The Expedition of the Research Vessel "Polarstern" to the Arctic in 2009 (ARK-XXIV/1)

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with contributions of the participants

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APPENDIX

1. ZUSAMMENFASSUNG UND FAHRTVERLAUF

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Der erste Fahrtabschnitt der 24. *Polarstern* Expedition in die Arktik begann am 20. Juni 2009. Das Schiff lief von Bremerhaven aus, um Forschungsarbeiten in der Grönlandsee und in der Framstraße durchzuführen. Das genannte Gebiet steht seit einigen Jahrzehnten verstärkt im Fokus des wissenschaftlichen Interesses, da sich dort Schlüsselprozesse im Ozean abspielen. Es ist selbstverständlich, dass die aktuellen großräumigen klimatischen Betrachtungen auf hochwertigen regionalen Beobachtungen lokaler Veränderungen aller Forschungsdisziplinen aufbauen müssen.

Die hydrographischen Arbeiten auf diesem Fahrtabschnitt etablieren einen weiteren Mosaiksstein zweier Langzeit-Meßreihen, wie sie für die klimabezogene Forschung unverzichtbar sind. Sowohl in der Grönlandsee als auch in der Framstraße hat das Alfred-Wegener-Institut bereits eine beachtliche Forschungshistorie aufzuweisen, welche die Quantifizierung solch wichtiger Vorgänge wie die des meridionalen Wärmeflusses, der winterlichen Konvektionstiefen, der Speicherung von Wärme und Salz im Ozean und dergleichen mehr gestattet, sowie die Variabilitäten und Trends der mit diesen verbundenen physikalischen Parametern bestimmbar macht. In den Projekten werden Stationsarbeiten durchgeführt, und es finden sowohl konventionelle als auch innovative autonome selbstprofilierende Verankerungen sowie autonome Unterwasserfahrzeuge Verwendung.

In der Grönlandsee wurden CTD-Stationsmessungen auf einem Zonalschnitt bei 75°N zwischen 5°E und der Küste Grönlands durchgeführt und vier autonom profilierende Verankerungen gewechselt. Östlich von 5°E konnten aufgrund von Zeitmangel keine Messungen durchgeführt werden. Drei der Verankerungen profilieren täglich zwischen etwa 100 m Wassertiefe und dem Ozeanboden in 3700 m Tiefe, die vierte profiliert zwischen etwa 160 m und der Wasseroberfläche. Mit dieser letzteren Verankerung wurde die prinzipielle Schwierigkeit, bis hin zur Wasseroberfläche zu messen, erfolgreich gemeistert. Diese Messungen sind für die Entwicklung des Süsswasseranteils in der Oberflächenschicht wesentlich.

In der Framstraße wurden 6 Verankerungen gewechselt und CTD-Stationsmessungen über den gesamten tiefen Bereich durchgeführt. Ein Sea-Glider, der sich messend autonom in den oberen 1000 m der Wassersäule bewegt, wurde ausgesetzt und kurzzeitig begleitet.

Die Validation von Paläoproxies war ein weiteres Thema des Fahrtabschnitts. Hierzu wurden Foraminiferen und Coccolithophoren aus der Seewasserversorung des

Schiffs auf dem gesamten Schiffsweg gesammelt und analysiert. Ein Hauptanliegen ist dabei, die Rekonstruktion der Temperaturen und der Eisbedeckung während des Holozäns in den existierenden klimatischen Szenarien zu verbessern. Des weiteren soll das Verständnis der Interaktionen zwischen Umwelt und Ökosystem verbessert werden sowie abgeschätzt werden, inwieweit spezielle Teile der arktischen Biota die zu erwartenden klimatischen Veränderungen überstehen. Mit dem vorliegenden Fahrtabschnitt wurde eine erfolgreiche und neuartige interannuelle Vergleichsstudie fortgesetzt.

Es besteht kein Zweifel, daß die im globalen Kontext rapidesten Veränderungen der Umweltbedingungen in der Arktik auch Auswirkungen auf die marine Fauna haben werden. Die Forschungen zum arktischen Ökosystem auf diesem Fahrtabschnitt umfassten die gesamte Größenskala von der Mikrobiologie bis hin zu den weltgrößten Lebewesen. Temperatur- und CO_2-bedingte Effekte auf Produktion, Diagenese und Aggregation von organischem Material wurden mit Hilfe von Inkubationexperimenten untersucht. Ein wesentliches Ziel ist es dabei, zu einem besseren Verständnis von Richtung und Stärke der biogeochemischen und mikrobiologischen Rückkopplungsprozesse im Ozean der Zukunft beizutragen. Das Vorkommen und das Verhalten von marinen Säugern, insbesondere - aber nicht ausschließlich - von Walen, war Gegenstand zweier weiterer Projekte, in denen modernste akustische und optische Methoden Verwendung fanden. Die sich verändernde Eisbedeckungsstruktur in der Aktis führt bereits heute zu veränderten Vorkommen einiger Arten, und die zu erwartende Zunahme des Geräuschpegels im Ozean durch die Nutzung der nördlichen Schiffsrouten schon in der näheren Zukunft impliziert die Notwendigkeit, verlässliche Bestandsänderungsabschätzungen unverzüglich in Angriff zu nehmen. Zwei Verankerungen mit akustischen Empfängern wurden in Grönlandsee und Framstraße ausgelegt und verbleiben dort bis 2010. Ein IR-Linescanner zur Detektion von marinen Säugern vom Schiff aus wurde erfolgreich in Betrieb genommen.

Aus logistischen Gründen wurde am 5. Juli vor Longyearbyen ein Kapitänswechsel per Helikopter vorgenommen. Der Fahrtabschnitt endete planmäßig am 10. Juli 2009 in Longyearbyen.

SUMMARY AND ITINERARY

The first leg of the 24th *Polarstern* expedition to the Arctic started on 20 June, 2009. The ship departed from Bremerhaven to do research in the Greenland Sea and in the Fram Strait. This region has attained increased scientific attention during the recent few decades due to the fact that it plays a key role in the subarctic ocean. Investigations of large scale climatic aspects must evidently be based on sound perceptions of local modifications.

The hydrographic work during this cruise leg contributes to the establishment of long-term time series as they are indispensable to study climatic aspects in the ocean. Both in the Greenland Sea and in Fram Strait, the Alfred Wegener Institute already has a long research history which allows to quantify meridional heat fluxes, winter convection depths, heat and salt storage in the ocean, and the like, and to determine variability and trends of related physical parameters. The projects include station work, conventional moorings as well as innovative autonomously profiling moorings, and the use of autonomous underwater vehicles.

In the Greenland Sea, CTD-stations have been performed between 5°E and the Greenland coast on a zonal transect at 75°N and four autonomously profiling moorings have been exchanged. Due to time constraints, no work could be done east of 5°E. Three of the moorings perform daily profiles between about 100 m water depth and the ocean bottom at 3,700 m. The forth mooring profiles between 160 m and the water surface proper. This mooring overcomes successfully the general difficulty to reach the water surface with moored instruments. These measurements are important for the evaluation of the fresh water development in the near surface layer.

In Fram Strait, six moorings have been exchanged and CTD-stations have been performed across the entire deep part of the strait. A sea-glider, which moves autonomously through the upper 1,000 m of the ocean, was deployed and shortly accompanied.

Proxy validation studies were another theme of the cruise. The sampling of foraminifera and coccolithophores used the ship's sea water supply to gain on-track samples across the main frontal systems. A major aim of this research is to contribute temperature and ice-cover reconstructions of the Holocene to the existing climate databases. A second aim is to improve current understanding of environment-ecosystem interactions and to estimate to which extent Arctic biota can absorb the currently predicted climate changes. With ARK-XXIV/1, a novel and successful interannual comparative proxy validation study has been continued.

The Arctic Ocean is one of the fastest changing environments on earth, and there is no doubt that these changes will also affect the marine fauna. Studies of the Arctic ecosystem during this cruise leg covered the scale from microbiology to the largest species on earth. Temperature- and CO_2-related effects on the production, fate, and aggregation of organic matter have been investigated by incubation experiments. The main intention is to further our understanding of the direction and strength of biochemical and microbiological feedback processes in the future ocean. The occurrence and behaviour of marine mammals, particularly but not exclusively whales, was studied by two projects using most modern acoustic and infrared methods. The changing ice cover in the Arctic leads to modified routes of many species already to date, and the expected increase in ocean noise as is related to the use of the northern routes by freight ships in the near future necessitates monitoring of its effects, so that action is requested now. Two moorings equipped with acoustic receivers have been deployed in the Greenland Sea and in Fram Strait. They will be serviced in 2010. An innovative IR-Line scanner for the shipborne detection of marine mammals has been installed and put into operation successfully.

For logistic reasons an exchange of the captain was organised on 5 July while staying close to Longyearbyen. The cruise leg ended as scheduled on 10 July 2009 at Longyearbyen, Svalbard.

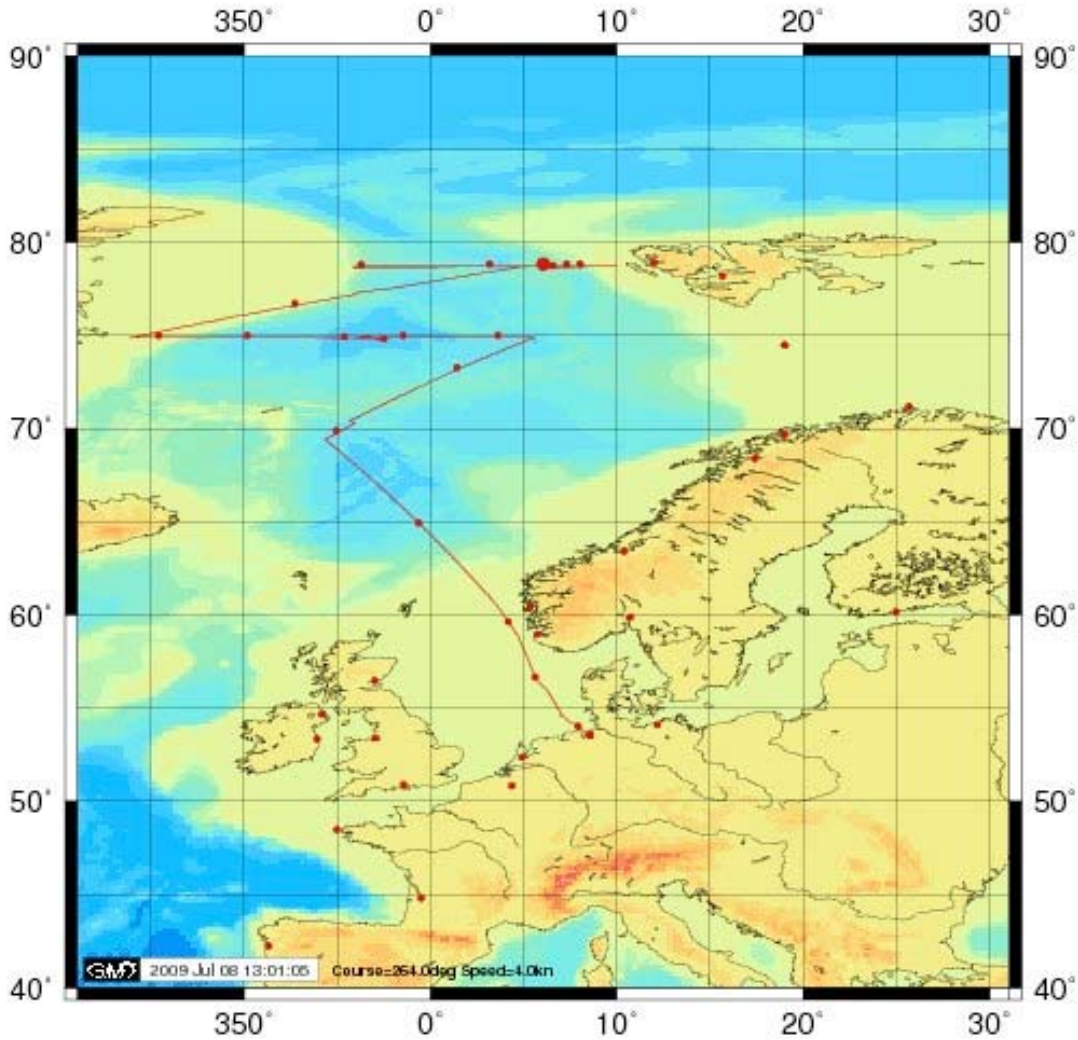

Abb. 1.1: Kurskarte der Polarstern Reise ARK-XXIV/1
Fig. 1.1: Cruise track of Polarstern during the expedition ARK-XXIV/1

2. LONG-TERM VARIABILITY OF THE HYDROGRAPHIC STRUCTURE, CONVECTION AND TRANSPORTS IN THE GREENLAND SEA (LOTEVA-GS)

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Objectives

Physical processes in the entire Polar Oceans are regarded with increased attention because of their high sensibility against climatic changes. This includes the hydrographic development in the Greenland Sea. The changes here represent the first example of a basin wide structural modification as a reaction to an increased fresh water input, which took place in the early 90s. The doming structure of the 80s has subsequently been superseded by a marked two layer structure. The interface between these two layers is accompanied by a density step/stability maximum and is not static, but moves vertically with time. Between 1993 and the most recent years, a descent from about 900 m to almost 2,000 m has been observed. As up to date even modern numerical models include neither this structural change nor the interface movement, it is important to observe the hydrographic development carefully. In the present situation, the lower layer is apparently well isolated from atmospheric influences and effectively shielded against ventilation by winter convection. For years, bottom water properties change towards higher temperatures and salinities. This can to a large part be explained by a vertical displacement of the water column together with bottom water export. At the same time, lateral inputs do also modify deep water, as well as shallow water properties.

At all depth levels, the Greenland Sea represents a highly dynamical environment with considerable temporal changes. Our present knowledge about the relevant hydrographic processes does not allow to predict the future hydrographic development (including convective activity and transports) and consequently most of the analysis relies on field measurements. In order to assess the changes correctly and to gain an adequate perception of the related processes, a longer time series is indispensable. It has to comprise continuous and consistent observations including the water mass end members on the shelves, and has to determine convection history reliably. As convection history is established by comparisons between subsequent years, a disruption of the time series is adverse to its analysis (a one year gap leading to a loss of convection determination of two years).

The present state of the hydrographic structure in the Greenland Basin leads to distinct difficulties with respect to the determination of ventilation depths and ventilation history. A precise determination of the convection depth over several years is however essential if one wants to be able to decide what processes are responsible for the observed changes from one year to another.

There are a number of unambiguous indicators for convection, but the fact that these indicators are absent is by no means synonymous to the absence of convection activity. Therefore it is often not possible to determine convection depths and ventilated volumes by the development of the physical parameters alone. Measurements from oxygen sensors show that both around the border and in the middle of the ventilated central areas of the Greenland Basin considerable concentration fluctuations take place. With the use of bottle samples only there will be an uncertainty in the total amount of oxygen and exact depth of latest convection which may lead to considerable difficulties in interpretation as well as misinterpretation. Since the electrical oxygen sensor reproduces the fluctuations very well but doesn't have the necessary accuracy (due to hysteresis and drift), the adequate method is to combine electrically measured vertical profiles (which reveal the detailed vertical structure) with bottle sample Winkler titrations (which provide the ultimate accuracy).

The combined use of electronic and chemical methods to measure oxygen concentration are used to evaluate the younger ventilation history of the upper part of the Greenland Sea Gyre on one hand and to examine the grade of isolation of the lower part on the other.

Recently, suprisingly long lived submesosclae vortices (SCVs) have been detected in the Greenland Sea (diameter about 10 to 20 km). In the centre of these features, convection reaches depths that are about 1,000 m greater than in the background (some 2,600 m vs. 1,600 m). These eddies seem to survive a number of years by a repeated homogenisation during winter. It is in the centres of these eddies where winter convection is expected to meet the ocean bottom first.

Within the IPY-legacy project LOTEVA-GS, a unique hydrographic time series is being established by an annually repeated zonal transect across the Greenland Gyre center and by measurements of autonomous profilers (EP/CC-Yoyo, daily profiles, full ocean depth, 1 year exchange cycle) which give unprecedented insight to winter convective activity as well as to advective modifications. The major aim of the project is to detect and quantify the interannual and seasonal physical/chemical changes in the Greenland Gyre interiour as well as in the surrounding large currents and to identify the responsible processes for the former.

Work at sea

Due to the large spatial gradients and relatively small spatial scales involved (Rossby radius about 20 km) it is indispensable to perform measurements with a comparatively small station spacing and in a sufficient number. Otherwise spatial and temporal differences, which are of the same order in this region, cannot be distinguished and any derived trend is most likely heavily biased. Furthermore, SCVs have to be identified, distinguished from the background, and skipped from the background trend analysis. According to this, the transects are performed with a station spacing of 10 nautical miles or less, what results in about 60 CTD stations on a zonal transect at 75°N using a Sea-Bird 911plus system. A double sensor set is used for temperature and conductivity and various additional sensors have been utilised. The most important of these is the electical oxygen sensor.

In addition to the electrical measurements, water samples have been taken by a carousel water sampler. The water samples serve as in situ calibration material and are used to determine oxygen content according to the Winkler method.

Three autonomously profiling EP/CC moorings have been exchanged. They are equipped with modified SBE-16 CTDs with Digiquartz pressure sensors. They deliver complete profiles every other day, travelling between the parking position at roughly 100 m and the ocean bottom at 3,700 m. In order to assess the annual fresh water cycle in the Greenland Gyre, a special profiling shallow water yoyo CTD has been installed in 2008 (NGK winch and Optimare/Sea-Bird instrument). This mooring reveals profiles between 160 m and the surface proper, and has been exchanged, too.

Due to time constraints, the transect could not cover the region east of 5°E.

Preliminary results

a) General

Today it is clear that the straightforward idea of regular, repeated bottom water renewal in winter is not correct at present. Previously proposed concepts for deep convection in the 80s do not adequately describe the actual processes in the Greenland Sea. E.g., there was not a single year during which bottom water has been ventilated by winter convection since regular field expeditions have been started during the end of the 1980s. Work during the recent years showed a.o. that even the seemingly simple identification of winter convection fails when using single criterions. In contrast to present knowledge, temperatures in a ventilated volume can be higher as well as lower after a convection phase. The same is true for salinities. The application of a more complex criterion catalogue shows that in the last decade winter convection penetrated to the density step (interface between the two vertial layers) in mid depth during many years. This density step is observed in increasing depths levels which allows for increasing convection depths. Consequently, these increasing depths are not synonymous with the ventilation of older water masses.

The interface between the two layers is situated at almost 2,000 m in the centre of the gyre today, as can be seen from the salinity distribution on the transect. This plot also shows that the interface forms a slight depression in the gyre centre now. This is combined with a massive inflow of Atlantic Waters into the gyre. These waters cross the two fronts between the major rim currents and the gyre in near surface layers of a few hundred metres thickness. Winter convection is needed, to distribute this salinity signal to greater depths. According to the high temperatures and salinities of the Atlantic Waters (they represent the high salinity and high temperature end member in the TS-space of the Arctic), they decend when cooled in winter. Due to their high salinities, the Atlantic Waters take over the role of ice formation in the previous regime with respect to deep ventilation. As these waters attain high enough densities to sink already far above the freezing point, they provide a heat input into the deeper layers and prevent ice formation effectively. Thus, when Atlantic Waters dominate the cross frontal input into the gyre, ice formation is inhibited and the ventilated waters increase in temperature and salinity. The salinity distribution in 2009 (Fig. 2.1) suggests a two parted ventilation scenario in the preceeding winter with fresh water input to deeper layers in one, and an input of more saline waters in the second part.

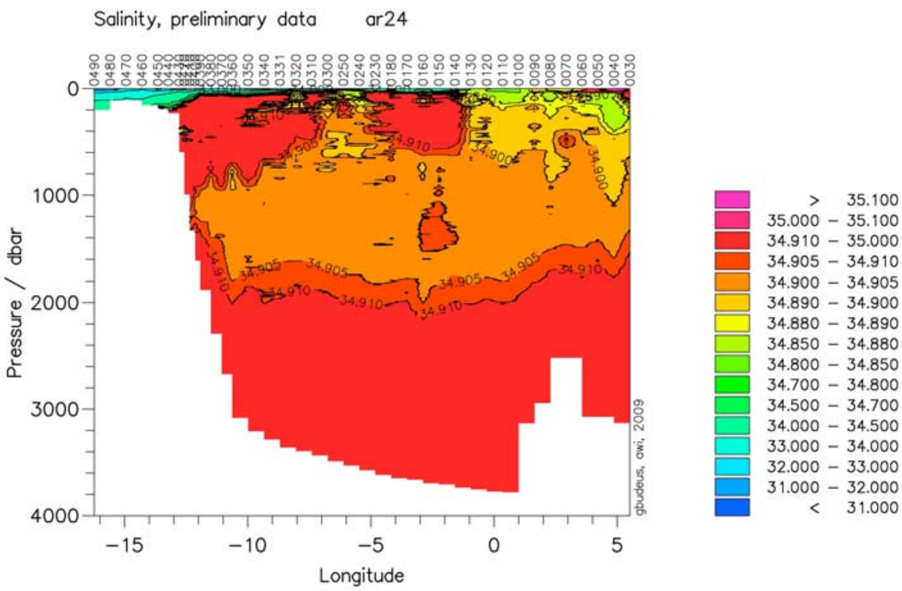

Fig.2.1: Salinity distribution on the zonal CTD-transect (west is left), preliminary values

b) Deep sea and shallow water autonomous profiling CTD system

The performance of the NGK/Optimare shallow water surface approaching underwater system deserves a special chapter, as the deployment is the first in Arctic waters, the first use outside Asia, and the first which was scheduled to operate over a time interval of such a length. Considerable redesign has been applied in order to meet the needed specifications.

