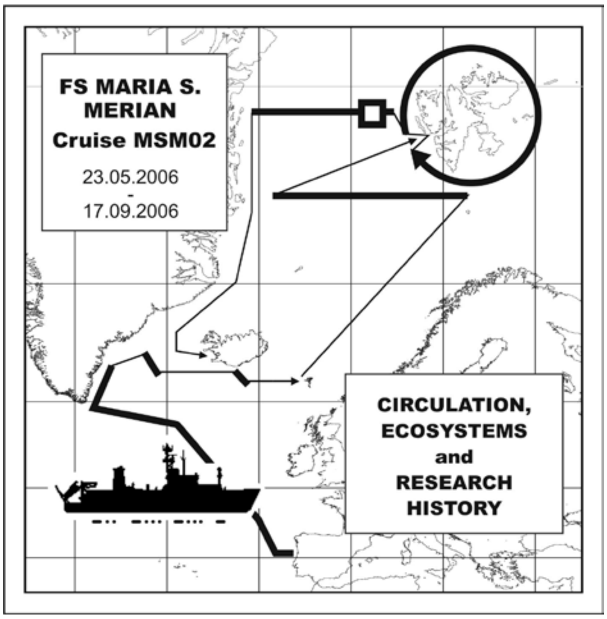
MARIA S. MERIAN-Berichte 09-1

Circulation and Ecosystems in the Subpolar and Polar North Atlantic

Cruise No. 2

May 23 to September 16, 2006
Lisbon – Tórshavn – Longyearbyen – Longyearbyen – Reykjavik



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Leitstelle METEOR/MERIAN
Institut für Meereskunde der Universität Hamburg

2009

The Maria S. Merian-Berichte are published at irregular intervals. They are working papers for people who are occupied with the respective expedition and are intended as reports for the funding institutions. The opinions expressed in the Maria S. Merian-Berichte are only those of the authors. The reports can be obtained from:

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The reports are available in PDF format from http://www.dfg-ozean.de/. The Maria S. Merian expeditions are funded by the *Deutsche Forschungsgemeinschaft* and the *Bundesministerium für Bildung und Forschung*.

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Citations:

Lherminier P, Meincke J, Freiwald A, Schauer U (2009) (Eds) Circulation and Ecosystems in the Subpolar and Polar North Atlantic, Cruise No. 2, May 23 - September 16, 2006. Maria S. Merian-Berichte 09-1, 174 pp, Universität Hamburg.

ISSN 1868-8543

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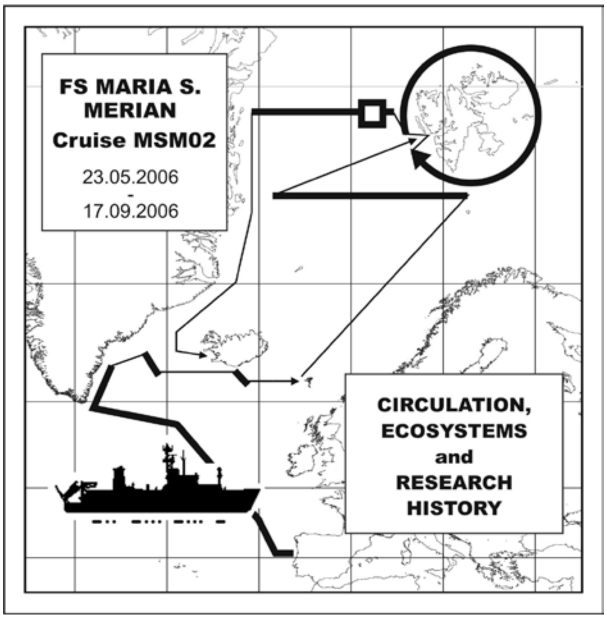

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2009

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Abstract

The four legs of the second cruise of R/V MARIA S. MERIAN, MSM02, served mainly long-term studies of the variability of physical and biological systems of the northern North Atlantic. Leg 1 was part of the international barter agreement between NERC (Natural Environment Research Council), IFREMER (Institut Français de Recherche pour l'Exploitation de la Mer), BMBF (Bundesministerium für Bildung und Forschung), IMR (Institute for Marine Research, Bergen) and NIOZ (Royal Netherlands Institute for Sea Research) which is organised by the Ocean Facilities Exchange Group (OFEG). The leg served to continue a French long-term observation of the North-Atlantic circulation and meridional overturning. It repeated a hydrographic section including a comprehensive tracer programme between Portugal and southern Greenland and exchanged moorings. The second leg conducted CTD sections and mooring work addressing the East Greenland Current and the convection state in the Greenland Sea Gyre. During the third leg biosedimentary systems of polar carbonate deposits were investigated with respect to recent climate variability. This work was combined with a study of polar research history on Spitsbergen. The last leg addressed the interannual variability of water mass exchange between North Atlantic and Arctic Ocean through the Fram Strait and of the ecology of the polar deep sea.

Zusammenfassung

Die zweite Reise des R/V MARIA S. MERIAN setzte sich aus vier Abschnitten mit vorwiegend ozeanographischen und biologischen Langzeitprogrammen zur Variabilität im nördlichen Nordatlantik zusammen. Der erste Fahrtabschnitt führte ein französisches Langzeitprogramm zur Erfassung der atlantischen Umwälzbewegung fort, bei dem ein hydrographischer Schnitt mit einem umfangreichen Tracerprogramm zwischen Portugal und dem südlichen Grönland aufgenommen wurde. Der zweite Abschnitt galt dem Ostgrönlandstrom und der Konvektion in der Grönlandsee. Auf dem dritten Abschnitt wurden neben einer polarforschungs-historischen Studie auf Spitzbergen biosedimentäre Systeme polarer Karbonatvorkommen auf den Schelfen Svalbards im Zusammenhang mit rezenter Klimavariabilität analysiert. Im letzten Abschnitt wurden Langzeitmessungen zum Wasser-massenaustausch zwischen Nordatlantik und dem Nordpolarmeer durch die Framstraße und zur Ökologie der polaren Tiefsee fortgeführt.

Research Objectives

The second cruise of RV MARIA S. MERIAN aimed at continuing long-term studies of the variability of physical and biological systems of the North Atlantic. The first leg focused at continuation of a French long-term observation of the North-Atlantic circulation and meridional overturning (OVIDE). It repeated a hydrographic section including a comprehensive tracer programme between Portugal and southern Greenland and exchanges moorings array. The second leg was a contribution to the Hamburg Special Research programme 512, work package ”The east Greenland Current - indicator of low frequency variability of the outflow from the system Arctic Ocean/Nordic Seas” and to the research topic “Convection and transports in the Greenland Sea” of the Alfred Wegener Institute. During the third leg biosedimentary systems of polar carbon deposits were investigated with respect to recent climate variability. This was combined with a study of polar research history on Spitsbergen. The last leg addressed the interannual variability of water mass exchange between North Atlantic and Arctic Ocean through Fram Strait and the ecology of the polar deep sea.

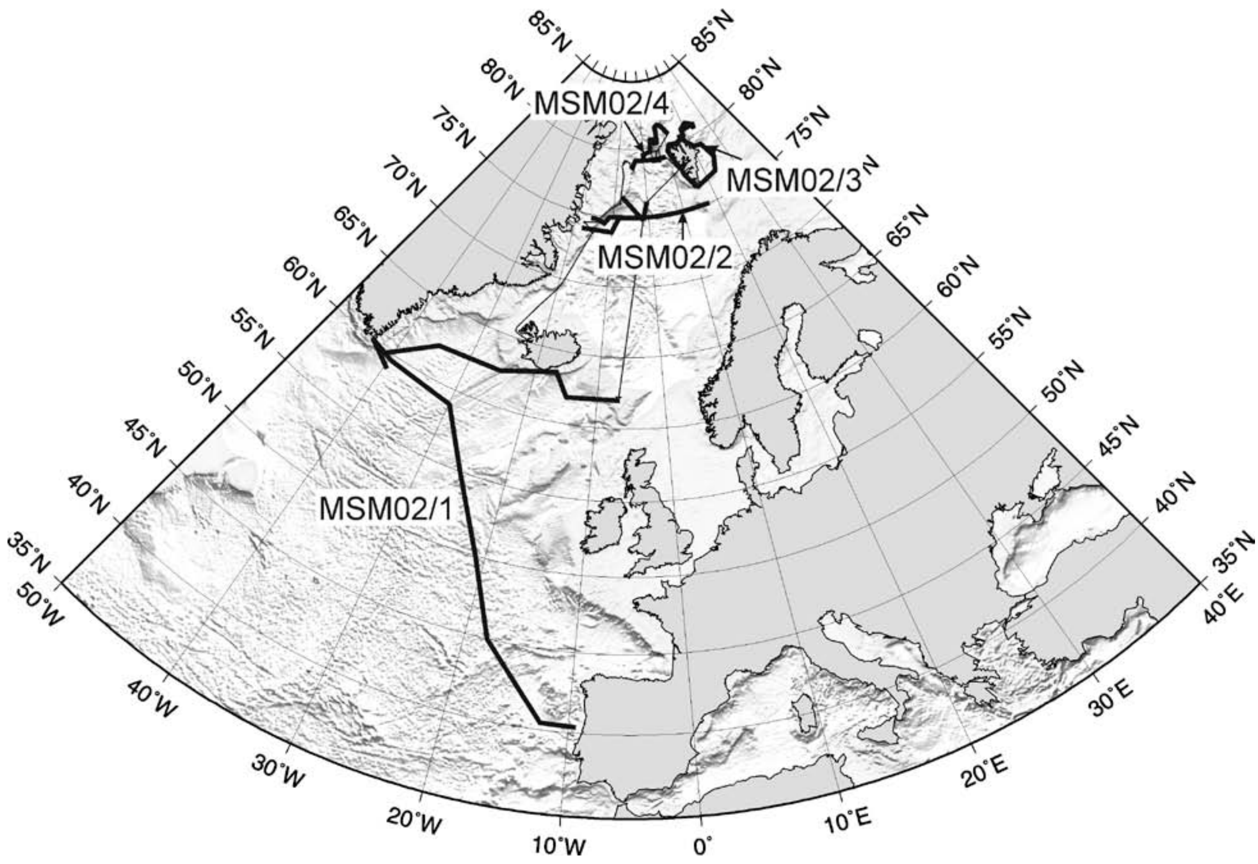

Fig. 1: Working areas of the four legs of cruise MSM02. Detailed cruise tracks and sampling stations are illustrated in the respective reports

Abb. 1: Untersuchungsgebiete der vier Fahrtabschnitte der Expedition MSM02. Detaillierter Fahrtverlauf und Stationen können den jeweiligen Fahrtabschnittsberichten entnommen werden

MSM02/1 repeated a hydrological section (CLIVAR section A25) crossing the North Atlantic from Greenland to Portugal to monitor the variability of water mass properties and transports in the basin. It was the third survey after 2002 and 2004. Along the section, 95 stations were conducted measuring tracers and carbon in addition to temperature, salinity and currents at full depth stations every 30 nm at most. At this section, the Meridional Overturning Circulation is mainly the balance between the North Atlantic Current and the Deep Western Boundary Current and the highly variable East Greenland Current. The flow field across the section was obtained by combining geostrophy with direct current observations measured by the shipborne ADCP. In addition, an array of four current meter moorings and one ADCP lander was recovered on the East Greenland slope and shelf after 2 years at sea. The cruise was carried out in the framework of the French programmes OVIDE and PNEDC, and was also related to the ARGO programme and to CARBOCEAN.

MSM02/2 was directed to measuring the seasonal to interannual variability of the water mass composition and the transports within the East Greenland Current and of the convective activity in the Greenland Sea gyre. It aimed at quantifying those processes of the Nordic Seas which provide the Arctic input of freshwater and dense overflow to the North Atlantic and thereby control the Atlantic thermohaline overturning circulation. The programme had three components: (i) the deployment of a bottom current meter at the sill of the Jan Mayen Channel for colleagues at the Geophysical Institute of the University of Bergen/Norway; (ii) a hydrographic section and the recovery/redeployment of moored current meters on the shelf and the slope off East Greenland near 74° N for the ZMAW Hamburg and (iii) Hydrographic sections and recovery/redeployment of moored profiling CTDs along 75° N from the shelf off East Greenland to the shelf north of Bear Island for the AWI.

MSM02/3 was a multidisciplinary approach to investigate the environmental controls and post-glacial climate variability of biosedimentary systems on the shelves around Svalbard. Special emphasis was laid on the evolution of polar carbonates – the least known system of non-tropical carbonate factories – and their potential as paleo-environment recorder. The major working tool was the manned research submersible JAGO which operated in the topographically complex terrains that are difficult to sample with conventional gear. Detailed bathymetric maps were produced with the multibeam before a complex program was conducted including bottom photography with a towed photo sledge, underwater light level measurements, CTD profiles and water sampling with special attention to measurement of carbonate saturation and isotopic calibration, and dredging and coring for description of the sediment and its fauna. The programme was complemented by geological sampling of the seabed. The cruise included also a polar-historical component, the search of remnants of the Deutsche Arktis-Expedition in 1912 as well as the rescue expedition, which was partly conducted on land.

