- Plots of every cast including salinity, temperature, oxygen, transmissometer, nutrients, fluorometer and irradiance : Shares\Leg10\Rosette_CTD\plots

A total of 064 casts were performed between July 17th, 2008 and August 7th, 2008.

Self Contained Autonomous MicroProfiler (SCAMP)

Unfortunately the SCAMP was out of commission in leg 10.

MVP (Moving Vehicle Profiler)



The Moving Vehicle Profiler (MVP) is basically a towed CTD (with fluorescence and dissolved oxygen sensors). The MVP has been used only once with the ship stopped, just as a regular CTD, to compare with the profiles given by the CTD attached to the rosette.

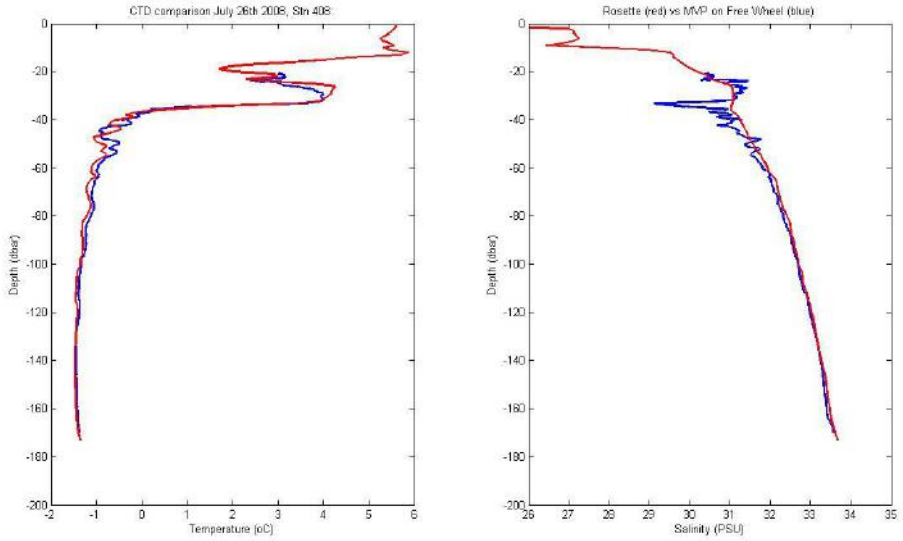


Figure 5: Comparison of CTD profiles from the Seabird SBE-911 attached to the rosette (red line) and the Brooke Ocean in the MVP (blue line).

ADCP

Data have been recorded continuously using a ship mounted RDInstruments Ocean Surveyor ADCP (150kHz).

The currents were only partly measured sometimes during the leg. The ADCP could not determine the middle range of the water column currents for a still unknown reason. The ADCP also stopped receiving any information a few times due to ice under the ship blocking the signal.

2.2. Team 2

PI: David Barber (CEOS, University of Manitoba)
Participants: Mukesh Gupta (PhD Student, CEOS, University of Manitoba), Lauren Candlish (Masterôs Student, CEOS, University of Manitoba), Andrey Rubchenia (Professorôs Assistant, St. Petersburg State University)

2.2.1. Ice Dynamics

Participants: Mukesh Gupta and Lauren Candlish

Surface EM measurements

Objectives:

Ship-based ice-EM measurements were conducted to investigate the interactions between microwave signatures (both active and passive) and sea ice thermo-physical properties. The observed data will be used to calibrate sea-ice products from the satellite sensors and to evaluate the theoretical microwave emission/scattering models. This result will provide more advanced knowledge of how microwave signature reacts to the evolution of sea ice thermo-physical properties on small scales during the fall freeze-up period.

Instrumentation and methods:

The radiometers are dual polarized (vertical and horizontal) radiometers at 37 and 89 GHz with 6° beamwidth antennas (Radiometrics). The radiometers were mounted about 12 m above the sea surface on the portside of the ship. The radiometers were fixed at the incident angle of 55°. The SBR positioner did not work since the end of Leg 9A. A network camera (Cannon, VB-C10R) was mounted on a rail right beside the wheelhouse. The initial set-up for the camera was pan=0.00°, tilt=-25.00° and zoom=43.40° and was changed to tilt=-40.00° from Nov. 1. The pictures were taken every 10 seconds to 1 minutes depending on surface conditions. A hand-held digital camera was also used to record the visual surface condition. The data was acquired until August 1, 2008.

A C-band polarmetric (VV, VH, HV, HH) scattereometer system (PROSENSING) was deployed about 7.56 m above the sea surface (Figure 1). Whenever the ship was stationary, measurements from the ship were done from -30° to 30° in the azimuth, with the 0° reference at a perpendicular line to the ship side and from 20° to 60° in elevation at 5° increment. An infrared transducer (Everest, 4000L) was mounted on a rail in the shed for the C-band scattereometer system (Figure 1). The scatterometer positioner from University of Calgary was being used after June 26th onwards and data was acquired as per the plan.

Infrared Transducer back up was taken on weekly basis.

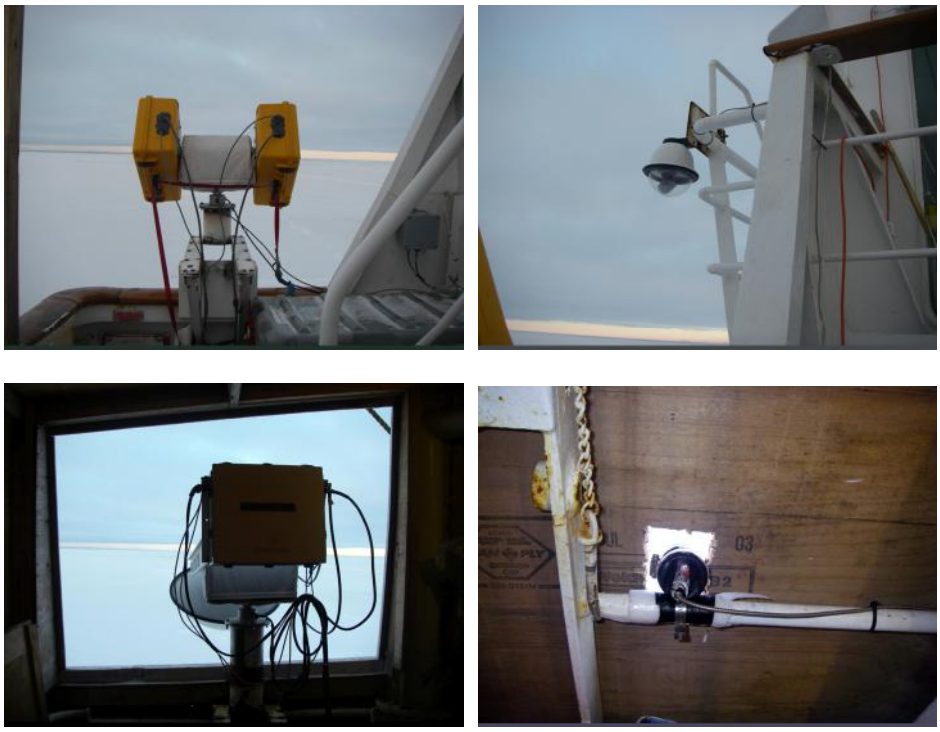


Fig. 1. Microwave radiometer system (top left), webcam (top right), scattereometer (bottom left) and infrared transducer (bottom right).

Meteorological Ocean Buoy (MOB)
The Meteorological Ocean Buoy (MOB) is comprised of a Data Well DWR-G4 buoy, modified to provide the additional functionality of a wind speed and direction sensor and an RF locating beacon. The Datawell DWG-4 buoy acquires and logs wave height data from a stabilized accelerometer, and wave direction data derived from GPS signals. To supplement this data, a number of additional parameters are collected and logged by the Metocean electronics (Metocean stack).

The Metocean stack includes an Ultrasonic Wind Sensor and a TCM2 compass that accurately measures the compass heading, buoy pitch and roll. Metocean stack also measures the battery voltage of the battery pack.

While the Datawell stack logs data into a flash card on the data logger on its stack, in order to store results from the Metocean Sensor stack, a second flash card is used with the Persistor CF-1 CompactFlash® datalogger module as part of the Metocean stack. Data from these flash cards can be saved on a hard drive independently and decoded using Metocean and datawell supplied decoding programs.

Once activated, the battery pack provides 25 days of continuous operation of the buoy. The Metocean stack samples various sensors connected to it once every 15 minutes and logs the results accordingly.

Deployment:
The buoy was deployed at every full station for minimum of 2 hours and maximum of 7 hours. It was deployed most of the time by line and kept 100 m away from the ship. Help from the crew in deployment and recuperation is highly appreciated.

Recuperation:
The buoy was recovered using zodiac and from the ship. The ship heading and the buoy bearing on ship DF was matched and the ship was sailed towards the buoy and a team with binoculars started finding the little yellow dot right in front of the ship. As soon as the buoy was spotted, zodiac was deployed to retrieve it or crew helped recovering it from the front deck using poles.

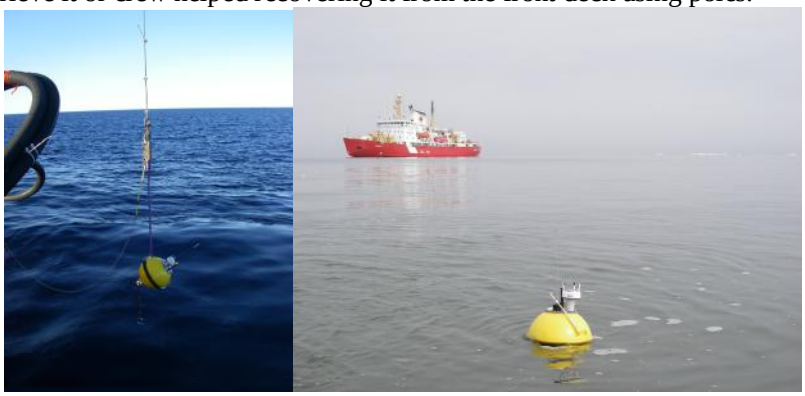


Fig. 2. Meteorological Ocean Buoy (MOB) deployment by line (left) and data acquisition (right).

Data acquired:

Table 1. MOB data acquisition dates.

Met Ocean Buoy s/no.	Date
E54021-02	July 23
	July 25
	July 26
	July 27
	July 30

On the performance of buoys:
The buoy worked very well during most of the deployments. The buoy was recuperated using zodiac with a hand held DF. High quality DF on ship was also used in parallel to track the buoy.

Vaisala wind sensors record data quite irregularly. Therefore, the surface wind data is not available for many stations. The reason behind the irregular functioning of wind sensor is still a mystery.

Laser Wave Slope (LAWAS)
Lawas was operated at every station when ship was at stop and sometimes during the motion.

Deployment:
For all open water stations, the Lawas was deployed on the foredeck on the beam (see picture).

Fig. 3. LAWAS deployment on foredeck.

The wind direction was noted at every deployment and picture of the wind tower was taken every time.

Table 2. LAWAS dates of data acquisition and station numbers.

Station	Folder name
1900-10a	July21_deployment1
CA16-07	July22_deployment1
CA16-07	July22_deployment2
CA05 MM07	July24_deployment1
CA05 (408-10a)	July24_deployment2
CA08-07	July26_deployment1
CA08-06	July26_deployment2
CA16-07	July27_deployment1
1601-10a	July28_deployment1
Not a station	July29_deployment1
2008-10a	August1_deployment1

Weather balloon
The weather balloons were launched as per the following table:

Table 3. Weather balloon launches.

Date	UTC
July 20	20:43
July 22	19:45
July 23	19:11
July 24	20:12
July 25	11:10
July 25	18:54

July 26	19:30
July 27	09:27
July 28	19:06
July 29	20:00
July 31	20:01

Others
Other automated instruments viz. Laser Precipitation Gauge, Microwave Atmospheric Profiler, Webcam, Ceilometer and All Sky Camera acquired data as usual until August 1, 2008 and backed up frequently.

2.2.2. CTD measurements

Participant: Andrej Rubchenya.

Objectives
Description of thermohaline characteristics of water masses in Amundsen Gulf of Beaufort Sea.

Materials, methods and problems
Physical parameters of water were recorded using a rosette frame equipped with 24 bottles of 12L and the following sensors: CTD (SBE-911), temperature (SBE 3plus), pressure (SeaBird), conductivity (SBE 4C) and others (oxygen, PAR, fluorometer).

CTD was not working properly; there were problems with sensors and pump.

Field of measurements
16 stations with comparatively good data was made in Amundsen Gulf, and two ï on the slope in Beaufort Sea (Fig.1).

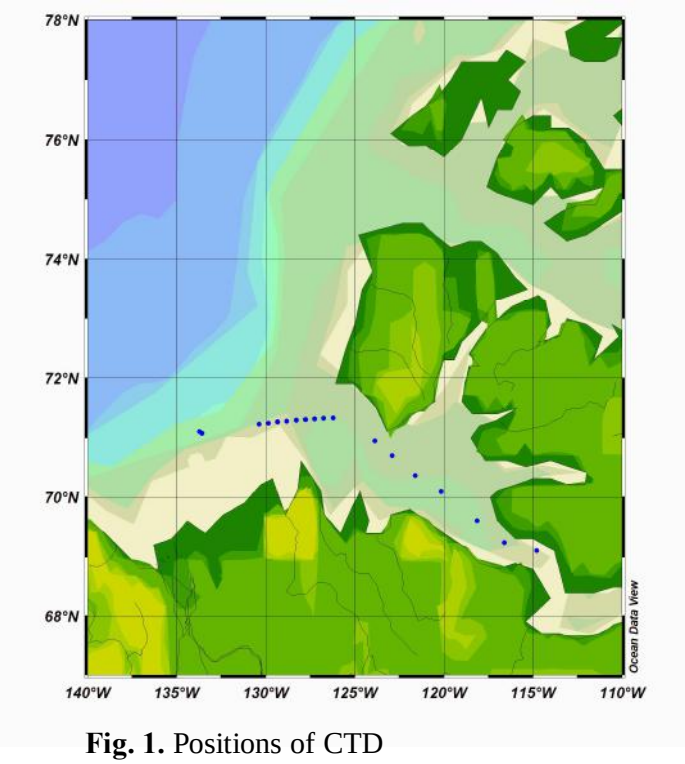


Fig. 1. Positions of CTD stations in Beaufort Sea.

Preliminary results

Only 18 stations (due to errors in others) were selected for primary analysis.
Using averaged data from 18 stations data (Jul, 19-Aug, 02) were prepared several sections and profiles.

Fig.2 illustrates surface temperature and salinity distribution.
On sections (Fig.3) we can clearly see freshing in upper layers.
Profiles of temperature and salinity, and T-S diagram presented on Fig.5.