The Automated Elevator System by NGK, Japan, consists of a sophisticated combination of an underwater winch, a control unit, multiple parallel power supplies, and a structure of frame and buoyancy. It is intended for the use in the open ocean where it has to reside in a depth smaller than 300 m and enables measurements right into the ocean surface. This important inclusion of the surface layer poses severe problems to mooring designs, and no commercially available operational alternative to the NGK solution is apparent. When the NGK system pays out rope, a buoyant instrument ascends until it reaches the water surface proper. The winch is halted then and reverses it’s rotational direction, thus moving the instrument back to its parking position close to the winch. A tension sensor in the elevator system detects the instrument’s arrival at the surface. Our mooring in the Greenland Sea is the premier use of the NGK system in Europe.

In our mooring, the Optimare/Sea-Bird Electronics CTD-logger is the buoyant instrument which is moved to the surface and back to the winch. It comprises a pumped SBE41 CTD module and a custom designed pressure case containing the special electronics and the electrical supply. The synchronisation of the Elevator System and the CTD is realised by their clocks only, there is no communication between them.

This shallow water yoyo-mooring is added to a site where EP/CC Deep Sea Jojo moorings have been deployed for a number of years. These deep sea yoyos reside in a depth of roughly 100 m and measure daily profiles between this depth and the ocean bottom at about 4 km. The shallow water yoyo complements these measurements by covering the important upper part of the water column with daily measurements, too.

The mooring which contains the NGK Automated Elevator System and the Optimare/Sea-Bird Electronics CTD-logger has been deployed in June 2008 during a cruise with *Polarstern*. Position is 76°56’N 4°37’E. Water depth at the mooring site is 3,680 m.

The buoyancy of the NGK system is about 500 N. In order to carry the mooring rope and to apply a resonable tension to it, buoyancy must be added. We used a modular set of cylindric syntactic foam pieces, which have the same diameter as the NGK frame, for this purpose. Three slices of syntactic foam have been located just beneath the winch, and one has been mounted on it’s top. Each of these four foam pieces provides a buoyancy of ca. 900 N, so the total buoyancy is ca. 4,000 N. The rope is an 8.6 mm Aramid rope by Lippmann, Hamburg.

The Optimare/Sea-Bird Electronics CTD-logger has a buoyancy of about 20 N, a diameter of 160 mm and a length of 1.05 m. It’s buoyancy does not suffice to keep the necessary tension on the winch’s rope. Two plastic spheres with 30 N buoyancy each were therefore added to the logger.

The mooring was adjusted so that the parking position of the CTD and the winch were at a nominal depth of 160 m. With the winch’s 300 m rope length the surface could be securely reached from this depth. The winch was scheduled to perform one cycle per day, whereas the CTD-logger was programmed to measure 30 min periods in time intervals of 12 hours. Hereby, CTD data sets are recorded alternatingly during an ascent/descent cycle and at the parking position.

The Shallow Water Yoyo performed more than 300 casts and reached the surface routinely. Only few events of dives to greater depths have occurred, predominantly in the latest part of the record. Such dives are caused by ocean currents which lead to an inclination of the mooring rope. The record ends after 312 days. At this time, the instrument's memory had been used up, and the energy supply for the winch as well. The perfect operation of the NGK winch is particularly remarkable as it was in operation for a total of two years with only an exchange of batteries at sea after the first year.

The performance of the Deep Sea Yoyo (EP/CC-yoyo), which is operational for numerous years but has been redesigned substantially for the present mooring period, is similarly good. Occasionally there are short pauses in the profiles, and after some time every forth profile is lacking. The pauses are caused by outstanding current events which prevent the vehicle from profiling due to increased friction between the instrument and the mooring rope. As soon as the current event has passed, the profiling is continued due to the self healing character of the design. The principal operation of the system is not affected by this.

The two data sets overlap between 100 and 160 meters water depth. After correcting and despiking them, they were merged by slicing the related profiles at 130 meters. It turned out that despite the small distance between the two mooring locations (1.8 kilometers), the profiles do not combine seamlessly. This indicates that there exists small scale local variability in the ocean also far away from frontal regions, and this in summer as well as during winter. Water parcels do pass both mooring sites consecutively on occasion, but not necessarily nor always. No attempt has been made to artificially smooth the junction between the upper and lower yoyo profiles.

The measurements show that cooling at the surface starts in October, but substantial deepening of the surface mixed layer (best seen in salinity) does not take place before January. Then, the subsurface salinity maximum is entrained in the deepening low saline mixed layer and the salt of this maximum helps to achieve densities high enough to let the water parcels sink to greater depths. It is immediately apparent that ventilation depths exceed 1,200 meters, but a more detailed analysis is needed for an exact determination. Temperatures stay way above the freezing point of roughly -1.8°C all over winter, thus providing adverse conditions for ice formation in this region. In contrast still to the 1990s, we regard the latter as normality nowadays.

The mooring has been recovered on 28.6.2009. The NGK system came back on deck in an as-new optical condition, and so did the Optimare/Sea-Bird Electronics CTD-logger.

3. FLOW THROUGH FRAM STRAIT AND IN THE ENTRANCE TO THE ARCTIC OCEAN

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Scientific objectives

Exchanges between the North Atlantic and the Arctic Ocean result in the most dramatic water mass conversions in the World Ocean: warm and saline Atlantic waters, flowing through the Nordic Seas into the Arctic Ocean, are modified by cooling, freezing and melting to become shallow fresh waters, ice and saline deep waters. The outflow from the Nordic Seas to the south provides the initial driving of the global thermohaline circulation cell. Knowledge of these fluxes and understanding of the modification processes is a major prerequisite for the quantification of the rate of overturning within the large circulation cells of the Arctic and the Atlantic Oceans, and is also a basic requirement for understanding the role of these ocean areas in climate variability on interannual to decadal time scales.

The Fram Strait represents the only deep connection between the Arctic Ocean and the Nordic Seas. Just as the freshwater transport from the Arctic Ocean is of major influence on convection in the Nordic Seas and further south, the transport of warm and saline Atlantic water affects the water mass characteristics in the Arctic Ocean which has consequences for the internal circulation and possibly influences also ice and atmosphere.

The complicated topographic structure of the Fram Strait leads to a splitting of the West Spitsbergen Current carrying Atlantic Water northward into at least three branches. One current branch follows the shelf edge and enters the Arctic Ocean north of Svalbard. This part has to cross the Yermak Plateau which poses a sill for the flow with a depth of approximately 700 m. A second branch flows northward along the north-western slope of the Yermak Plateau and the third one recirculates immediately in Fram Strait at about 79°N. Evidently, the size and strength of the different branches largely determine the input of oceanic heat to the inner Arctic Ocean. The East Greenland Current, carrying water from the Arctic Ocean southwards has a concentrated core above the continental slope.

It is our aim to measure the oceanic fluxes through Fram Strait and to determine their variability on seasonal to decadal time scales. Since 1997, year-round velocity, temperature and salinity measurements have been carried out in Fram Strait with moored instruments. Hydrographic sections exist since 1980. The estimates of mass and heat fluxes through the strait are provided through a combination of both data sets. From 1997 to 2000 intensive fieldwork occurred in the framework of the European Union project VEINS (Variability of Exchanges in Northern Seas). After the end of VEINS it was maintained under national programmes. From 2003 to 2005, the work was carried out as part of the international Programme ASOF (Arctic-Subarctic Ocean Flux Study) and was partly funded in the EU ASOF-N project. Since 2006 measurements in Fram Strait have been continued in the frame of the EU DAMOCLES (Developing Arctic Modelling and Observing Capabilities for Long-term Environment Studies) Integrated Project. The mooring line is maintained in close co-operation with the Norwegian Polar Institute. The results of the measurements will be used in combination with regional models, to investigate the nature and origin of the transport fluctuations on seasonal to decadal time scales.

Work at Sea

The oceanographic work at sea during ARK-XXIV/1 embraced three main activities: the recovery and redeployment of the array of moorings, the deployment of the Seaglider and measurements of CTD (Conductivity, Temperature, Depth) profiles. The standard section in Fram Strait at 78°50'N, which has been occupied regularly since 1997, was measured with high resolution coverage by 27 CTD stations, extending from 10°E to 4°13'W.

The mooring array maintained by AWI consists of 12 moorings along a 78°50'N extending from 8°40'E to 2°W. These moorings were completely exchanged during *Polarstern* cruise ARK-XXIII/2 in 2008, see Fig. 3.1. Data from the recovered acoustic modems from F4 to F6 (HAM.NODE) were evaluated by "develogic" (manufacturer of the HAM.NODE) after the 2008 recovery. It was found that only very few data sets from F4 were transmitted by the HAM.NODE via F5 to F6 completely. The modems recorded the background noise and were equipped with tilt sensor to get information about the conditions during the transmission. "develogic" finds out that the transmission has failed when the background noise and the tilt was too high. The modem could only transmit at a fixed time and therefore the message could only be received by modem at F6 during good transmission conditions. Because of these results "develogic" has modified the hard and software of the modems. The new version of HAM.NODE checks the background noise and tilt before it starts the transmission. The mooring exchange during ARK-XXIV/1 aims to verify the advantage of the new modified hard – and software. Therefore the mooring exchange confined on eastern part of the mooring array F1 to F6. The modem verification test was extended by an additional mooring (F22-1) placed at the middle between F5 and F6 with HAM.NODE in 750 m depth. This mooring carries a sound logger device too; see report by Holger Klinck.

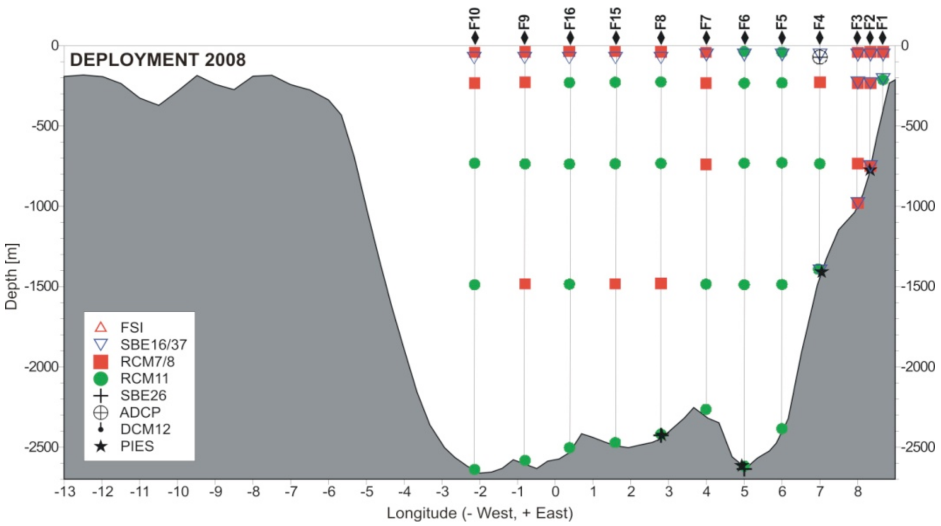

Fig. 3.1: Transect across Fram Strait with the moored instruments deployed during ARK-XXIII/2

All six moorings were recovered in open water. The moorings were located and released with the POSIDONIA system. A new POSIDONIA antenna was installed behind an acoustic window, which was used the first time during this cruise. The use of the fixed installed antenna saves a lot of time, which was needed otherwise by installing the mobile antenna in the moon-pool. The located position is not as good and reliable compared to the mobile antenna. But the results are still good enough for mooring recovery. The weather conditions were very good and thus all moorings were exchanged without any problem.

Failures - no data recorded, lost rotors or broken vane bearing – were noticed for 5 of 39 instruments which is a failure rate of 13 %. The failure rate was only 4 % during the previous recovery.

During ARK-XXIII/2 the first operational mission of the Seaglider in Fram Strait was launched. This Seaglider SG127 was recovered with KV Svalbard two months later. SG 127 was refurbished by Seaglider Fabrication Center (SFC) at the University of Washington, Seattle for its second mission. It was launched during ARK-XXIV/1 on July 7 at 78.7445 ° N; 6.5572 ° E and lasts from 11:00 to 13:00 UTC. SG127 was equipped with SBE Temperature/Conductivity sensors, SBE43 dissolved oxygen sensor, Wetlabs BB2SF chlorophyll a, fluorescence and optical backscatter sensors.

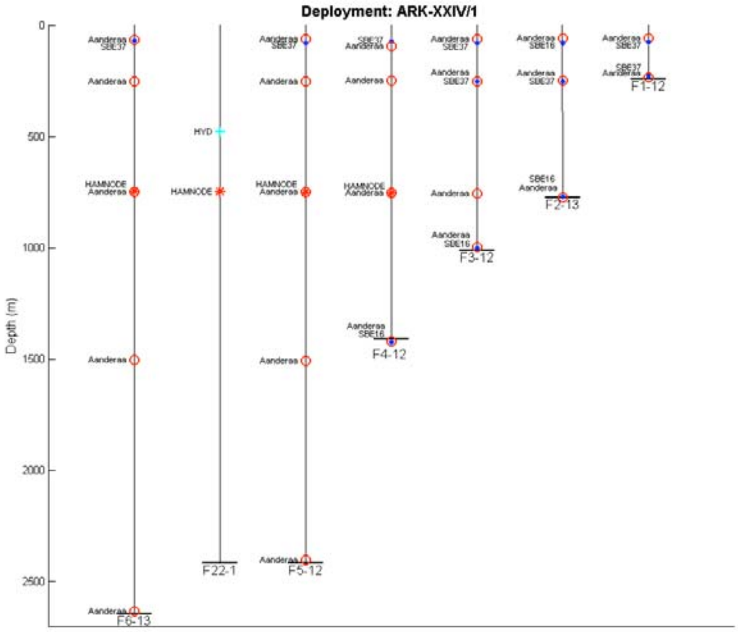

Fig. 3.2: Moorings deployed during cruise ARK-XXIV/1

The first mission in 2008 has established serious problems with the Iridium connection between the Seaglider and the base station in Bremerhaven, which was operated by Optimare. (Optimare used the base station software package developed by APL group at the University of Washington in Seattle.) For this reason Optimare has changed to another Iridium provider providing RUDICS (Router Based Unrestricted Digital Interworking Connectivity Solution). SG127 was tested in Bremerhaven with the new RUDICS-SIM card installed before the cruise successfully. Several days before launching SG127 was placed on the helicopter deck to verify the connection with the base stations while running the deck dive test procedures. The tests performed well on both sides – base station and Seaglider. The morning before launch the pre-launch routine was performed without errors and thus it switched into the 'launch conditions'. SG127 was launched from a rubber boat about 0.5 nautical miles leeward of *Polarstern*, see Fig. 3.3.

Fig. 3.3: Deployment of SG127 with rubber boat during ARK-XXIV/1

The remote Seaglider pilot in Bremerhaven started with a shallow dive (50 to 100 meters) and checked the Seagliders behaviour when it surfaced after the first dive. Rubber boat crew and Seaglider pilot communicated via satellite telephone. An optimal trim of the buoyancy is very important to save battery power. Therefore the rubber boat followed SG127 to its surfacing locations and the rise of the Seagliders tail out of the water was observed. Using the code shown in Fig. 3.4 the tail position was passed on to the Seaglider pilot.

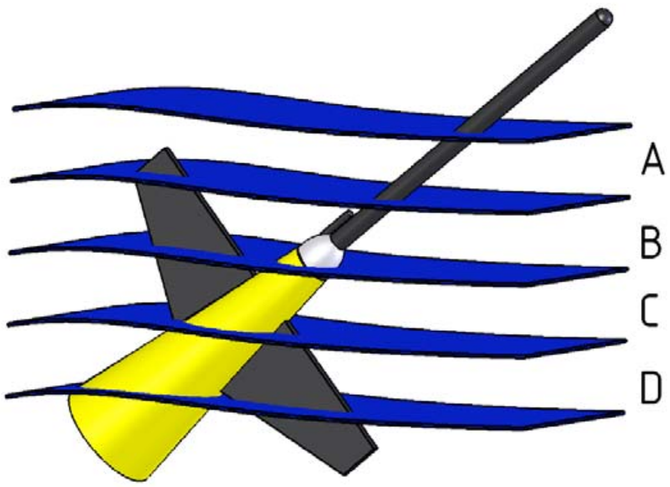

Fig. 3.4: Indication for trimming the Seaglider at surface. Position A: pumped oil volume must be decreased. Position D: pumped oil volume must be increased.

In 2008 SG127 was profiling along transect between WP2 and WP3, see Fig. 5. Therefore SG127 was navigated towards WP3 to repeat the 2008 section. Afterwards a parallel transect south of the mooring transect should be performed. The deployment location northeast of WP3 was chosen because of safety reasons. After the deployment *Polarstern* can continue the station work at the 78°50'N transect. In case a failure was recognized by the Seaglider pilot in Bremerhaven the Seagilder was still not so far off *Polarstern*.

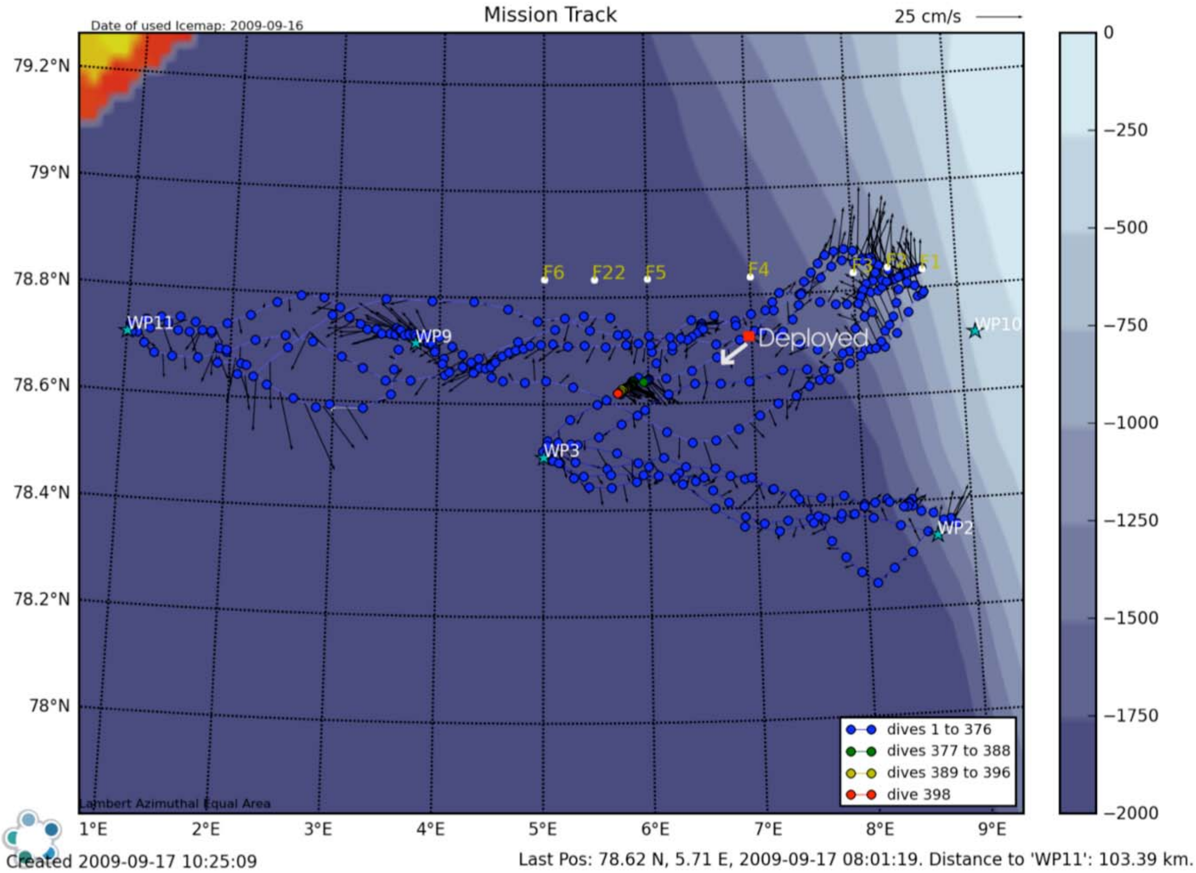

Fig. 3.5: Locations of the Seaglider surfacing positions between successive dives performed from deployment until September 17 and vertically averaged currents measured during selected dives. The deployment location is indicated as a red square and the arrow shows the first transect towards waypoint WP3.