MSM02/4 served to determine the long-term variability of oceanic fluxes through Fram Strait and changes of marine polar ecosystems carried out by AWI. The flow between the North Atlantic and the Arctic Ocean is captured by a mooring line at 79°N that is maintained since 1997, at present in the framework of the EU-funded programme DAMOCLES. The moorings of this line were recovered and redeployed, complemented by a CTD survey providing temperature, salinity and velocity at a high spatial resolution. The multidisciplinary study of polar deep-sea ecosystems in the AWI-HAUSGARTEN lasts for a similar time period. In order to identify interannual changes, repeat-stations between 1000 and 5500 m water depth were sampled for biological, geochemical and sedimentological parameters. Lander and moorings for seasonal resolution were exchanged. U Bremen conducted multinet casts to capture the biodiversity and feeding strategy of dominant polar deep-sea copepods. This work was part of the national project “Biodiversity and ecology of deep-sea copepods in polar seas – speciation processes and ecological niches in the homogeneous environment of the pelagic realm” and a contribution to Census of Marine Zooplankton (CMarZ) and Census of Marine Life (CoML).

Forschungsziel

Die zweite Reise des FS MARIA S. MERIAN setzte sich aus vier Abschnitten mit vorwiegend ozeanographischen und biologischen Langzeitprogrammen zur Variabilität im nördlichen Nordatlantik zusammen. Der erste Fahrtabschnitt führte ein französisches Langzeitprogramm zur Erfassung der atlantischen Umwälzbewegung fort, bei dem ein hydrographischer Schnitt mit einem umfangreichen Tracerprogramm zwischen Portugal und dem südlichen Grönland aufgenommen wurde. Der zweite Abschnitt galt dem Ostgrönlandstrom und der Konvektion in der Grönlandsee. Auf dem dritten Abschnitt wurden neben einer polarforschungs-historischen Studie auf Spitzbergen biosedimentäre Systeme polarer Karbonatvorkommen auf den Schelfen Svalbards im Zusammenhang mit rezenter Klimavariabilität analysiert. Im letzten Abschnitt wurden Langzeitmessungen zum Wassermassenaustausch zwischen Nordatlantik und dem Nordpolarmeer durch die Framstraße und zur Ökologie der polaren Tiefsee fortgeführt.

MSM02/1

Im Rahmen des 2002 begonnenen französischen Langzeitprogramms OVIDE zur Erfassung der atlantischen Umwälzbewegung wurde ein hydrographischer Schnitt zwischen Portugal und dem südlichen Grönland wiederholt. Der Schnitt bestand aus 95 CTD-Stationen mit einem umfangreichen Tracer-Programm. Begleitet wurden die Messungen durch direkte Strömungsmessungen mit ADCPs, einem im Schiff verankerten sowie einem mit der Rosette gefierten Gerät. Auf dem Ostgrönlandschelf wurden 5 Verankerungen aufgenommen. Die Arbeiten waren Teil des französischen Programms PNEDC und des internationalen Programms CLIVAR.

MSM02/2

Der Fahrtabschnitt diente der Fortführung von zwei längerfristigen physikalisch-ozeanographischen Beobachtungsprogrammen des ZMAW Hamburg und des AWI. Mit Hilfe von Verankerungen wird die saisonale bis mehrjährige Veränderlichkeit der Wassermassenzusammensetzung und -transporte des Ostgrönlandstromes und des Grönlandsee-Wirbels untersucht. Anhand der Verankerungsdaten werden die Prozesse im Europäischen Nordmeer untersucht, die den Eintrag von oberflächennahem Süßwasser in die tiefen Overflows in den Nordatlantischen Ozean kontrollieren und damit die für das europäische Klima wichtige atlantische thermohaline Umwälzzirkulation beeinflussen.

MSM02/3

Der Abschnitt MSM02/3 widmete sich der postglazialen Entwicklung benthischer Lebensgemeinschaften auf den Schelfen um Spitzbergen. Die Fragestellungen wurden nach geologischen, biologischen, meereschemischen und ozeanographischen Aspekten untersucht. Die komplexe Topographie wurde mit dem Multibeam vermessen, bevor als wichtigstes Arbeitsgerät das bemannte wissenschaftliche Tauchboot JAGO zum Einsatz kam. Die Arbeiten umfassten Bodenfotografie mit einem geschleppten System, Lichtmessungen, CTD-Profilierungen, sowie geologische Sedimentbeprobungen. Zusätzlich wurde – zum Teil auf Landgängen – das Schicksal der gescheiterten Deutschen Arktisexpedition und ihrer Rettungsexpedition in den Jahren 1912 und 1913 erforscht.

MSM02/4

Das Programm diente ozeanographischen und biologischen Langzeitstudien in der Framstraße. Schwerpunkt war der Austausch von Verankerungen und Landern mit insgesamt 48 Verankerungsbewegungen. Im Rahmen des EU-geförderten Programms „DAMOCLES“ wird der ozeanische Austausch zwischen dem Nordatlantik und dem Nordpolarmeer bestimmt. Dazu wird seit 1997 auf 79°N ein Verankerungsarray betrieben, das auch auf dieser Reise zur besseren Auflösung der räumlichen Skalen durch CTD-Messungen ergänzt wird. Über den gleichen Zeitraum währen multidisziplinäre Untersuchungen im Bereich der Tiefsee-Langzeitstation AWI-HAUSGARTEN. Neben einem zentralen Experimentierfeld in 2500 m Wassertiefe wurden Stationen entlang zweier Transekte in 1000 - 5500 m Wassertiefe für biologische, geochemische und sedimentologische Untersuchungen bearbeitet. Im Rahmen des DFG-Projekts “Biodiversity and ecology of deep-sea copepods in polar seas – speciation processes and ecological niches in the homogeneous environment of the pelagic realm” wurden Multinetzfänge entlang 79°N gefahren um die Biodiversität und die Ernährungsökologie dominanter Copepodenarten der arktischen Tiefsee zu untersuchen.

Fahrtabschnitt / *Leg* MSM02/1	**23. 5. - 28. 6. 2006** **Lisbon (Portugal) – Tórshavn (Färöer)** **Fahrtleiter / *Chief Scientist:* Dr. Pascale Lherminier**
Fahrtabschnitt / *Leg* MSM02/2	**2. 7. - 26. 7. 2006** **Tórshavn (Färöer) – Longyearbyen (Svalbard)** **Fahrtleiter / *Chief Scientist:* Prof. Dr. Jens Meincke**
Fahrtabschnitt / *Leg* MSM02/3	**31. 7. - 17. 8. 2006** **Longyearbyen – Longyearbyen (Svalbard)** **Fahrtleiter / *Chief Scientist:* Prof. Dr. André Freiwald**
Fahrtabschnitt / *Leg* MSM02/4	**20. 8. - 16. 9. 2006** **Longyearbyen (Svalbard) –Reykjavik (Iceland)** **Fahrtleiter / *Chief Scientist:* Dr. Ursula Schauer**

Acknowledgements

MSM02 has been the first and maybe the last cruise with R/V MARIA S. MERIAN in the Arctic ice. The scientific parties of all legs gratefully acknowledge the perfect execution of the work of Captains F. von Staa, K. Bergmann and L. Holtschmidt and their crews with this new ship in this new environment. We experienced that R/V MARIA S. MERIAN is a great ship and has large capabilities. However, all legs suffered from severe malfunctions of the ship’s constructions. Consequently the success of the working programmes depended entirely on the unremitting efforts of the crew members and their unlimited ability to improvise solutions. We also appreciate the great help of Captain M. Berkenheger at the Leitstelle METEOR/MERIAN, Hamburg. Financial support for the cruise was supplied by the *Deutsche Forschungsgemeinschaft* (DFG).

MARIA S. MERIAN-Berichte 09-1

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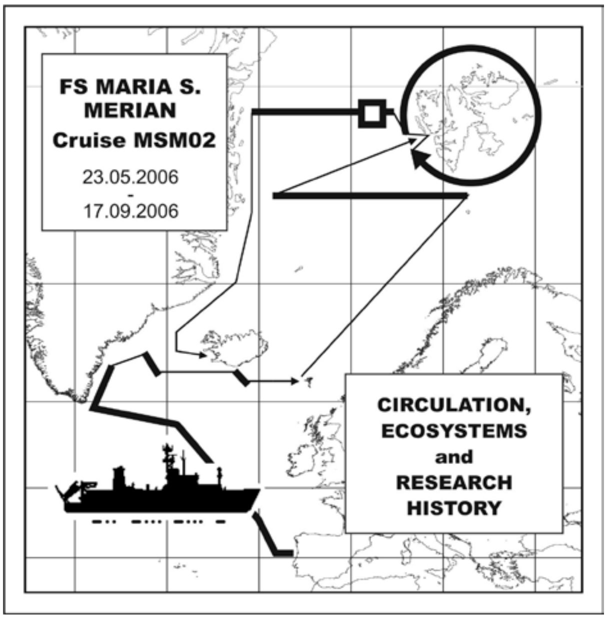
Part 1

Cruise No. 2, Leg 1

May 23 to June 28, 2006
Lisbon – Tórshavn



OVIDE: Observatoire de la Variabilité Interannuelle à DEcennale en Atlantique Nord

Observatory of the interannual to decadal variability in the North Atlantic

P. Lherminier, H. Mercier, T. Huck, B. Ferron, P. LeGrand, N. Daniault, F. F. Perez, M. Vazquez-Rodriguez, C. Gourcuff, A.-S. Kremeur, J.-P. Gouillou, P. Le Bot, S. Leizour, O. Ménage, N. Carn, N. Ducousso, P. Branellec, J. Lerebours, P. Morin, B. Cocquempot, T. Cariou, E. Louarn, E. Macé, G. Thoumelin

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1.1 Participants

Tab. 1.1: List of Participants on Leg MSM02/1 and Abbreviations

Name	Position, Institute	Function
Pascale Lherminier	Researcher, Ifremer	Chief Scientist
Pierre Branellec	Technician Ifremer	Salinity et O_2 analyses
Thierry Cariou	Technician, CNRS	CFCs et nutrients
Nolwenn Carn	Technician, Ifremer	CTD 8-12
Boris Cocquempot	Technician, CNRS	CFCs et nutrients
Nathalie Daniault	Assistant Professor, LPO/UBO	CTD 4-8
Nicolas Ducousso	Student, LPO	CTD 4-8
Bruno Ferron	Researcher, CR1 CNRS	CTD 8-12+ VMP profiler
Jean-Pierre Gouillou	Engineer, Ifremer	CTD, LADCP hardware
Claire Gourcuff	Student, LPO	SADCP&LADCP data
Thierry Huck	Researcher, CR1 CNRS	CTD 0-4
Anne-Sophie Kremeur	Student, LOCEAN	CTD 0-4
Philippe Le Bot	Technician, Ifremer	CTD 4-8
Stéphane Leizour	Technician, Ifremer	CTD 0-4, moor., glider, floats
Olivier Ménage	Technician, Ifremer	CTD 8-12, moor, VMP, floats
Pascal Le Grand	Researcher Ifremer	Salinity et O_2 analyses
Johanna Lerebours	Etudiante Intechmer (internship)	Salinity et O_2 analyses
Essyllt Louarn	Student, LOC/IUEM	CFCs et nutrients
Eric Macé	Technician CNRS	CFCs et nutrients
Pascal Morin	Researcher CR1 CNRS	CFCs et nutrients
Fiz F. Perez	Researcher IIM Vigo	pH / alcalinity / carbon
Guy Thoumelin	Assistant Professor, Université de Lille	CFCs et nutrients
Marcos Vazquez-Rodriguez	Postgraduate Student IIM Vigo	pH / alcalinity / carbon

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1.2 Research Programme

Cruise MSM02/1 is the third occurrence of the OVIDE hydrological section that was performed in 2002 and 2004, as part of the CLIVAR programme under the name of A25. The Ovide Principal Investigator is Herlé Mercier. A Greenland-Portugal section was previously performed in 1997 under the leadership of S. Bacon (NOCS), slightly south of the Ovide path. The Ovide route crosses Reykjanes Ridge 300 miles north of Charlie-Gibbs Fracture Zone and runs through the West European Basin without having to sample on top of the complex Mid-Atlantic Ridge.

The objective of this repeated hydrological section is to monitor the variability of water mass properties and main current transports in the basin, complementing the international observation array relevant for climate studies. The western part of the Ovide section is redundant with AR7E (called also A1) which was done on the odd years and will allow a better analysis of the inter annual variability.

The hydrological section includes a hundred surface-bottom stations from coast to coast, collecting profiles of temperature, salinity, oxygen and currents. From the 28 bottles closed at various depth at each stations, samples of sea water are used for salinity and oxygen calibration, and for measurements of biogeochemical components, including tracers, isotopes, nutrients and carbon.