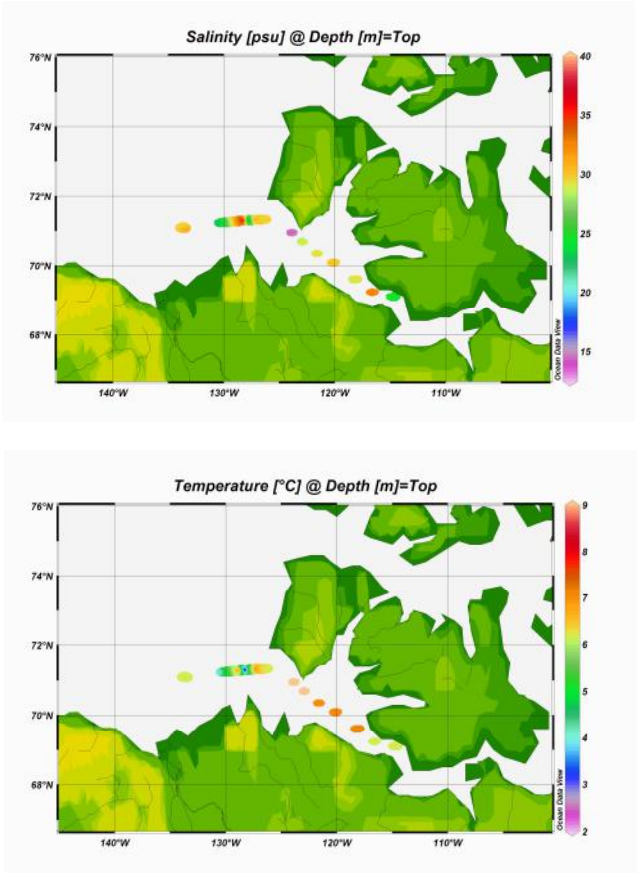


Fig.2. Surface temperature and salinity.

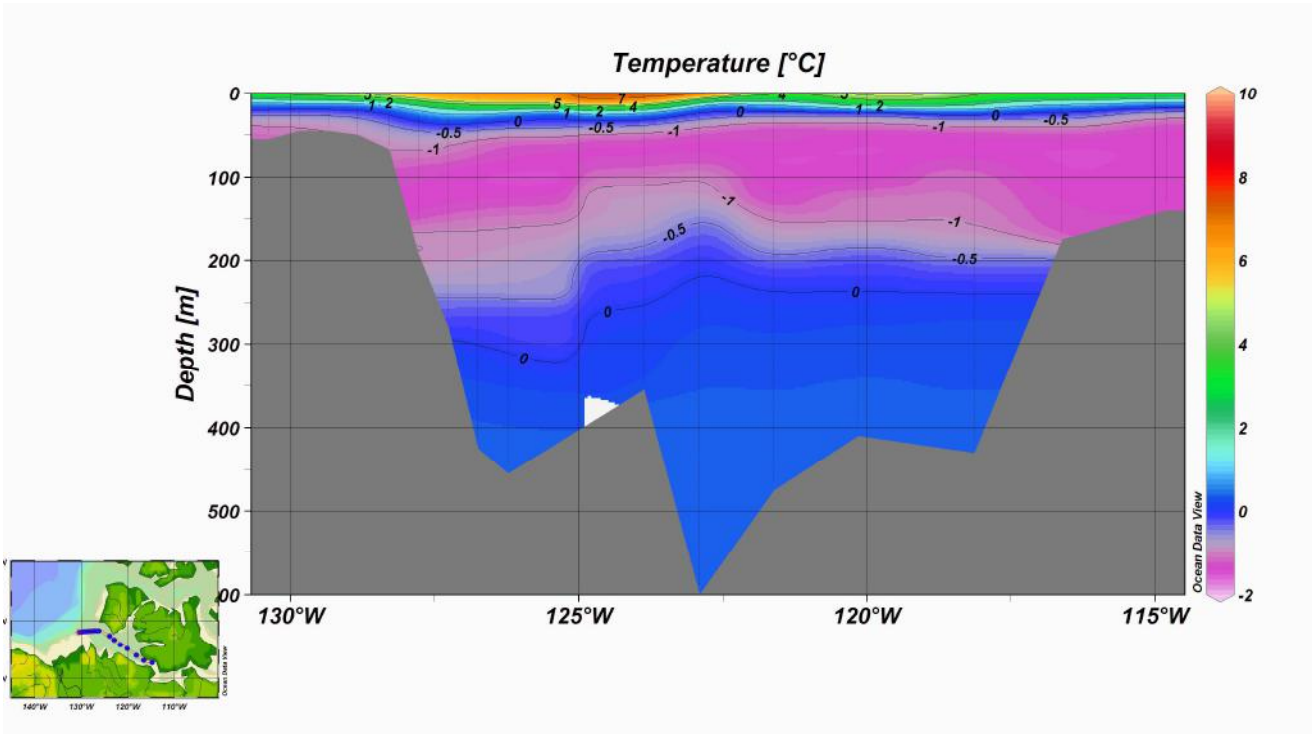


Fig.3a. Section 1a: Temperature distribution in Amundsen Gulf.

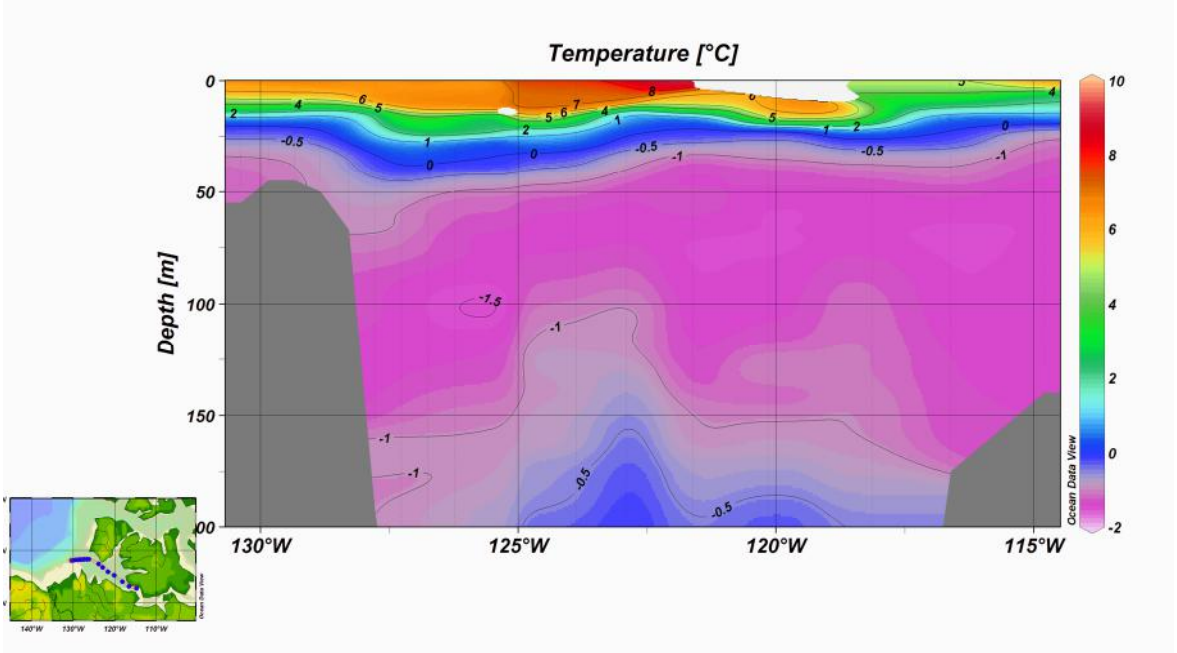


Fig.3b. Section 1b: Temperature distribution in Amundsen Gulf (200m layer).

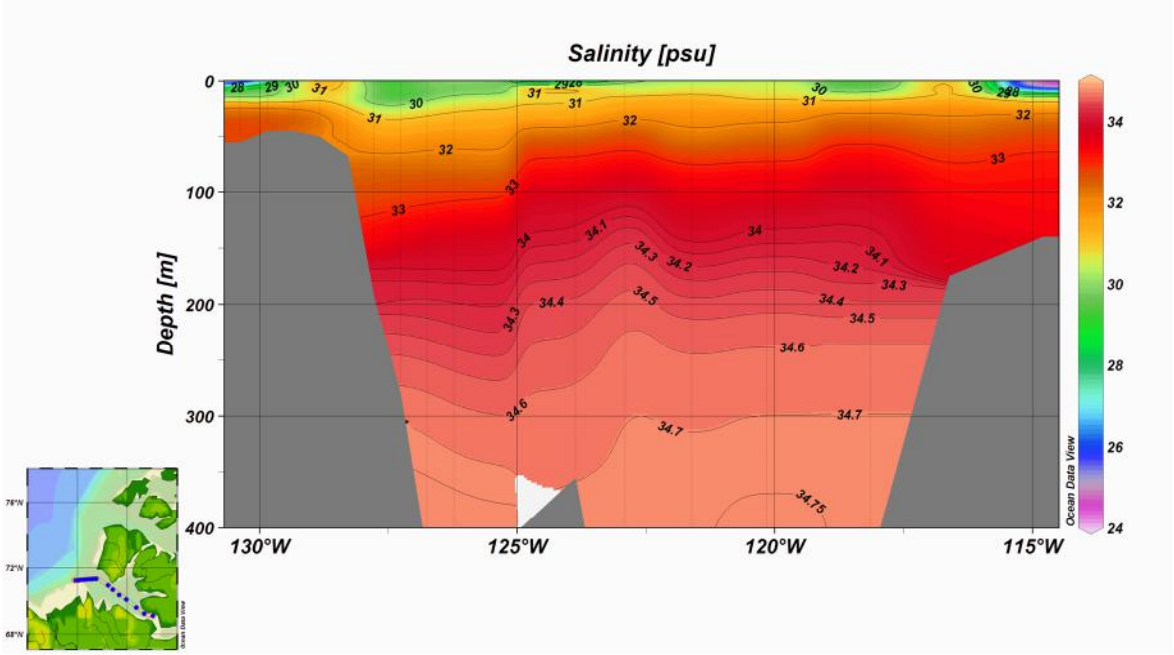


Fig.4a. Section 2a: Salinity distribution in Amundsen Gulf.

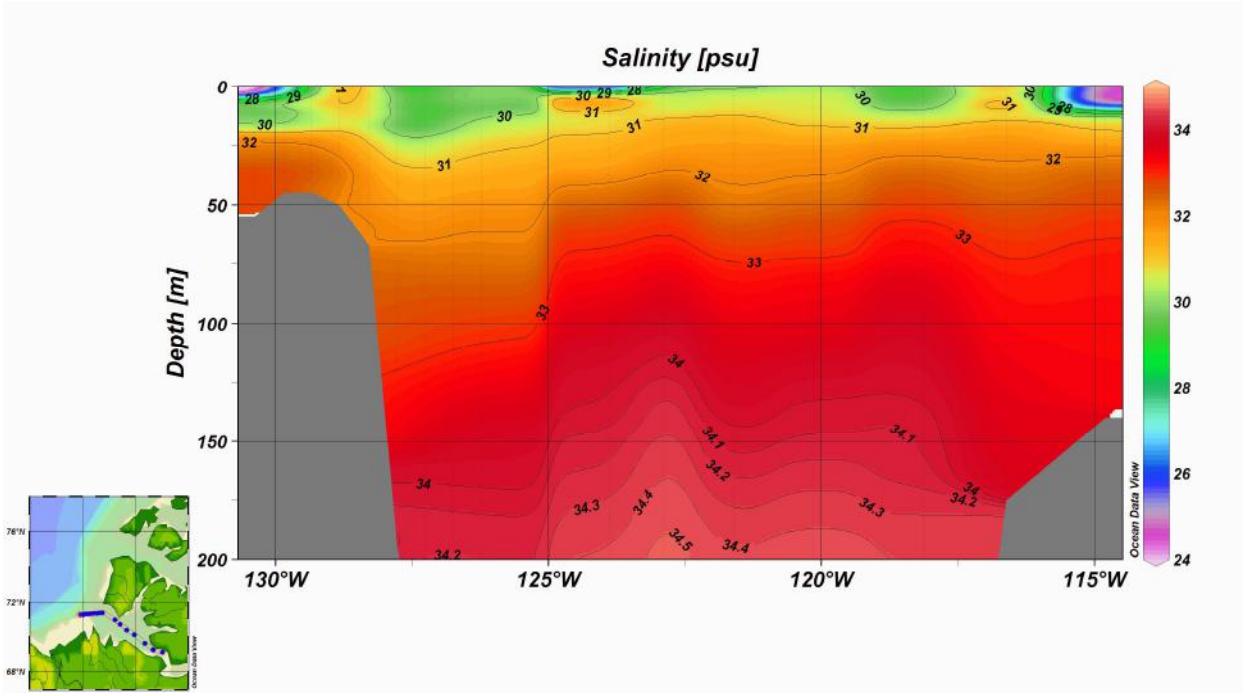


Fig.4b. Section 2b: Salinity distribution in Amundsen Gulf (200m layer).

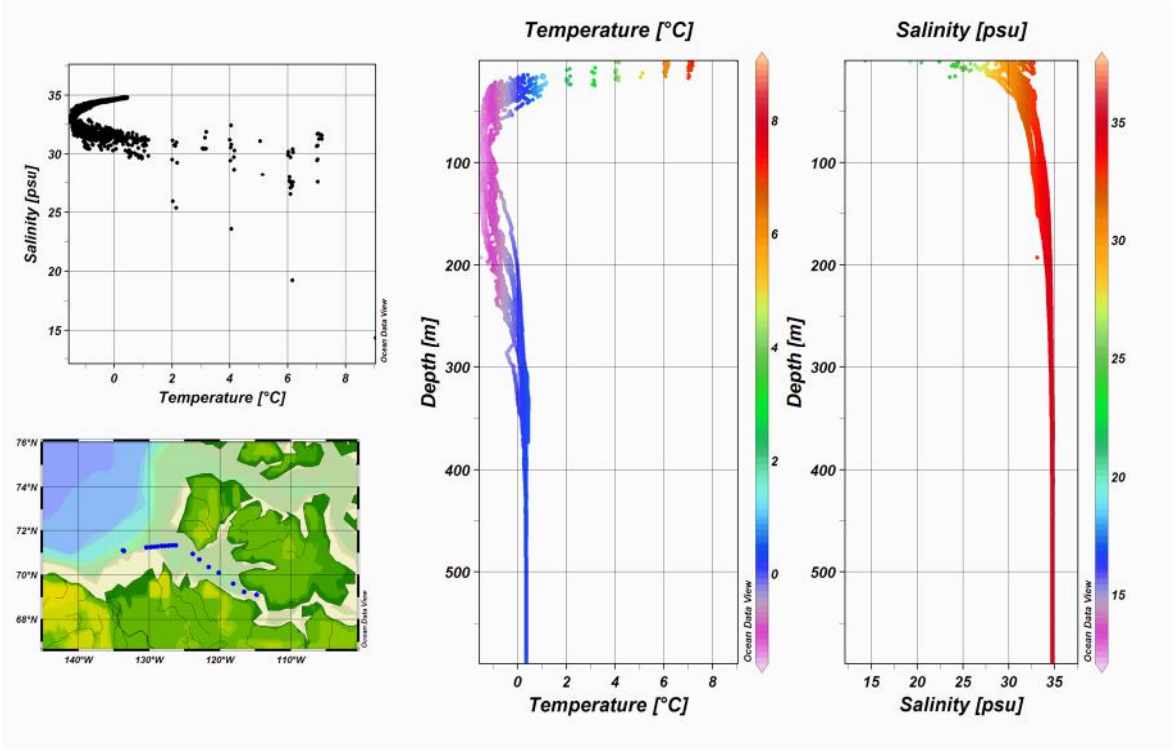


Fig.5. Temperature and salinity profiles, T-S diagram.