The same CTD equipment as mentioned in chapter 2 had been used.

Underway measurements with a vessel-mounted narrow band 150 kHz ADCP from RD Instruments and a Sea-Bird SBE21 thermosalinograph measurements were conducted along the transect to supply temperature, salinity and current data at a much higher spatial resolution than given through the moorings. Two thermosalinographs were in use, one in 5 m depth in the bow thruster tunnel and one in 11 m depth in the keel. Both instruments are controlled by taking water samples, which are measured on board. The processed thermosalinograph measurements can be retrieved from the PANGAEA data base: http://doi.pangaea.de/10.1594/PANGAEA.727475

Preliminary Results

Positions of CTD stations in 2009 are shown on Fig. 3.6. Due to limited ship-time, spatial resolution of stations was lower than in 2008, still the main features of hydrographic fields in Fram Strait were resolved. The temperature and salinity sections across the Fram Strait are shown in Fig. 3.7. The main core of northward flowing warm and saline Atlantic Water is found at the eastern side of the transect in the shallow to intermediate layers. The West Spitsbergen Current is visible at the eastern slope by downward sloping isolines. The AW layer in the West Spitsbergen Current above the slope was warmer and the amount of AW in the recirculation area has significantly increased as compared to previous year. In summer 2009 the temperature of the Atlantic Water in the WSC core was higher and the offshore branch of the WSC was significantly more pronounced that in 2008. The recirculating Atlantic Water westward extent was farther as in previous year and its temperature and particularly salinity were significantly higher (in 2009 isotherm 3°C reached 3.5°W and the whole Atlantic layer was filled with water warmer than 3°C while in 2008 AW water with temperature above 3°C was present only in the WSC and small patch in the middle of the strait). The cold and low saline Polar Waters of the East Greenland Current were not covered by CTD stations in 2009, however location of the front between Polar and Atlantic waters was clearly visible at 3°30'W. The cold and freshened Polar Water which overlaid the Atlantic Water layer in upper 100 m in 2008 was not found in 2009.

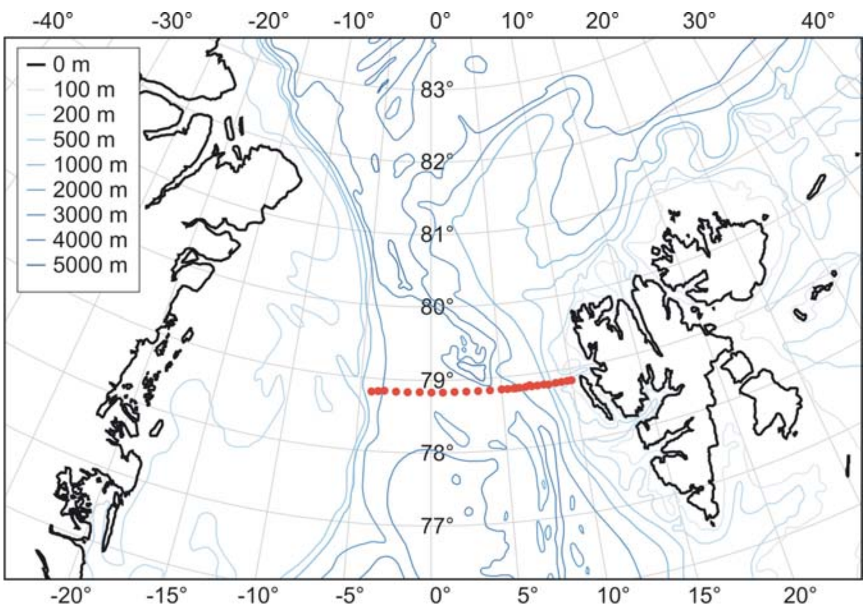

Fig. 3.6: Positions of CTD stations in Fram Strait during ARK-XXIV/1

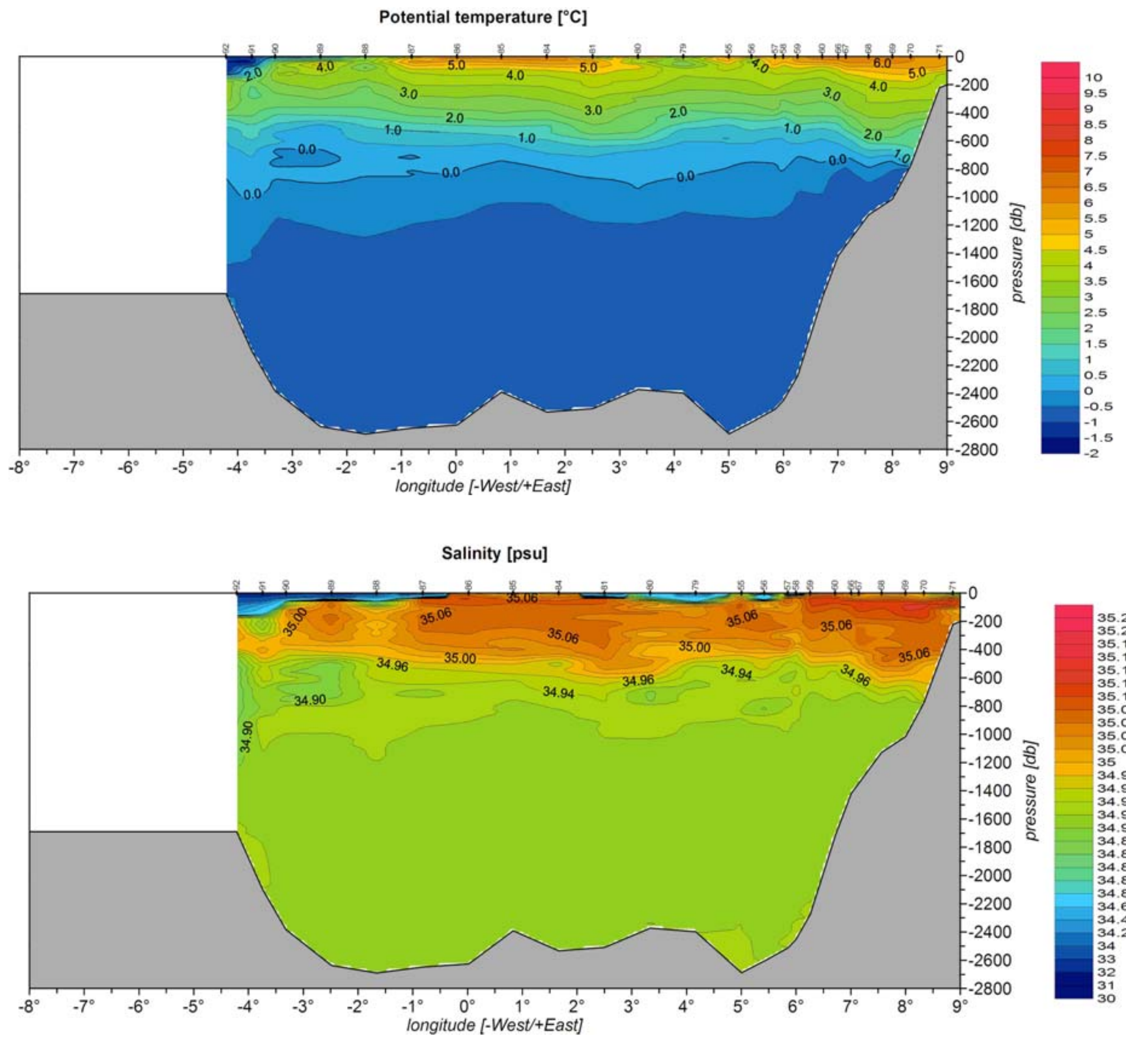

Fig. 3.7: Temperature (upper fig.) and salinity (lower fig.) measured at the Fram Strait section at 78°50'N during ARK-XXIV/1

The differences of temperature between observations in 2009 and 2008 are shown on Fig. 3.8. In summer 2009 significant warming was found in all areas occupied by the inflowing as well as by the recirculating Atlantic Water. The strongest difference as compared with 2008 was observed in upper 200 m, with the highest values in the central and western Fram Strait. Areas of the slight warming were also observed in deep waters.

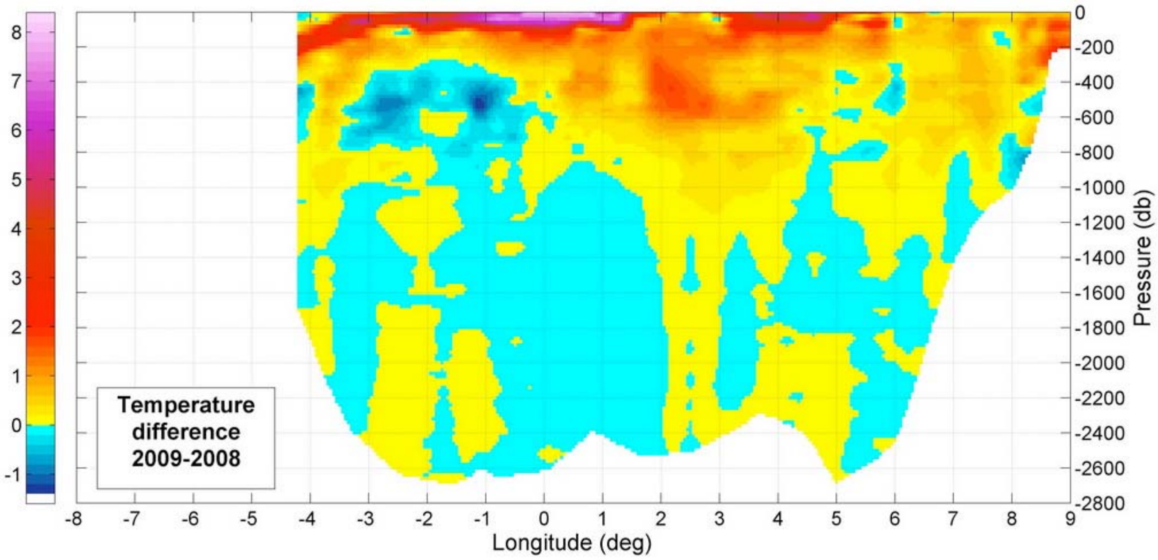

Fig. 3.8: Difference in temperature distribution measured at the Fram Strait section in 2008 and 2009

To identify the longer-term variability, time series of mean temperatures and salinities for typical water masses were derived for the depth interval from 50 to 500 m (Fig. 3.9). Three characteristic areas were distinguished in relation to the main flows: the West Spitsbergen Current (WSC) between the shelf edge and 5°E, the Return Atlantic Current (RAC) between 3°W and 5°E, and Polar Water in the East Greenland Current (EGC) between 3°W and the Greenland Shelf. In WSC and RAC domains, spatially averaged (in boxes defined by the longitude and depth ranges) temperatures and salinities were significantly higher than in 2008. Salinity and temperature in the RAC were the highest since the beginning of observation period. The mean values of temperature and salinity might be biased by the seasonal variability, facing the fact that the Fram Strait section in last 6 years was occupied in the late summer/early autumn as compared to July in 2008 and 2009. However, the observed differences in temperature and salinity are clearly larger than seasonal bias.

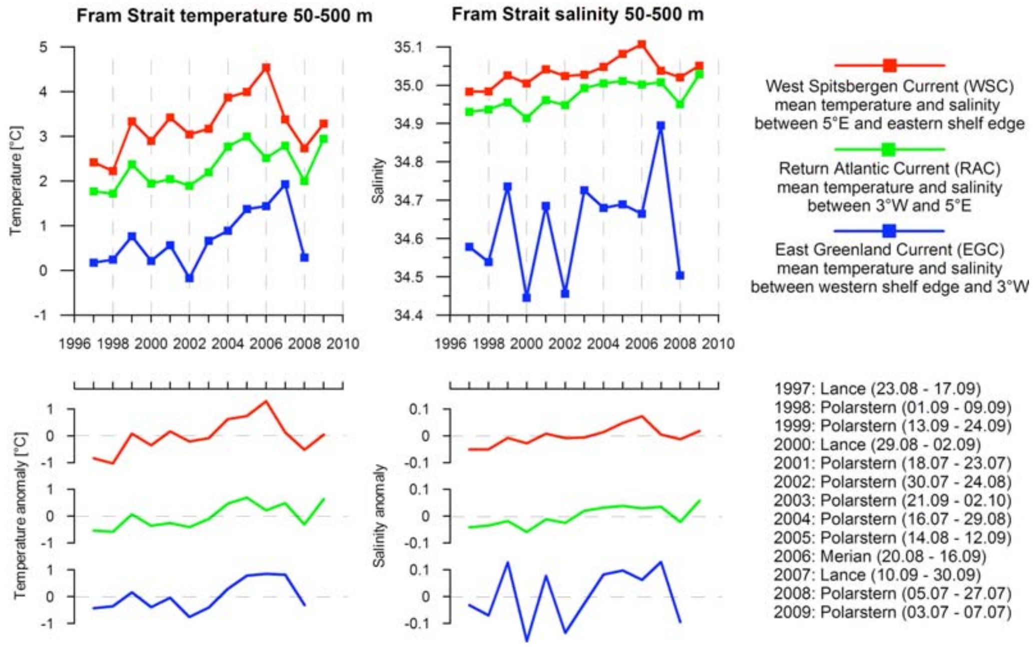

Fig. 3.9: The variations of the mean temperatures (upper left) and salinities (upper right) and their anomalies from long-term mean (lower figs) in the Fram Strait in the West Spitsbergen Current (WSC), Return Atlantic Current (RAW) and East Greenland Current (EGC)

The preliminary results obtained by the moored array confirm finding from the hydrographic snapshot. Since in 2009 only moorings F1 to F6 were recovered, estimates of volume transport were done only for the West Spitsbergen Current, while estimations of total volume and heat fluxes were not possible. This will be done in 2010 after recovering of the complete array. The mean Atlantic Water temperature (defined as >1°C) and AW volume transport in the WSC are shown on Fig. 3.10, while the total net transport in the WSC is presented on Fig. 3.11. The total volume transport in the WSC in the deployment period 2008 - 2009 was similar to observed in the previous year with slightly higher monthly transports in late winter. However, volume transport of the AW warmer than 1°C was significantly higher through nearly all months of 2008 - 2009 than found in 2007 - 2008. This was due partially to larger coverage of the section by warmer AW as well as to significantly higher mean current in the AW in the WSC since winter 2008.

Preliminary results from glider measurements are shown on Fig. 3.12 and 3.13. The vertically averaged currents in the layer measured by the glider (1,000 m in the deep water or ca 50 m above the bottom in shallower areas) clearly show the strong and stable northward flow in the WSC and strong and variable current in the recirculation area. At the repeated section between 1° and 9°E variations in spreading of the AW in the 100 m upper layer are pronounced. Spatial resolution of glider measurements allows to resolve structures with the horizontal scale of δ(5 - 10 km), providing an insight into mesoscale variability in Fram Strait.

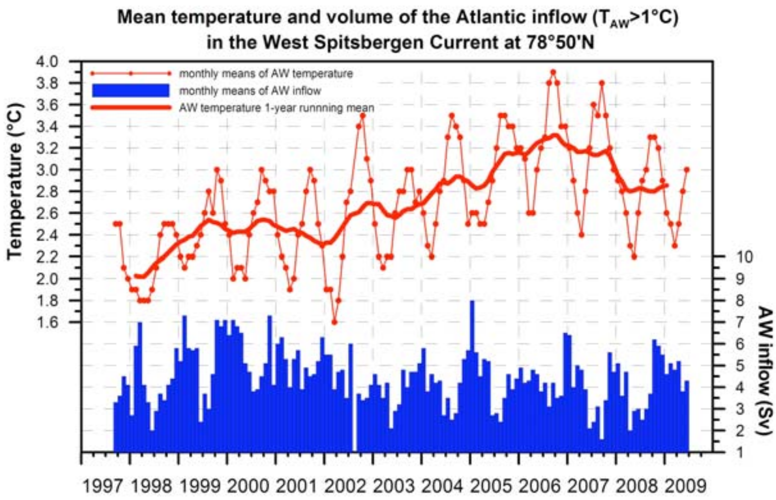

Fig. 3.10: Mean temperature and volume transport of the Atlantic Water in the West Spitsbergen Current measured by moored array at 78°50'N

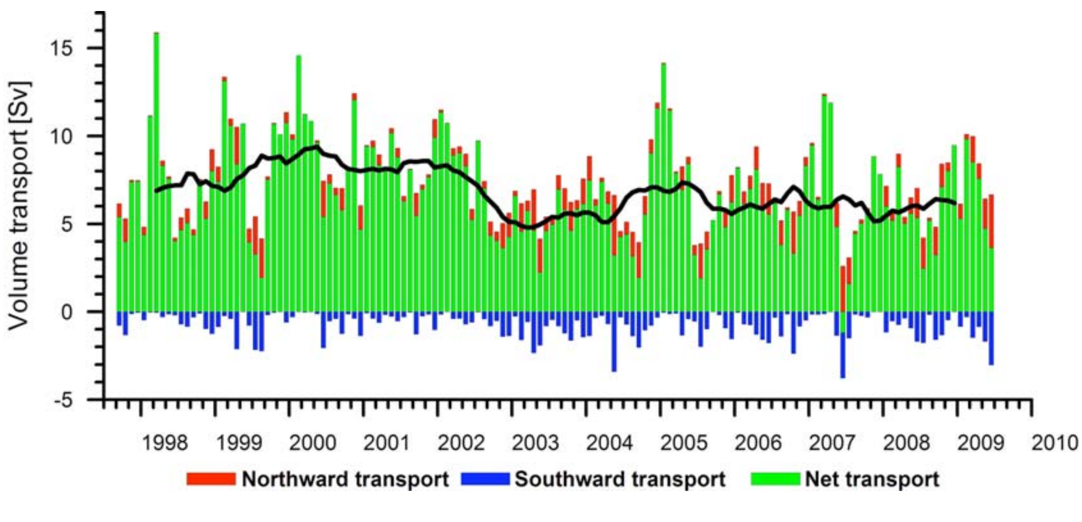

Fig. 3.11: Volume transport in the whole water column in the West Spitsbergen Current measured by moored array at 78°50'N

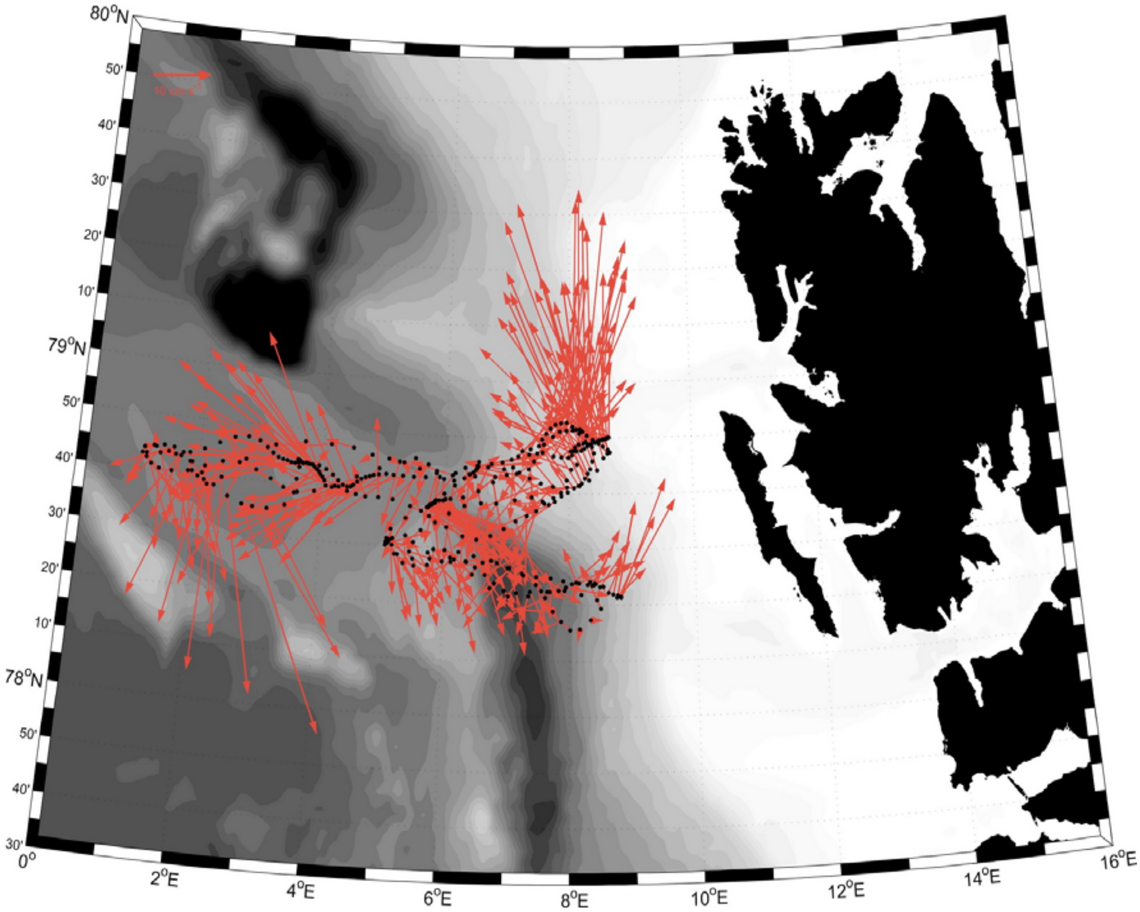

Fig. 3.12: Vertically averaged currents in the upper 1,000 m measured by the glider SG127 during its summer mission in Fram Strait in 2009