From the thermal wind equations, geostrophic transports are deduced from temperature and salinity. Then, direct current observations, preferentially those measured by the ship ADCP, are used to constrain the velocity at the chosen reference level. This is particularly important in the Irminger Sea, where bottom currents are very energetic. This way, the contribution in heat and fresh water of the major currents crossed (mostly perpendicularly) by the Ovide line can be estimated. From north to south, the major currents are the East Greenland/Irminger Current (about 20 Sv southward, 1 Sv = 10^6 m^3s^{-1}), the Deep Western Boundary Current (about 10 Sv southward), the Irminger Current (about 10 Sv northward), and the North Atlantic Current (about 20 Sv northward). Between 1997 and 2004, we already observed a significative variability of these transports (about 30%).

The Meridional Overturning Circulation reflects the equilibrium between the warm and salty waters flowing poleward near surface and the cold and relatively fresh water flowing equatorward near the bottom. Measured across Ovide, it is mainly the balance between the North Atlantic Current and the Deep Western Boundary Current. The simple sketch is however complicated by the export into the Labrador Sea and around the Subpolar Gyre of part of the highly variable East Greenland Current. This is why an array of four currentmeter moorings and one ADCP lander was deployed on the East Greenland slope and shelf in 2004, for two year.

While temperature and salinity are often the basic parameters to identify water masses, it is useful to use tracers like CFCs to determine when they were ventilated. Oxygen is also a good indicator near the sources, but not conservative. Combining oxygen with nutrients gives useful information on the biological activity and on the remineralization processes. CFCs and nutrients are analysed by the Roscoff team led by Pascal Morin (LCM).

The measurements and analyses of pH, alkalinity and pCO_2 are performed by a Fiz Perez and Aida Rios from Vigo (IIMV) at every Ovide cruise. In 2006, it was officially part of the CARBO-OCEAN international program, and the objective is to better quantify the role of the North Atlantic in the storage and transport of anthropogenic carbon accumulated in the atmosphere.

In 2006, samples were taken to measure isotopes of oxygen (18) and carbon (13) after the cruise. Oxygen isotopes are very useful to determine the proportion of fresh water from different origin (rain/snow, runoff, sea ice).

This leg was part of the international barter agreement between NERC (Natural Environment Research Council), IFREMER (Institut Français de Recherche pour l'Exploitation de la Mer), BMBF (Bundesministerium für Bildung und Forschung), IMR (Institute for Marine Research, Bergen) and NIOZ (Royal Netherlands Institute for Sea Research) which is organised by the Ocean Facilities Exchange Group (OFEG).

1.3 Narrative of the Cruise

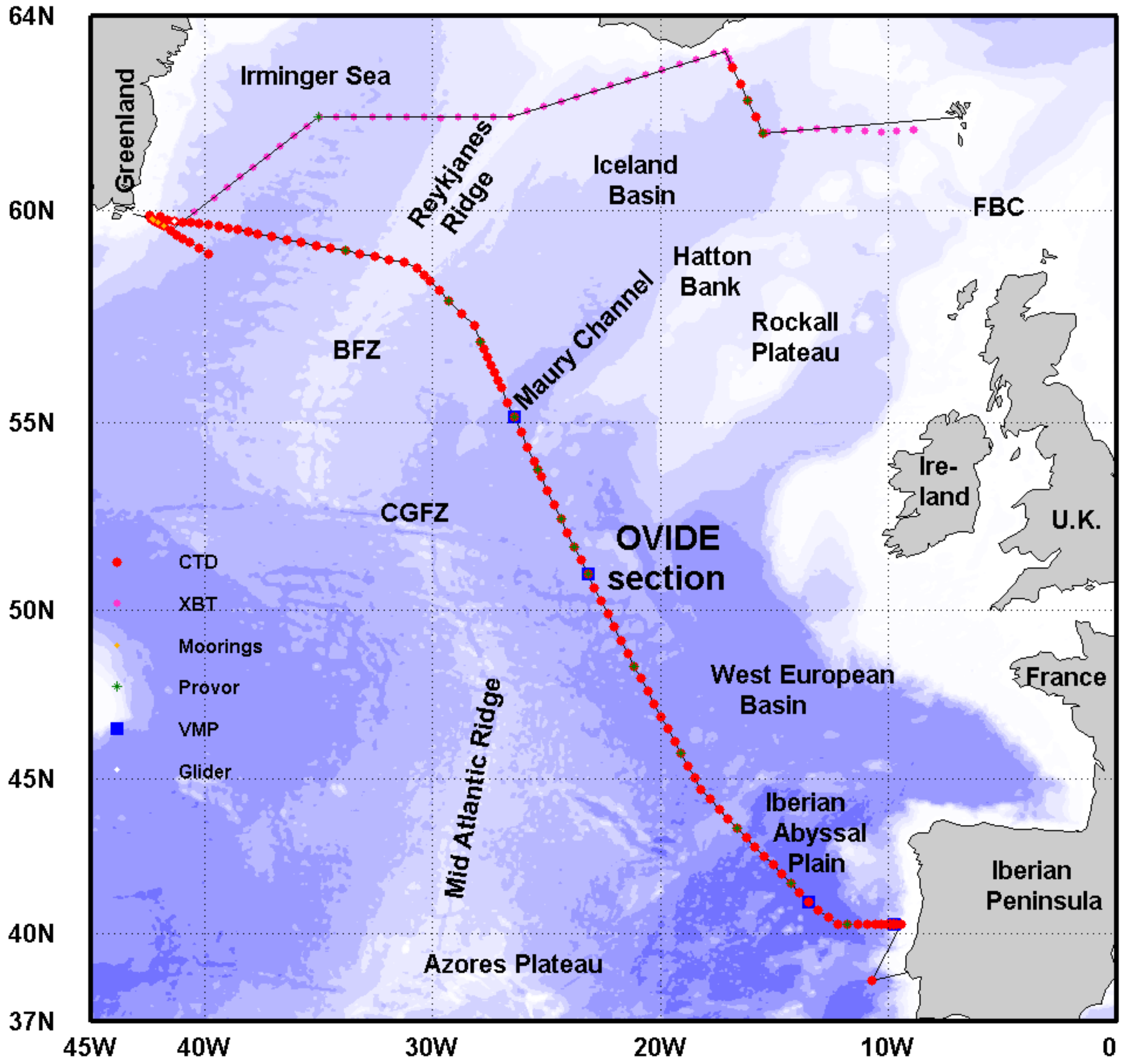


Fig. 1.1: Ovide section in 2006. Red dots indicate the hydrological stations, and smaller pink dots for XBTs. The blue squares are the stations where we added a VMP profile, and the green dots, the stations where we also deployed a profiling float. The 4 orange dots near Greenland are where we recovered our moorings. Abbreviated topographic features: Bight Fracture Zone (BFZ), Charlie-Gibbs Fracture Zone (CGFZ), ESM (Eriador Sea Mount), ABR (Azores-Biscay Rise)

During the 120 stations of this cruise, 2740 seawater bottles were sampled for measuring the different biogeochemical quantities detailed above. In addition to the 100 stations required for the Ovide section, 15 stations are localized along the mooring array line south east of Greenland, and 5 south of Iceland, where Iceland-Scotland Overflow Water can be found near its main source (the Faeroe Bank Channel). For all stations, LADCP data were successfully collected to determine the current profiles.

The ship ADCP, a RDI 75kHz, ran nicely from the beginning to the end of the cruise. The data until station 18 are unfortunately noisy due to interferences with the DoLog at 78kHz. The problem was found and then solved after 6 days.

May 22-23: On Monday morning, while scientists are settling down in their 6-week home, our six containers are loaded aboard. Then 36 hours are dedicated to connect the different waters, the electricity and network between the ship and the 3 containers that are used as laboratories, and to initialize the experiments. A few of us immediately concentrate our efforts on the configuration of the ship ADCP, helped by Catherine Kermabon from Ifremer. In the deck lab, Thierry Terre (Ifremer) and Breck Owens (WHOI) are also finishing the preparation of the 2 SPRAY gliders, teaching us the last steps before deployment that should occur mid June near Greenland. A group of 4 people, Stephen Dye, Neil Needham (both from CEFAS, UK), Ulrich Drübbisch and Andreas Welsch (from IfM Geomar), come aboard to prepare their 2 pipe moorings that we plan to deploy at 63°N east of Greenland.

R/V MARIA S. MERIAN left the port of Lisbon at 10 pm on May 23, after some repair works on the engines. Six containers were embarked, including 3 laboratories. Objective: the deep test station at 38° 26’ N 10° 42’W. The long Atlantic swell welcomes us as soon as we exit from the Tage.

May 24: a day dedicated to tests of the different systems around 2 CTD stations. We learn to work together. A few days will be needed to determine procedures necessary to smooth the operations. During the CTD descent, the EM120 is used to listen to the rosette pinger, helping in the bottom approach. The signal is sometimes noisy. All the stations were performed down to 5 to 15m from the bottom, as confirmed by the signal of a contacter. The Posidonia system was also used at all stations to get the 3D position of the rosette under the water.

Using the ship sounders for detecting actual depth is not trivial. The objective is naturally to avoid hitting the CTD at the bottom of the downcast. It turns out that most of them work around 12kHz. So we must check the possible interferences between the EM120 (we only need the vertical beam of this multi-beam), the EA600, our own pinger mounted on the CTD, and the Posidonia system. We finally choose to use the EA600 as a receiver of our pinger, so that we can monitor the distance between our rosette and the sea-floor. The EM120 is used to evaluate the depth at the beginning of the station and during the upcast, but we have to switch it off during the downcast because it blurs the signal of our pinger. Then, we observe that Posidonia has no effect on all this. A backup system consists in a 15-meter chain attached at one end under the rosette, the “contacter”, that rings in the container whenever the apparent weight of the chain decreases.

May 25: We are back on the Iberian shelf, at 150m depth. This is the first station of the Ovide section (Fig. 1.1). Apart from a little surprise on the depth shallower than expected, everything turns out to be good. The upward looking 300kHz ADCP refusing to communicate, we have to install a spare for the following stations. Fortunately, our old downward looking BB150kHz is faithfully fulfilling our expectations.

First chemical analyses give satisfactory results. The team from the Université de Bretagne Occidentale measure CFCs and nutrients, while the team from CSIC Vigo gather information to better understand the carbon cycle.

The 4th station is placed on the upper continental slope at 800m depth. Therefore, the favorable meteorological conditions give us an excellent opportunity to test our new Vertical Microstructure Profiler. Deployed at 14:35 local time, it pops up half an hour later, and is easily localized by both VHF and captain's eyes. After a very smooth approach, the VMP is recovered with the starboard crane without difficulty. 3 hydrological stations close this very active day.

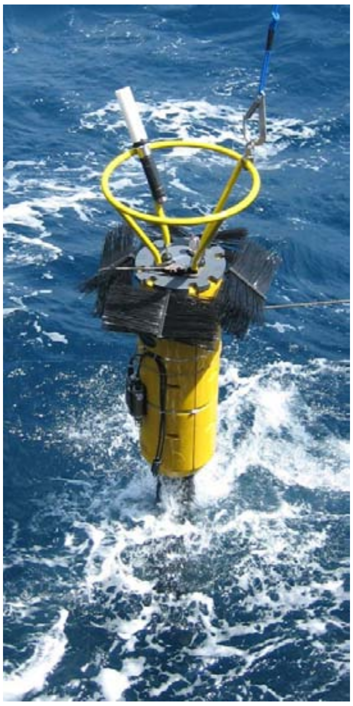


Fig. 1.2: Vertical Microstructure Profiler. Deployment on May 25

May 26: Night station work begins, and we are now more than 3000m deep. In the middle of the night, a failure occurs in the steering gear of a pumpjet, preventing any dynamical positioning. After a discussion with the scientists, the captain decides to come back to land to be delivered a spare part the following day. Meanwhile, we keep on working, until midnight, achieving five hydrological stations held manually at the bridge.

May 27: Figuera da Foz looks nice from the sea, but we will not have a chance to visit it: the spare part is delivered by the pilot at 12:00, and we "immediately" return to the last station. By the time we reach it, the pumpjet is repaired. After measuring this profile again to check its variability, we resume our course a little before midnight. This day is also special. Franck Riedel finally discovered why the 75 kHz ship ADCP signal showed interferences: the DoLog is pinging at 78… and cannot be legally switched off. A short test in station confirms the diagnosis, and shows the remarkable potential of this ADCP. Even with the DoLog pinging, we can get some information on the currents, but the calculated errors are big.

May 28: The influence of Mediterranean Water decreases slowly as we are steaming westward; but at station 15, a relative maximum of salinity at 1000 meters surprises us. Immediately warned by Nathalie, I make a careful comparison with the last 2 profiles and decide to launch a profiling float that is programmed to drift at 1000m depth. Following stations tend to confirm that we were dealing with a Meddy. Let’s hope we will be able to follow its path with the float in the following months.