2.3. Team 4

2.3.1. Zooplankton & Fish/ Acoustic/ Moored Sediment Traps

PI: Louis Fortier

Participants: Alexandre Forest (U. Laval), Makoto Sampei (U. Laval), Samuel Lauzon (U. Laval), and Louis Létourneau (U. Laval); with the precious help of Luc Michaud, Pascal Massot & Steve Gagné (ArcticNet central).

Introduction

The fragmented, thin, and often absent ice cover in the flaw lead allows solar radiation to reach the surface layer of the ocean where it triggers photosynthesis by microscopic algae. Team 4, Pelagic and Benthic Food Web, investigates how and to what extent microalgae growing in the flaw lead are consumed by the zooplankton and reach the benthos and how physical processes affect the abundance, physiology and community structure of zooplanktonic organisms. Our simple hypothesis is that, relative to adjacent ice-covered regions, enhanced algal production in the flaw lead translates into biological hot spots where higher zooplankton and benthos production prevail. We also investigate how the Arctic cod, a central species in the Arctic food web, uses the flaw lead for feeding, overwintering, reproduction, and as a nursery ground for their young stages (http://www.ipy-cfl.ca/page1/page1.html).

General objectives and summary

Our sampling program is derived from that of ArcticNet project 1.4 led by Dr. J.-É. Tremblay (U. Laval), ôMarine productivity and sustained exploitation of emerging fisheriesô, whose overarching goal is to assess the impact of sea-ice cover reduction and increasing sea temperatures on biological productivity, fisheries resources and marine mammal populations of the coastal Canadian Arctic. Since the beginning of the CFL field program last October, we focus on how physical processes moderate biogeochemical processes within the changing northern flaw lead ecosystem in the Amundsen Gulf - Banks Island area. The objective of the team 4 for the short three-week leg 10A was mainly to continue the work conducted during the previous leg in open water by deploying zooplankton nets from the front deck (double (horizontal), quadruple (vertical) 1-m^2 nets, Hydrobios and Rectangular Midwater Trawl). We concentrated our sampling efforts on pelagic secondary producers as well as on larval, and juvenile Arctic cod. An additional goal of our team during leg 10A was to recover and redeploy the automated instruments that record all year-long the vertical flux of biogenic matter and marine mammal distribution on the ArcticNet long-term marine observatories (i.e. moorings ï see leg 3 cruise report for details). Hence, our multidisciplinary ArcticNet-CFL team is strongly linked with Team 7 (Carbon Fluxes ï Tremblay) of the CFL program.

The primary objectives of our team during CFL-10A were:

1- To assess zooplankton / fish abundance and diversity by using various sampling devices.
2- To track zooplankton / fish biomass and distribution with the EK60 Echo sounder, and nets.
3- To turnover the automated sediment traps and hydrophones deployed on the moorings.

Our secondary field objectives were to collect and use zooplankton samples to:

1- Identify the sources and pathways of omega-3 in the Arctic marine food web (J. Michaud, E. Dewaily and L. Fortier, U. Laval). This project is linked to the CFL-URSUK program and ArcticNet theme 1.5, focusing on the importance of omega-3 fatty acids in the traditional diet of Inuit communities;
2- Assess the biomass and respiration rates of the zooplankton community by the Electron Transfer System (ETS) activity at specific stations (G. Darnis and L. Fortier);
3- Collect samples for stable isotope analysis of the food web structure and carbon fluxes mediated by zooplankton (i.e. calculation of gut evacuation rates [GER] and gut fluorescence content); this is a joint project between Teams 4 and 7 of CFL (A. Forest, L. Fortier, J-E. Tremblay, P. Wassmann);

4- Measure copepod *in-situ* egg production (EPR) and gonad maturation of *Calanus glacialis*, *C. hyperboreus* and *Metridia longa* (G. Darnis, L. Fortier);
5- Increase the size of arctic cod larval dataset (length-at-age) in order to validate an individual-based model designed to calculate growth and survival of this species (S. Thanassekos, L. Fortier).
6- To establish a conversion factor of backscatter intensity, from moored ADCP (acoustic Doppler current profiler), to dry weight and particulate carbon contents of zooplankton in water column. (M. Sampei, L. Fortier)

The short leg 10A (20-days) was fully devoted to open water sampling. Over the whole study area, sea ice has completely vanished when leg 10A began at mid-July. In total, 5 Full stations (i.e. mooring stations) and 4 Basic stations were visited for zooplankton & fish sampling. At a typical full station, the Hydrobios, Monster, Oblique tucker, and RMT (weather-dependent) were deployed whereas only the Monster and the Oblique tucker were used at a Basic station. Acoustics EK60 monitoring was done continuously during the cruise, but no fish schools were detected. A total number of 305 Arctic cod larvae were caught during leg 10, from which 221 were measured and preserved individually (see section III for details). On the 5 moorings, 6 sediment traps were recovered and 7 were redeployed. 5 hydrophones were recovered and 4 were redeployed. Weather conditions during leg 10A were not as good as in the previous leg and on-deck operations were often perturbed by strong winds (> 30 knots). Actually, science operations were cancelled for approximately 3 full days during leg 10A due to bad weather.

The Table 1 summarizes the sampling & science activities at each of the 9 stations visited during the short three-week leg 10A. The details of the operations are fully described in the following sections: Zooplankton & fish sampling; Mooring operations; Experiments and laboratory work; Acoustic monitoring.

Zooplankton & Fish Sampling
Overall, 32 sampling events occurred from which ~300 samples were preserved for taxonomy. Samples from the ódive towsô were used for laboratory experiments (as described in section V) or were frozen for further analyses at Laval University, Québec.

a) Hydrobios (Fig. 1a). Multi-depth plankton profiler equipped with nine 200 εm-mesh nets (opening 0.5 m^2) for depth specific sampling of the water column. The Hydrobios is also equipped with a CTD to record water column properties while collecting biological samples. Downward and upward winch speeds are 40 and 30 m/min respectively. For most casts, the net collection was preserved in formaldehyde for taxonomic analysis. However, the content of each net from some deployments was divided 50% for taxonomy (4% buffered formaldehyde), 25% for biomass estimates and 25% for ETS analysis. At mooring stations, a second Hydrobios cast was conducted to collect zooplankton samples to estimate zooplankton standing stocks in dry weight and particulate carbon from 0 to 100 m. These data will be used to establish a conversion factor of backscatter intensity, from moored ADCP (acoustic Doppler current profiler), to dry weight and particulate carbon contents of zooplankton in water column.

b) Monster net (Fig. 1b). Four 1-m^2 metal frames attached together, all rigged with a 1-m^2 200 εm mesh net, one with a TSK flow meter and one with a G.O. flow meter for abundance measurements, two with a 1-m^2 200 µm mesh net without a flow meter for "live" sampling, and an external 10 cm diameter 50 εm net. The gear is deployed vertically from 10 meters off the bottom to the surface. Downward and upward winch speeds are 40 and 30 m/min respectively.

c) Tucker net (Fig. 1c). Type gear rigged with two 1m^2-opening nets (500 µm mesh each), out-trigged with a 10 cm diameter net (50 εm mesh) and equipped with flowmeters (2 TSKôs) and a temperature-depth recorded (TDR). When towed, ship speed was 2-2.5 knots and winch speed down was around 30 m/min and around 20m/min on the way up. This gear was mainly use to catch fish larvae and to provide water column zooplankton samples from the upper 100 m layer. One of the 500 µm mesh net was preserved in 4% buffered formaldehyde for

Table 1: Summary of station-collections of the CFL leg-10A Expedition

Date (UTC)	Sampling station	Mooring station	GEAR	Latitude (°N)	Longitude (°W)	Bottom depth	Sampling depth	Time (UTC)	# of BOSA	Fatty acids (Michaud)	EPR (Darnis)	ETS/R-ETS (Darnis)	Stable iso. (Forest)	GER/Gut fluo (Forest)	ADCP/Zoo (Sampei)
20-Jul-08	403	-	Monster Net	70.0908	120.1443	411	401	5:31	0	X	X		X	X	
20-Jul-08	403	-	Tucker	70.0865	120.1462	410	90	6:18	49	X					
21-Jul-08	405	CA18-07	Monster Net	70.6950	122.9245	599	580	6:51	1	X			X	X	
21-Jul-08	405	CA18-07	Hydrobios	70.6987	122.9318	592	580	9:05	0			X			
21-Jul-08	405	CA18-07	Tucker	70.6995	122.9290	598	92	10:05	13						
21-Jul-08	405	CA18-07	RMT	70.6863	123.2170	518	92	16:04	33						
22-Jul-08	495	CA16-07	Mooring	71.7925	126.4912	301	-	19:56	-	2 sediment traps & 1 hydrophone recovered					
23-Jul-08	437	CA16-07	Hydrobios	71.7937	126.4855	293	100	20:50	0						X
23-Jul-08	437	CA16-07-MMP	Monster Net	71.7038	126.6267	439	430	6:45	0	X		X	X	X	
23-Jul-08	437	CA16-07-MMP	Hydrobios	71.7037	126.6240	439	430	7:33	0						
23-Jul-08	437	CA16-07-MMP	Tucker	71.6895	126.5957	439	92	11:22	12						
25-Jul-08	408	CA05-07	Mooring	71.3119	127.5893	200	-	1:51	-	1 sediment trap & 1 hydrophone recovered					
25-Jul-08	408	CA05-07-MMP	Hydrobios	71.3032	127.5800	199	100	3:06	0						
25-Jul-08	408	CA05-07	Monster Net	71.2957	127.5478	205	195	4:06	0	X			X	X	
25-Jul-08	408	CA05-07	Tucker	71.2967	127.4780	220	92	4:43	46						
25-Jul-08	408	CA05-07-MMP	Hydrobios	71.3058	127.4608	231	220	5:12	0						
25-Jul-08	408	CA05-07	RMT	71.3152	127.5907	205	90	6:35	52						
26-Jul-08	408	CA05-08	Mooring	71.3118	127.5858	205	-	1:50	-	1 sediment trap & 1 hydrophone deployed					
26-Jul-08	407	CA08-07	Monster Net	70.9895	126.9430	398	385	16:49	2	X			X	X	
27-Jul-08	407	CA08-07	Mooring	71.0512	126.0300	395	-	1:52	-	1 sediment trap & 1 hydrophone recovered					
27-Jul-08	407	CA08-07	Hydrobios	71.1455	126.1353	402	390	20:37	0			X			
27-Jul-08	407	CA08-07	Hydrobios	71.0485	126.0235	395	100	2:09	0						X
27-Jul-08	407	CA08-07	Tucker	71.0533	126.0205	395	92	2:56	23						
27-Jul-08	407	CA08-07	Tucker	71.0383	126.0222	395	92	3:22	24						
28-Jul-08	405	CA16-08	Mooring	71.7885	126.4982	314	-	1:31	-	2 sediment traps & 1 hydrophone deployed					
28-Jul-08	1601	-	Monster Net	71.5633	130.7110	326	315	18:36	0	X	X	X	X	X	
28-Jul-08	1601	-	Tucker	71.5600	130.7183	326	90	19:19	0						
29-Jul-08	435	CA04-07	Hydrobios	71.0782	133.5978	334	100	3:22	0						X
29-Jul-08	435	CA04-07	Mooring	71.0826	133.6325	313	-	5:41	-	2 sediment traps & 1 hydrophone recovered					
30-Jul-08	Kugmallit	-	Tucker	70.1955	133.5447	43	30	5:25	0						
30-Jul-08	435	CA04-07	Hydrobios	71.0928	133.7540	335	325	14:18	0			X			
31-Jul-08	435	CA04-08	Mooring	71.0813	133.6327	310	-	20:37	-	2 sediment traps & 1 hydrophone deployed					
31-Jul-08	435	CA04-08	Monster Net	71.0703	133.5657	288	280	22:35	0	X			X	X	
31-Jul-08	435	CA04-08	Tucker	71.0937	133.5780	361	92	23:18	18						

2-Aug-08	2008	-	Monster Net	71.3330	126.1965	441	430	5:13	0	X			X	X	
2-Aug-08	2008	-	Tucker	71.3388	126.1838	431	90	6:04	13	X					
3-Aug-08	405	CA18-07	Monster Net	70.6957	122.9157	591	580	5:38	0	X		X	X	X	
3-Aug-08	405	CA18-07	Tucker	70.7012	123.0412	554	92	7:06	19						
5-Aug-08	405	CA18-08	Mooring	70.6656	177.5360	542	-	1:13	-	2 sediment traps & 1 hydrophone recovered					
5-Aug-08	405	CA18-08	Hydrobios	70.6685	122.9205	527	100	2:45	0						X

taxonomy and the other 500 µm mesh met was frozen for further analyses.

d) Rectangular Midwater Trawl (RMT, Fig. 1d**).** Trawl with an opening of 9 m^2 fitted with a 1600 εm mesh-net. When towed, ship speed was typically 2-3 knots; and winch speed down was 30 m/min and around 20 m/min on the way up. This net, only deployed at full stations when weather conditions allowed, was used to catch larval and fish. Collected zooplankton was frozen for further studies.