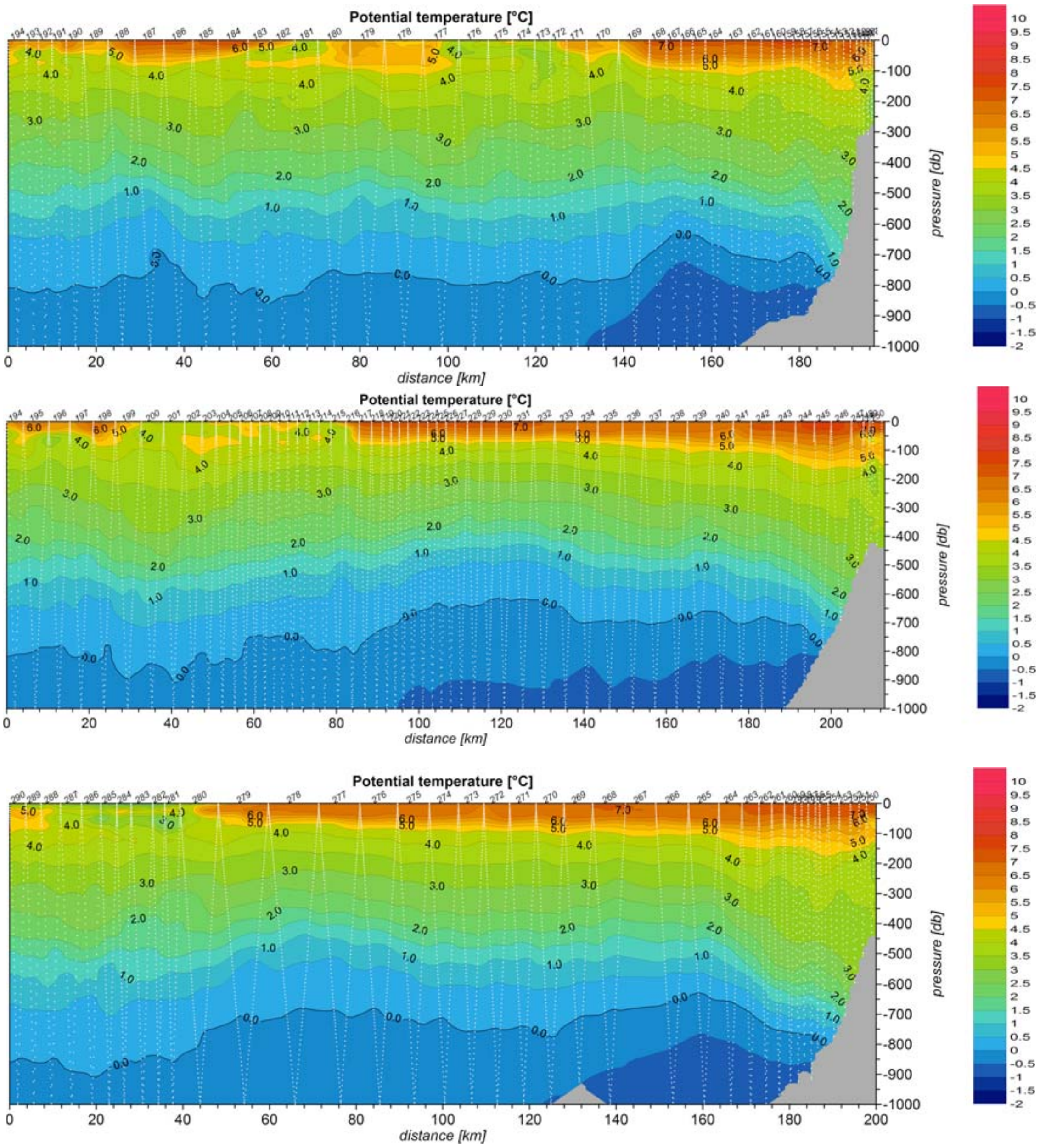

Fig. 3.13: Temperature distributions in the upper 1,000 m layer measured by SG127 between 1° and 9°E along ca. 78°45'N (three repeated sections) in summer 2009

4. AT-SEA DISTRIBUTION OF SEABIRDS AND MARINE MAMMALS

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not on board: C. Joiris
Laboratory for Polar Ecology

Objectives

The present study is part of a long-term one made by Joiris (see eg Joiris 2000, 2007, Joiris & al. 1997) in the same area.

Our main goal was to study the distribution "at-sea" of the top predators; especially birds and mammals. The two main questions are: How are the species spread and how do the pack ice and different water masses influence their movements and feeding behaviour.

Method

During the 3 weeks, 430 countings of half an hour each; except for 20 shorter counts (7 - 20 minutes) due to bad weather and/or "at sea" exercises. Each is made from the bridge and is valuable when the boat is moving.

Many countings could not be done due to bad weather or dark nights in the southern part of the study area.

Observation

In all, 31 species (4 seals, 7 whales and dolphins, 19 birds and the Polar Bear) were encountered.

It was observed (although not new!) that some species are highly ice-depending (polar bear, Ivory Gull, 4 seals), other ones (like Little Auk) are depending on the food abundance available in the area between free water and ice-pack. This transition zone attracts many species like fulmar, kittiwake… The most empty areas were the high seas and the densely ice-covered zones. When approaching the land (Greenland, Svalbard), the numbers increase sudenly, mainly due to the breeding birds moving to catch food in the transition area.

a) Seabirds

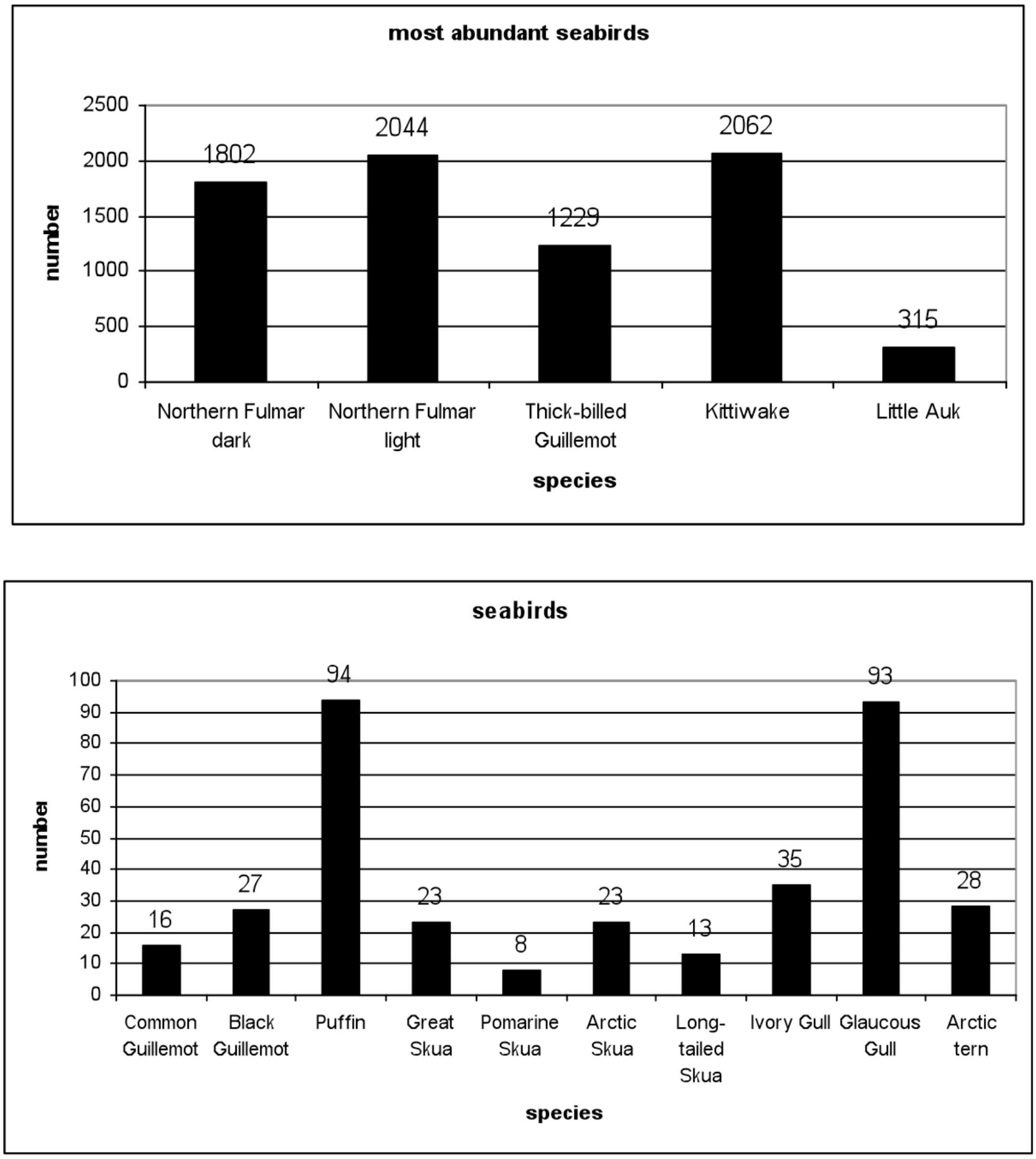

Fig. 4.1: Seabird counts. Most abundant species (top), remaining species (bottom)

- Little Auk: very few were noted but the main counts were obtained along the pack ice and off Svalbard

- Ivory Gull: species strictly depending of the ice as his scientific name "pagophila" attests, feeding mainly on seals caracasses left by e.g. polar bear

- Northern Fulmar: by far the most abundant species. Two different forms were seen: the light one was the main seen "at sea"; sometimes accompanied by a few dark ones. This proportion is reversed when approaching the land.

- Brunnich's Guillemot and Kittiwake: are the second and third most numerous species. The two species have a relatively similar distribution at sea. They were contacted regularly in small number anywhere along the transect. The main flocks were present off Svalbard.

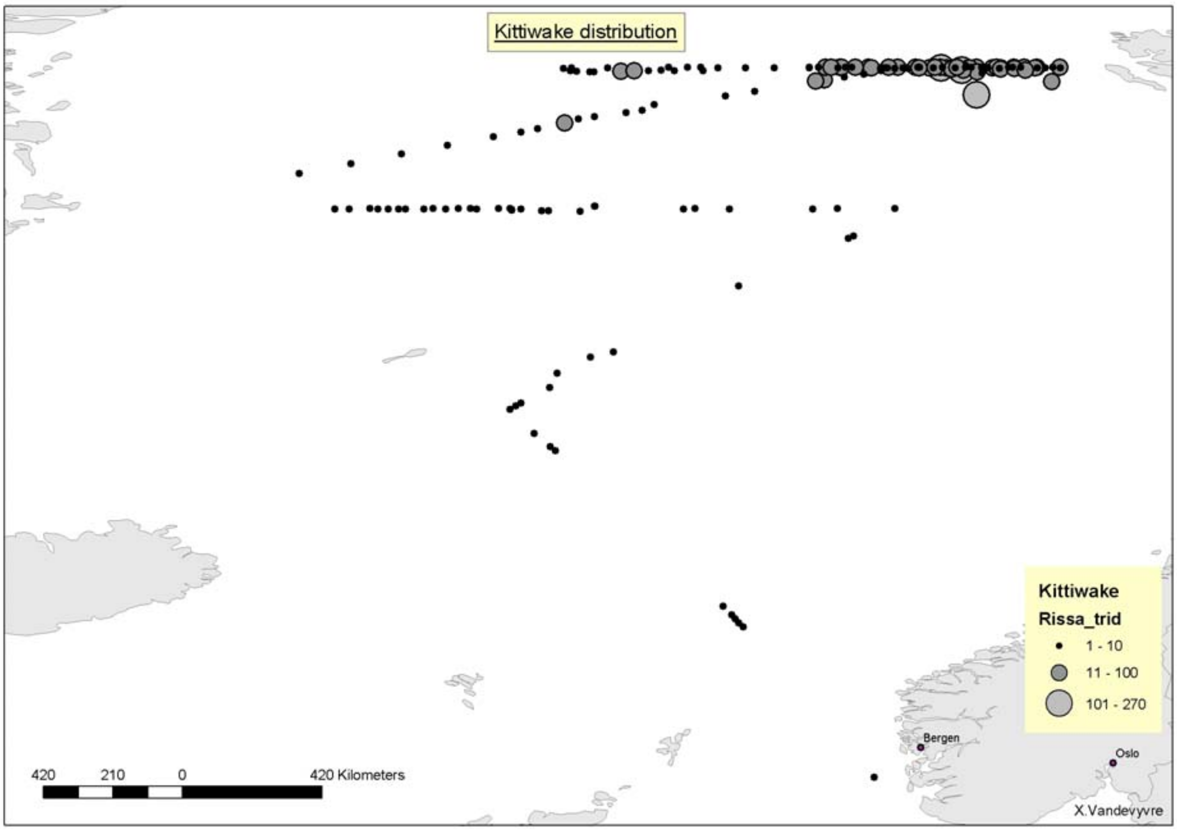

Fig. 4.2: Kittiwake distribution

Some unexpected species landed on board for some time (Northern Weather, Purple sandpiper). This phenomen concerns lost or exhausted migrants, considering the boat as "an island".

b) Whales and dolphins

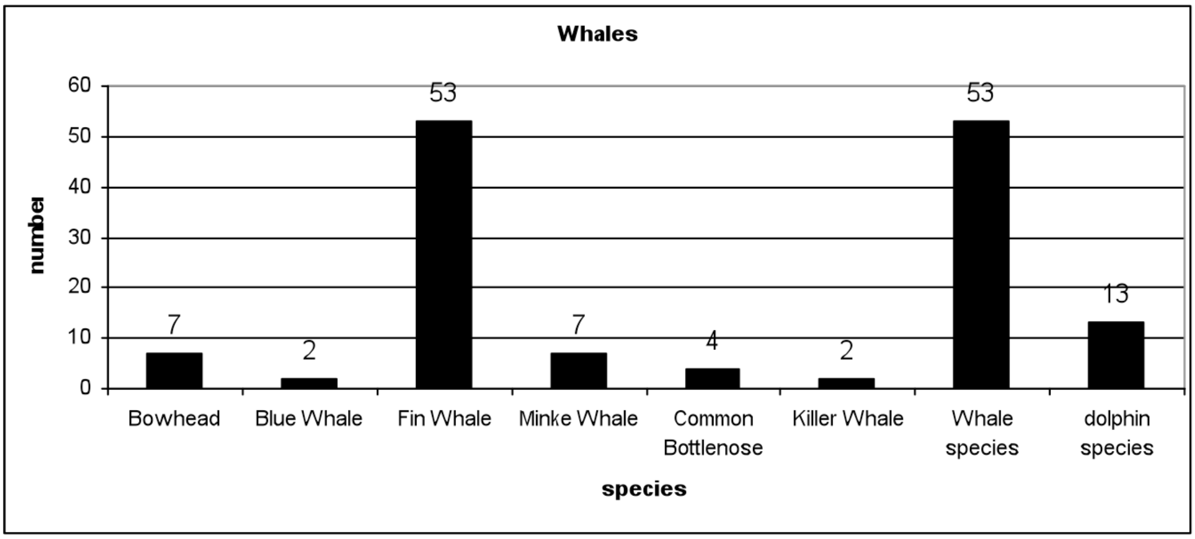

Fig. 4.3: Counts of whales and dolphins

- Bowhead: one of the rarest whales. Seven contacts were obtained and 2 individuals together by two times. The very first one was seen at the edge of the pack ice at 77°N

- Whales: we had to wait reaching the 79°N to have significant contacts with cetaceans! Between 2°E and 9°E, we had no less than 114 contacts. The most difficult thing was to avoid double counts as the boat made go back along this transect.

c) Seals and bears

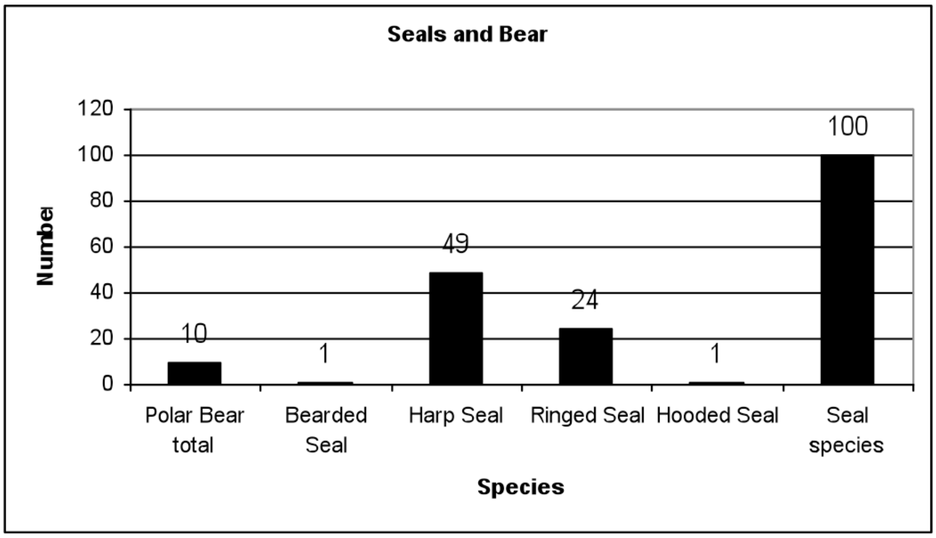

Fig. 4.4: Counts of seals and bears

- Polar Bear (cfr map): we saw "only" adults. The first sight was made in an area with very slight ice cover. The main observation was made during a CTD exercise. A bear was discovered far away but thanks to the length exercise (~2 hours) it was approaching the boat at a restricted range of nearly 200 meters! Undoubtedly a highlight of the cruise! In total 5 bears were seen and main tracks were seen in the foggy areas. Without surprise, most of the observations were made in the highly ice-covered zones.

- Harp seal: except some individuals in open water, these species was the most abundant present on the pack ice; sometimes in small group of 5 - 20 individuals

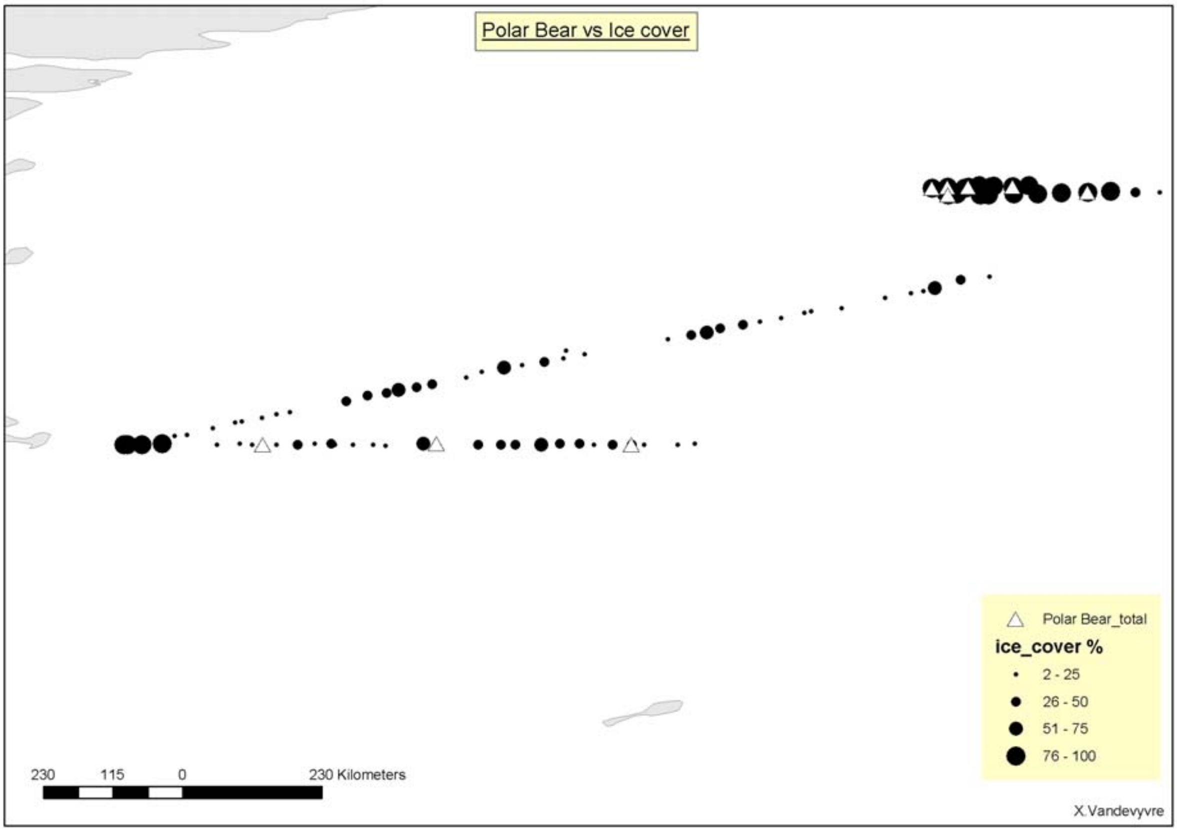

Fig. 4.5: Ice cover and observations of polar bears

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5. MARINE MAMMAL PERIMETER SURVEILLANCE (MAPS)

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Introduction/Scientific background

The MAPS project focuses on the detection of marine mammals in the vicinity of the ship, both for acquiring abundance data and spatial temporal distribution patterns of species and to implement effective mitigation procedures in the context of seismic research. A reliable determination of cetacean abundances and habitat preferences depends on the acquisition of significant amounts of sighting data. Multiple approaches to gather such data continuously from ships of opportunity are currently being developed and tested. Both, human observers and automated detection systems are employed for these tasks. Methods include passive and active hydroacoustics as well as dedicated and opportunistic sighting surveys and video and infrared imaging. Sighting data may then be merged with environmental proxies such as sea-ice conditions, water depth and sea surface temperature in environmental suitability models to model and predict the distribution and abundance of cetaceans in a given area. To enhance the effectiveness of marine mammal detection for mitigation purposes, automated detection signals are to be generated by algorithms integrating all methods mentioned above.