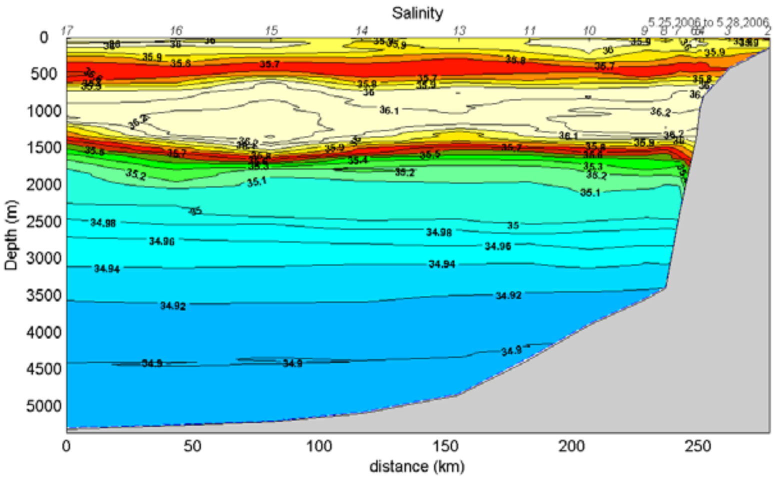


Fig. 1.3: Salinity section showing the Meddy at station 15 and the Mediterranean vein flowing northward along the Portuguese west coast, centered around 1000 meter depth

May 29: CTD measurements show a noisy signal, usually attributed to a default in the CTD-wire connection. However, a more serious issue stops our progression: the steering gear of the yellow winch breaks, while the CTD is hanging 4000 meters under our feet (upcast of station 19). After the replacement of the broken piece, we can slowly come back to the surface and recover all the equipment. The time for repairing is used for instrument trials: the VMP is sent down to 5300m depth, while a new type of free-fall CTD (SBE 19, on the left) is tried twice on 500m deep profiles. All the instruments behave as expected, and the 3 recoveries are perfectly performed.

Meanwhile, the CTD is connected to the violet winch that we will use now on.

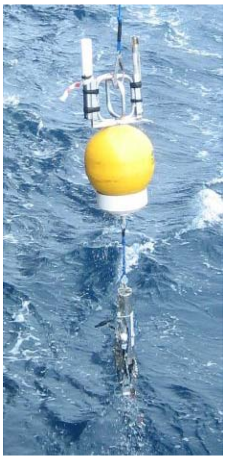


Fig. 1.4:
The free-fall CTD (SBE 19) conceived by P. Le Grand, O. Peden, O. Ménage and S. Leizour

May 30: Five stations and one Provor deployment. Despite the increasing swell and wind, we keep on working hard, and the winch and cable too. Due to the important rolling of the ship, the cable endures several chocks at deployment and recovery of the CTD. We must also interrupt the up-cast several times to correct the spooling on the winch. But data are collected, saved, calibrated, compared. The DoLog is finally switched off and the SADCP data get immediately better in range and precision.

May 31: Rolling speaking, the worse day of the week, consequence of 5m waves and force 7 to 8 winds. We occasionally oscillate on more than 20° on each side. Sometimes, despite our efforts to fix it, the 1-ton rosette jumps on the deck. The Posidonia system cannot locate the rosette while profiling. Meal times are not especially relaxing. The scientists working in the containers located on the outside deck take the closest indoor corridor to avoid the salty shower. But it is quite sunny though …

At station 25, the end of the CTD upcast profile is missing: 2 bulbs show the damage of the bad weather on the last 20 meters of the wire. The cable is cut, and the connection rebuilt. Next station is fine. *Alles klar*.

We all clearly observe that the Merian rolling behaves as if she was resonating at a period of about 10s. When she begins to roll at this rhythm, the movement slowly builds up for several periods before decaying suddenly.

Only 3 CTD stations today … fortunately, the weather forecasts bring hope of better days.

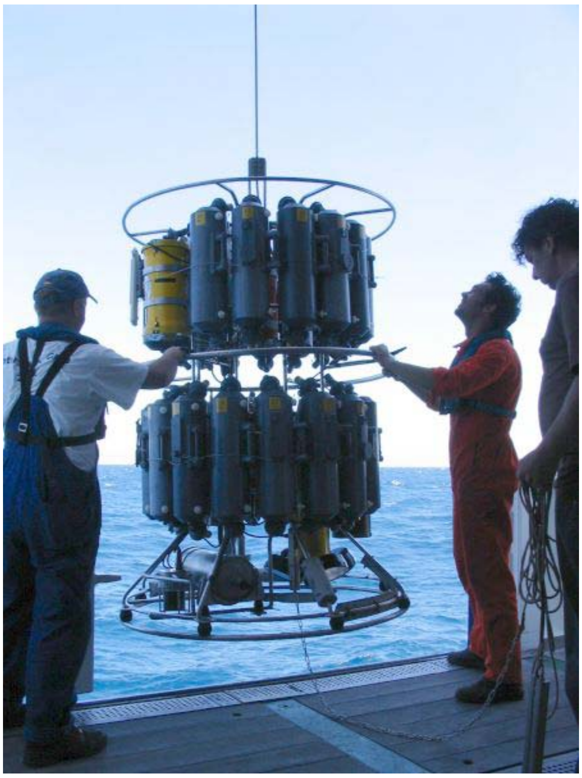


Fig. 1.5: CTD deployment

June 1: 5 CTD stations and a Provor deployment. A sane routine finally settles down despite the 3 meter swell. Chemical analysis are performed in real time, with no major failure or delay.

June 2: better meteorological conditions. 4 CTD stations and a Provor deployment today. We pass 46°N and 19°W. From station 37, we decide to start to collect data before immerging the CTD, so that we won't be obliged to replay the stations after the cruise.

June 3: In the afternoon of this beautiful day, the BB150kHz LADCP refuses to wake up for station 38. To make a long story short: we will have to rely on a smaller, but less efficient, 300kHz LADCP for stations 38 and 39, while the old fellow is repaired in the night, after blowing up 3 fuses… 4 CTD casts were performed today.

June 4: Early morning, the chain of the violet winch breaks during the down-cast of station 40, at 3200m. One and a half hour later, the winch is repaired and the cast resumed, but interrupted several times until the bottom. After some work on the data, we should be able to recover a correct profile of temperature, salinity and oxygen. Later in the evening, alarming messages oblige the crew to stop one of the two pods. Transit speed between stations is reduced from 12 to 9 knots, while engineers and electricians are working hard on the problem. We still gather 4 more profiles of 28 bottles each, and as usual, a Provor is deployed. At the end of the day, we pass north of Brest latitude: 49°N.

June 5: Work progresses well. No diagnostic for the pod is given yet, so we keep a speed of 9-10 knots between the stations. At 8 p.m., a group of pilot whales is observed during station 46. Jean-Pierre celebrated his 60th birthday.

June 6: The sky is grey but wind and sea are quiet. While the VMP is profiling, the cable of the yellow winch is deployed with a weight at the back of the ship and rolled back up properly so that it can be used again. During this operation, we cover a distance of 8nm to the NNW along the section, and when it’s over, we come back to recover the VMP at 1:15pm. The instrument signals are well received both on radio and Argos.

Some problems arise on nutrients experiment (instability in electric power?). We also note difficulties with the pump that provides the water for Gaspar (pCO2) and surface alkalinity analysis.

At 7:30pm, an unfortunate hit on the C key lauches the recalibration of the compass of the glider Spray 010, which now shows unacceptable values and cannot be deployed.

June 7: since the weather is freshening, we decide delay station 53 and to perform a calibration of the Spray 010 in the zodiac (which is mostly magnetic). After two tries, each implying the zodiac performing a full circle in a not so quiet sea at half a mile from the Merian, we finally get some acceptable values from the glider’s software, and decide to come back aboard. We take this opportunity to calibrate also the zero of the goniometer case (for Argos reception).

June 8: still no diagnostic on the port pod. Weak wind, turning from north to west. Work is progressing well in the Iceland Basin.

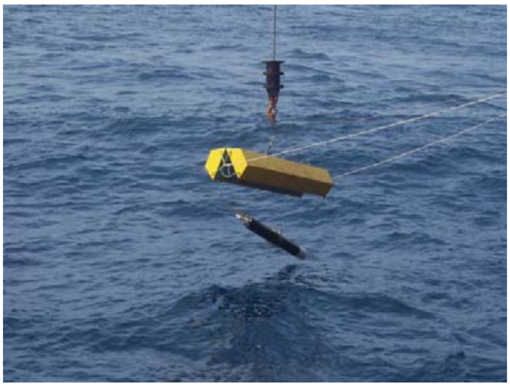


Fig. 1.6:
A PROVOR profiling float is deployed

June 9: a bright blue sky for a terrible day. At 0:30am, winches don't answer to commands. The solution is found one hour later. Then, the worse verdict is pronounced in the morning: the port pod is definitely dead. It is decided to pursue the mission, but we won't try anything in the ice and the speed will not exceed 10 kn.

Finally, the last but not the least, the VMP does not come back from its 3km-deep profile after station 61. We wait for 2 hours 2nm north of the deployment position with no result. We finally proceed to station 62 with a 3 hour delay. Since all safety procedures (chemical and electronical) are supposed to release the VMP weight within the next 24 hours, I decide to double the spatial sampling (to slow us down) so that the VMP could be recovered if a signal is received.

June 10: on land, Herlé is watching closely any Argos signal that would come from the VMP. Stations 63, 65 and 67 were added at mid distance from the 2002 station positions.

June 11: the weather is freshening (force 7, NNW), leading to a difficult progression at 6kn. The forecast is worse. Since the VMP did not emit, we decide to proceed. In the evening, the wind slows down unexpectedly.

June 12: moderate sea and wind. We enter the Irminger realm. As usual, LADCP on Reykjanes Ridge are well sheared. It would be nice to perform a 24h repeated station here to determine the exact nature of the internal waves here, although internal tide is probably the best candidate. Too bad that we don't have the VMP anymore to estimate the mixing there. The ballast in the bow of the ship are cleaned during station 77. During this 3-hour operation, the ship ADCP is at 6.3m under the surface, instead of 7m.

June 13: a strong crossed swell adds to 30kn winds (ESE). From station 79 to 82, many spur data are noticed in the oxygen profiles, resulting from the important rolling. At station 83, the cable jumps out from the pulley.

June 14: the 35kn wind slow us down, but we keep working. And we are not in a hurry, since these westerlies push the ice off of the Greenland coast, blocking our progression in a near future. 9pm: the forecast gives force 8+ after midnight, so we decide to stop working until the next morning after station 88 since we have only one pod. Actually, the last recovery of the rosette proves how wise this decision is …

June 15: work resumes at 9am. Still 30 knots of South Westerlies the whole day, but the sea is not too rough. Only 4 CTD stations today.

June 16: Wonderful weather: 8kn W-SW winds and flat sea. 6 hopeful stations until a sea-ice wall 35 miles from the Greenland coast. Neither sea-ice charts nor weather forecasts allow some optimism. We call the Greenland station, we radio the fishermen nearby : it seems to be a quite exceptional situation compared to last years, but maybe not so exceptional 20 years ago … good to know. We seek a path through the ice more to the north to reach at least the shelf. No way. At 63°N, we learn that everything is blocked down to the 1000m isobath. Operations there are really compromised. We have a week ahead of us.

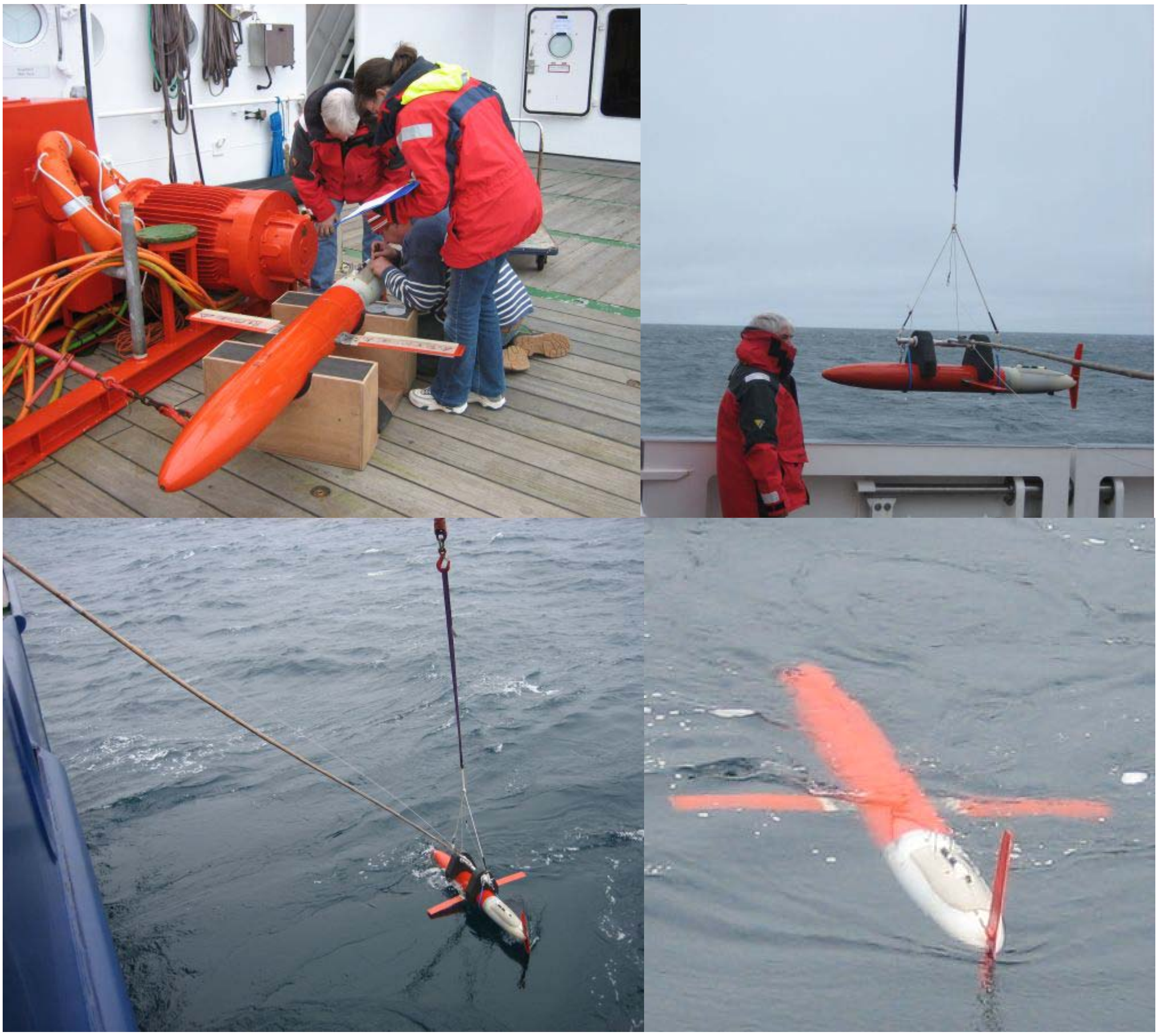


Fig. 1.7: Spray 004 deployment: last verifications and mission launching (up left), crane lifting (up right), smooth immersion behind the ship (bottom left), and last “au revoir” (bottom right)