Figure 1: Zooplankton and fish sampling gear used during leg 10A: (a) Hydrobios; (b) 4 x 1-m^2 Monster net; (c) 2 x 1-m^2 Tucker net; (d) Rectangular Midwater Trawl [pictures were taken during the previous ArcticNet expeditions]

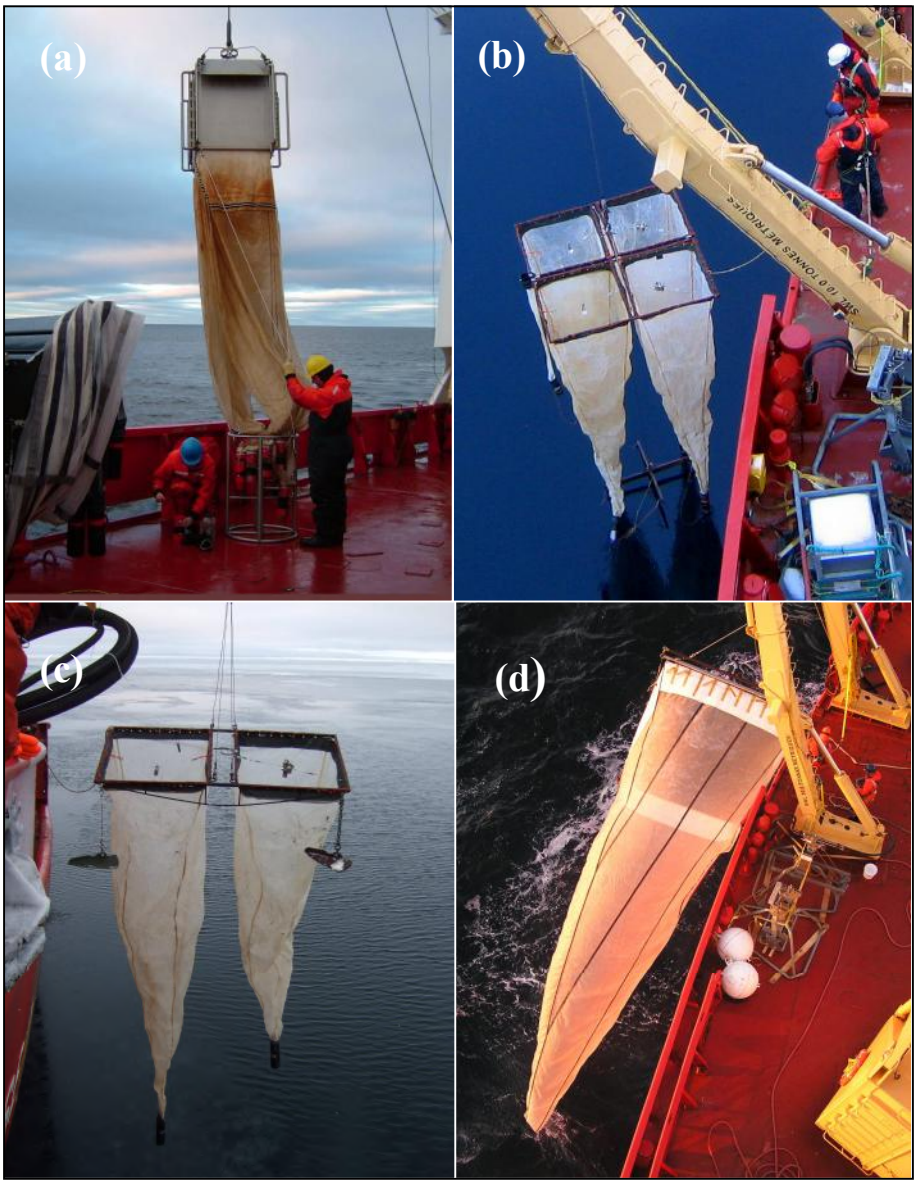
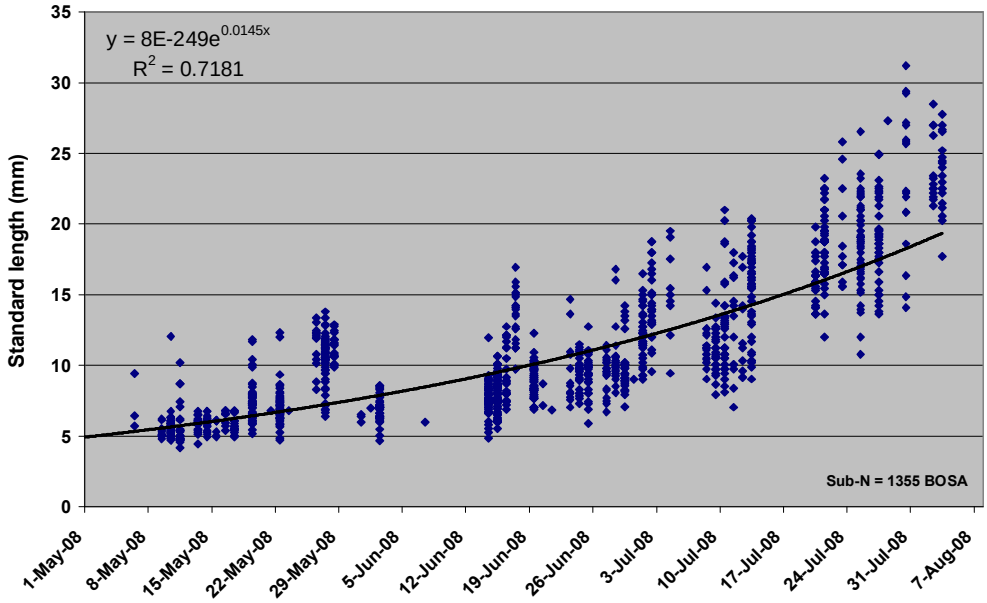


Figure 2: Standard length of Arctic cod larvae caught during the CFL program since May 1st, 2008 (legs 8, 9 and 10)



Mooring operations

As part of CFL/ArcticNet, nine long-term sediment traps have been deployed at ca. 100 m on CA05 and CA08, at ca. 100 m and 200 m on CA04 and CA16, and at ca. 100m, 200m and 480 m (50 m above the bottom) on CA18 from October 2007 to late July 2008. Six sediment traps (at CA04, 05, 08 and 16) were successfully recovered on the Canadian Coast Guard ice-breaker *Amundsen* during CFL Leg 10A. Seven sediment traps have been re-deployed at CA04, 05, 16 and 18 during this cruise. These traps will be recovered in September 2009 (on ArcticNet cruise). The samples from sediment traps will be processed for chemical analysis (DW, POC, PON, Si and Al) and microscopic observations (counting on phytoplankton, zooplankton swimmers and fecal pellets). This will allow us to analyze the seasonal pattern of biogenic matter sinking to the seafloor, and to quantify the vertical export pathway of particulate organic carbon. For future sediment traps deployments, we recommend that our sediment trap, TECHNICAP PPS3/3 24-cups (Figure 3a) should be equipped with a stronger joint between the vertical steel bar and the glass-fiber chassis. By example, it could be good to put ropes around the chassis at top- and bottom-end and/or to build steel rings around the trap.

On the moorings, we also recovered five passive hydrophones (Figure 3b), while four hydrophones were redeployed (at CA04, 05 16, 18). Later analyses of the recovered data will allow our team to track marine mammal distribution in the CFL area during 2007-2008.

Figure 3: Instruments on the moorings: (a) Sediment trap Technicap PPS 3/3 24-cups being deployed at CA04; b) Passive acoustic hydrophone AURAL M2

a) 

b)

Experiments and laboratory work
Chosen samples from the Monster Net and Hydrobios were used for further analyses and laboratory experiments. Samples for lipid and stable isotopes analyses were placed in cryovials and stored at -80ęC. Other samples were preserved as a *bulk* at -80ęC for later gut fluorescence measurements. All these samples will be sorted and analysed at Laval University. Some experiment took place directly on board:

1) **Egg production rate experiments (EPR)**
   Copepod *in-situ* egg production rate (EPR) were monitored by incubating the females of three species (*Calanus hyperboreus*, *C. glacialis* and *Metridia longa*) at 0°C, a temperature similar to that they experience in their environment. The results from the experiments conducted during leg 10 showed that the egg production season is over for all these species. Poor abundance of females *C. glacialis* limited our capacity to sort enough organisms for the EPR experiments.
2) **Biomass and Transfer System (ETS) activity**
   Samples were sorted for biomass and ETS activity assays at 3 Hydrobios stations (Table 1). At these stations, each Hydrobios net was subdivided: 50% for taxonomy (i.e. preserved in formol), 25% for population biomass estimates and 25% for ETS activity measurements. For biomass estimates, the sub-sample (i.e. 25% of total sample) was fractionated with sieves in > 1000 µm and < 1000 µm size classes; these fractions were preserved at -0ęC. Sub-samples for zooplankton population ETS activity assays (i.e. 25% of the total sample) were also sieved through the same two size fractions. Samples were incubated at 40ęC. ETS experiments were also performed on individual copepods of *Calanus glacialis*, *C. hyperboreus* and *Metridia longa*.
3) **Respiration experiments**
   To derive respiration from the activity of the Electron Transfer System (ETS), a ratio of respiration on ETS activity is required. Thus, 3 incubations were carried out to measure oxygen consumption of zooplankton and selected copepods species in sealed chambers.
4) **Gut evacuation rate experiments**
   To calculate ingestion rates of mesozooplankton, gut evacuation rates and gut fluorescence measurements are needed. Thus, at each station, a live tow from the Monster Net was quickly incubated at 0°C for 60 minutes in a 11-L incubation chamber. About 500 mL of mesozooplankton were filtered on a 200µ mesh at T=0, 5, 15, 30, 45 and 60 minutes, and were rapidly frozen at -80°C. Later chlorophyll extraction and fluorescence biomass measurement from frozen mesozooplankton at Laval University will allow us to calculate the phytoplankton ingestion rates of the diverse zooplankton species.

Acoustic monitoring
The Simrad EK-60 Echosounder of the Amundsen allows our group to continuously monitor the spatial and vertical distribution of zooplankton and fish, the later mostly represented by Arctic cod (*Boreogadus saida*). The hull-mounted transducers are in operation 24h a day and will provide a mapping of where the fishes are within the region of interest over a yearly cycle.

2.4. Team 6

2.4.1. Surface Meteorology and Flux Project

PI: Tim Papakyriakou (University of Manitoba)
Participant: Silvia Gremes-Cordero (RSMAS, U of Miami, USA)

Introduction
The surface meteorology and flux program (CFL Team 6) is designed to record basic meteorological conditions and to study exchanges of momentum, heat and mass across the atmosphere-sea ice-ocean

interface. The main value of this program to the overarching objectives of Team 6 is the direct measurement of CO_2 fluxes.

Turbulent fluxes of CO_2 are measured by the eddy covariance technique, which is dependent only on atmospheric measurements. Although measurement of these fluxes is extremely useful information, it is essentially meaningless without an understanding of the processes (physical, biological and chemical) that drive gas exchange. In an open-ocean situation this context is largely provided by measurement of sea-surface pCO_2, but the situation becomes much more complex when a sea ice cover is included in the equation.

This section of the CFL Team 6 cruise report reviews the atmospheric and sea surface pCO_2 measurements that were made during Leg 9. Other sections of the annual report will deal with the sea ice measurements that were made in support of the CO_2 flux measurements.

Amundsen Micrometeorology and Eddy Covariance Flux Tower

Methods

The micrometeorological tower located on the front deck of the Amundsen (Figure 1) provided continuous monitoring of meteorological variables and eddy covariance parameters. The tower consists of slow response sensors that record bulk meteorological conditions (air temperature, humidity, wind speed/direction, surface temperature) and fast response sensors that record the eddy covariance parameters (CO_2/H_2O concentration, 3D wind velocity, 3D ship motion, air temperature) (Table 1). In addition, radiation sensors (Figure 1, Table 1) were installed on the roof of the wheelhouse to provide information on incoming longwave, shortwave and photosynethetically active radiation. All data was logged to Campbell Scientific dataloggers; a model CR5000 logger was used for the eddy covariance data, a CR1000 logger for the slow response met data, and a CR23X for the radiation data. All loggers were synchronized to UTC time using the shipôs GPS system as a reference.

The eddy covariance system on the tower makes use of two separate gas analyzers and a single 3D sonic anemometer. The dual gas analyzers system allows us to make use of both closed path and open path eddy covariance systems. The open path gas analyzer has the benefit of making measurements concurrently with the sonic anemometer, but the closed path gas analyzer is not as easily disturbed by adverse weather conditions.

In order to make sure that the two systems are comparable, careful calibrations were performed on both instruments. The closed path system is based on a LI-7000 gas analyzer which employs two optical cells, one of which was used to monitor the drift of the instrument by constantly passing a stream of ultra-high purity N_2. In addition, the sample cell of the instrument was calibrated daily using the ultra-high purity N_2 to zero the CO_2 and H_2O measurements, and a reference gas of known CO_2 to span the instrument. Occasionally, a span calibration of the H_2O sensor was performed using a dew point generator (model LI-610).

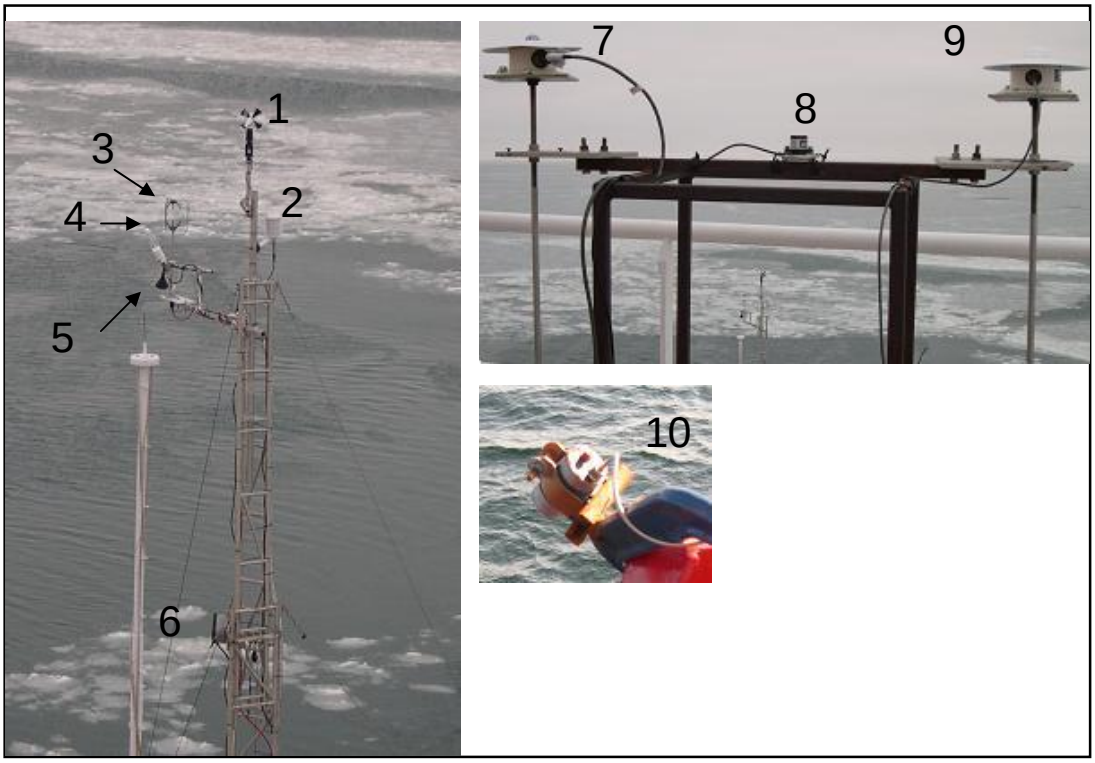


Figure 1: Meteorology and flux program instrument setup. See Table 1 for description of instruments based on the numbers. Note that on Nov. 18 the Motion Pak (6) was moved to the rear face of the tower to facilitate easier motion correction.

Table 1: Description of instruments shown in Fig. 1.