Work at sea

The scientific programme comprises the implementation of the procedures of opportunistic sighting reports for the ships crew and the commissioning of a new infrared camera system.

Opportunistic sightings of cetaceans are recorded by the nautical officers of *Polarstern* since 2005, using first paper log sheets and since 2008 an electronic logging programme "Wallog" (Fa. Werum). To alleviate this task and to interlink the sighting data with the ship-based data acquisition system "DSHIP", a new electronic log "WALOG" (Fig. 5.1) was developed by the Ocean Acoustics Group (AWI) prior to the cruise and installed and tested on the bridge during this expedition. A touch screen allows entering a sighting with just four taps. Additionally, photographs taken with a digital camera on the bridge are automatically transferred to the PC, referenced and stored in a database along with the sighting data, allowing for offline species verification.

Fig. 5.1: Screen layout of the new WALOG programme

During this cruise, visual sightings were recorded both by the nautical officers and in parallel by a dedicated marine mammal observer (MMO). Nautical officers, who occupy the bridge 24 hrs and 7 days/week do not conduct dedicated observations, yet are instructed to systematically record every (opportunistic) cetacean observation. Dedicated observations were conducted by a single observer from the bridge and the crows nest (if weather permitted), with an average of 10 hours effort each day. However, as this study was not designed as distance sampling survey, no effort data was recorded. The main goals of the dedicated MMO were: a) to introduce the new electronic WALOG programme to the nautical officers of *Polarstern* b) to test the programme and arrange for necessary changes to assure unobstructed handling for future cruises and c) to log cetacean sightings with the necessary additional information for later comparison with video sequences recorded by the newly installed infrared imaging system.

This system - "FIRST-Navy" - had been developed for defence applications by the company Rheinmetall Defence Electronics, Bremen. It consists of a state-of the art thermal imager, capable of taking five full 360° images per second with a resolution of 7200 x 576 pixels mounted on a stabilized platform providing a stable alignment under all weather conditions. The first operational unit of this series was installed on the crow's nest of *Polarstern* (Fig. 5.2.) during docktime before the expedition. The controlling computer system and the console for image acquisition, display and processing was installed in the lab on deck "A". An engineer of the company accompanied the cruise for the final commissioning. The main goal of the cruise regarding this camera was a comprehensive field test of the system and to fully integrate it into the ship's data network. The high resolution video data generated by the camera accumulates to about 4TB per day. The computer is capable of storing up to 10TB in total which are laid out as a ringbuffer which keeps the last two days. A trigger mechanism was implemented during the cruise, which automatically marks 10 minute snippets, 5 minutes before to 5 minutes after an event, for permanent storage. Triggering can occur either locally by the operator or via the ship's network from other locations like the WALOG console on the bridge.

Fig. 5.2: FIRST Navy camera and gimbal on the crow's nest

Preliminary results

a) Visual sightings

A total of 105 sighting events, including 8 cetacean species and three seal species were recorded. Table 5.1 lists all cetacean sighting events by species. Here we preferred to use the term ‘sighting event’ instead of ‘sighting’ due to the fact that in some occasions (e.g. high animal encounters or while ship was on station) we could not clearly distinguish if consecutive sightings in a short period of time were two separate sightings or a possible re-sighting of the same animal.

Tab. 5.1: Cetacean sightings by species from the bridge of *Polarstern* during ARK-XXIV/1

Species	number of sighting events
Blue whale	2
Bowhead whale	2
Fin whale	34
Humpback whale	2
Minke whale	5
Orcinus orca	4
Northern bottlenose whale	1
Dolphins Lagenorhynchus spp.	2
Dolphins, unidentified	1
Unidentified, large whale	13
Unidentified, blow only	10
unidentified	9

b) FIRST-Navy Infrared Imaging System

While the system was fully operational almost continuously for 400 hrs all the way from Bremerhaven to Svalbard with no major failure, a few flaws regarding image alignment were recognised which required some rework at the factory. Thus the sensor head was dismantled at the end of the leg and shipped back to Bremen from Svalbard. 55 TB of image data were recorded in total from which 2 TB with noteworthy content were kept and stored for further analysis. This material contains all the periods when whales were reported from either the bridge personnel or the MMO. Almost all visual sightings from the bridge could retrospectively be linked to blows which are visible in the IR footage. Whale blows were clearly detectable up to a distance of 1.5 km under relatively warm water conditions of 6°C and up to 3 km when water temperatures were decreasing (Figs. 5.3 and 5.4).

Fig. 5.3: A whale's blow at a distance of about 250 m

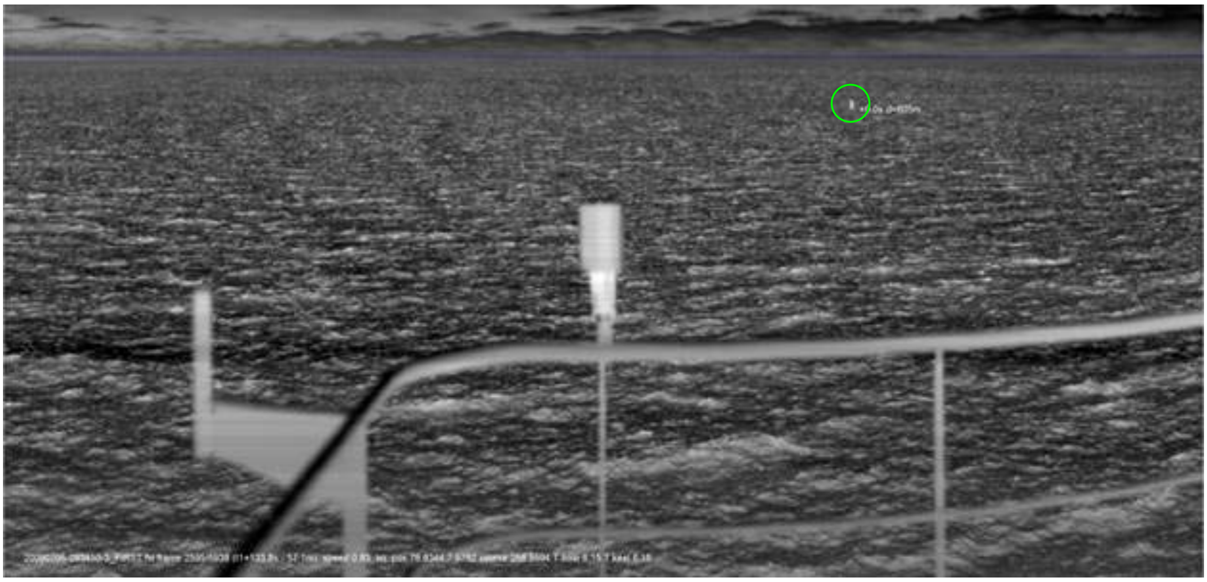

Fig. 5.4: A whale's blow at a distance of about 600 m

6. LONG-TERM PASSIVE ACOUSTIC MONITORING OF MARINE MAMMALS AND OCEAN NOISE LEVELS IN THE GREENLAND SEA AND THE FRAM STRAIT

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Objectives

The Arctic Ocean is one of the fastest changing environments on earth, and there is no doubt that these changes will affect marine fauna in near future. However, continuous monitoring of changes in this remote and hostile area is difficult and expensive. Passive acoustic long-term recorders offer the possibility to perform this task effectively and at relatively low cost. The project's goal is to monitor changes in the ambient sound field associated with the melting of the Arctic icecap and to evaluate the impact the anticipated increased sound levels will have on marine mammals - especially the endangered north Atlantic right whales (*Eubalaena glacialis*), bowhead whales (*Balaena mysticetus*) and walruses (*Odobenus rosmarus*).

(1) Whale acoustics: Estimates of the abundance and distribution of marine mammals in the high latitudes are burdened with large error estimates, sometimes of the same magnitude as the estimate itself. Improvements of the current estimates are difficult. Given the vast extent of the Arctic Ocean and its adjacent seas located above the Arctic Circle, dedicated surveys that visually scan the ocean surface for marine mammals are difficult to organize, as ship time - particularly in ice-covered regions - is costly and personnel are limited. In general most visual sightings are available for inshore waters as these can be obtained from shore or from small vessels on day trips.

To gain knowledge on the distribution and abundance of marine mammals, offshore passive acoustic monitoring has become an important research tool. Due to the low attenuation of sounds, especially low frequency sounds, and the fact that most marine mammals vocalize regularly, passive acoustic devices allow scientists to monitor a large area efficiently. Several research institutions (mostly located in the US) have initiated passive acoustic research projects in the Arctic in recent years. These projects are focused primarily on endangered whales, including the North Atlantic and North Pacific right whales (*Eubalaena glacialis* and *Eubalaena japonica*), bowhead whale (*Balaena mysticetus*), and blue whale (*Balaenoptera musculus*). However, most of these projects have been conducted in the Bering Sea, Chukchi Sea, and Beaufort Sea (US waters). The project proposed here is intended to gain knowledge on marine mammal species inhabiting the Greenland Sea and the Fram Strait.

The North Atlantic right whale is one of the world's most endangered cetaceans. The western North Atlantic population is estimated to number 300 - 350 animals, and the eastern population is extinct or nearly so. North Atlantic right whale populations do not appear to be increasing, with anthropogenic factors - notably ship strikes and net entanglement - responsible for significant numbers of deaths. North Atlantic right whales from the western stock inhabit areas off the coast of the United States and Canada from Florida to the Scotian Shelf. Surveys of these areas are conducted relatively often, but despite intensive survey effort, approximately one-third of this population is not found in these areas during the summer months. In addition, wintering grounds for much of the right whale population are unknown, and pelagic areas have received little dedicated survey effort. In 2007/2008 five hydrophones were deployed in a former whaling ground east of the southern tip of Greenland. The analysis of the recorded data revealed a significant number (>2000) of right whale vocalizations. Knowing that right whales occupy this area seasonally may guide conservation efforts aimed at reducing anthropogenic mortality. The proposed work further north will provide important information on the migration pattern of this and other species and provide baseline information for a future, more comprehensive passive acoustic study on this species as well as on other baleen whales in the area. The CIMRS bioacoustics group has developed algorithms for the detection of calls by many species of marine mammals, including right, bowhead, humpback, blue, fin, and sperm whales. We will use these algorithms to analyze the acoustic data collected by these instruments to study the seasonal occurrence of these species.

(2) Ocean noise: Ocean noise is an increasing problem in our oceans. Currently > 80 % of global trade uses the sea for transportation. Thus it is not surprising that shipping is a dominant sound source in the oceans. The main impact of this noise occurs in the frequency range between a few Hertz to a few hundred Hertz. Because of the low attenuation of sounds in the ocean, marine mammals developed evolutionary navigation and long-range communication systems based on sound. Most baleen whales, for example, emit sounds at frequencies < 1 kHz and could be directly affected by the increase in the noise levels caused by shipping. The potential impacts of anthropogenic noise on marine mammals are numerous, including the masking of biological signals. The Arctic Ocean is one of the fastest changing environments on earth. Due to global warming the sea ice in the Northern hemisphere is dramatically shrinking. In 2007 the Northwest Passage was ice free for the first time in recorded history. The Northeast Passage was only blocked by a narrow strip of ice most of the summer, and was ice free in 2008. An ice-free Northeast Passage would change the global ship-based trade dramatically as this route is radically shorter than the normal trip through the Suez Canal. For example, from Hamburg, Germany (one of the busiest harbors in Europe) to the Japanese port city of Yokohama, the trip using the northern route is ~7,400 nautical miles - just 40 percent of the 11,500 nautical mile trip through the Suez. An increase in ship traffic in

this area would significantly increase (1) ocean noise levels which will influence the behavior of marine mammals and (2) the likelihood of ship strikes.

CIMRS is analyzing deep-ocean sound recordings from hydrophones deployed in the equatorial East Pacific (EEP), central Mid-Atlantic (CMA), northern Mid-Atlantic (NMA), Bering Sea (BS), Antarctic Peninsula (ANP), and Indian Ocean (IO). These datasets provide insight into the overall structure for the deep-water global sound field. The hydrophones are moored in the deep sound channel, taking advantage of the efficient propagation characteristics which enable the instruments to monitor effectively large sections of the global oceans. Although not always concurrent, the deployment of the hydrophone arrays from 1996 to present allows for an up-to-date assessment of the global scale distribution of ocean sound levels in discrete frequency bands. Comparisons of intra- and interannual time averaged ambient sound levels reveal strong latitudinal variations, where higher latitudes correspond with higher noise levels. Seismic and volcanic activities dominate the lower frequency bands (0 - 10 Hz) of all hydrophone arrays. Of interest is the periodic nature of broad band ice noise observed in the ANP acoustic data, suggesting a climate link for these signals related to ice breakup during seasonal warming events. In addition, the multi-species marine mammal vocalizations observed in all of our hydrophone datasets dominates sound energy levels at specific frequencies. The work in the Greenland Sea and Fram Strait will allow a more comprehensive study on a "global ocean noise budget". The Arctic is of special interest as this area is heavily affected by global warming, and the shrinking of the ice cap will lead to more shipping traffic and oil exploration in this area in near future. For this reason it is very important to get baseline information on current noise levels in this area soon.

Work at sea

Two hydrophones were deployed off the German research icebreaker *Polarstern* in the Fram Strait (M1) and the central Greenland Sea (M2). Details are given in Tab. 6.1 and Fig. 6.1.

Tab. 6.1: Detailed information on hydrophone deployments

	Position:	Mooring:	Water depth [m]:	Hydrophone depth [m]:
M1	78° 50,03'N 05° 29,12'E	AWI-F22-1	2549	488
M2	74° 56,00'N 04° 37,00'W	AWI-JP37	3540	480

To our knowledge this is the first time that a hydrophone has been deployed in the Greenland Sea. The hydrophones will record the underwater soundscape continuously for one year. A turnaround of the instruments is planned for summer 2010.

Preliminary results

In the vicinity of both deployment locations various marine mammals incl. the endangered bowhead whales were sighted by Elke Burkhardt (AWI), visual observer during ANT-XXIV/1 (see Fig. 6.1).

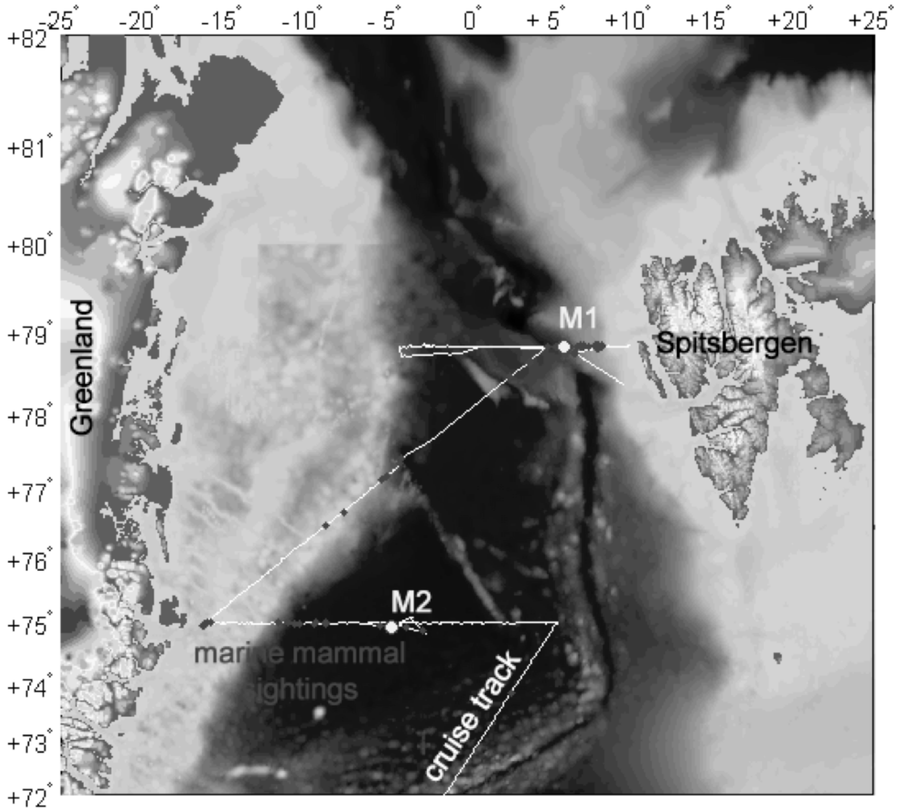

Fig. 6.1: Cruise track of Polarstern (white line), marine mammal sightings (dark dots), and location of deployed hydrophones M1 and M2

Accordingly the chosen deployment locations seem to be suitable spots for conducting the proposed research. We are confident that the recorded data will deliver new insights into the seasonal presence of marine mammals as well as on noise levels in the Greenland Sea and the Fram Strait.

7. PRODUCTION, FATE AND AGGREGATION OF ORGANIC MATTER IN A CHANGING ARCTIC OCEAN

Mascha Wurst, Nicole Händel
AWI, Helmholtz Young Investigators Group 'GloCar'

Objectives

Based on the awareness, that global change has increasingly changed marine ecosystems, we intend to determine the effects of higher temperature and CO_2 on the production, fate and aggregation of extracellular organic matter in the Arctic Ocean. Incubation experiments with Arctic marine bacterioplankton communities will be performed to observe temperature- and CO_2-related effects on the concentration and composition of exopolymer substances. Furthermore, secondary effects on the formation of organic aggregates will be investigated by bubble absorption onboard. Biogeochemical and microbiological measurements are necessary to determine future changes in the origin and the turnover of organic matter during production and decomposition processes in the Arctic Ocean. Our overarching goal is to contribute to a better understanding of the direction and strength of biogeochemical and microbial feedback processes in the future ocean. The investigations are conducted in close cooperation with E. Nöthig, I. Peeken, A. Bracher, K. Metfies, E. Bauerfeind and M. Klages (AWI) in the *AWI HAUSGARTEN* (ARK- XXIV /2), studying plankton ecology and sedimentation of organic matter in a changing Arctic ocean.

Work at sea / preliminary results

During ARK-XXIV/1, two perturbation experiments with arctic marine bacterioplankton were performed to determine the impact of increasing temperature and CO_2 on the microbial turn-over of exopolymer substances. Secondary effects on the formation of organic aggregates were investigated by bubble absorption. Seawater was collected by CTD/Rosette at 75°N, 5°30' E and at 75°N, 15°40' W in the peak of chlorophyll a (Chl a) concentration (30 m and 20 m depth, respectively). Before manipulation of temperature and pH, the seawater was filtrated (1.2μm) and concentrated from 1 l to 5 l by ultrafiltration (>10kDa). After manipulation of seawater chemistry (decreased pH), seawater was incubated for 4 days at *in-situ* and increased temperature. Subsequently the formation of organic aggregates was investigated by bubbling air into the seawater for 12 h. Subsamples were collected for biogeochemical parameters (total and dissolved organic carbon (TOC/DOC), total and dissolved nitrogen (TN/DN), dissolved and total polysaccharides (DCHO/CHO), dissolved and total amino acids (DAA/AA), nutrients, transparent exopolymer particles (TEP), Coomassie stainable particles (CSP)) and microbiological parameters (bacterial cell numbers, bacterial DNA, bacterial production (incorporation of 3H-Thymidine and 3H-

Leucine), activity of extracellular enzymes). Beside of the microbial activity measurements, samples were preserved, kept refrigerated (4°C) or frozen (20°C/-80°C) for further analyses in the home laboratory.