June 17: we arrive near mooring A (the most offshore mooring) at 5 am. It is covered by sea-ice! So we come back on station 96 to do it again (station 98) since CFC could not be sampled. The ice front moved 1/2nm within 1 hour, so we retreat to former station 95 to measure it again (station 99) and deploy the Spray glider (#004). The deployment is easy and nominal at 11:25. We are in contact with Thierry Terre on shore to verify the data status. At 2pm, after 2 dives at 100m and 200m depth, we leave the glider to Thierry’s control and try to penetrate into the ice pack (more or less loose) with much cautiousness, but it turns out that it would have been faster to skirt the edge to the north-west. After exiting the pack, we head towards mooring A that is finally in an area free of ice. It is released at 8pm. At least we suppose so, but we’ll learn later from the data that it was actually accidentally released during our first visit. That is why we have to run after it for 1 hour helped with our Argos beacon, to finally discover it nearly embedded in a growler (fortunately not under it). We recover a pack of knots and all our instruments (5 RCM8 and a Seacat). A CTD near mooring A position is performed, and we escape further offshore for the night since the weather is supposed to freshen again.

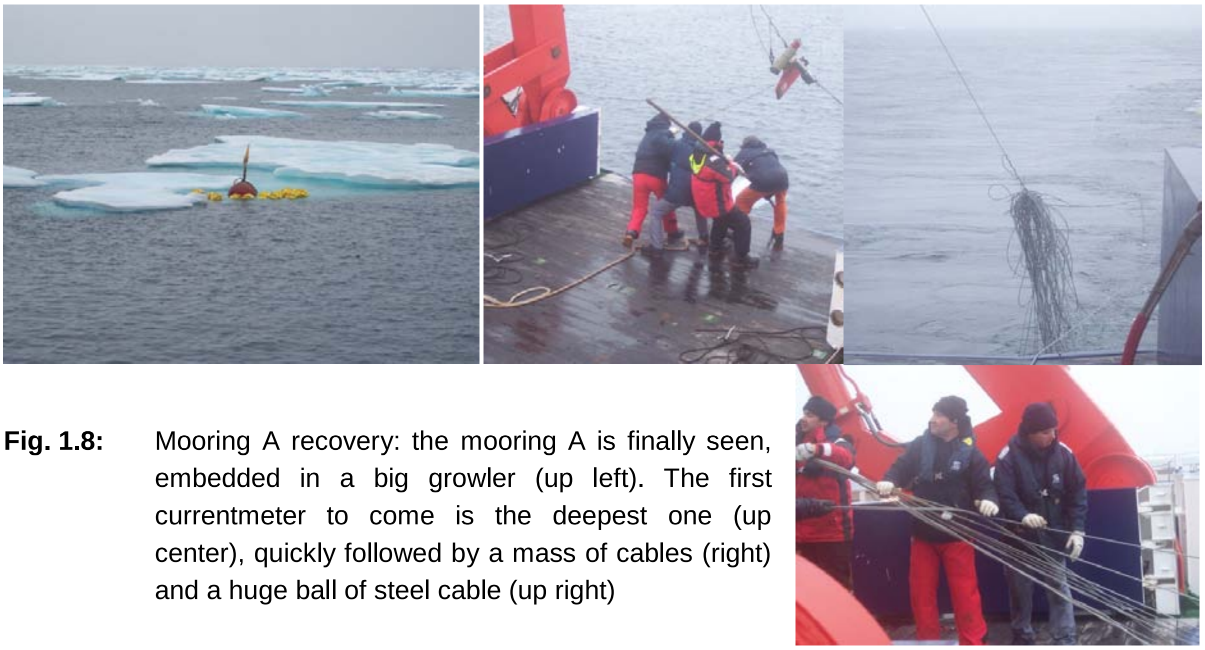


Fig. 1.8: Mooring A recovery: the mooring A is finally seen, embedded in a big growler (up left). The first currentmeter to come is the deepest one (up center), quickly followed by a mass of cables (right) and a huge ball of steel cable (up right)

June 18: 50kn of South-Westerlies. Nothing we can do, and sea ice expands. Fortunately, the glider goes faster. Everybody relax a little while the ship goes back and forth. Trying to hold a station is hopeless. A new CTD section along the NOCS mooring line is defined. The winds pushed the Kap Farvel ice tongue south of our position. Today is Sunday. Weather forecast indicate possibly weak North-Easterlies for Tuesday. By performing the new 13 stations from offshore, we should arrive on mooring B position by Tuesday. And if it is free of ice, we push as far as we can on the shelf to finish the section.

June 19: was yesterday just a bad dream? No wind, no wave. We begin the new section by station 101 at 8am. The journalist from Thalassa, who was planning to come aboard by helicopter, is very disappointed: the small helicopter has only a 10nm autonomy, and the big one is too expensive. He is in Narsassuaq and tries to find good pictures there while waiting. But if we can get as close as 15nm from the coast, I consider that we will be lucky.
8pm: 30kn westerlies slow us again. The captain changed the attitude of the ship with the ballasts: she is now at 6.6m under the water at the bow, and 6.8m at the stern. The ADCP (near the bow) is at a depth of 6.5m.

June 20: 1am: parse growlers appear, half way between stations 104 and 105. Slaloming among the growlers, we finally reach station 105, that we perform non conventionally with port to the wind so that the reinforced bow of the ship could face the ice drift. At this latitude, the night of the Summer solstice is not totally dark and it helps the monitoring.

3am: an accident occurs. At the end of the CTD profile, while he is trying to close the heavy sliding door on starboard side, Ronald Kuhn, alias Kuhno, has his right index tip crushed. The electric command of this door (for the CTD) is broken, and it has been opened and closed manually for a few days. The captain immediately called for help and a frigate is on her way from Reykjavick to transfer Kuhno to a hospital asap. We steam in its direction as fast as we can, hoping that Kuhno could recover his finger. 10pm: Kuhno is transferred by helicopter (lifted). He seems to be alright. A depression is passing south of Greenland, that should create the expected easterlies. Since the situation is not so clear at 63°N, we decide to come back to the mooring site at 60°N.

June 21 : a long day. We decide not to deploy the Spray glider #010, since our last try for calibration in the main shelter is not satisfying (although other compasses show that the magnetic field is quite good there, probably because the hangar is so big).

In the evening, it is a patience game for all of us. Ice backed off, but not enough for mooring B. A CTD station help us to wait. Then, we can finally recover mooring B, but we loose the Seacat near the head of the mooring: the collar was obviously weakened with some corrosion, and a shock with the shell at the recovery broke it: we literally saw it sink. The 5 currentmeters are fine, and we did not have to run after the mooring after release. Then we proceed to mooring D position: no ice, but a thick fog that prevent us to see what's ahead. Helped with the radar, we keep going to the NW, and miraculously end up on the shelf.

June 22: 1am: CTDs 107 and 108 on the shelf (near the shelf break). The fog disappears suddenly with the dawn, and suddenly the sharp white peaks of Greenland appears under a bright orange sky, so close that it surprises us (still 23nm away …). We recover mooring D. And finally C. Relief sighs. All the instruments are aboard. It is 7:20am. We use 4 hours to get a bathymetric map of the mooring site with the EM120 multibeam sounder. And finally, we finish the secondary hydrological section, hoping that both segments connect well enough.

June 23: the section is finished at 3am. It's too late to go to deploy the pipe moorings on the shelf at 63°N: due to the missing pod, the transit time is uncertain, as are the winds that begin to turn to the west again. We have to go back to the Faeroes, and if the weather is favorable, we will sample the ISOW with 5 stations south of Iceland. While turning off the Aanderaa ADCP of the pipe mooring, we realize that batteries are empty. We inform Stephen Dye immediately in case he deploys the mooring during the following cruise.

During the transit to Tórshavn, an 700m XBT is launched every other hour (i.e. 20nm apart approx.). Helped with the ADCP, we may be able to calculate sub surface heat fluxes.

Fig. 1.9: An XBT is launched

June 24: we cross Reykjanes Ridge at 62°N. Just before, aligned on the 200nm Islandic EEZ line, we cross an impressive fleet of large trawlers. On the radar, we can count 28 of them dispatched on 12 miles. Knowing that each has a 1km deep net that is dragged 1/2nm behind the ship, I wonder how a fish could survive. A Red Fish to be precise. The captain explains that they are here the whole year long. We have to remember to absolutely avoid this area for autonomous platforms …

June 25: First look at the whole dataset during a scientific meeting aboard. TA, pH, Cant, Nitrates, Phosphates, Silicates, and even CCl_4 sections are shown, in addition to the classical T, S, O_2 data. The harvest is promising.

June 26: Our day is filled with 5 CTD stations south of Iceland (probably the last stations of our 20 year-old Neil-Brown CTD), + 2 test stations for our new Seabird CTD system. The ISOW is well sampled.

June 28: we arrive in Tórshavn at 3am local time, in time for the final ASOF meeting.

1.4. Observations, Analysis Methods and Preliminary results

1.4.1 Water Masses and Variability Compared to Previous Years

Pascale Lherminier, Pierre Branellec

1.4.1.1 Calibrations and Data Quality of CTD and Oxygen Measurements

The CTD used on all hydrographic stations on this cruise leg (MSM02/1) was a Neil-Brown Mark III B (#2782), in conjunction with a 28 (8-liter) bottle carousel PASH 6000. The CTD was systematically lowered at less than 15m from the bottom, as attested by the signal of a contacter. The Neil-Brown temperature and pressure sensors were calibrated on March 30, 2006 and January 18, 2007. 2738 salinity bottle samples were drawn from the whole water column of the 120 stations. A PORTASAL salinometer (serial number: 62302) was standardized using standard seawater batch P146 (K15=0.99979, labelled S=34.992, bottles filled in May 2005). No mentionable drift in the salinometer was observed during the calibration work which was performed during the cruise. After calibration, the accuracy for conductivity (respective salinity) is better than 0.003 (see Fig. 1.10), consistently with the statistics calculated of 59 duplicates. The median filter used for calibration discarded 273 samples that are not shown on Fig. 1.10.

The oxygen was measured with a SeaBird SBE43 probes (#526). The calibration is presently quite crude and data should not be used before a more precise processing based on the 98 duplicates and 2793 samples. First results show that we can expect an accuracy better than 3 µmol.kg^{-1}.