Fig 1	Sensor	Variables	Units	Ht from deck (m)	Scan (s) / Ave (min)	Specs
1	wind monitor (RMYoung 05103)	wind speed/ direction	m/s; º	8.45	2/1	±0.6 m/s ±3º deg
2	temperature/relative humidity probe (Vasailla HMP45C21	T and RH	ºC; %	7.53	2/1	Humidity ±2% 0-90% @ 20ºC ±3% 90-100% @ 20ºC 0.05% RH/ºC Temperature ± 0.1 ºC
3	3D wind velocity (Gill R3 ultra-sonic anemometer)	u,v,w, speed of sound (SOS)	m/s	7.1	10 Hz	RMS noise <1% offset <0.01 m/s SOS < 0.5% accuracy
4	LI7500 open path gas analyzer	CO_2/H_2O	µmol/ m^3 mmol/ m^3	7.1	10 Hz	RMS noise ±0.1 µmol/mol zero drift 0.1 µmol/mol/ºC gain drift 0.1%/ºC
5 (inlet, analyzer not shown)	LI7000 closed path ga analyzer	CO_2/H_2O	µmol/ m^3 mmol/ m	inlet at 7.1	10 Hz	RMS noise ±0.1 µmol/mol zero drift 0.3 µmol/mol/ºC gain drift 0.2%/ºC
6	multi-axis inertial sensor	rate x,y,z accel x,y,z	º/s; g	6.48	10 Hz	rate <0.004º/s acc <10 µg

	(MotionPak, Systron Donner)					
7	pyranometer (Eppley, model PSP)	SW_in	W/m^2	7.0	2/1	~±5%
8	quantum sensor (Kipp & Zonen, PARLite)	PAR	µmol/m s^1	7.6	2/1	~±5%
9	pyrgeometer (Eppley, model PIR)	LW_in	W/m^2	7.0	2/1	~±10%
10	surface temperature (Everest infrared transducer, model 4000.44ZL)	Tsrfc	ºC	1.6 m	3/1	±0.5 ºC accuracy
not shown	pressure transducer (RM Young, 61205V)	Patm	kPa		2/1	

Notes
The meteorological tower ran consistently for the duration of the leg (June 5 ï July 16) with the exception of brief periods when the tower was taken down for maintenance. However, for significant periods of time during the leg certain sensors were inoperable due to atmospheric conditions. The most common problem encountered during this leg was riming due to the cold, moist conditions. The extent of data lost due to atmospheric conditions cannot be estimated at this time, and will only be known once post processing is complete.

On-track pCO2 System

Methods
A custom-built pCO_2 system was utilized on this leg to measure dissolved CO_2 at the sea surface in near real time. The system (Figure 2) is located in the engine room of the Amundsen, and draws sample water from the shipôs clean water intake. The water is passed into a sealed container through a shower head, maintaining a constant headspace. This set up allows the air in the headspace to come into equilibrium with the CO_2 concentration of the seawater, and the air is then cycled from the container into a LI-7000 gas analyzer in a closed loop. Thermocouples are used to measure water temperature immediately before entering the equilibration chamber, and to measure the temperature of the air in the chamber. All data is logged to a Campbell Scientific CR1000 datalogger.

The LI-7000 gas analyzer was calibrated daily using ultra-high purity N_2 as a zero gas, and a gas with known CO_2 concentration as a span gas. Spanning of the H_2O sensor was not necessary because a desiccant column removes H_2O from the air stream before passing into the sample cell. As with the closed path system, a stream of N_2 is constantly cycled through the reference cell of the LI-7000 to monitor and correct for drift of the instrument.

Figure 2: The on-track pCO_2 system located in the engine room of the Amundsen. The equilibration chamber is the clear cylinder (left bottom) and the gas analyzer is the box with the digital display.

Notes
The on-track pCO_2 system was active for the duration of the leg, with some minor interruptions for maintenance. Major interruptions in data collection were experienced when the ship was breaking ice, which either reduced the flow of water into the equilibration tank, or completely blocked it. In the case of blocked flow, the data is lost, but tests will have to be conducted to determine if data obtained with low water flow is useful. Preliminary results suggest that the pCO_2 values calculated from the DIC samples match very well with the equilibrator values.

2.4.2. Laser Wave System (LAWAS) Project

Participant: Silvia Gremes-Cordero (RSMAS, U of Miami, USA)

The University of Miami LAWAS consists of 4 Riegl LD90-3 laser altimeters mounted in a square array of 0.3m diameter. LAWAS is mounted on a boom near the bow on the port side (see Fig. 3). A Systron Donner MotionPak is mounted at the center of the array to measure all six components of motion of the laser array.

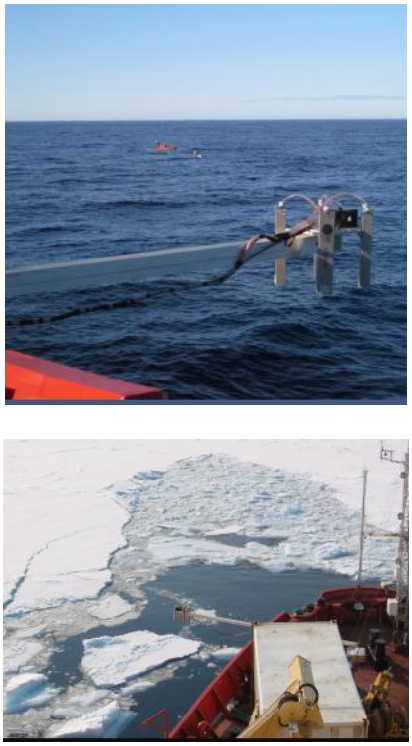


Fig. 3 Photographs showing LAWAS position near bow of Amundsen

The LAWAS system is designed to measure time series of wave slope in two directions, from which rms slope of the sea surface can be calculated. Of particular interest are measurements coincident with Quiksat overpasses. Typically eight overpasses occur each day, between 01 ï 13 UTC. The project objective is to relate CO2 gas transfer to Quikscat derived backscatter measurements. LAWAS deployments took place on July 18th, 19th,21th , 22nd, 26th ,27th , 29th , 31st, and August 1st, during different weather condition, including 30 kn winds and rain.

The data was obtained at a ship speed between 2 and 5 kn, depending on the surface conditions, but also at full ship speed and at 7 knots (maximum ship speed before bow-generated wake appears). During the dedicated time, the wind direction was 0 degrees relative, or with a maximum relative angle of 30 degrees, in order to allow a comparison with the flux tower data.

2.4.3. Carbon monoxide

PI: H. Xie
Participant: Cyril Aubry

Objectives:

1. To determine the spatiotemporal distributions of carbon monoxide (CO) in various types of sea ice.
2. To determine the concurrent distributions of colored dissolved organic matter (CDOM), dissolved organic carbon (DOC) and salinity.
3. To assess the relationships between the distribution of CO and the distributions of CDOM, DOC, and salinity.
4. To model the photoproduction of CO in sea ice.
5. To determine the seasonal evolution of the microbial CO uptake kinetics.

Activities:

Six land-fast ice sites were sampled during Leg 9 (Table 1). Each ice core was cut into 8-9 sections and sub-sampled into 200-ml glass syringes. Ice in the syringe was melted in a water bath. CO in the ice was quantified with a manual headspace method aboard the ship. The melt water was 0.2-µm filtered and will be brought to a land-based laboratory at Rimouski for CDOM and DOC measurements.

Three to six different Melt ponds were sampled for few days, in Darnley Bay and Franklin Bay sites, for CO concentration and salinity. When possible, daily variation in concentration was followed by sampling in the morning, afternoon and evening for the same melt ponds.

One brine sample and one melt pond water were also collected from Franklin Bay land-fast ice site (Stn F8). These samples will be used to determine the efficiency spectra of CO photochemical production in the ice and the melt ponds. The efficiency spectra, in conjunction with sea ice optical data from the sea ice physics group, will be used to model CO photoproduction rates in sea ice and in melt ponds.

Time-course incubations of microbial CO uptake were conducted at nineteen stations (Table 1) to elucidate how CO uptake kinetics changes with CO concentration and with season. For some stations, samples were taken on 4 depths to increase the depth resolution of microbial CO uptake.

Data collected aboard the ship (see Table 1)

Table 1. Data collected aboard the ship

Stn	Date	Sample (ice/water)	Number of depths/time sampled	CO	S	Microbial CO uptake
F-7	08-June-08	Melt pond water	3 times	x	x	
F-7	09-June-08	ice	9	x	x	
405B	10-June-08	Water	0 (bucket)		x	x
F-7	11-June-08	Melt pond water	3 times	x	x	
F-7	12-June-08	ice	9	x	x	
F-7	13-June-08	Melt pond water	2 times	x	x	
FB-01	14-June-08	water	0 (bucket)		x	x
FB-03	14-June-08	water	0 (bucket)		x	x
FB-05	15-June-08	ice	9	x	x	
FB-05	15-June-08	Melt pond water	1 time	x	x	
FB-05	17-June-08	Melt pond water	1 time	x	x	
F-7	18-June-08	ice	9	x	x	
F-7	19-June-08	Melt pond water	1 time	x	x	
FB-07	20-June-08	Melt pond water	3 times	x	x	

FB-07	21-June-08	ice	9	x	x	
1216	23-June-08	water	0 (bucket)		x	x
F-7	24-June-08	water	0 (bucket)		x	x
1200	27-June-08	water	0 (bucket); 2,5m ; 10m ; 20m		x	x
421	01-July-08	water	0 (bucket)		x	x
2010	06-July-08	ice	9	x	x	
410	08-July-08	water	0 (bucket)		x	x
416	09-July-08	water	0 (bucket); 5m ; 10m ; 20m		x	x
1100	11-July-08	water	2,5m; 10m		x	x
D34	13-July-08	water	0 (bucket)		x	x
402-10a	19-July-08	water	0 (bucket); 10m		x	x
405-10a	20-July-08	water	0 (bucket); 5m ; 10m ; 20m		x	x
437	23-July-08	water	0 (bucket); 5m ; 10m ; 20m		x	x
408-10a	25-July-08	water	0 (bucket); 5m ; 10m ; 20m		x	x
McKenzie #3	29-July-08	water	0 (bucket)		x	x
McKenzie #8	29-July-08	water	0 (bucket)		x	x
McKenzie #10	29-July-08	water	0 (bucket)		x	x
2004-10a	1-Aug-08	water	3m ; 5m ; 10m ; 20m		x	x

2.5. Team 7

2.5.1. Carbon & nutrient fluxes

PI: Jean-Éric Tremblay (Department of Biology, Laval University)
Participants: Jonathan Gagnon, Mariane Berrouard & Marjolaine Blais (Department of Biology, Laval University)

Rationale. The Arctic climate displays high inter-annual variability and decadal oscillations that modulate growth conditions for marine primary producers. Much deeper perturbations recently became evident in conjunction with globally rising CO_2 levels and temperatures (ACIA 2004; Comiso 2003). The thickness and extent of Arctic sea-ice decrease rapidly (Johannessen et al. 1999; Rothrock et al. 1999) and the ice-free season is extending both in the Arctic (Laxon et al. 2003) and subarctic (Stabeno & Overland 2001). Models predict further reductions in ice cover (ACIA 2004). These changes entail a greater penetration of light into surface waters, which is expected to bolster phytoplankton production (Rysgaard et al. 1999), food web productivity and CO_2 drawdown by the ocean. At present, phytoplankton production varies by two orders of magnitude across the Canadian Arctic, but the forcing mechanisms are poorly understood and quantified. In the Canadian Archipelago, the productivity of phytoplankton is likely to be limited by light or the supply of allochtonous nitrogen, depending on ice conditions. The supply of allochtonous nitrogen is influenced by climate-driven processes, mainly the large-scale circulation, river discharge, upwelling and regional mixing processes. Over most of the western Arctic, and especially the Beaufort Sea, the concentrations of inorganic nitrogen (i.e. nitrate, nitrite and ammonia) at surface remain low throughout the year and the phytoplankton possibly depend on local recycling and the dissolved organic nitrogen (DON; e.g. urea, amino acids and primary amines) supplied by rivers. A large portion of the phytoplankton biomass is typically located within subsurface chlorophyll maxima (SCM). SCM productivity is possibly in balance with the episodic supply of nitrate across the halocline and/or the supply of ammonium and nitrate by local recycling and nitrification, respectively. Despite the importance of SCM for the food web and CO_2 fluxes, little is known about their structure, turnover and susceptibility to environmental variability and change.

Objectives. The main goals of our team for leg 10a of CFL were to **(1)** establish the horizontal and vertical distributions of phytoplankton nutrients and the influence of different processes (e.g. mixing, upwelling and biological processes) on these distributions, **(2)** characterize the detailed vertical structure of chlorophyll-*a* with respect to irradiance, nutrient supply and physical structure, **(3)** experimentally assess causal relationships between the assimilation of different nitrogen sources by phytoplankton and the availability of light **(4)** determine the utilisation of different sources of inorganic and organic nitrogen by phytoplankton and bacteria, **(5)** determinate the rates of nitrification and **(6)** the regeneration of ammonium at SCM. Ancillary objectives were to calibrate the *SeaPoint* fluorometer and *ISUS* nitrate probe attached to the Rosette.

Methods. Samples for inorganic nutrients (ammonium, nitrite, nitrate, orthophosphate and orthosilicic acid) were taken at all rosette stations (see Table 1) to establish detailed vertical profiles (see Fig. 1 for vertical sampling resolution). Additional samples for dissolved organic nitrogen (DON) and urea were taken at stations where incubations were performed. Ammonium was determined immediately after collection using modifications of the manual fluorometric method (e.g. Holmes et al. 1999). Urea samples were stored frozen and DON samples were preserved with acid and stored in the dark at 4°C for post-cruise determination. The concentrations of nitrate, nitrite, orthophosphate and orthosilicic acid were determined on fresh samples using an Autoanalyzer 3 (Bran+Luebbe) with colorimetric methods adapted from Grasshof (1999).

Samples for the natural abundance of ^{15}N and ^{13}C in particulate organic matter were taken at 5 m and in the chlorophyll maximum at stations where incubations were performed (Table 1). Volumes ranging from 12 to 20 liters were filtered onto 47 mm pre-combusted GF/F filters with a peristaltic pump and the filters were desiccated at 60°C in a drying oven. These data will be used for nitrogen uptake calculations and to assess the nitrogen status of phytoplankton communities.

The relationship between light and the uptake of C and N by phytoplankton from the surface was assessed using dual labelling with stable isotopes of C and N in four light-gradient modules (10 light intensities). Temperature was maintained at *in situ* levels with a chilling circulator. Ten samples for each nitrogen source were spiked (10 with ^{15}N-nitrate and ^{13}C-bicarbonate, 10 with ^{15}N-ammonium and ^{13}C-bicarbonate, 10 with $^{13}C/^{15}N$-urea and 10 with $^{13}C/^{15}N$-glycine). Incubations were terminated by filtration onto 24-mm pre-combusted glass fiber filters. All filters were desiccated at 60°C and stored dry for post-cruise determination of isotopic enrichment and the measurement of both particulate organic carbon and nitrogen.

The rate of assimilation of the same four nitrogen sources by phytoplankton and bacteria from surface and chlorophyll maximum depth were also assessed with natural irradiance, using on-deck incubators covered with filters to simulate natural light conditions at those depths. Incubations were terminated by filtrations onto 0.8µm and 0,2µm silver filter. The filtrates of the samples incubated with ^{15}N-ammonium and ^{13}C-bicarbonate were acidified and frozen for post-cruise analysis of regeneration of ammonium using the method of Holmes (1998) and for measurement of the nitrification rate by the extraction of ^{15}N-nitrite with the method of Olsen (1981).

Presence of dinitrogen fixation in surface water was verified by using the method described by Montoya *et al.* (1996) with on-deck incubators. Incubations were terminated by filtration onto 3 µm and 0,2µm silver filter. All filters were desiccated at 60°C and stored dry for post-cruise determination of isotopic enrichment and the measurement of both particulate organic carbon and nitrogen.