Furthermore, seawater samples were collected at 6 m depth by taking the advantage of a membrane pump installed at the bow of *Polarstern* according to Table 7.1. Samples were taken for the analyses of parameters that provide information on primary production, phytoplankton diversity and bacterial abundance. This involved the preparation of filters for the measurement of Chl a, particle absorbance (PAB), pigment composition (HPLC) and bacterial DNA. In addition subsamples were preserved for bacterial cell numbers. Filters and samples are kept frozen (at -80°C and 20°C, respectively) and will be analysed in the home laboratory.

Tab. 7.1: Station list of collected seawater on ARK-XXIV/1

Date	Latitude	Longitude	Depth [m]	bacterial DNA	bacterial cell numbers	Chl a	HPLC	PAB
22.06.2009	61° N	2°45' E	6	x	x		x	x
23.06.2009	63°54' N	0° 24' E	6	x	x		x	x
23.06.2009	64° 53.3' N	0° 34.5' W	6			x	x	x
23.06.2009	65° 58' N	1° 42' W	6	x	x	x	x	x
24.06.2009	69° 0.9' N	5° 8.77' W	6	x	x	x	x	x
24.06.2009	69° 36' N	5° 34.3' W	6	x	x	x	x	x
25.06.2009	72° 30.1' N	0° 18' E	6	x	x	x	x	x
25.06.2009	73° 6.5' N	1° 1.9'E	6			x	x	x
25.06.2009	73° 58.7' N	3° 1.7' E	6	x	x	x	x	x
26.06.2009	75° N	5° 30' E	30	x	x	x	x	x
26.06.2009	75° N	3° 4.5' E	6	x	x	x	x	x
27.06.2009	75° N	0° 8.6' E	6	x	x			
27.06.2009	74° 58' N	1° 42' W	6			x	x	x
30.06.2009	75° N	9° 18.4' W	6	x	x	x	x	x
01.07.2009	75° N	15° 40' W	20	x	x	x	x	x
06.07.2009	78° 50' N	3° 43' E	6	x	x			
07.07.2009	78° 48.5' N	3° 45.5' W	10	x	x			

APPENDIX

A.1 PARTICIPATING INSTITUTIONS

A.2 CRUISE PARTICIPANTS

A.3 SHIP'S CREW

A.4 STATION AND MOORING LIST

A.1 TEILNEHMENDE INSTITUTE / PARTICIPATING INSTITUTIONS

	Adresse Address
AWI	Alfred-Wegener-Institut für Polar- und Meeresforschung in der Helmholtz-Gemeinschaft Postfach 120161 27515 Bremerhaven
DWD	Deutscher Wetterdienst Geschäftsbereich Wettervorhersage Seeschifffahrtsberatung Bernhard Nocht Str. 76 20359 Hamburg
Fielax	Gesellschaft für wissenschaftliche Datenverarbeitung mbH Barkhausenstr. 4 27568 Bremerhaven
Heli Service	Heli Service International GmbH Im Geisbaum 2 63329 Egelsbach
IPÖ	Institut für Polarökologie Wischhofstr. 1-3, Geb.12 24148 Kiel
Laeisz	Reederei F. Laeisz (Bremerhaven) GmbH Brückenstr. 25 27568 Bremerhaven
NOAA	Oregon State University & NOAA Pacific Marine Environmental Laboratory Hatfield Marine Science Center 2030 Marine Science Drive Newport, OR 97365, USA
Optimare	OPTIMARE Am Luneort 15a 27572 Bremerhaven

	Adresse Address
PolE	Laboratory for Polar Ecology Rue du Fodia 18 B-1367 Ramillies/Belgium
Rheinmetall Electronics	Brueggeweg 54 28309 Bremen
UAB	Institut de Ciència i Tecnologia Ambientals (ICTA) Universitat Autònoma de Barcelona (UAB) Edifici Cn, 4°, Campus Bellaterra 08193 Barcelona Spain

A.2 FAHRTTEILNEHMER / CRUISE PARTICIPANTS

Name/ Last name	Vorname/ First name	Institut/ Institute	Beruf/ Profession
Baudorff	Christian	Heliservice	Pilot
Brauer	Jens	Heliservice	Technician
Budéus	Gereon	AWI	Chief Scientist,Oceanographer
Büchner	Jürgen	Heliservice	Pilot
Buldt	Klaus	DWD	Technician
Burkhardt	Elke	AWI	Technician, biology
El Naggar	Saad	AWI	Physicist
Etienne	Fabrice	PoIE	Biologist
Fietz	Susanne	UAB	Biologist
Gall	Fabian	Heliservice	Technician
Händel	Nicole	AWI	Technician, biology
Heidemann	Harald	SAM Electronics	Engineer
Heinze	Birte	AWI	Student, oceanography
Jacob	Juliane	AWI	Student, oceanography
Kindermann	Lars	AWI	Physicist
Klinck	Holger	NOAA	Biologist
Lehner	Flavio	AWI	Student, physics
Monsees	Matthias	Optimare	Technician
Paranhos Zitterbart	Daniel	AWI	Physicist
Pardiñas	Judit	UAB	Biologist
Reimann	Andreas	Rheinmetall	Engineer
Rentsch	Harald	DWD	Meteorologist
Rogenhagen	Johannes	Fielax	Geophysicist
Rohardt	Gerd	AWI	Oceanographer
Saynisch	Jan	AWI	Oceanographer
Schneider	Alice	IPÖ	Technician
Schnieders	Jana	AWI	Student, oceanography
Spielke	Steffen	Laeisz	Inspector
Strothmann	Olaf	AWI	Technician, oceanography

Name/ Last name	Vorname/ First name	Institut/ Institute	Beruf/ Profession
Vandevyvre	Xavier	PolE	Biologist
Viseur	Stephane	PolE	Biologist
Wisotzki	Andreas	AWI	Oceanographer
Wurst	Mascha	AWI	Biologist
Zakrzewski	Svenja	AWI	Student, oceanography
Zenk	Oliver	Optimare	Engineer, oceanography
Zoch	Nico	AWI	Student, oceanography

A.3 SCHIFFSBESATZUNG / SHIP'S CREW

No.	Name	Rank
1.	Pahl, Uwe	Master
2.	Ettlin, Margrith	1. Offc.
3.	Krohn, Günter	Ch. Eng.
4.	Fallei, Holger	2. Offc.
5.	Peine, Lutz G.	2. Offc.
6.	Dugge, Heike	3. Offc.
7.	Heine, Werner	Doctor
8.	Hecht, Andreas	R. Offc.
9.	Minzlaff, Hans-Ulrich	2. Eng.
10.	Sümnicht, Stefan	2. Eng.
11.	Schaefer, Marc	3. Eng.
12.	Scholz, Manfred	Elec. Eng.
13.	Dimmler, Werner	ELO
14.	Himmel, Frank	ELO
15.	Muhle, Helmut	ELO
16.	Winter, Andreas	ELO
17.	Loidl, Reiner	Boatsw.
18.	Reise, Lutz	Carpenter
19.	Bäcker, Andreas	A.B.
20.	Brickmann, Peter	A.B.
21.	Guse, Hartmut	A.B.
22.	Hagemann, Manfred	A.B.
23.	Scheel, Sebastian	A.B.
24.	Schmidt, Uwe	A.B.
25.	Wende, Uwe	A.B.
26.	Winkler, Michael	A.B.
27.	Preußner, Jörg	Storek.
28.	Elsner, Klaus	Mot-man
29.	Pinske, Lutz	Mot-man

No.	Name	Rank
30.	Schütt, Norbert	Mot-man
31.	Teichert, Uwe	Mot-man
32.	Voy, Bernd	Mot-man
33.	Müller-homburg, R.-D.	Cook
34.	Silinski, Frank	Cooksmate
35.	Völske, Thomas	Cooksmate
36.	Jürgens, Monika	1. Stwdess
37.	Wöckener, Martina	Stwdess/N.
38.	Czyborra, Bärbel	2. Stwdess
39.	Gaude, Hans-Jürgen	2. Steward
40.	Huang, Wu-Mei	2. Stwdess
41.	Möller, Wolfgang	2. Steward
42.	Silinski, Carmen	2. Stwdess
43.	Yu, Kwok Yuen	Laundrym.
44.	Junge, Johannes	Apprent.
45.	Schliffke, Banyamin	Apprent.

A.4 STATION AND MOORING LIST PS 74

Station PS74/	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abbreviat-ion
0001-1	24.06.2009	15:50:00	70° 30,39' N	4° 21,83'W	1296,8	CTD/RO
0001-1	24.06.2009	16:21:00	70° 30,40' N	4° 23,03'W	1314,2	CTD/RO
0001-1	24.06.2009	16:21:01	70° 30,40' N	4° 23,03'W	1314,2	CTD/RO
0001-1	24.06.2009	16:44:59	70° 30,38' N	4° 23,43'W	1317,1	CTD/RO
0001-2	24.06.2009	16:55:00	70° 30,39' N	4° 23,72'W	1323	TEST
0001-2	24.06.2009	16:57:00	70° 30,38' N	4° 23,82'W	1324,6	TEST
0001-2	24.06.2009	17:14:00	70° 30,32' N	4°24,53'W	1334,7	TEST
0001-2	24.06.2009	17:18:59	70° 30,30' N	4° 24,66'W	1340,3	TEST
0002-1	25.06.2009	15:07:00	73° 45,53' N	2° 28,53' E	3208,3	TD
0002-1	25.06.2009	15:15:00	73° 46,29' N	2° 30,33' E	3216	TD
0002-1	25.06.2009	15:16:59	73° 46,41' N	2° 30,74' E	3218,6	TD
0003-1	25.06.2009	23:32:00	74° 59,96' N	5° 30,53' E	3133,8	CTD/RO
0003-1	26.06.2009	0:34:00	74° 59,94' N	5° 29,97' E	3117,3	CTD/RO
0003-1	26.06.2009	1:32:59	74° 59,95' N	5° 30,00' E	3117,9	CTD/RO
0004-1	26.06.2009	3:14:00	74° 59,97' N	4° 51,62' E	3245,6	CTD/RO
0004-1	26.06.2009	4:24:00	74° 59,96' N	4° 51,86' E	3239,7	CTD/RO
0004-1	26.06.2009	5:20:59	75° 0,04' N	4° 52,20' E	3236,4	CTD/RO
0005-1	26.06.2009	6:46:00	75° 0,08' N	4° 13,53' E	3082,3	CTD
0005-1	26.06.2009	7:58:00	75° 0,13' N	4° 14,27' E	3083,7	CTD
0005-1	26.06.2009	8:48:59	75° 0,04' N	4° 14,00' E	3094,6	CTD
0006-1	26.06.2009	10:04:00	75° 0,00' N	3° 34,98' E	3479,2	CTD/RO
0006-1	26.06.2009	11:13:00	75° 0,03' N	3° 35,69' E	3488,5	CTD/RO
0006-1	26.06.2009	12:09:59	75° 0,01' N	3° 35,66' E	3488,4	CTD/RO
0007-1	26.06.2009	13:27:00	74° 59,92' N	2° 55,49' E	2529,5	CTD/RO
0007-1	26.06.2009	14:12:00	74° 59,81' N	2° 55,71' E	2540,9	CTD/RO
0007-1	26.06.2009	14:52:59	74° 59,47' N	2° 55,40' E	2601,5	CTD/RO
0008-1	26.06.2009	16:03:00	75° 0,07' N	2° 16,62' E	2950,5	CTD/RO
0008-1	26.06.2009	16:55:00	74° 59,69' N	2° 16,52' E	2961	CTD/RO
0008-1	26.06.2009	17:42:59	74° 59,81' N	2° 16,55' E	2978	CTD/RO
0009-1	26.06.2009	18:58:00	75° 0,02' N	1° 37,46' E	3156,1	CTD/RO
0009-1	26.06.2009	20:03:00	75° 0,01' N	1° 37,94' E	3129	CTD/RO
0009-1	26.06.2009	20:52:59	75° 0,04' N	1° 38,11' E	3122,8	CTD/RO
0010-1	26.06.2009	22:12:00	74° 59,98' N	0° 58,62' E	3775,5	CTD/RO
0010-1	26.06.2009	23:26:00	74° 59,93' N	0° 56,91' E	3775,4	CTD/RO
0010-1	27.06.2009	0:26:59	75° 0,01' N	0° 56,15' E	3775,5	CTD/RO
0011-1	27.06.2009	1:33:00	74° 59,93' N	0° 20,99' E	3773,1	CTD/RO
0011-1	27.06.2009	2:52:00	74° 59,79' N	0° 20,02' E	3772,7	CTD/RO
0011-1	27.06.2009	3:51:59	74° 59,79' N	0° 19,30' E	3772,5	CTD/RO
0012-1	27.06.2009	5:05:00	75° 0,04' N	0° 17,61'W	3764,8	CTD/RO
0012-1	27.06.2009	6:20:00	74° 59,72' N	0° 17,14'W	3764,7	CTD/RO
0012-1	27.06.2009	7:21:59	74° 59,61' N	0° 17,35'W	3764,2	CTD/RO
0013-1	27.06.2009	8:37:00	74° 59,96' N	0° 55,24'W	3747,4	CTD/RO
0013-1	27.06.2009	9:52:01	74° 59,92' N	0° 55,73'W	3738,4	CTD/RO

Station PS74 /	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abbreviat-ion
0013-1	27.06.2009	10:59:59	74° 59,92' N	0° 56,55'W	3739,6	CTD/RO
0014-1	27.06.2009	12:14:00	74° 59,95' N	1° 35,14'W	3729,2	CTD/RO
0014-1	27.06.2009	13:28:00	74° 59,79' N	1° 34,42'W	3730	CTD/RO
0014-1	27.06.2009	14:27:59	74° 59,62' N	1° 34,56'W	3730	CTD/RO
0015-1	27.06.2009	15:42:00	75° 0,03' N	2° 12,81'W	3631,1	CTD/RO
0015-1	27.06.2009	16:52:00	74° 59,55' N	2° 11,15'W	3706,4	CTD/RO
0015-1	27.06.2009	17:49:59	74° 59,01' N	2° 10,41'W	3717,4	CTD/RO
0016-1	27.06.2009	19:12:00	74° 59,96' N	2° 50,78' W	3692,6	CTD/RO
0016-1	27.06.2009	20:25:00	74° 59,77' N	2° 51,08' W	3692,5	CTD/RO
0016-1	27.06.2009	21:28:59	74° 59,90' N	2° 50,95' W	3692,3	CTD/RO
0017-1	27.06.2009	22:46:00	74° 60,00' N	3° 29,92' W	3671	CTD/RO
0017-1	27.06.2009	23:59:00	75° 0,08' N	3° 30,00' W	3667	CTD/RO
0017-1	28.06.2009	0:57:59	75° 0,22' N	3° 30,21' W	3667	CTD/RO
0018-1	28.06.2009	2:10:00	75° 0,06' N	4° 8,00' W	3643,3	CTD/RO
0018-1	28.06.2009	3:25:00	74° 59,95' N	4° 6,75' W	3644,2	CTD/RO
0018-1	28.06.2009	4:27:59	74° 59,81' N	4° 5,52' W	3645,7	CTD/RO
0019-1	28.06.2009	5:34:00	75° 5,15' N	3° 26,44' W	3668,2	MOR
0019-1	28.06.2009	5:37:00	75° 5,13' N	3° 26,26' W	3668,8	MOR
0019-1	28.06.2009	5:39:00	75° 5,11' N	3° 26,13' W	3668,4	MOR
0019-1	28.06.2009	5:53:00	75° 4,98' N	3° 26,45' W	3668,8	MOR
0019-1	28.06.2009	5:59:00	75° 4,98' N	3° 26,20' W	3668,7	MOR
0019-1	28.06.2009	6:03:00	75° 4,98' N	3° 26,00' W	3669	MOR
0019-1	28.06.2009	7:00:00	75° 5,37' N	3° 23,22' W	3670,3	MOR
0019-1	28.06.2009	7:01:00	75° 5,38' N	3° 23,16' W	3670,4	MOR
0019-1	28.06.2009	7:03:59	75° 5,39' N	3° 23,03' W	3670,3	MOR
0019-1	28.06.2009	7:08:00	75° 5,29' N	3° 22,52' W	3670,5	MOR
0020-1	28.06.2009	7:30:00	75° 5,04' N	3° 27,40' W	3667,6	MOR
0020-1	28.06.2009	7:31:00	75° 5,04' N	3° 27,39' W	3667,4	MOR
0020-1	28.06.2009	7:32:00	75° 5,04' N	3° 27,38' W	3667,5	MOR
0020-1	28.06.2009	7:33:00	75° 5,04' N	3° 27,37' W	3667,5	MOR
0020-1	28.06.2009	9:10:00	75° 5,02' N	3° 27,13' W	3667,5	MOR
0020-1	28.06.2009	9:18:00	75° 5,02' N	3° 27,09' W	3667,3	MOR
0020-1	28.06.2009	9:18:01	75° 5,02' N	3° 27,09' W	3667,3	MOR
0020-1	28.06.2009	9:20:00	75° 5,03' N	3° 27,07' W	3667,8	MOR
0020-1	28.06.2009	9:28:59	75° 5,02' N	3° 27,07' W	3667,8	MOR
0020-1	28.06.2009	9:33:00	75° 5,01' N	3° 27,07' W	3667,5	MOR
0021-1	28.06.2009	11:54:00	74° 50,02' N	2° 29,87' W	3695,4	MOR
0021-1	28.06.2009	11:55:00	74° 50,03' N	2° 29,85' W	3696,1	MOR
0021-1	28.06.2009	11:57:00	74° 50,03' N	2° 29,83' W	3696	MOR
0021-1	28.06.2009	12:15:00	74° 49,83' N	2° 30,54' W	3694,9	MOR
0021-1	28.06.2009	12:20:00	74° 49,84' N	2° 30,45' W	3695,5	MOR
0021-1	28.06.2009	12:24:00	74° 49,88' N	2° 30,35' W	3695,2	MOR
0021-1	28.06.2009	13:18:00	74° 50,10' N	2° 29,79' W	3696,6	MOR
0021-1	28.06.2009	13:18:01	74° 50,10' N	2° 29,79' W	3696,6	MOR
0022-1	28.06.2009	13:30:00	0° 0,00' N	0° 0,00' E	0	MOR
0022-1	28.06.2009	13:30:01	74° 49,98' N	2° 30,01' W	3696,2	MOR