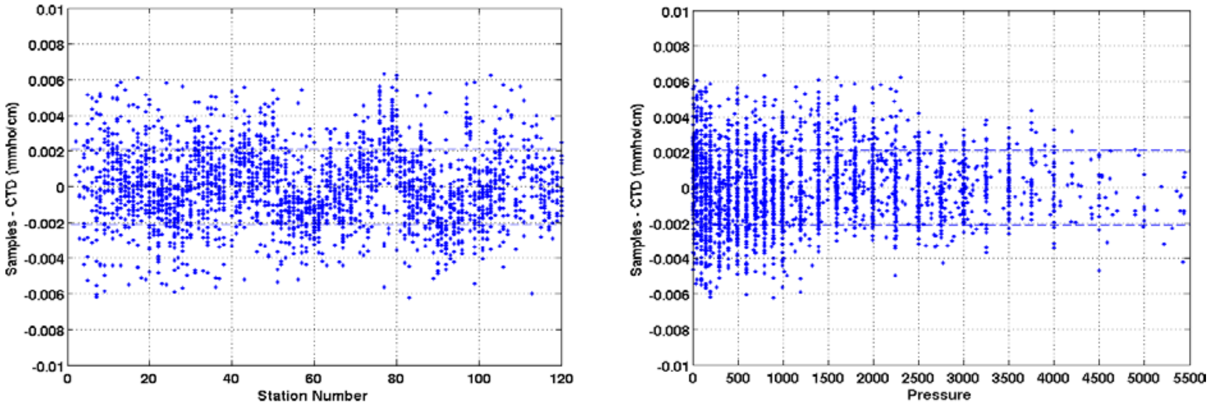
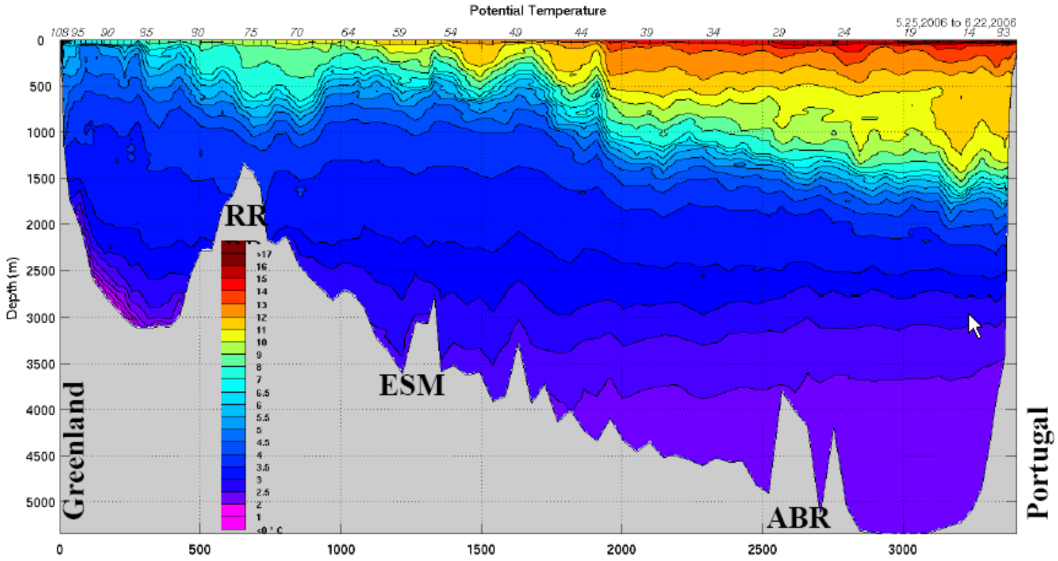
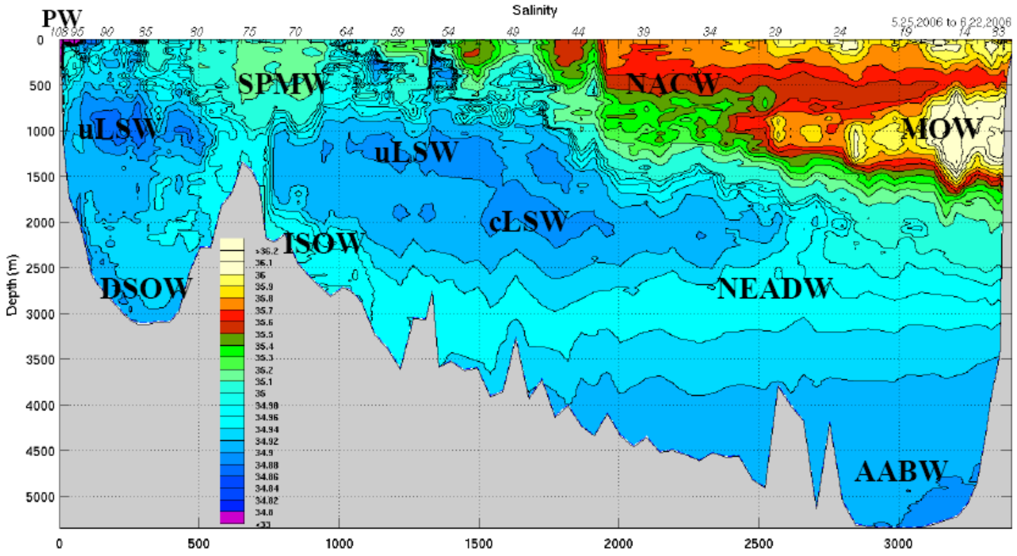
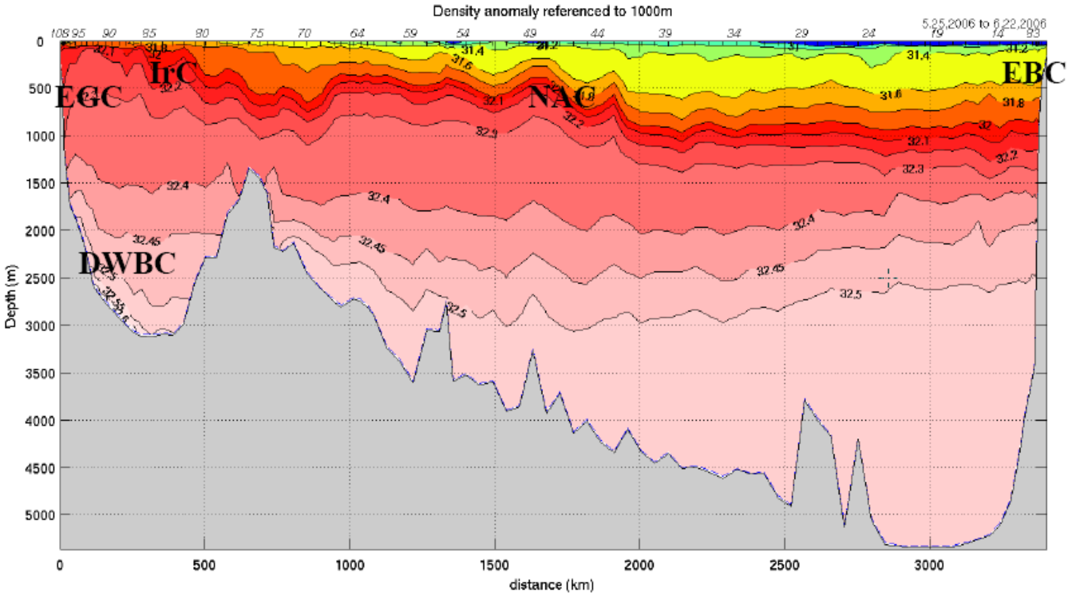


Fig. 1.10: Differences between sample and probe conductivity measurements in mmho/cm, as a function of station number or pressure, after calibration. The standard deviation of 0.0021 is plotted

1.4.1.2 Hydrological Sections from Greenland to Portugal







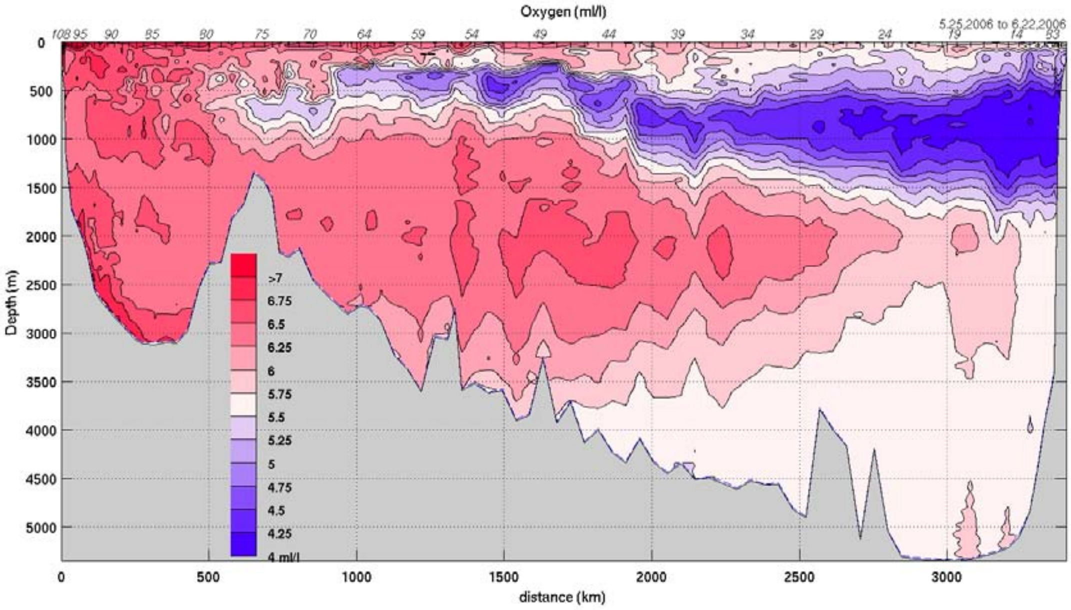


Fig. 1.11: Hydrological sections. From top to bottom: potential temperature (°C), salinity, potential density anomaly referenced to 1000m, oxygen (ml/l)

All the hydrological sections are plotted on Fig. 1.11 (temperature, salinity, potential density and oxygen). Main topographic features also shown on Fig. 1.1 are localized: Reykjanes Ridge (RR), Eriador Sea Mount (ESM), Azores-Biscay Rise (ABR).

Main water masses are shown on the salinity section:
PW: Polar Water (PW),
uLSW & cLSW: upper and classical Labrador Sea Water,
SPMW: SubPolar Mode Water,
DSOW: Denmark Strait Overflow Water,
ISOW: Iceland-Scotland Overflow Water,
NACW: North Atlantic Central Water,
MOW: Mediterranean Overflow Water,
NEADW: North-East Atlantic Deep Water,
AABW: Antarctic Bottom Water.

Main currents are shown on the density section
EGC: East Greenland Current,
DWBC: Deep Western Boundary Current,
IrC: Irminger Current (the part that circulates around the Reykjanes Ridge),
NAC: North Atlantic Current (at least 2 branches embedded in eddies cross the section),
EBC: Eastern Boundary Current.

1.4.1.3 θ-S Plots of the Different Basins: Comparison with 2002 and 2004

The Antarctic Bottom Water is seen in the Iberian Abyssal Plain and presents a remarkable linear relation between temperature and salinity documented by Saunders (1986), as shown on the different θ-S diagrams on Fig. 1.12. A freshening of 0.003 in 2004 could not be explained after calibration and is considered as potentially real, although θ-S characteristics are back on the Saunders line in 2006.

Geostrophic transports are calculated with a box inverse model that includes additional constraints derived from the SADCP (Ship Acoustic Doppler Current Profiler) plus a net mass transport of 1+/-3Sv flowing to the north through the section. The method and results for Fourex 1997 and Ovide 2002 are detailed in Lherminier et al. (2007). On Fig. 1.12, transports are binned with a resolution of 0.02 in salinity and 0.2°C in temperature. As expected, about 1 Sv of AABW flows systematically to the north in the Iberian Abyssal Plain.

The same plotting exercise is done in the whole Western European Basin, from Reykjanes Ridge to Portugal (Fig. 1.13). Surface water in 2006 show a better agreement with 2002. It is not surprising since 2004 cruise was slightly later in the year (finishing on July 18) and followed a particularly warm Spring.

Another striking feature is the progressive appearance of the upper Labrador Sea Water west of Reykjanes Ridge (the warmest deep minimum in salinity).

In 2006, the Mediterranean Water show a peak in salinity that is intermediate between 2002 and 2004 (when it reached 36.3).

In the Irminger Sea, the characteristics are this time plotted against oxygen (Fig. 1.14). While 2002 and 2004 showed quite scattered properties in the deep waters, 2006 data show a surprising “purity” of the Denmark Strait Overflow Water, with quite salty and warm properties. This contrasts with the very fresh and scattered values of 2004. First inversions suggest that the Deep Western Boundary Current would be only about 6 Sv in 2006, while it was 11 Sv in 2004. Such a weak value would suggest a much weaker entrainment in 2006 and would then partly explain the observed differences.

We observed also a sensible erosion of the elbow that marked the cLSW, while the uLSW is very well sampled for all 3 sections. This observations corroborates the formation and export of the 2000s shallower vintage of LSW in the Labrador Sea.

Studying the possible ventilation of the uLSW in the Irminger Basin requires other tracers.