The effects of incubation treatments (variable nutrient additions, temperature and light conditions) on the photosynthetic characteristics of phytoplankton were assessed by Pulse Amplitude Modulated fluorometry (PAM; Heinz-Walz). Calibration of the Rosette fluorometer was achieved by comparing the instrumentôs output with extracted chlorophyll *a* and PAM data. The Phytoflash system was powered by a CTD (SBE-19) and deployed in self-contained mode from the front deck.

Table 1. List of sampling stations and measurements during leg 10a CFL.

Station	Rosette Cast	Nutrients	Ammonium	Urea	Amino acids	Chlorophyll extract	PAM	Natural Abundance	Phytoflash	CTD	Light Gradient	Nitrogen assimilation	Nitrification	Nitrogen fixation
400-10a	01	x												
401-10a	02	x												
402-10a	03	x												
403-10a	06	x	x	x	x	x	x	x	x	X				
404-10a	07	x												
405-10a	09,10,62	x	x	x	x	x	x	x	x	X	x	x	x	x
408-10a	28,31	x	x	x	x	x	x	x			x	x	x	x
412-10a	21	x												
414-10a	23	x												
437-10a	17,18	x	x	x	x	x	x	x	x	X	x	x	x	x
1300-10a	32	x												
1601-10a	39,41	x	x	x	x	x	x	x	x	X				x
1901-10a	12	x												
2000-10a	46	x												
2002-10a	48	x												
2004-10a	51	x												
2006-10a	53	x												
2008-10a	56,57	x	x	x	x	x	x	x	x	x	x			x
2009-10a	58	x												
2011-10a	60	x												
CA04-08	45										x	x	x	x
Mackenzie River		x	x	x	x									x
Kugmallit Bay station 1		x	x	x	x					x				
Kugmallit Bay station 2														
Kugmallit Bay station 3		x	x	x	x	x		x		x	x	x	x	x
Kugmallit Bay station 4														
Kugmallit Bay station 5		x	x	x	x					x				
Kugmallit Bay station 6		x	x	x	x					x				
Kugmallit Bay station 7														
Kugmallit Bay station 8		x	x	x	x					x				

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2.5.2. Marine Photochemistry

Participants: Cédric G. Fichot, Simon Bélanger, Ron Benner

Introduction
Major uncertainties currently exist within global budgets of carbon, nitrogen, phosphorous and sulfur (Berner and Lasaga, 1989; Sarmiento, 1993; IPCC, 2001). Attempts at filling gaps in these budgets have led scientists to recognize the potential role of marine photochemistry in global biogeochemical cycling. In its broadest sense, marine photochemistry refers to the chemical processes that result from the interaction of solar radiation with all seawater constituents. However, since most photochemically-efficient solar radiation (ultraviolet and blue region of the solar spectrum, 280-500 nm) in the ocean is scavenged by chromophoric dissolved organic matter (CDOM), most marine photochemical studies are concerned with the effects of solar radiation on the dissolved constituents of seawater.

Studies over the past four decades have demonstrated that marine photochemistry is involved in a variety of chemical reactions of significance to numerous marine, atmospheric and climate-related processes (Zepp et al., 1998; Mopper and Kieber, 2000; Zepp et al., 2007). Through absorption of solar radiation, the ubiquitous CDOM undergoes photochemical reactions, serving as the major precursor for the creation of a variety of short-lived radicals and stable photoproducts. Photoproducts important to carbon cycles include dissolved inorganic carbon (DIC) carbon monoxide (CO) and a variety of low molecular weight (LMW) biologically labile carbon compounds (Mopper and Kieber, 2001). Among other processes, marine photochemistry also acts as: a direct sink for dissolved organic matter (DOM) ; a source of volatile sulfur compounds (COS, CS_2) (Xie et al., 1998; Uher and Andreae, 1997) and methyl iodide (CH_3I) (Moore and Zafiriou, 1994) ; a potentially significant and indirect sink for dimethyl sulfide (DMS) in the ocean (Brimblecombe and Shooter, 1986; Kieber et al., 1996). In light of these recent findings, the need to quantify the role of marine photochemical processes in global biogeochemical cycles is being increasingly recognized by the scientific community.

As a result of their dependence on incident solar radiation, photochemical processes in the Arctic are extremely seasonal with maximum rates in summertime. Meanwhile, the continuous shrinking of the summer ice cap contributes to a larger fraction of the ocean becoming exposed to solar radiation. In addition, a recent increase in incident UV radiation and the release of large amounts of terrestrial DOM from the melting of the permafrost are also expected to make photochemical fluxes increasingly significant in the forthcoming years.

Bélanger et al. (2006) provided the first estimate of photochemical remineralization of terrestrial DOM in the Arctic using remote sensing. Although novel, their approach is severely hindered by our lack of knowledge about the photoreactivity of the photochemical precursor (CDOM).

Objective

Our objective is to gain a better understanding of how the photoreactivity of DOM relates to its composition in an attempt to provide a better quantitative assessment (using remote sensing) of the role of marine photochemistry in biogeochemical cycling of carbon and nitrogen in the Arctic. In particular, we investigate the role played by DOM components of terrestrial origin as they are suspected to play a disproportionately large role in photochemical processes.

Methods

Optical measurements for algorithm development and validation (Optics):

1) Hyperspectral remote-sensing reflectance, $R_{rs}(\lambda)$ with λ = 350 - 700 nm, using a Satlantic® HyperSAS (belonging to Dave Barber). Measurements were done onboard the Amundsen at the bow under clear-sky conditions only and around 2 P.M (local time) to maximize the likelihood of match-up with remotely sensed reflectances (SeaWiFS and MODIS). See figure 1 for illustration.
2) Simultaneous sampling of surface seawater (0 m) for measurements of absorption coefficients of CDOM, $a_g(\lambda)$, and particles, $a_p(\lambda)$. Filtrations were done onboard the Amundsen and spectrophotometry will be done in the lab at the Université du Québec à Rimouski.

Water sampling for determination of DOM composition (DOM composition):

1) A WetLABS ECO CDOM fluorometer (ex/em 370/460 nm) plugged into the CTD/rosette was deployed during some of the CTD casts. When deployed, the CDOM fluorescence profiles exhibited minima in the surface mixed layer and maxima somewhere in the 60-120 m depth range. See figure 2 for illustration.
2) About 100 mL of filtered seawater (GF/F, 0.7 mm) was collected for measurements of DOC, DON, CDOM absorption coefficient spectra, $a_g(\lambda)$, amino acids and possibly $d^{13}C$. For each station sampled, samples at 2 or 3 depths were obtained (usually surface (5 m), mid-water column or CDOM fluorescence maximum and near the bottom). Samples are kept frozen (- 20 ^{o}C) and will be analyzed by Cedric Fichot in Dr R. Benner's lab at the University of South Carolina.
3) Lignin extraction for lignin oxidation product analysis was done based following the method of Louchouarn et al. (2000). About 10 L of 0.2 mm-filtered acidified (pH ~ 2.5) seawater (from the same Niskin bottle as for item 2) was used for lignin extraction on the C18 Varian cartridges. After extraction, cartridges are kept at + 4 ^{o}C and will be processed by Cedric Fichot in Dr R. Benner's lab at the University of South Carolina for analysis of lignin oxidation product analysis. See figure 3 for illustration.

Water sampling for photochemical experiments (Photochemistry)

1) Either 300 mL or 1.2 L of 0.2 mm-filtered seawater were collected from the same Niskin bottles as the DOM Composition samples. Samples are kept at + 4 ^{o}C and will be used by Cedric Fichot in Dr R. Benner's lab at the University of South Carolina in a series of photochemical experiments aimed at determining the photoreactivity of the DOM sampled.

Stations sampled

Station ID	Latitude	Longitude	Date	Depth (m)	Optics	DOM composition	Photochemistry
400-10A	69.107	-114.792	7/19/08	5	no	yes	yes
				80	no	yes	yes
401-10A	69.238	-116.605	7/19/08	5	no	yes	yes
				80	no	yes	yes
402-10A	69.605	-118.129	7/20/08	5	no	yes	yes
				80	no	yes	yes
404-10A	70.351	-121.604	7/20/08	5	no	yes	yes
				200	no	yes	yes

CA18-07 (= 405-10A)	70.688	-122.904	7/21/08	5	no	yes	yes
				200	no	yes	yes
1901-10A	71.224	-124.702	7/22/08	5	no	yes	yes
				120	no	yes	yes
				200	no	yes	yes
CA16-07 (= 437-10A)	71.700	-126.615	7/23/08	5	no	yes	yes
				222	no	yes	yes
				438	no	yes	yes
412-10A	71.563	-126.916	7/24/08	5	no	yes	yes
				140	no	yes	yes
				411	no	yes	yes
CA05-07 (= 408-10A)	71.324	-127.743	7/26/08	2	no	yes	yes
				100	no	yes	yes
				200	no	yes	yes
1601-10A	71.567	-130.703	7/28/08	5	no	yes	yes
				125	no	yes	yes
				350	no	yes	yes
CA04-07	71.098	-133.739	7/31/08	5	no	yes	yes
				120	no	yes	yes
				300	no	yes	yes
CA18-07 (second time)	71.098	-133.739	8/3/08	5	no	yes	yes
				60	no	yes	yes
				500	no	yes	yes
Mackenzie	69.267	-134.093	7/29/08	1	no	yes	yes
Stn01	69.464	-133.091	7/29/08	3.5	no	yes	yes
Stn03	69.504	-133.254	7/29/08	3.8	no	yes	yes
Stn05	69.547	-133.405	7/29/08	3.5	no	yes	yes
Stn06	69.569	-133.485	7/29/08	3.7	no	yes	yes
Stn08	69.635	-133.449	7/29/08	5.3	no	yes	yes
Stn09	69.763	-133.359	7/29/08	6.8	no	yes	yes
SB1 (407)	71.149	-126.248	7/26/08	0	yes	no	no
SB2	71.013	-126.930	7/27/08	0	yes	no	no
SB3	71.567	-130.719	7/28/08	0	yes	no	no
SB4	69.633	-133.458	7/29/08	0	yes	no	no
SB5	70.670	-123.002	8/2/08	0	yes	no	no

Illustrations

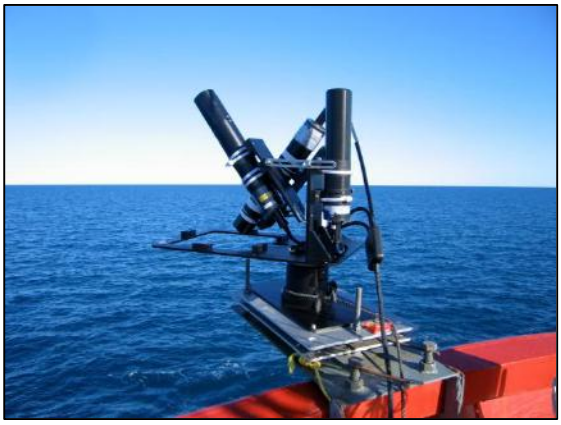

Figure 1. Satlantic® HyperSAS.

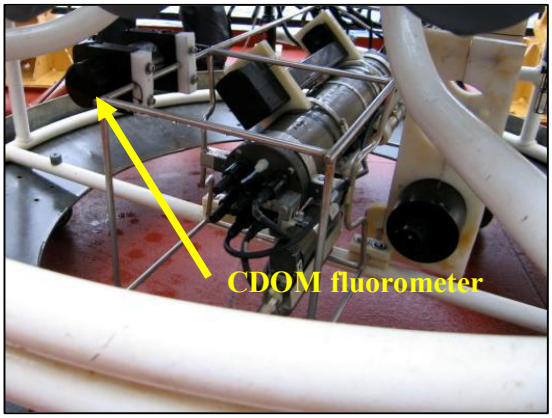

Figure 2. WetLABS® ECO CDOM fluorometer mounted on CTD.

Figure 3. Lignin extraction setup.

2.5.3. Dissolved Inorganic Carbon System

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Participant: Stephanie Moore; Department of Oceanography, Dalhousie University, Halifax, NS, Canada; moore@phys.ocean.dal.ca

The oceanôs exchange of carbon dioxide with the atmosphere is governed by the biogeochemical cycling of carbon and physical processes throughout the water column, which determine the concentration of dissolved inorganic carbon in the surface waters. Of the seven relevant carbon system parameters, a minimum of two are needed to calculate the others and fully describe the inorganic carbon chemistry, over-determination of the system being beneficial. During CFL Leg 10a, roughly 110 samples were analyzed for dissolved inorganic carbon (DIC) and total alkalinity (TA), yielding two of the relevant parameters. Due to project priorities, problems with the CTD, and bad weather less than half the expected sampling was done, accounting for the low number of analyzed samples.

Water samples were collected at full, basic and mooring stations in parallel with the nutrients rosettes. DIC and TA were sampled using 500 mL glass bottles which were rinsed and filled using a plastic tube. DIC samples were the first to be taken from the Niskin bottles. These samples were either

analyzed immediately following sampling, or spiked with $HgCl_2$ and stored in the dark at 4°C to await analysis.

Water was sampled from the entire water column from the bottom water up to 5 meters depth. At station 408, the only station for which time and weather permitted, surface water was collected with the use of the zodiac. This water was collected using a Niskin bottle. The salinity of the sample was measured with a salinometer.

DIC and TA were analyzed on board using a VINDTA 3C (Versatile Instrument for the Determination of Titration Alkalinity) by Marianda. Total alkalinity was determined by titrating a volumetrically accurate sub-sample of seawater using HCl as a titrant. In the case of dissolved inorganic carbon, a volumetrically determined sub-sample of seawater is acidified with 8.5% H_3PO_4 to convert all inorganic carbon into gaseous CO_2. The CO_2 is then stripped out of the sample using ultra-pure N_2 gas, followed by transfer into the titration cell where total inorganic carbon is then detected using the coulometric method (Johnson et al., 1993).

Surface water samples were also collected at four stations near the MacKenzie River delta. Since the Niskin broke on the way to the river, the samples were collected by submerging the 500 mL glass bottles. These samples were subsequently analyzed for DIC and TA. This was of particular interest, since TA can be used as a fresh water tracer. Measurements of alkalinity from this freshwater source should allow us to distinguish between freshwater input from sea ice melt and freshwater input from the MacKenzie river to the Arctic Ocean in the CFL sampling region.

Table 1: Water column sampling for DIC, TA

STATION	LAT ° N min	LON ° W min	CTD CAST	DATE
403	70° 5.443'	-120° 5.629'	0805006	20/07/08
405	70° 42.119'	-122° 56.291'	0805010	21/07/08
437	71° 41.636'	-126° 36.011'	0805018	23/07/08
408	71° 18.972'	-127° 45.173'	0805031	26/07/08
1601	71° 33.908'	-130° 42.846'	0805041	28/07/08
MacKenzie estuary	69.463°	-133.100°	N/A	29/07/08
MacKenzie estuary	69.504°	-133.259°	N/A	29/07/08
MacKenzie estuary	69.545°	-133.418°	N/A	29/07/08
MacKenzie estuary	69.633°	-133.458°	N/A	29/07/08
2008	71° 19.986'	-126° 13.163'	0805056	02/08/08

References:

Johnson, K. M., K. D. Wills, D. B. Butler, W. K. Johnson and C. S. Wong. Coulometric total carbon dioxide analysis for marine studies: maximizing the performance of an automated gas extraction system and coulometric detector. Marine Chemistry, Vol. 44, pp. 167-187, 1993.