Station PS74 /	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abbreviat-ion
0022-1	28.06.2009	14:52:00	74° 50,02' N	2° 29,98' W	3696,6	MOR
0022-1	28.06.2009	15:04:00	74° 50,02' N	2° 29,98' W	3696,4	MOR
0022-1	28.06.2009	15:10:00	74° 49,99' N	2° 30,02' W	3696,4	MOR
0022-1	28.06.2009	15:12:59	74° 49,99' N	2° 29,98' W	3696,5	MOR
0023-1	28.06.2009	19:36:00	75° 0,05' N	4° 47,10' W	3612,7	CTD/RO
0023-1	28.06.2009	20:49:00	74° 59,99' N	4° 47,13' W	3612,8	CTD/RO
0023-1	28.06.2009	21:46:59	74° 59,98' N	4° 47,08' W	3613	CTD/RO
0024-1	28.06.2009	23:00:00	74° 59,94' N	5° 24,88' W	3575,7	CTD/RO
0024-1	29.06.2009	0:09:00	75° 0,25' N	5° 25,52' W	3574,6	CTD/RO
0024-1	29.06.2009	1:03:59	75° 0,44' N	5° 26,44' W	3573,3	CTD/RO
0025-1	29.06.2009	2:18:00	74° 59,93' N	6° 3,73' W	3526,7	CTD/RO
0025-1	29.06.2009	3:29:00	75° 0,22' N	6° 2,49' W	3529	CTD/RO
0025-1	29.06.2009	4:21:59	75° 0,40' N	6° 1,06' W	3530,9	CTD/RO
0026-1	29.06.2009	6:52:00	74° 54,78' N	4° 38,50' W	3614,5	MOR
0026-1	29.06.2009	6:54:00	74° 54,77' N	4° 38,55' W	3613,9	MOR
0026-1	29.06.2009	7:00:00	74° 54,84' N	4° 38,60' W	3614	MOR
0026-1	29.06.2009	7:01:00	74° 54,85' N	4° 38,58' W	3614	MOR
0026-1	29.06.2009	7:02:00	74° 54,85' N	4° 38,55' W	3614,4	MOR
0026-1	29.06.2009	7:14:00	74° 55,02' N	4° 36,92' W	3615,7	MOR
0026-1	29.06.2009	7:20:00	74° 54,98' N	4° 36,96' W	3616,1	MOR
0026-1	29.06.2009	8:06:00	74° 55,05' N	4° 37,17' W	3615	MOR
0026-1	29.06.2009	8:07:00	74° 55,05' N	4° 37,17' W	3614,9	MOR
0026-1	29.06.2009	8:08:00	74° 55,05' N	4° 37,17' W	3615	MOR
0026-1	29.06.2009	8:10:00	74° 55,05' N	4° 37,16' W	3615,2	MOR
0026-1	29.06.2009	8:10:59	74° 55,05' N	4° 37,16' W	3615,2	MOR
0027-1	29.06.2009	8:44:00	74° 55,11' N	4° 37,08' W	3615,3	MOR
0027-1	29.06.2009	8:48:00	74° 55,12' N	4° 37,08' W	3615,4	MOR
0027-1	29.06.2009	8:49:00	74° 55,13' N	4° 37,07' W	3615,2	MOR
0027-1	29.06.2009	8:50:00	74° 55,13' N	4° 37,07' W	3614,9	MOR
0027-1	29.06.2009	9:52:00	74° 55,04' N	4° 37,09' W	3614,6	MOR
0027-1	29.06.2009	9:55:00	74° 55,04' N	4° 37,05' W	3615,4	MOR
0027-1	29.06.2009	10:05:00	74° 55,01' N	4° 37,01' W	3615	MOR
0027-1	29.06.2009	10:08:00	74° 55,01' N	4° 36,99' W	3615,1	MOR
0027-1	29.06.2009	10:11:59	74° 55,01' N	4° 36,96' W	3615,2	MOR
0028-1	29.06.2009	10:32:00	74° 55,99' N	4° 36,67' W	3618	MOR
0028-1	29.06.2009	10:33:00	74° 55,98' N	4° 36,62' W	3618,1	MOR
0028-1	29.06.2009	10:37:00	74° 55,97' N	4° 36,49' W	3618,2	MOR
0028-1	29.06.2009	10:41:00	74° 55,97' N	4° 36,54' W	3618	MOR
0028-1	29.06.2009	10:52:00	74° 56,02' N	4° 37,16' W	3618,1	MOR
0028-1	29.06.2009	10:55:00	74° 56,03' N	4° 37,12' W	3617,7	MOR
0028-1	29.06.2009	11:01:00	74° 56,01' N	4° 36,96' W	3617,7	MOR
0028-1	29.06.2009	11:16:00	74° 55,97' N	4° 36,69' W	3618	MOR
0028-1	29.06.2009	11:44:00	74° 55,93' N	4° 36,84' W	3617,8	MOR
0028-1	29.06.2009	11:45:01	74° 55,93' N	4° 36,83' W	3617,7	MOR
0028-1	29.06.2009	11:45:59	74° 55,93' N	4° 36,83' W	3617,7	MOR
0029-1	29.06.2009	12:02:00	74° 56,04' N	4° 36,95' W	3618,2	MOR

Station PS74 /	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abbreviat-ion
0029-1	29.06.2009	13:02:00	74° 56,05' N	4° 36,88' W	3618,1	MOR
0029-1	29.06.2009	13:21:00	74° 56,04' N	4° 36,89' W	3618,3	MOR
0029-1	29.06.2009	14:22:00	74° 56,02' N	4° 36,89' W	3618,3	MOR
0029-1	29.06.2009	14:47:00	74° 56,03' N	4° 36,94' W	3618,3	MOR
0029-1	29.06.2009	15:00:00	74° 56,06' N	4° 36,92' W	3618,8	MOR
0029-1	29.06.2009	15:04:59	74° 56,06' N	4° 36,97' W	3618,8	MOR
0030-1	29.06.2009	18:28:00	75° 0,15' N	6° 41,89' W	3491	CTD/RO
0030-1	29.06.2009	19:42:00	75° 0,01' N	6° 43,06' W	3490	CTD/RO
0030-1	29.06.2009	20:39:59	74° 59,97' N	6° 42,91' W	3490,2	CTD/RO
0031-1	29.06.2009	21:48:00	75° 0,05' N	7° 21,88' W	3438,8	CTD/RO
0031-1	29.06.2009	22:57:00	74° 59,89' N	7° 22,64' W	3437,8	CTD/RO
0031-1	29.06.2009	23:56:59	74° 59,73' N	7° 23,39' W	3437	CTD/RO
0032-1	30.06.2009	1:08:00	74° 59,98' N	8° 1,12' W	3399	CTD/RO
0032-1	30.06.2009	2:17:00	74° 59,58' N	8° 0,72' W	3399,3	CTD/RO
0032-1	30.06.2009	3:10:59	74° 59,23' N	8° 0,41' W	3397	CTD/RO
0033-1	30.06.2009	4:20:00	75° 0,09' N	8° 39,61' W	3360,5	CTD/RO
0033-1	30.06.2009	4:53:00	74° 59,94' N	8° 39,98' W	3361	CTD/RO
0033-1	30.06.2009	5:01:00	74° 59,90' N	8° 39,89' W	3361	CTD/RO
0033-1	30.06.2009	5:47:00	74° 59,81' N	8° 40,43' W	3361,3	CTD/RO
0033-1	30.06.2009	6:58:00	74° 59,49' N	8° 40,30' W	3363	CTD/RO
0033-1	30.06.2009	7:49:59	74° 59,40' N	8° 40,82' W	3363	CTD/RO
0034-1	30.06.2009	9:07:00	75° 0,01' N	9° 19,59' W	3297	CTD/RO
0034-1	30.06.2009	10:13:00	74° 59,93' N	9° 21,29' W	3291,3	CTD/RO
0034-1	30.06.2009	11:09:59	74° 59,84' N	9° 21,32' W	3291,7	CTD/RO
0035-1	30.06.2009	12:14:00	75° 0,03' N	9° 57,60' W	3217,3	CTD/RO
0035-1	30.06.2009	13:18:00	74° 59,52' N	9° 59,48' W	3216	CTD/RO
0035-1	30.06.2009	14:07:59	74° 59,16' N	10° 0,91' W	3219,5	CTD/RO
0036-1	30.06.2009	15:12:00	74° 59,57' N	10° 36,11'W	3088,2	CTD/RO
0036-1	30.06.2009	16:17:00	74° 59,35' N	10° 37,36'W	3089	CTD/RO
0036-1	30.06.2009	17:07:59	74° 59,44' N	10°37,78' W	3083,3	CTD/RO
0037-1	30.06.2009	18:20:00	75° 0,67' N	11° 2,22' W	2687	CTD/RO
0037-1	30.06.2009	19:16:00	75° 0,68' N	11° 1,79' W	2691	CTD/RO
0037-1	30.06.2009	20:00:59	75° 0,87' N	11° 1,72' W	2678,2	CTD/RO
0038-1	30.06.2009	21:12:00	75° 0,02' N	11° 29,00'W	2316	CTD/RO
0038-1	30.06.2009	22:00:00	75° 0,05' N	11° 28,73'W	2320	CTD/RO
0038-1	30.06.2009	22:37:59	75° 0,16' N	11° 29,18'W	2307,7	CTD/RO
0039-1	30.06.2009	23:44:00	74° 59,92' N	11° 52,05'W	1912,8	CTD/RO
0039-1	01.07.2009	0:25:00	74° 59,83' N	11° 52,87'W	1905	CTD/RO
0039-1	01.07.2009	0:54:59	74° 59,75' N	11° 53,21'W	1904,5	CTD/RO
0040-1	01.07.2009	1:28:00	74° 59,85' N	12° 4,98' W	1648,5	CTD/RO
0040-1	01.07.2009	2:04:00	74° 59,69' N	12° 5,98' W	1633,5	CTD/RO
0040-1	01.07.2009	2:28:59	74° 59,62' N	12° 7,25' W	1607	CTD/RO
0041-1	01.07.2009	3:01:00	74° 59,52' N	12° 18,59'W	1354	CTD/RO
0041-1	01.07.2009	3:32:00	74° 59,28' N	12° 20,10'W	1347	CTD/RO
0041-1	01.07.2009	3:50:59	74° 59,16' N	12° 20,66'W	1344,3	CTD/RO
0042-1	01.07.2009	4:18:00	74° 59,95' N	12° 30,90'W	1024,5	CTD/RO

Station PS74/	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abbreviat-ion
0042-1	01.07.2009	4:45:00	74° 59,69' N	12° 32,13'W	1012,2	CTD/RO
0042-1	01.07.2009	5:01:59	74° 59,56' N	12° 32,68'W	1007,5	CTD/RO
0043-1	01.07.2009	5:31:00	75° 0,09' N	12° 43,89'W	617,8	CTD/RO
0043-1	01.07.2009	5:47:00	75° 0,05' N	12° 44,31'W	613,3	CTD/RO
0043-1	01.07.2009	5:58:59	75° 0,06' N	12° 44,61'W	592,7	CTD/RO
0044-1	01.07.2009	7:00:00	75° 0,16' N	13° 9,38'W	239	CTD/RO
0044-1	01.07.2009	7:08:00	75° 0,11' N	13° 9,37'W	240	CTD/RO
0044-1	01.07.2009	7:16:59	75° 0,06' N	13° 9,37'W	241,8	CTD/RO
0045-1	01.07.2009	9:12:00	74° 59,87' N	13° 39,26'W	188	CTD/RO
0045-1	01.07.2009	9:21:00	74° 59,81' N	13° 39,17'W	187	CTD/RO
0045-1	01.07.2009	9:30:59	74° 59,75' N	13° 39,05'W	185	CTD/RO
0046-1	01.07.2009	11:03:00	75° 0,02' N	14° 19,37'W	151	CTD/RO
0046-1	01.07.2009	11:11:00	74° 59,95' N	14° 19,36'W	155	CTD/RO
0046-1	01.07.2009	11:15:59	74° 59,91' N	14° 19,27'W	151	CTD/RO
0047-1	01.07.2009	12:43:00	75° 0,03' N	15° 1,75'W	104	CTD/RO
0047-1	01.07.2009	12:51:00	74° 59,98' N	15° 1,94'W	105	CTD/RO
0047-1	01.07.2009	12:55:59	74° 59,92' N	15° 2,05'W	109	CTD/RO
0048-1	01.07.2009	14:19:00	74° 59,99' N	15° 39,96'W	202,7	CTD/RO
0048-1	01.07.2009	14:29:00	74° 59,99' N	15° 40,21'W	208	CTD/RO
0048-1	01.07.2009	14:36:59	74° 59,99' N	15° 40,38'W	207,3	CTD/RO
0049-1	01.07.2009	16:55:00	74° 58,20' N	16° 14,03'W	309,2	CTD/RO
0049-1	01.07.2009	17:08:00	74° 58,13' N	16° 14,02'W	309,5	CTD/RO
0049-1	01.07.2009	17:15:59	74° 58,06' N	16° 14,02'W	309,2	CTD/RO
0050-1	03.07.2009	5:19:00	78° 49,91' N	4° 59,90' E	2701,5	MOR
0050-1	03.07.2009	5:20:00	78° 49,92' N	4° 59,90' E	2702,1	MOR
0050-1	03.07.2009	5:31:00	78° 49,95' N	5° 0,15' E	2703	MOR
0050-1	03.07.2009	5:45:00	78° 49,91' N	5° 0,12' E	2702,5	MOR
0050-1	03.07.2009	6:06:00	78° 49,85' N	5° 1,05' E	2698,2	MOR
0050-1	03.07.2009	6:11:00	78° 49,86' N	5° 1,17' E	2697,9	MOR
0050-1	03.07.2009	6:18:00	78° 49,88' N	5° 1,37' E	2698,5	MOR
0050-1	03.07.2009	6:28:00	78° 49,93' N	5° 1,68' E	2696,2	MOR
0050-1	03.07.2009	6:40:00	78° 49,79' N	5° 1,68' E	2694,3	MOR
0050-1	03.07.2009	6:42:00	78° 49,78' N	5° 1,71' E	2692,3	MOR
0050-1	03.07.2009	7:02:59	78° 49,78' N	5° 14,51' E	2626,9	MOR
0051-1	03.07.2009	7:58:00	78° 49,77' N	5° 58,96' E	2477,5	MOR
0051-1	03.07.2009	8:02:00	78° 49,75' N	5° 58,92' E	2477,8	MOR
0051-1	03.07.2009	8:18:00	78° 49,71' N	6° 0,01' E	2468,2	MOR
0051-1	03.07.2009	8:22:00	78° 49,63' N	5° 59,94' E	2468,5	MOR
0051-1	03.07.2009	8:24:00	78° 49,60' N	5° 59,96' E	2468,2	MOR
0051-1	03.07.2009	8:34:00	78° 49,42' N	6° 0,14' E	2467,3	MOR
0051-1	03.07.2009	8:50:00	78° 49,15' N	5° 59,73' E	2470,8	MOR
0051-1	03.07.2009	9:00:00	78° 48,96' N	5° 59,54' E	2471	MOR
0051-1	03.07.2009	9:09:00	78° 48,81' N	5° 59,30' E	2471,7	MOR
0051-1	03.07.2009	9:10:00	78° 48,80' N	5° 59,26' E	2471,9	MOR
0051-1	03.07.2009	9:10:59	78° 48,80' N	5° 59,26' E	2471,9	MOR
0052-1	03.07.2009	10:31:00	78° 49,62' N	6° 58,36' E	1492,5	MOR

Station PS74/	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abbreviat-ion
0052-1	03.07.2009	10:33:00	78° 49,76' N	6° 58,30' E	1492,6	MOR
0052-1	03.07.2009	10:45:00	78° 50,10' N	7° 0,32' E	1455,9	MOR
0052-1	03.07.2009	10:51:00	78° 50,24' N	7° 0,12' E	1455,3	MOR
0052-1	03.07.2009	10:56:00	78° 50,23' N	7° 0,02' E	1456,3	MOR
0052-1	03.07.2009	11:00:00	78° 50,18' N	7° 0,01' E	1457,1	MOR
0052-1	03.07.2009	11:06:00	78° 50,13' N	7° 0,10' E	1457,3	MOR
0052-1	03.07.2009	11:14:00	78° 50,19' N	7° 0,02' E	1456,7	MOR
0052-1	03.07.2009	11:21:00	78° 50,18' N	6° 59,96' E	1457,5	MOR
0052-1	03.07.2009	11:33:59	78° 50,16' N	6° 59,99' E	1458,3	MOR
0053-1	03.07.2009	12:51:00	78° 50,02' N	7° 58,70' E	1043,6	MOR
0053-1	03.07.2009	12:53:00	78° 50,04' N	7° 58,92' E	1042,6	MOR
0053-1	03.07.2009	13:06:00	78° 50,00' N	7° 59,86' E	1033,2	MOR
0053-1	03.07.2009	13:08:00	78° 50,00' N	7° 59,84' E	1033,1	MOR
0053-1	03.07.2009	13:13:00	78° 49,96' N	7° 59,87' E	1031,9	MOR
0053-1	03.07.2009	13:25:00	78° 49,88' N	7° 59,76' E	1032,3	MOR
0053-1	03.07.2009	13:35:59	78° 49,79' N	7° 59,92' E	1031,6	MOR
0054-1	03.07.2009	13:38:01	78° 49,75' N	7° 59,98' E	1030,6	BUOY
0054-1	03.07.2009	13:38:59	78° 49,75' N	7° 59,98' E	1030,6	BUOY
0055-1	03.07.2009	17:23:00	78° 49,96' N	5° 0,30' E	2704,2	CTD/RO
0055-1	03.07.2009	18:17:00	78° 49,81' N	4° 59,11' E	2697	CTD/RO
0055-1	03.07.2009	19:00:59	78° 49,85' N	4° 58,91' E	2697,5	CTD/RO
0056-1	03.07.2009	19:38:00	78° 49,93' N	5° 25,07' E	2619,5	CTD/RO
0056-1	03.07.2009	20:33:00	78° 50,00' N	5° 25,32' E	2620,2	CTD/RO
0056-1	03.07.2009	21:14:59	78° 49,99' N	5° 25,45' E	2620	CTD/RO
0057-1	03.07.2009	21:54:00	78° 49,95' N	5° 50,88' E	2527	CTD/RO
0057-1	03.07.2009	22:46:00	78° 50,05' N	5° 50,56' E	2529,3	CTD/RO
0057-1	03.07.2009	23:24:59	78° 50,18' N	5° 50,20' E	2532	CTD/RO
0058-1	03.07.2009	23:48:00	78° 49,84' N	5° 59,86' E	2470,5	CTD/RO
0058-1	04.07.2009	0:41:00	78° 49,87' N	5° 59,95' E	2469,7	CTD/RO
0058-1	04.07.2009	1:20:59	78° 49,97' N	6° 0,26' E	2468,3	CTD/RO
0059-1	04.07.2009	1:47:00	78° 49,94' N	6° 15,60' E	2283,5	CTD/RO
0059-1	04.07.2009	2:36:00	78° 49,76' N	6° 15,38' E	2288	CTD/RO
0059-1	04.07.2009	3:13:59	78° 49,84' N	6° 16,22' E	2272,3	CTD/RO
0060-1	04.07.2009	3:50:00	78° 50,01' N	6° 42,65' E	1738	CTD/RO
0060-1	04.07.2009	4:27:00	78° 50,25' N	6° 42,36' E	1741,8	CTD/RO
0060-1	04.07.2009	4:56:59	78° 50,33' N	6° 42,11' E	1746,6	CTD/RO
0061-1	04.07.2009	7:00:00	78° 50,27' N	8° 19,39' E	799,9	MOR
0061-1	04.07.2009	7:02:00	78° 50,29' N	8° 19,54' E	796,6	MOR
0061-1	04.07.2009	7:18:00	78° 50,16' N	8° 19,05' E	807,9	MOR
0061-1	04.07.2009	7:19:00	78° 50,16' N	8° 18,97' E	808,6	MOR
0061-1	04.07.2009	7:24:00	78° 50,13' N	8° 18,69' E	813,3	MOR
0061-1	04.07.2009	7:33:01	78° 50,09' N	8° 18,13' E	820,9	MOR
0061-1	04.07.2009	7:33:02	78° 50,09' N	8° 18,13' E	820,9	MOR
0061-1	04.07.2009	7:33:59	78° 50,09' N	8° 18,13' E	820,9	MOR
0062-1	04.07.2009	8:12:00	78° 49,93' N	8° 39,84' E	251,3	MOR
0062-1	04.07.2009	8:13:00	78° 49,94' N	8° 39,92' E	250,1	MOR