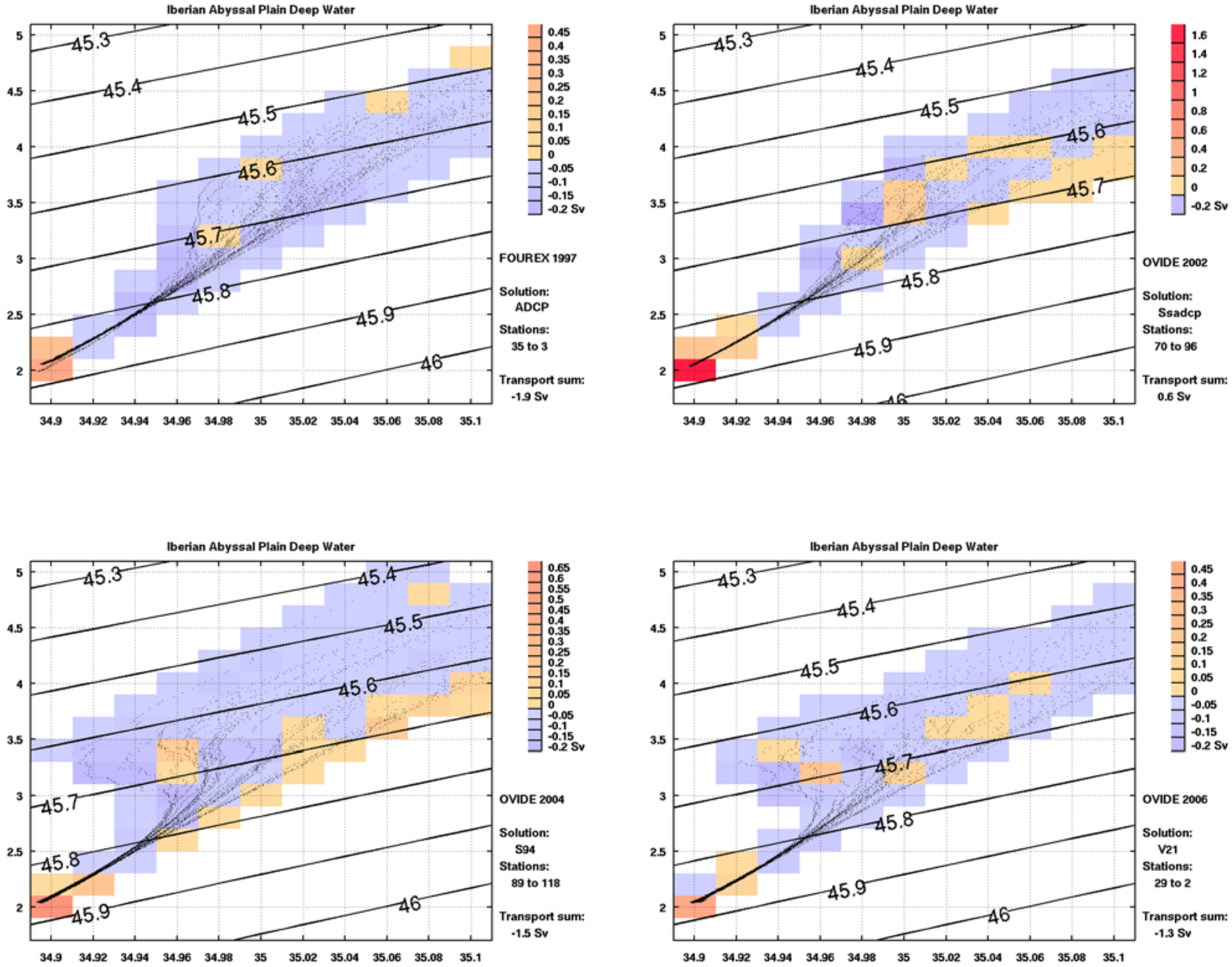


Fig. 1.12: Potential temperature versus salinity in the Iberian Abyssal Plain as measured in 1997 (FourEx cruise led by S. Bacon), 2002 (Ovide cruise led by H. Mercier), 2004 (Ovide cruise led by T. Huck) and 2006 (this cruise).Isopycnal lines referenced to 4000m are drawn. Color square indicate binned transports

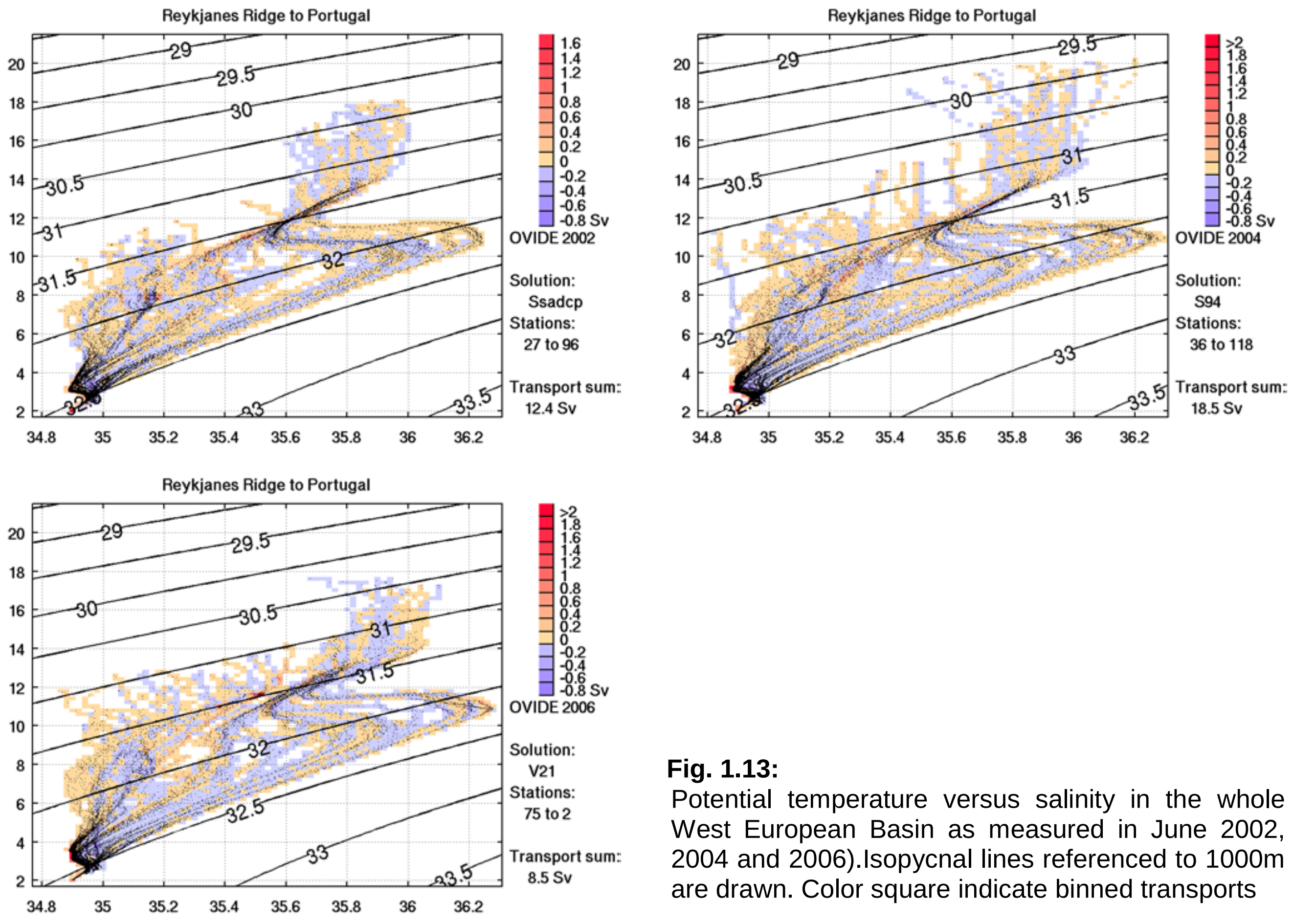


Fig. 1.13:
Potential temperature versus salinity in the whole West European Basin as measured in June 2002, 2004 and 2006).Isopycnal lines referenced to 1000m are drawn. Color square indicate binned transports

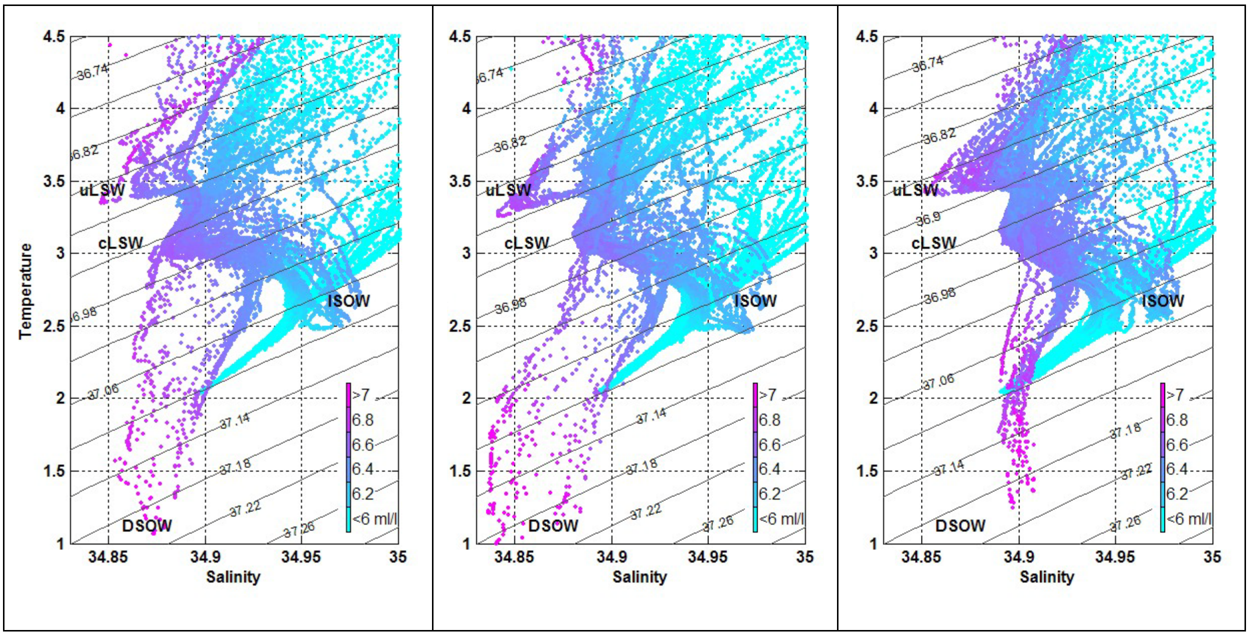


Fig. 1.14: Potential temperature versus salinity in the Irminger Basin as measured in June 2002, 2004 and 2006 (from left to right). Isopycnal lines referenced to 2000m are drawn. Profiles were decimated with a 10-meter resolution and colored by oxygen measurements

1.4.2 Current Profiling Sections

Pascale Lherminier, Claire Gourcuff

1.4.2.1 VMADCP

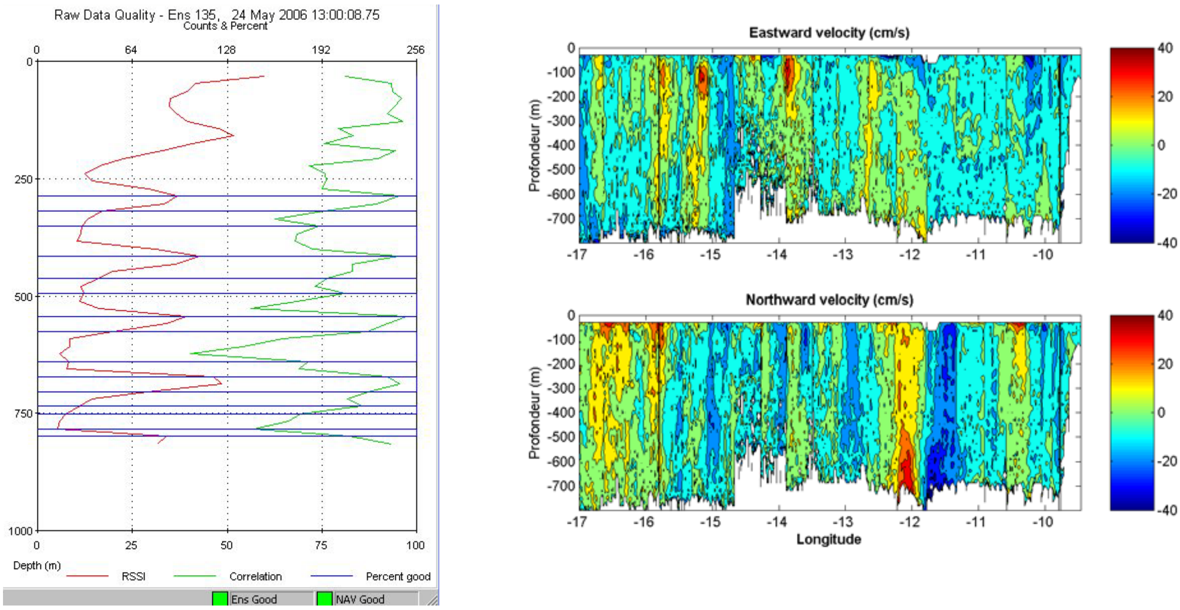


Fig. 1.15: SADCP raw and processed data. On the left, the result of one ping that shows interferences. 80% of the raw profiles looked like this before May 30 when the78kHz DoLog was finally switched off. On the right, the velocities after processing. The ship is progressing eastward. The weather deteriorates at about 14°W. At 14°35’W, the DoLog is switched off

The Ship ADCP is a RDI Ocean Surveyor 75kHz. The configuration was chosen based on our experience on the Pourquoi pas? and also helped by Andreas Lehmann experience. These data are very important for Ovide cruises since they are used to determine the velocity at the reference level (indirectly) and allow a quite precise determination of the western boundary currents.