2.5.4. Barium

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In the Canadian Arctic, barium (Ba) is mainly released from the North American continent and can therefore be used as a tracer for terrestrial freshwater input. Together with ^{18}O, a tracer for freshwater input from precipitation and ice melt, all freshwater sources to the Arctic can be quantified.

Throughout Leg 10a, samples for barium were taken from the rosette parallel to samples for ^{18}O, at approximate depths 5, 10, 20, 50, 70, 100, 200 and 400 m. Small plastic bottles (15 ml volume) were

rinsed three times, then filled and spiked with 15 µl concentrated HCl. Sample bottles were then sealed with parafilm and kept for later analysis using isotope dilution mass spectrometry.

Table 1: Stations sampled for Barium

STATION	LAT ° N min	LON ° W min	CTD CAST	DATE
403	70° 5.443ô	-120° 5.629ô	0805006	20/07/08
405	70° 42.119ô	-122° 56.291ô	0805010	21/07/08
408	71° 18.972ô	-127° 45.173ô	0805031	26/07/08
1601	71° 33.908ô	-120° 42.846ô	0805041	28/07/08

2.5.5. Sediment traps

PI: Christine Michel, Freshwater Institute Winnipeg (DFO)
Participant: Amélie Sallon, University of Québec of Rimouski (UQAR)

Sediment traps have been used to estimate the sinking flux of organic material in the ocean and to assess the composition of that flux. There are two pathways to describe organic carbon in the water column. 1) Phytoplankton carbon can be transferred to the higher trophic level by zooplankton grazing. Part of this carbon can be used by other organisms including fish, mammals and bird, while another part may be exported at deeper depth in the form of fecal pellets (feces). This pathway favors transfer to the pelagic ecosystem. 2) On the other hand, phytoplankton carbon that is not used can be directly exported through sedimentation of intact cells. This pathway leads to food input to the benthic (sea floor) community.

Objectives
This study investigates the biogeochemical cycling of carbon and other organic constituents through the use of short-term particle interceptor traps. The general objective of this study is to characterize the sinking export of carbon and organic material from the euphotic zone (magnitude and composition of the sinking fluxes and material), and the transformation of material during its sinking to depth. This research aims at understanding how climate-related changes in the distribution, timing, magnitude and type of primary production may affect the fluxes of material to the benthic and pelagic food webs.

Methods
During CFL program (17^{th} of July to 5^{th} of August 2007), we deployed the traps at five stations (5 mooring stations) throughout the Canadian High Arctic. The traps were PVC cylinders with an internal diameter of 10 cm and a height/diameter ratio of 7. Before each deployment, seawater collected at 150-200m deep at a previous station was filtered through 0.22 µm filter membranes. The traps were filled with the filtered seawater to create a dense layer. A series of five PVC cylinders were installed on a line at each sampling depth (50m, 100m, and 150m) in order to collect enough material to perform subsequent analyses. At the surface, the trap line was attached to a positioning system (ARGOS and radio beacon) and a series of small floats (Viny floats) to minimize vertical motion. The traps were deployed for a period of 12-24 hours. Upon recovery, the traps were placed in a dark cold room for 8 h. After allowing the sediment to settle, the supernatant was removed and the bottom volume (ca. 1000ml) of the traps was kept for analysis. Samples were analyzed for particulate organic carbon and nitrogen (POC/PON), dissolved organic carbon (DOC) and nitrogen (DON), stable isotopes (Isotopes), biogenic silica (BioSi), total chlorophyll *a* and phaeopigments (total chl*a*), exopolymeric substances (EPS) phytoplankton composition and abundance (Cells), fecal pellet abundance (FP), bacteria (FC) and thorium (Th) (Table 1).

Another aspect of this project is to evaluate the spatial and vertical distribution of dissolved organic carbon and nitrogen in Arctic marine waters, as these constituents play important roles in the cycling of organic material on the shelves. Water column samples were taken at all basic and full stations throughout the Canadian High Arctic for a total of 6 stations.

Table 1: Deployment/recovery and analysis details of the free-drifting particle interceptor traps in the Canadien High Arctic (17th of July ï 5th of August)

Stations	Duration (d)	Deployment		Recovery		Target depth (m)	POC/ PON	DOC/ DON	Chl tot	Chl >5um	Biosi	EPS	Isotope	Th	Cells	FP	Bacteria (FC)
		Latitude (N)	Longitude (W)	Latitude (N)	Longitude (W)												
405 CA 18-07	0d 18:25	70°4'500	122°57'925	70°42'93	123°06'14	50-100-150	6	6	6	3	6	9	3	3	3	3	6
437 CA 16-07	1d 17:13	71°44'16'	126°29.76'	71°41.51'	126°26.85'	50-100-150	6	6	6	3	6	9	3	3	3	3	6
408 CA 05-07	1d 02:13	71°19.19'	127°35.49'	71°15.12'	127°30.43'	50-100-150	6	6	6	3	2	9	3	3	3	3	6
407 CA 08-06	0d 13:12	71°00.18'	126°02.62'	70°58.83'	126°05.50'	50-100-150	6	6	6	3	5	9	3	3	3	3	6
435 CA 04	0d 08:27	71°04.33'	133°45.47'	71°01.15'	133°45.05'	50-100-150	6	6	6	3	6	9	3	3	3	3	6

2.5.6. Marine Microbiology Group

Participants: Mary Thaler (Universite Laval), Cristina Romera (Institut de ciencies del mar)

Objectives
Our team collected samples and data for three laboratories: Connie Lovejoy, Roxanne Marangar and Carlos Pedros-Alio. Our work addressed different aspects of microbial diversity and processes in the Amundsen Gulf at this time of year, including both eukaryotic and prokaryotic groups.

Sampling and data collection
DNA and RNA
DNA and RNA were sampled together from the same casts and depths from which the nitrogen team (Mariane and Marjolaine) drew their samples, typically the surface and the chlorophyll maximum. Three times during the leg, the full water column was sampled including bottom, O_2 minimum and/or nitricline. Two peristaltic pumps with four heads each were generally available for filtration, and a third peristaltic pump with a single head, discovered mid-leg, made it possible to filter a fifth depth for DNA on 31 July 2008.

Station 1601-10a was sampled during the difficulties with the CTD rosette, and the CTD profile may be subject to errors. However, the chlorophyll maximum at 93 m, while unusual, seemed to be confirmed by Jonathanôs preliminary results.

On 29 July 2008, Marjolaine and Mariane went to the Mackenzie delta by helicopter and barge respectively, and brought back surface water for sampling (the water was not deep enough to include other depths. These samples should be very interesting, but may be of limited use because of the delay between collection and filtration, and the high sediment load. Station Mackenzie 3 was filtered in duplicate.

Live Samples
On 31 July, 2008, two 125 ml bottles were filled with seawater from the chlorophyll maximum of station CA04.08. This water was kept in the incubator at 4 °C until it could be transported back to Québec in an ice-filled cooler. It is intended to be used to establish monoclonal cultures, particularly of *Micromonas*. In addition, 1 L of 0.22 µm filtered sea water from the same station and depth was retained from DNA filtration, and kept at 4 °C until it could be transported to Québec.

ETS
The ETS was intended as a backup to measures of bacterial respiration, in which up to 8 L of seawater was filtered in duplicate through a gf/f filter from the chlorophyll maximum and surface. We had intended to collect these samples on 21 July and 31 July; however, on the 21 July we misjudged the amount of water needed to take duplicate samples. On 31 July, the number of users on our scheduled rosette precluded taking such a large quantity of water, and weather conditions prevented scheduling of an additional rosette. There is therefore only a single set of samples from 2 July.

Chlorophyll
Samples for quantifying chlorophyll in the total fraction and <3 µm fraction were collected on 21 July, 29 July and 31 July. Because the 21 July was our first full station, we decided to do only four depths so that we could familiarize ourselves with the protocol. On 29 July we sampled from the Mackenzie River delta. However, owing to the high sediment content, we were not able to filter the full amount of seawater specified by the protocol. On 31 July we sampled from six depths: bottom, O_2 minimum, nitrate minimum, nitricline, chlorophyll maximum and surface.

FISH, viral abundance
Samples for FISH were collected on 21 July, 29 July and 31 July from all available depths.

Nanoflagellate abundance
Samples for nanoflagellate abundance were filtered on 21 July, 29 July and 31 July from all available depths. Seawater was filtered onto a black polycarbonate filter and made into a slide for later counting. The amount filtered depended on the density of particles in the seawater, and ranged from 40 ml for Mackenzie 3 to 75 ml for bottom water at station 405-10a.

Bacterial abundance
Samples for bacterial abundance were usually collected together from the same casts and depths from which the nitrogen team (Mariane and Marjolaine) drew their samples. They were not collected on 20 July, 23 July or 2 August. Slides of bacterial abundance were also made whenever a bacterial respiration experiment was terminated (see below).

Ciliate abundance
Samples for ciliate abundance were collected on 21 July and 31 July.

Bacterial Respiration
Bacterial respiration was measured on samples already collected during the previous leg. Because of a delay in getting tasks organized for the first few days on the ship, there is a lacuna of several days in these measurements. On the 23 July, a crack was noticed in the light tube belonging to the light sensor of the FiBox. This crack soon became a break. An initial field repair using toothpicks and duct tape was successful and allowed measurements to continue for two more days. It was noticed, however, that measurements, while coherent with previous measurements, were generally more variable, up to 10 µmol/l, probably owing to the effect of the shipôs motion on the wobbly join. After two days, the repair broke, and further efforts were unsuccessful. All observations were therefore terminated, and slides for bacterial abundance were made from the samples.

Owing to a miscommunication, samples 1-8 were not made into slides for bacterial abundance.

Virus Abundance
Samples for virus abundance were collected on 21 July, 29 July and 31 July from all available depths. The samples were fixed with glutaraldehyde and frozen at -80 ºC.

Nitrous oxide
Samples of nitrous oxide were taken during 3 days. On 21 and 25 July two samples were taken, in triplicate, from surface and chlorophyll maximum. On July 31 three samples were taken at the same depths, and also the oxygen minimum. Samples of the atmospheric air of the deck (where the gas samples were taken) and the rosette room were also taken. The gas of each sample was taken immediately at the time of sampling, and stored in vials provided with a septum at room temperature.

MARFISH and uptake experiments
Two MARFISH experiments were carried out on July 21. The urea experiments were done with surface water and the bicarbonate and leucine experiments were done with surface and nitrocline seawater. The MARFISH filters were stored at -20ºC in petrislides until their analysis.

Bicarbonate and urea uptake experiments were also carried out, and the samples were counted in the scintillation counter.

Bacterial Production
Samples for bacterial production were taken in five stations during this leg, to complete the set of variables for the nitrogen team (Mariane and Marjolaine). These were Surface and chlorophyll only were sampled on July 26 and 28, while full profiles of four and six depths were taken on 21 July and 31 July respectively. Surface samples were taken from the Mackenzie river and two Mackenzie delta stations. These samples were processed in the RadVan, involving a 4-hour incubation in a cooler with water and ice.

Organic Matter

July 31, 4 depths of seawater were taken to get samples of fluorescent dissolved organic matter (FDOM), coloured dissolved organic matter (CDOM), amino acids, carbohydrates, dissolved organic carbon, total phosphorous and total nitrogen. The FDOM and CDOM were filtered with a GF/F filter and stored at -20 °C in amber-coloured glass bottles. Amino acid and carbohydrate samples were also filtered through a GF/F filter and stored at -20 °C in polyethylene bottles. Dissolved organic carbon samples, also filtered through a GF/F filter, were fixed with orthophosphoric acid, placed in amber-coloured glass ampoules, hot sealed and stored at 4 °C.

On July 29, a transect of stations was carried out approaching the Mackenzie delta. Organic matter samples were taken from all the 6 stations, because it is very interesting to know the influence of the river on these variables.

Table 1. Sampling Overview; Number of Depths

Date	Station	DNA & RNA	ETS	Chlorophyll	FISH		Abundances			
							Nanoflagellates	Bacterial	Viral	Ciliates
20.07.08	403-10a	4	-	-	-	-	-		-	-
21.07.08	405-10a	4	2	4 (-1 small)	4	4	4		4	4
23.07.08	437-10a	2	-	-	-	-	-		-	-
26.07.08	CA05.08	2	-	-	-	-	2		-	-
28.07.08	1601-10a	2	-	-	-	-	2		-	-
29.07.08	River	1	-	-	-	-	1		-	-
29.07.08	Mcknz 3	1 (2 repl.)	-	1	1	1	1		1	-
29.07.08	Mcknz 8	-	-	-	-	-	1		-	-
31.07.07	CA04.08	4 (+1 DNA)	-	6	6	6	6		6	6
02.08.08	2008-10a	1	-	-	-	-	-		-	-

Date	Station	N_2O	MARFISH	Bacterial Production	Organic Material
20.07.08	403-10a	-	-	-	-
21.07.08	405-10a	2	2	4	-
23.07.08	437-10a	-	-	-	-
26.07.08	CA05.08	2	-	2	-
28.07.08	1601-10a	-	-	2	-
29.07.08	River	-	-	1	1
29.07.08	Mcknz 3	-	-	1	1
29.07.08	Mcknz 8	-	-	1	1
31.07.07	CA04.08	3	-	6	4
02.08.08	2008-10a	-	-	-	-

2.6. Team 8

PI: Gary Stern (DFO, Freshwater Institute)
Participants: Gary Stern (DFO, Freshwater Institute), Hayley Hung (Environment Canada, Torono), Amanda Chaulk (MSc student, University of Manitoba)

2.6.1. Organic contaminants

by Hayley Hung

Air sampling for persistent organic pollutants (POPs) and perfluorinated compounds

Two high volume air samplers were installed at the bow of the Amundsen to perform air sampling for organic chemicals. One sampler operated daily from July 20 until August 5; using 1 glass fiber filter to trap the particle phase and 2 polyurethane foam plugs (PUF) to trap the gaseous phase. Thirteen 24-h integrated, two 48-h integrated samples and 3 procedural blanks were taken at an average sampling rate of approximately 460 L/min. The samples will be analyze for polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), organochlorine pesticides (OCPs) and polybrominated diphenyl ethers (PBDEs). The other sampler was operated occasionally between July 18 and August 2 with three 24-h, one 34-h and one 46-h integrated samples and two procedural blanks. The sampler operates with one glass fiber filter to trap the particle phase and one PUF-XAD resin sandwich to trap the gaseous phase at an average flow rate of approximately 260 L/min. The samples will be analyzed for perfluorinated compounds. Air samples were prepared in the aft laboratory and stored in the -20 C room behind the aft laboratory.