Station PS74/	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abbreviat-ion
0062-1	04.07.2009	8:28:00	78° 49,98' N	8° 39,67' E	254,3	MOR
0062-1	04.07.2009	8:34:01	78° 49,98' N	8° 39,53' E	256,5	MOR
0062-1	04.07.2009	8:34:02	78° 49,98' N	8° 39,53' E	256,5	MOR
0062-1	04.07.2009	8:34:59	78° 49,98' N	8° 39,53' E	256,5	MOR
0063-1	04.07.2009	11:34:00	78° 45,01' N	6° 31,07' E	1858,8	GLD
0063-1	04.07.2009	11:40:00	78° 45,00' N	6° 31,39' E	1852,5	GLD
0063-1	04.07.2009	12:54:01	78° 44,67' N	6° 33,43' E	1807,3	GLD
0063-1	04.07.2009	12:54:59	78° 44,67' N	6° 33,43' E	1807,3	GLD
0064-1	04.07.2009	13:05:00	78° 45,39' N	6° 36,53' E	1777,2	TD
0064-1	04.07.2009	13:05:59	78° 45,39' N	6° 36,53' E	1777,2	TD
0065-1	04.07.2009	13:54:00	78° 50,05' N	7° 0,06' E	1461,3	MOR
0065-1	04.07.2009	14:06:00	78° 50,02' N	7° 0,09' E	1461,4	MOR
0065-1	04.07.2009	14:16:00	78° 50,01' N	7° 0,04' E	1463,3	MOR
0065-1	04.07.2009	14:26:00	78° 50,02' N	6° 59,95' E	1463,8	MOR
0065-1	04.07.2009	14:35:00	78° 50,03' N	7° 0,02' E	1462,5	MOR
0065-1	04.07.2009	14:44:00	78° 50,01' N	7° 0,07' E	1462,5	MOR
0065-1	04.07.2009	14:46:00	78° 50,00' N	7° 0,06' E	1463	MOR
0065-1	04.07.2009	14:52:00	78° 50,00' N	7° 0,02' E	1463,7	MOR
0065-1	04.07.2009	14:55:00	78° 50,00' N	7° 0,02' E	1464	MOR
0065-1	04.07.2009	14:56:59	78° 50,00' N	7° 0,03' E	1463,5	MOR
0066-1	04.07.2009	15:10:00	78° 50,98' N	7° 0,34' E	1447,8	CTD/RO
0066-1	04.07.2009	15:42:00	78° 51,16' N	7° 0,70' E	1440,3	CTD/RO
0066-1	04.07.2009	16:05:59	78° 51,11' N	7° 0,71' E	1441,2	CTD/RO
0067-1	04.07.2009	16:23:00	78° 50,03' N	7° 8,66' E	1366,3	CTD/RO
0067-1	04.07.2009	16:53:00	78° 50,19' N	7° 9,09' E	1364,8	CTD/RO
0067-1	04.07.2009	17:11:59	78° 50,36' N	7° 9,46' E	1354,3	CTD/RO
0068-1	04.07.2009	17:46:00	78° 50,01' N	7° 33,71' E	1146	CTD/RO
0068-1	04.07.2009	18:12:00	78° 50,00' N	7° 33,99' E	1144	CTD/RO
0068-1	04.07.2009	18:28:59	78° 50,01' N	7° 34,04' E	1144	CTD/RO
0069-1	04.07.2009	19:10:00	78° 50,03' N	7° 59,92' E	1033,3	CTD/RO
0069-1	04.07.2009	19:35:00	78° 50,05' N	8° 0,24' E	1030,6	CTD/RO
0069-1	04.07.2009	19:48:59	78° 50,06' N	7° 59,83' E	1034	CTD/RO
0070-1	04.07.2009	20:20:00	78° 49,50' N	8° 19,92' E	791,2	CTD/RO
0070-1	04.07.2009	20:42:00	78° 49,56' N	8° 20,17' E	786,2	CTD/RO
0070-1	04.07.2009	20:52:59	78° 49,57' N	8° 20,15' E	786,3	CTD/RO
0071-1	04.07.2009	21:40:00	78° 49,97' N	8° 51,87' E	230,8	CTD/RO
0071-1	04.07.2009	21:51:00	78° 49,96' N	8° 52,15' E	231,5	CTD/RO
0071-1	04.07.2009	21:56:59	78° 49,95' N	8° 52,18' E	231,4	CTD/RO
0072-1	04.07.2009	22:34:00	78° 49,99' N	9° 16,97' E	210,5	CTD/RO
0072-1	04.07.2009	22:45:00	78° 49,98' N	9° 17,16' E	209,9	CTD/RO
0072-1	04.07.2009	22:49:59	78° 49,98' N	9° 17,18' E	210,2	CTD/RO
0073-1	04.07.2009	23:27:00	78° 50,04' N	9° 42,75' E	99,4	CTD/RO
0073-1	04.07.2009	23:33:00	78° 50,01' N	9° 42,95' E	101,6	CTD/RO
0073-1	04.07.2009	23:35:59	78° 50,00' N	9° 42,90' E	101,8	CTD/RO
0074-1	05.07.2009	0:03:00	78° 50,00' N	9° 59,84' E	77	CTD/RO
0074-1	05.07.2009	0:09:00	78° 49,98' N	9° 59,77' E	2259,1	CTD/RO

Station PS74 /	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abbreviat-ion
0074-1	05.07.2009	0:12:59	78° 49,99' N	9° 59,92' E	136	CTD/RO
0075-1	05.07.2009	4:04:00	78° 50,01' N	8° 40,07' E	246,1	MOR
0075-1	05.07.2009	4:05:00	78° 50,02' N	8° 40,11' E	245,4	MOR
0075-1	05.07.2009	4:16:00	78° 49,99' N	8° 40,10' E	244,9	MOR
0075-1	05.07.2009	4:19:00	78° 49,99' N	8° 40,07' E	245,9	MOR
0075-1	05.07.2009	4:20:00	78° 49,99' N	8° 40,09' E	245,3	MOR
0075-1	05.07.2009	4:22:00	78° 50,00' N	8° 40,15' E	244,3	MOR
0075-1	05.07.2009	4:22:59	78° 50,00' N	8° 40,15' E	244,3	MOR
0076-1	05.07.2009	5:03:00	78° 50,44' N	8° 20,11' E	783,4	MOR
0076-1	05.07.2009	5:18:00	78° 50,41' N	8° 19,96' E	786,2	MOR
0076-1	05.07.2009	5:29:00	78° 50,40' N	8° 19,97' E	786,2	MOR
0076-1	05.07.2009	5:33:00	78° 50,39' N	8° 20,01' E	786	MOR
0076-1	05.07.2009	5:36:00	78° 50,40' N	8° 20,02' E	785,4	MOR
0076-1	05.07.2009	5:38:59	78° 50,40' N	8° 20,00' E	785,7	MOR
0077-1	05.07.2009	6:36:00	78° 49,98' N	7° 59,93' E	1032	MOR
0077-1	05.07.2009	6:37:00	78° 49,98' N	7° 59,95' E	1031,9	MOR
0077-1	05.07.2009	6:39:00	78° 49,99' N	7° 59,99' E	1031,7	MOR
0077-1	05.07.2009	6:47:00	78° 49,99' N	8° 0,10' E	1031,4	MOR
0077-1	05.07.2009	7:02:00	78° 50,01' N	8° 0,04' E	1031,7	MOR
0077-1	05.07.2009	7:12:00	78° 49,99' N	7° 59,92' E	1032,6	MOR
0077-1	05.07.2009	7:15:00	78° 50,00' N	7° 60,00' E	1032,1	MOR
0077-1	05.07.2009	7:18:00	78° 50,01' N	8° 0,03' E	1031,8	MOR
0077-1	05.07.2009	7:20:00	78° 50,01' N	8° 0,04' E	1031,8	MOR
0077-1	05.07.2009	7:20:02	78° 50,01' N	8° 0,04' E	1031,8	MOR
0077-1	05.07.2009	7:20:59	78° 50,01' N	8° 0,04' E	1031,8	MOR
0078-1	05.07.2009	15:38:00	78° 50,01' N	6° 0,29' E	2467,7	MOR
0078-1	05.07.2009	15:38:01	78° 50,01' N	6° 0,29' E	2467,7	MOR
0078-1	05.07.2009	15:54:00	78° 49,97' N	6° 0,07' E	2468,7	MOR
0078-1	05.07.2009	16:10:00	78° 49,99' N	6° 0,09' E	2468,8	MOR
0078-1	05.07.2009	16:31:00	78° 50,01' N	6° 0,06' E	2469,3	MOR
0078-1	05.07.2009	16:47:00	78° 50,00' N	6° 0,08' E	2469,2	MOR
0078-1	05.07.2009	16:57:00	78° 50,00' N	6° 0,02' E	2469,5	MOR
0078-1	05.07.2009	16:59:00	78° 50,00' N	6° 0,01' E	2469,8	MOR
0078-1	05.07.2009	17:02:00	78° 50,00' N	6° 0,01' E	2469,7	MOR
0078-1	05.07.2009	17:04:59	78° 50,00' N	6° 0,01' E	2469,8	MOR
0079-1	05.07.2009	19:22:00	78° 50,00' N	4° 10,01' E	2415,2	CTD/RO
0079-1	05.07.2009	20:11:00	78° 50,01' N	4° 10,32' E	2415,2	CTD/RO
0079-1	05.07.2009	20:48:59	78° 50,01' N	4° 10,12' E	2415,3	CTD/RO
0080-1	05.07.2009	21:56:00	78° 50,02' N	3° 20,19' E	2388	CTD/RO
0080-1	05.07.2009	22:45:00	78° 50,06' N	3° 20,13' E	2388,2	CTD/RO
0080-1	05.07.2009	23:24:59	78° 50,07' N	3° 20,18' E	2388	CTD/RO
0081-1	06.07.2009	0:33:00	78° 50,09' N	2° 30,14' E	2522,5	CTD/RO
0081-1	06.07.2009	1:22:00	78° 50,15' N	2° 30,01' E	2521,3	CTD/RO
0081-1	06.07.2009	1:58:59	78° 50,11' N	2° 29,55' E	2520,7	CTD/RO
0082-1	06.07.2009	5:50:00	78° 50,04' N	5° 29,25' E	2613,5	MOR
0082-1	06.07.2009	5:55:00	78° 50,05' N	5° 29,14' E	2613,7	MOR

Station PS74 /	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abbreviat-ion
0082-1	06.07.2009	5:58:00	78° 50,04' N	5° 29,16' E	2613,7	MOR
0082-1	06.07.2009	6:36:00	78° 50,04' N	5° 29,09' E	2613,5	MOR
0082-1	06.07.2009	6:51:00	78° 50,02' N	5° 29,06' E	2613,2	MOR
0082-1	06.07.2009	6:55:00	78° 50,03' N	5° 29,00' E	2613,5	MOR
0082-1	06.07.2009	7:06:00	78° 50,04' N	5° 29,08' E	2613,8	MOR
0082-1	06.07.2009	7:08:59	78° 50,03' N	5° 29,12' E	2613,5	MOR
0082-1	06.07.2009	7:10:00	78° 50,03' N	5° 29,10' E	2613,3	MOR
0083-1	06.07.2009	7:54:00	78° 50,05' N	5° 0,37' E	2704	MOR
0083-1	06.07.2009	7:56:00	78° 50,04' N	5° 0,39' E	2706	MOR
0083-1	06.07.2009	7:58:00	78° 50,03' N	5° 0,40' E	2704	MOR
0083-1	06.07.2009	8:16:00	78° 50,03' N	5° 0,37' E	2704	MOR
0083-1	06.07.2009	8:36:00	78° 50,01' N	5° 0,27' E	2704,7	MOR
0083-1	06.07.2009	8:53:00	78° 50,02' N	5° 0,33' E	2704,2	MOR
0083-1	06.07.2009	9:05:00	78° 50,02' N	5° 0,23' E	2704,7	MOR
0083-1	06.07.2009	9:24:00	78° 50,01' N	5° 0,28' E	2704,7	MOR
0083-1	06.07.2009	9:38:00	78° 50,03' N	5° 0,25' E	2704,8	MOR
0083-1	06.07.2009	9:40:01	78° 50,03' N	5° 0,25' E	2705	MOR
0083-1	06.07.2009	9:40:59	78° 50,03' N	5° 0,25' E	2705	MOR
0084-1	06.07.2009	13:49:00	78° 50,02' N	1° 39,92' E	2549	CTD/RO
0084-1	06.07.2009	14:41:00	78° 49,98' N	1° 37,96' E	2547	CTD/RO
0084-1	06.07.2009	15:26:59	78° 50,11' N	1° 37,66' E	2546,7	CTD/RO
0085-1	06.07.2009	16:27:00	78° 49,93' N	0° 49,98' E	2397,2	CTD/RO
0085-1	06.07.2009	17:16:00	78° 50,01' N	0° 48,22' E	2405,3	CTD/RO
0085-1	06.07.2009	17:50:59	78° 50,00' N	0° 45,84' E	2418,5	CTD/RO
0086-1	06.07.2009	18:48:00	78° 49,96' N	0° 1,32' E	2639	CTD/RO
0086-1	06.07.2009	19:43:00	78° 50,00' N	0° 0,13' E	2640,2	CTD/RO
0086-1	06.07.2009	20:20:59	78° 50,05' N	0° 0,15'W	2640,7	CTD/RO
0087-1	06.07.2009	21:30:00	78° 50,07' N	0° 48,82' W	2660	CTD/RO
0087-1	06.07.2009	22:23:00	78° 50,10' N	0° 50,63' W	2661	CTD/RO
0087-1	06.07.2009	23:02:59	78° 50,02' N	0° 51,70' W	2657,2	CTD/RO
0088-1	07.07.2009	0:19:00	78° 49,96' N	1° 39,69' W	2707	CTD/RO
0088-1	07.07.2009	1:16:00	78° 50,02' N	1° 35,57' W	2702,3	CTD/RO
0088-1	07.07.2009	1:59:59	78° 50,13' N	1° 32,42' W	2695,7	CTD/RO
0089-1	07.07.2009	3:43:00	78° 50,02' N	2° 29,11' W	2645,5	CTD/RO
0089-1	07.07.2009	4:33:00	78° 50,17' N	2° 26,55' W	2652,7	CTD/RO
0089-1	07.07.2009	4:50:00	78° 50,22' N	2° 25,46' W	2654,8	CTD/RO
0089-1	07.07.2009	4:57:00	78° 50,20' N	2° 25,11' W	2655,5	CTD/RO
0089-1	07.07.2009	5:41:59	78° 50,22' N	2° 22,03' W	2666,5	CTD/RO
0090-1	07.07.2009	8:10:00	78° 50,39' N	3° 18,71' W	2402,3	CTD/RO
0090-1	07.07.2009	9:02:00	78° 50,09' N	3° 18,98' W	2400,5	CTD/RO
0090-1	07.07.2009	9:40:59	78° 49,93' N	3° 18,72' W	2401,5	CTD/RO
0091-1	07.07.2009	11:06:00	78° 49,64' N	3° 44,39' W	2120	CTD/RO
0091-1	07.07.2009	11:52:00	78° 48,92' N	3° 44,55' W	2112,7	CTD/RO
0091-1	07.07.2009	12:23:59	78° 48,46' N	3° 44,53' W	2104,5	CTD/RO
0092-1	07.07.2009	13:51:00	78° 49,04' N	4° 12,98' W	1729	CTD/RO
0092-1	07.07.2009	14:26:00	78° 48,56' N	4° 13,87' W	1705,7	CTD/RO

Station PS74/	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abbreviat-ion
0092-1	07.07.2009	14:54:59	78° 48,16' N	4° 14,53' W	1688,2	CTD/RO
0093-1	08.07.2009	6:04:00	78° 49,98' N	5° 59,81' E	0	TEST
0093-1	08.07.2009	8:00:00	78° 49,75' N	6° 1,25' E	0	TEST
0093-1	08.07.2009	8:26:59	78° 49,82' N	6° 1,60' E	0	TEST
0094-1	08.07.2009	10:55:00	78° 50,01' N	5° 59,90' E	0	TEST
0094-1	08.07.2009	11:25:00	78° 50,02' N	5° 60,00' E	0	TEST
0094-1	08.07.2009	11:58:59	78° 49,99' N	5° 59,31' E	0	TEST
0095-1	08.07.2009	12:29:00	78° 49,98' N	6° 0,16' E	0	TEST
0095-1	08.07.2009	13:13:00	78° 50,26' N	5° 59,68' E	0	TEST
0095-1	08.07.2009	13:55:59	78° 49,99' N	5° 59,91' E	0	TEST
0096-1	09.07.2009	6:06:00	78° 28,54' N	8° 51,71' E	1066	CTD/RO
0096-1	09.07.2009	6:35:00	78° 28,60' N	8° 51,46' E	1067,7	CTD/RO
0096-1	09.07.2009	6:54:59	78° 28,68' N	8° 50,93' E	1075,2	CTD/RO

Moorings recovered in Fram Strait

Mooring	Latitude Longitude	Water Depth (m)	Date Time first Record last Record	Instrument Type	Serial Number	Instrument Depth (m)
F1-11	78° 50.00' N	241	07.07.2008	AVT	8395	61
	08° 40.03' E		06:00	SBE37	225	77[1]
			04.07.2009	SBE37	226	227
			08:00	RCM11	20	234
F2-12	78° 50.40' N	782	07.07.2008	AVT	10002	59
	08° 20.00' E		12:00	SBE16	1973	80
			04.07.2009	AVT	10004	251
			06:00	SBE16-TR	2418	771
				AVT	11613	773[2]
F3-11	78° 50.00' N	1011	07.07.2008	AVT	11889	62
	07° 59.99' E		16:00	SBE37	239	80
			03.07.2009	AVT	9213	254
			12:00	SBE37	2723	255
				AVT	9786	755[2]
				AVT	10498	999
				SBE17-TR	2419	1000
F4-11	78° 50.00' N	1432	07.07.2008	SBE37	236	74[1]
	07° 00.00' E		18:00	ADCP-up	1368	94
			03.07.2009	AVT	11888	249[3]
			10:00	RCM11	215	754
				RCM11	26	1423
				SBE16-TR	2421	1424
F5-11	78° 50.00' N	2412	12.07.2008	RCM11	474	63
	06° 00.00' E		14:00	SBE37	2395	80
			03.07.2009	RCM11	500	255
			06:00	RCM11	512	751
				RCM11	217	1507
				RCM11	214	2403
F6-12	78° 50.02' N	2644	12.07.2008	RCM11	475	65
	05° 00.25' E		18:00	SBE37	243	80
			03.07.2009	RCM11	491	252
			04:00	RCM11	469	748
				RCM11	488	1504
				RCM11	135	2635
				AVT	9219	255
				RCM11	462	752
				RCM11	506	1507
				RCM11	509	2654
				SBE26	227	2644

Moorings recovered along 75° N transect

Mooring	Latitude Longitude	Water Depth (m)	Date Time first Record last Record	Instrument Type	Serial Number	Instrument Depth (m)
AWI-J032	74° 50.00' N 02° 29.93' W	3697	27.06.2008 00:00 28.06.2009 11:00	SBE37 SBE19	478 2378	188 190-3680
AWI-J033	75° 05.00' N 03° 27.00' W	3667	27.06.2008 00:00 28.06.2009 05:00	SBE37 SBE19	479 2639	179 181-3670
AWI-J034	74° 55.03' N 04° 37.01' W	3616	27.06.2008 00:00 29.06.2009 07:00	SBE37 SBE19	803 1889	133 135-3560
AWI-JP34	74° 56.02' N 04° 36.90' W	3618	27.06.2008 00:00 29.06.2009 11:00	PROF	001	0-160

Moorings deployed along 75° N transect

Mooring	Latitude Longitude	Water Depth (m)	Date Time first Record last Record	Instrument Type	Serial Number	Instrument Depth (m)
AWI-J035	74° 49.99' N 02° 30.02' W	3698	28.06.2009 16:00	SBE37 SBE19	802 2377	120 125-3685
AWI-J036	75° 05.00' N 03° 27.10' W	3668	28.06.2009 10:00	AQD SBE37 SBE19	1649 2817 2639	85 90 181-3645
AWI-J037	74° 55.01' N 04° 36.99' W	3615	29.06.2009 11:00	AQD SBE37 SBE19	1958 2818 2027	85 90 95-3600
AWI-JP37	74° 56.06' N 04° 36.92' W	3618	29.06.2009 15:00	PROF	002	0-180

Moorings deployed in Fram Strait

Mooring	Latitude Longitude	Water Depth (m)	Date Time 1. Record	Instrument Type	Serial Number	Instrument Depth (m)
F1-12	78° 50.00' N	241	06.07.2009	AVT	10003	61
	08° 40.15' E		06:00	SBE37	211	77
				SBE37	241	227
				RCM11	513	234
F2-13	78° 50.40' N	782	05.07.2009	AVT	9204	61
	08° 20.02' E		06:00	SBE16	2413	80
				AVT	9785	251
				SBE37	214	252
				SBE16-TR	2418	771
				AVT	8037	773
F3-12	78° 50.01' N	1011	05.07.2009	AVT	8367	62
	08° 00.04' E		08:00	SBE37	244	80
				AVT	8400	254
				SBE37	215	255
				AVT	9212	755
				RCM11	315	999
				SBE17-TR	2419	1001
F4-12	78° 50.00' N	1432	04.07.2009	SBE37	245	74
	07° 00.02' E		16:00	AVT	9207	94
				RCM11	101	249
				RCM11	127	754
				HAM	516	755
				RCM11	570	1423
				SBE16-TR	2521	1424
F5-12	78° 50.00' N	2412	05.07.2009	AVT	10541	63
	06° 00.01' E		18:00	SBE37	246	80
				AVT	9997	255
				RCM11	458	751
				HAM	515	752
				RCM11	146	1507
				RCM11	212	2403
F22-1	78° 50.03' N	2564	06.07.2009	HYD	HS5	480
	05° 29.12' E		08:00	HAM	517	794
F6-13	78° 50.03' N	2644	06.07.2009	AVT	10926	65
	05° 00.25' E		10:00	SBE37	247	70
				AVT	9194	252
				RCM11	472	748
				HAM	514	749
				RCM11	216	1504
				RCM11	219	2635

Abbreviations:

ADCP	RD-Instruments, Self Contained Acoustic Doppler Current Profiler
AVT	Aanderaa Current Meter with Temperature Sensor
AQD	Nortec Aquadropp Acoustic Current Meter
RCM 11	Aanderaa Doppler Current Meter
SBE16	SeaBird Electronics Self Recording CTD to measure Temperature, Conductivity and Pressure
SBE16-TR	SeaBird Electronics Self Recording CTD to measure Temperature, Conductivity and Pressure; with Transmissometer
SBE19	SeaBird Electronics Self Recording CTD to measure Temperature, Conductivity and Pressure; used with density controlled profiling vehicle
SBE37	SeaBird Electronics, Type: MicroCat, to measure Temperature and Conductivity
HAM	Hydro Acoustic Modem (data link between moorings)
HYD	Hydrophone; sound recorder
PROF	CTD-Profiler with Under Water Winch

Remarks:
Blank field: passive instrument with not data recording
(1) No data recorded – battery low
(2) Rotor lost during the deployment
(3) Vane bearing broken – not clear whether it happened during the deployment