Air sampler for perfluorinated compounds

Air sampler for POPs

2.6.2. Mercury

by Amanda Chaulk and Hayley Hung

Rationale
Mercury (Hg) levels in marine mammals and fish are an ongoing concern in Arctic regions because of their inclusion in traditional subsistence diets among indigenous peoples in northern regions. Successful strategies to mitigate health impacts related to Hg in human diets require an understanding of both the social and cultural perspective of northern communities, as well as the natural environmental processes that lead to Hg in food resources. Our research on Hg in the Arctic is focused

on determining the environmental processes responsible for the distribution and speciation of Hg in Arctic marine ecosystems, for the purpose of supporting the development of strategies to lessen the impact of Hg on human and ecosystem health.

Marine Water Column Sampling

During Leg 10 of the CFL Study, the Team 8: Contaminants group collected samples from the marine water column in Amundsen Gulf from 11 locations within the Amundsen Gulf and the Beaufort sea as well as the MacKenzie River (Table 1). Samples from the 10 m depth to the seafloor were collected with the ship-based Rosette sampling equipment in PVC ôNiskin-styleô sample bottles remotely operated from onboard the ship. Supplementary ôSurfaceô samples from 0 to 10 m in depth were collected by a PVC Niskin water sampling bottle (General Oceanics, Miami, Florida) a few hundred meters of the ship (Table 1). Within each profile, 11 to 20 different depths were sampled (including Niskin sampling), producing high resolution profiles for ótotal Hgô (Hg_T). At each depth sampled for Hg_T, water was also collected for ŭ^{18}O analysis in tightly sealed glass scintillation vials. After collection of ŭ ^{18}O samples, bottles were further sealed with parafilm and stored at 4°C. Rosettes were sampled by Hayley Hung and Amanda Chaulk. All samples were analysed in PILMS by Amanda Chaulk.

Preliminary Results

Hg_T levels in the Amundsen Gulf measured during Leg 10 were very low, averaging roughly 1 pM (0.2 ng/L) throughout the water column. These values are comparable with the lowest concentrations of Hg_T observed in the global oceans (e.g., the Pacific and North Atlantic Oceans), and somewhat lower than those observed in coastal oceans and regional seas (e.g., the Baltic and the Celtic Seas, Hudson Bay). However, we were able to observe changes in the concentrations caused by the final ice /meltbreakup and influence of river inputs from the Horton and the Mackenzie River systems.

Table 1. Sampling Location and Date for Marine Water HgT Measurements During CFL Leg 10

Station	Latitude	Longitude	Sample Type	Bottom Depth	Cast
405-10a	70o42.119	122o56.291	rosette	597	10
437	71o41.636	126o36.0	rosette	431	18
437-b	71o20.868	127o17.226	surface water		niskin
408	71o18.972	127o45.173	rosette	408	31
407	71o00.78	126o11.64	surface water		niskin
1601-10a	71o33.908	130o42.846	rosette	333	41
MR1	69o463	133o100	surface water	3.5m	niskin
MR3	69o504	133o259	surface water	3.8	grab
MR5	69o545	133o418	surface water	3.5	grab
MR8	69o633	133o449	surface water	5.3	grab
2008-10a	71o19.986	126o13.163	rosette	442	56

At open water stations, surface water samples were taken with the zodiac to avoid contamination from the ship. It was quite evident that the results from the niskin sampling were lower in THg concentration. Of course, the niskin must be cleaned and tested at both the spigot and the top of the niskin before use.

Mercury in Ice

Two ice cores collected during leg 9 (F7 and FB04) as well one collected during leg 8 (D34) were processed during leg 10. All ice cores were cut into duplicates and each duplicate was scrapped with a freshly cleaned and tested ceramic blade. Both pieces were placed into separate zip lock bags and then stored in one larger bag to melt. When sampling, each individual zip lock bag was rinsed with MQ water over the area that would be cut and then sampled. A small amount was rinsed out and then the sample was collected. For example, a 5 cm piece of ice split would yield two 25 mL samples of water in the end. The scrapping was very clean, and the gloves were changed between each section of the core to be scrapped. This is essential to good reproducible results.

Methyl Mercury

The form of mercury that accumulates within the foodweb is the organic form of mercury known as methyl mercury. We are interested in determining the pathways in which mercury (Hg) becomes methylated and to study the levels in the abiotic and biotic environments. We are up and running Methyl Mercury samples with our new and improved BrooksRand Automated system. Methyl Mercury samples were not taken this leg. However bottles were cleaned in preparation for methyl mercury sampling during ArcticNet Leg 11.

BrooksRand Automated MeHg system.

Air sampling for gaseous elemental mercury

A Tekran mercury vapour analyzer was used to measure gaseous elemental mercury (GEM) in air on the starboard side of the front deck. The analyzer is automated. It collects and analyses the air concentrations of GEM every 5 minutes at a flow rate of 1 L/min. Air concentration data are archived on a laptop connected to the analyzer.

Mercury sampling inlet

Tekran Mercury Analyzer

Mercury air sampling container on starboard side of front deck

3. 2008 Circumpolar Inuit Schools on Board - Field Program

July 14 ï 25th, 2008 ï Onboard Leg 10A

Submitted by: Robin Gislason, Program Leader

Schools on Board is an outreach program of ArcticNet and the IPY-CFL study, used to promote Arctic sciences in high schools across Canada and abroad. The field program takes high school students and teachers on-board the CCGS Amundsen where they are integrated into the activities of the various science teams conducting research in the Arctic. It blends adventure, curiosity and exposure to create an energized learning environment and provides opportunities for scientists to share their passion for science and research with students ï both on the ship and in classrooms. The multidisciplinary nature of the field program demonstrates the breadth of opportunities that are available to aspiring young researchers and technicians. Face-to-face interactions with scientists of all levels (masters, PhDôs, researchers, CRC chairs) and access to state-of-the-art scientific instrumentation onboard the Canadian

research icebreaker are the focus of the on-board field program. To extend the outreach beyond the field program, experiences of those chosen to participate, are shared with fellow peers, family members and communities through a series of presentations that are delivered by the participant upon their return home.

In celebration of the International Polar Year (IPY), Schools on Board hosted three International Field Programs during the Circumpolar Flaw Lead system study (CFL). This initiative included two International Field Programs with high school students and teachers participating as well as a third Circumpolar Inuit Field Program (CIFP) which was held during Leg 10A of the CFL. As part of our commitment to education and outreach for IPY, the CIFP included collaboration with Team 10ôs Inuit Circumpolar Council Canada (ICC) and Inuit Tapiriit Kanatami (ITK). Our 10 spaces for this field program were filled by 8 students and 2 program leaders from the following regions and agencies:

Participants
Adamina Partridge- Kuujjuaq, Nunavik
Jacquenita Sammurtok ï Chesterfield Inlet, Nunavut
Logan Gruben ï Tuktoyaktuk, Northwest Territories
Lisa-Marie Alikamik ï Uluhaktok, Northwest Territories
James Kuptana ï Sachs Harbour, Northwest Territories
Ralph Sinnok, Shismaref, Alaska
Daniel Marco Keilsen Holm - Nuuk, Greenland
Evgeniya Yar ï Moscow, Russia

Program Leaders
Scot Nickels, ITK ï Ottawa, Ontario
Robin Gislason, University of Manitoba ï Winnipeg, Manitoba

Participants were selected by committee. Collaborating organizations included Schools on Board, Inuit Circumpolar Council (ICC Canda, Greenland, and Alaska) and Inuit Tapiriit Kanatami (ITK). Participants met in Inuvik, July 14th. Prior to boarding the ship, participants engaged in cultural and community activities in Inuvik, NT. These included: a visit to the Visitor Centre; activities at the Great Northern Arts Festival; a boat tour of the MacKenzie Delta with local Inuit tour guide, Gerry Suilig, and interactions with youth and community leaders in Inuvik.

A highlight of the Inuvik community visit included a one-day workshop, July 16th, on the analysis and dissemination of the Traditional Knowledge (TK) students collected from their home communities before participating in the field program. The workshop was held at the Inuvialuit Regional Corporation Boardroom and included opening remarks from Nellie Cournoyea. The inspiring words from Nellie were well received by the participants and helped to set the stage for the group discussions on how to work with the TK research the participants collected.

The group chartered a flight from Inuvik to Kugluktuk and boarded the ship at 2:00pm on July17th, 2008. Our Schools on Board group arrived onboard hours before the crew and scientists of Leg10A. This turned out well as the participants were allowed time to unpack organize their rooms and get acquainted with life onboard a research vessel. The next day saw the students immediately integrated in the activities of the CFL science teams. The program included science lectures, lab activities and fieldwork. Details of the on-board program are posted on the IPY-CFL website (www.ipy-cfl.ca). Daily dispatches including a report, photos and ship location were sent to both, IPY-CFL and ArcticNet central, to be posted on their websites. This two-week adventure into Arctic research exposed circumpolar Inuit students to the research objectives and methods of numerous science teams representing a number of research disciplines from institutions across Canada and abroad. See attached table.

In addition to hands-on research activities the program included information and sessions on various aspects of climate change in Canadaôs North, including traditional knowledge, art, culture, history, and

politics. A major outreach project of the Schools on Board CIFP was the Youth/Elder/ Scientist Knowledge Exchange held July 22, 2008 onboard the CCGS Amundsen. Schools on Board invited community members and elders from Sachs Harbour, NT onboard for this inspiring one-day knowledge exchange. The morning consisted of ship and lab tours for the students and community members. Most scientists and crewmembers were able to participate by being in their labs and work areas as the tour went through the ship to explain their work and research.

The afternoon was spent in the Officerôs boardroom where youth and elders had the opportunity to break into small groups to discuss knowledge exchange between Inuit youth and elders in current times. Each group then presented their findings to the larger group. The afternoon session ended with presentations from Captain Stéphane Julien and Chief Scientist Gary Stern on the CCGS Amundsen and the science of the CFL project. The evening event included a panel discussion on the importance of the CFL project and the current relationship between researchers and northern communities. Members of the panel included: Chief Scientist, Gary Stern, Schs Harbour Elder, John Keogak, CCGS Amundsen Captain Stephane Julien, and CIFP youth participant, James Kuptana.

The CIFP participants were able to present their research on the traditional knowledge and climate change observations collected in their communities prior to the field program. The audience for the evening events included Sachs Harbour community members and elders, scientists, crew, and CIFP participants.

The following day, July 23rd, the CIFP participants along with a number of scientists, departed the ship for Sachs Harbour, NT. A community feast was held to celebrate the previous dayôs Elder/Youth/Scientist Workshop. The feast included a number of traditional Inuit dishes as well as informal exchanges between community members, participating CIFP students, and IPY-CFL scientists.

Outreach

Based on participant and scientist evaluations, activities of the Schools on Board program were successful in raising awareness of:

1. the Schools on Board program and its educational objectives
2. the IPY-CFL program and its scientific objectives
3. the role of traditional knowledge in scientific research

A unique feature of this field program was a pre-trip activity that engaged participants in the collection of traditional knowledge using Traditional Knowledge Kits developed by Schools on Board with the financial assistance of the Walter & Duncan Gordon Foundation. This activity was central to the field program and an anticipated follow-up activity planned in a collaboration with the Institute for International Sustainable Development (IISD) Circumpolar Youth Internship program. Outreach activities planned for this program include attendance and presentation at the Arctic Changes 2008 conference and the Arctic Climate Change Youth Forum in Quebec City, December 2008; presentation at the upcoming AGU conference in San Fransisco, December, 2008; presentation at the upcoming Arctic Frontiers conference, Tromso, Norway, January 2009); publication of process and results of TK activities.

Website & dispatches

The primary communication tool for the program was the webpage hosted on the IPY-CFL and ArcticNet websites. These sites were used to deliver program details and relevant application information. The site was a very effective tool, as it also contained all of the necessary science information relevant to the science project and the Amundsen. During the field program, participants submitted daily dispatches (July15-24th, 2008) to the CFL website and the ArcticNet Expedition logbook. These sites included text and pictures describing daily activities and interactions between scientists and participants. They allowed communities, schools, friends, and families to share the experience, as well as provided visitors to the website (general public and other scientists) with detailed information of this outreach initiative.

Media continues to show an interest in the program. They include (but are not limited to):

1. Various newspaper articles and radio interviews prior to departure in each respective community
2. Interviews and ongoing media coverage onboard the Amundsen with Chris Yakk, Inuvialuit Communications Society
3. Participants featured in The Drum (ICC Alaska newsletter)
4. Interviews with NewsNorth and CBC-North ï Inuvik

In conclusion, this first 2008 Schools on Board Circumpolar Inuit Field Program was a great success. The circumpolar Inuit perspective fulfilled our mandate to broaden our outreach activities on a global and cultural scale during IPY. The overwhelming positive feedback received from all stakeholders (participants, communities, and scientists) indicates that this program is welcomed in both science and northern communities.

Participating Scientist and CCGS Crew, 2008 Circumpolar Inuit Field Program

Date	Participant	Session	Position	Affiliation
July 18	Gordon, Liz	Introduction to wildlife monitor techniques	Wildlife Monitor	Inuvialuit Regional Corporation, Team 10
July 18	Barber, Doug	Introduction to photoshop	CFL Photographer	IPY-CFL
July 18	Tremblay, Olivier	Logistics and Safety tour	Officer	CCGS
July 18	Gremes Cordero, Sylvia	Deployment of LAWAS	PhD Student	University of Miami
July 18	Gupta, Mukesh	Tour of Ocean roughness sensors	PhD Student	University of Manitoba
July 19	Julien, Stéphane	Tour of the bridge	Captain-CCGS	CCGS
July 19	Forest, Alex	Lab activity ï sorting zooplankton	PhD student	Université Laval
July 19	Link, Heike	Box core field work ï tour of labs; Benthic ecology presentation	PhD Student	University of Rimouski
July 19	Forest, Alex	Presentation; introduction to moorings	PhD Student	Université Laval
July 19	Hung, Hayley	Presentation: contaminants in the Arctic, INCAPTA/NCP	Research Scientist	Environment Canada
July 20	Sampei, Makoto	Fieldwork: monster net and sediment traps	Post-doc	Université Laval

July 20	Stern, Gary	Lecture: Contaminants in the Arctic & the CFL	Chief Scientist	University of Manitoba
July 20	Letourneau, Louis	Fieldwork: monster net and sediment traps	Technician	Université Laval
July 20 & 22	Candlish, Lauren	Radiosone demo and tour of acquisition lab	Master's student	University of Manitoba
July 20	Nickels, Scot	ITK/ICC presentation	Science advisor	ITK
July 20	Michaud, Luc	Fieldwork: monster net and sediment traps	Technician	Université Laval
July 20	Gagne, Steve	Fieldwork: monster net and sediment traps	Technician	Université Laval
July 20	Massot, Pascal	Fieldwork: monster net and sediment traps	Technician	Université Laval
July 21	Ho, Vincent	Presentation: The works of Vincent Ho	Composer, Artist on Board	Winnipeg Symphony Orchestra
July 21	Grondin, Vincent	Tour of engine room	Chief mechanic	CCGS
July 22	Gagnon, Jonathon	Lab tour	Technician	Université Laval
July 22	Julien, Stéphane	Lecture: The Amundsen: Scientific modifications and plans for IPY	Captain-CCGS	CCGS