Until we reached the longitude of 14°30’W, interferences were observed on the SADCP raw data (Fig. 1.15). Although less precise, we chose the Narrow Band mode since the signal was better recovered despite the numerous holes in the raw data. After realizing that the DoLog (78kHz) was responsible for this default, the Captain took the responsibility to shut it off although it gives the official speed of the ship.

The dataset is remarkable, with validated velocities down to more than 800m most of the time. It was processed using our Cascade Software written in Matlab language. A complete report was written, in which details on the configuration and the processing can be found (Gourcuff et al., 2006).

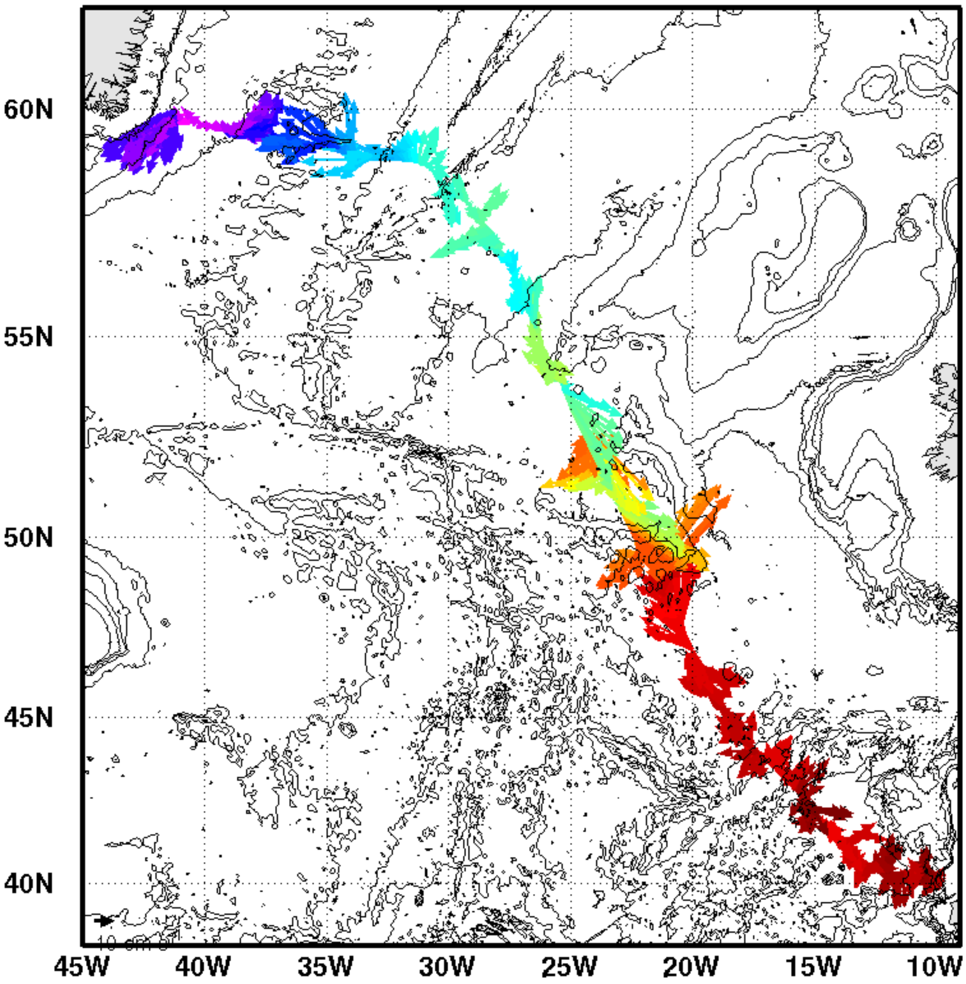


Fig. 1.16: Mean current between 100 and 400m depth as measured by the SADCP. Colors indicate the temperature interpolated from CTD data in the same layer

1.4.2.2 LADCP

The rosette is equipped with a downward-looking RDI BB150kHz (Broad Band), one of the last of its generation. Its 200m range is enough to get a good profile without additional information from another LADCP. However, a 300kHz Work-Horse was mounted on the rosette, looking upwards, to be combined with the BB150 in the processing, but it was not possible to synchronize both ADCP and using both of them does not always lead to a more accurate result.

The data were processed with the LDEO software version 7e (Visbeck, 2002), and compare well with the SADCP data in the first 800m (Gourcuff et al., 2006). Stations 38 and 39 were performed with only one down-looking 300kHz (the 150kHz blew a fuse twice in a row on its comm. card), and as anticipated, the profiles are less reliable. The whole Ovide section is plotted on Fig. 1.17.

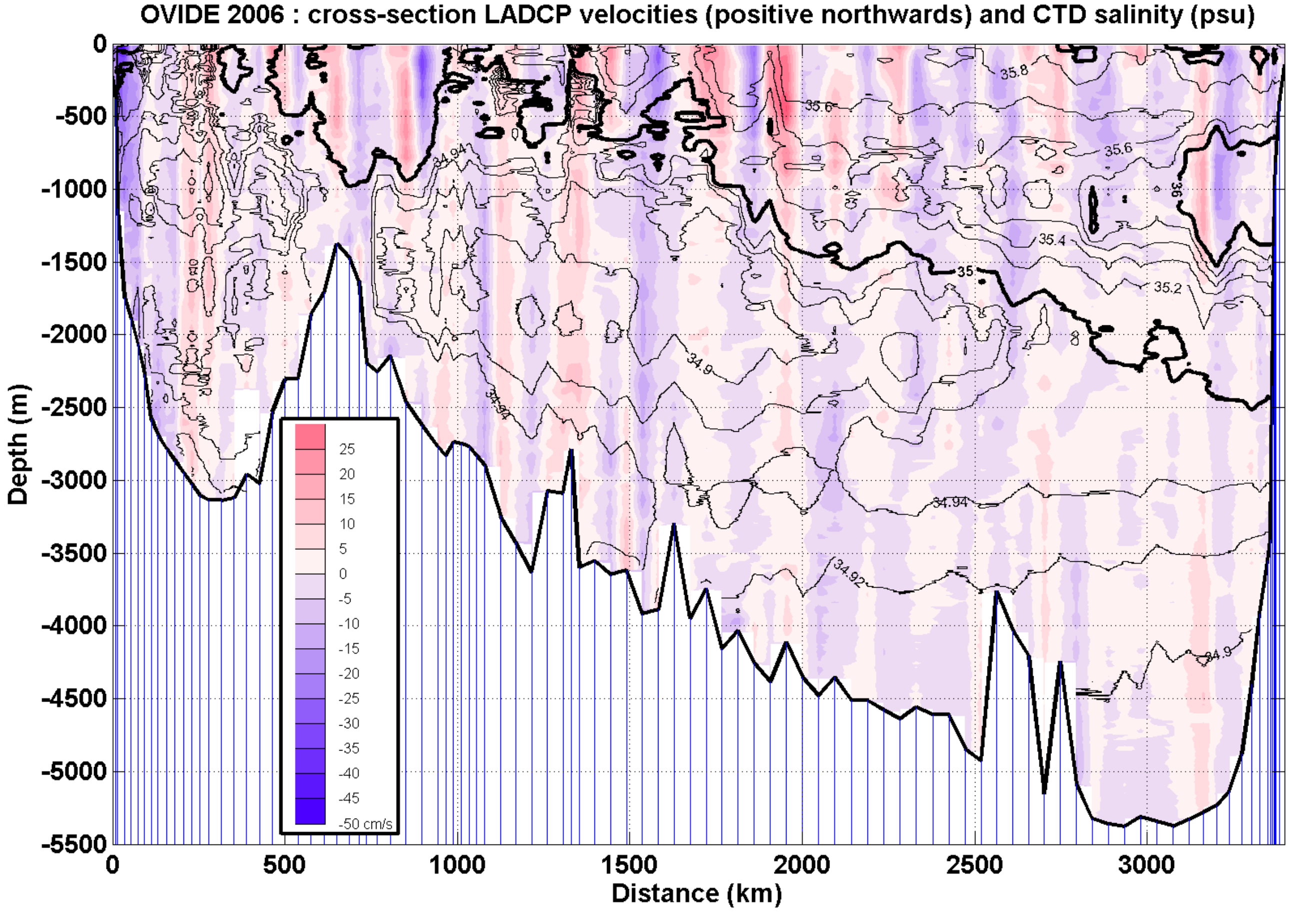


Fig. 1.17: The LADCP section with salinity contours

1.4.3 Nutrients, Chlorofluorocarbon (CFC), and Carbon Measurements

Pascal Morin, Essyllt Louarn, Fiz F. Perez, Marcos Vazquez Rodriguez

1.4.3.1 Nutrients

Nutrients were sampled in 125ml polyethylene bottles and analyzed following the protocols given in Aminot et Chaussepied (1983) and using a Auto Analyser II Bran et Luebbe. Procedures and results for this cruise are described in details in Morin et al. (2007). 2722 samples were analysed, leading to 10888 measurements of nitrates, nitrites, silicates and phosphates.

[NO_3^-]: uncertainty on nitrates measurements is less than 0.11 and 0.25 µmol l-1 at 2500m and 4600m respectively (0.54 et 1.09% relatively to the measured concentrations). Relatively to the scale defined by the WHP (1991), resulting precisions (0.24 et 0.54%) are well below the limit value defined by the WHP (0.9%).

[$Si(OH)_4$]: uncertainty on silicates measurements is less than 0.32 et 0.33 µmol l^{-1} at 2500m and 4600m respectively (0.67 et 0.97% relatively to the measured concentrations). Relatively to the scale defined by the WHP (1991), resulting precision (0.13%) is well below the limit value defined by the WHP (0.20%).

[PO_4^{3-}]: uncertainty on phosphates measurements is less than 0.02 µmol l^{-1} (1.59 et 1.31% relatively to the measured concentrations). Relatively to the scale defined by the WHP (1991), resulting precision (0.36%) is below the limit value accepted by the WHP (0.40%).

Nutrients can contribute to identify the origin of specific watermasses, or even to constrain deep circulation patterns. Silicates are for example an excellent tracer of the AABW (Fig. 1.18).

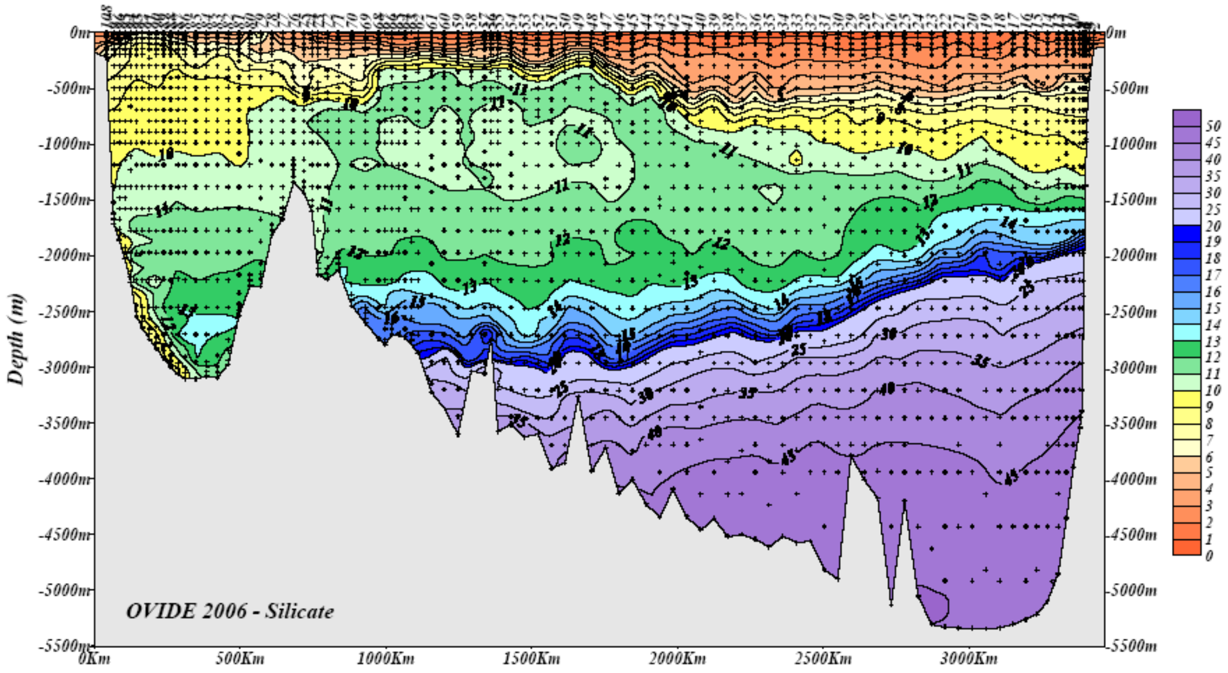


Fig. 1.18: Silicate vertical section (µmol.l^{-1})

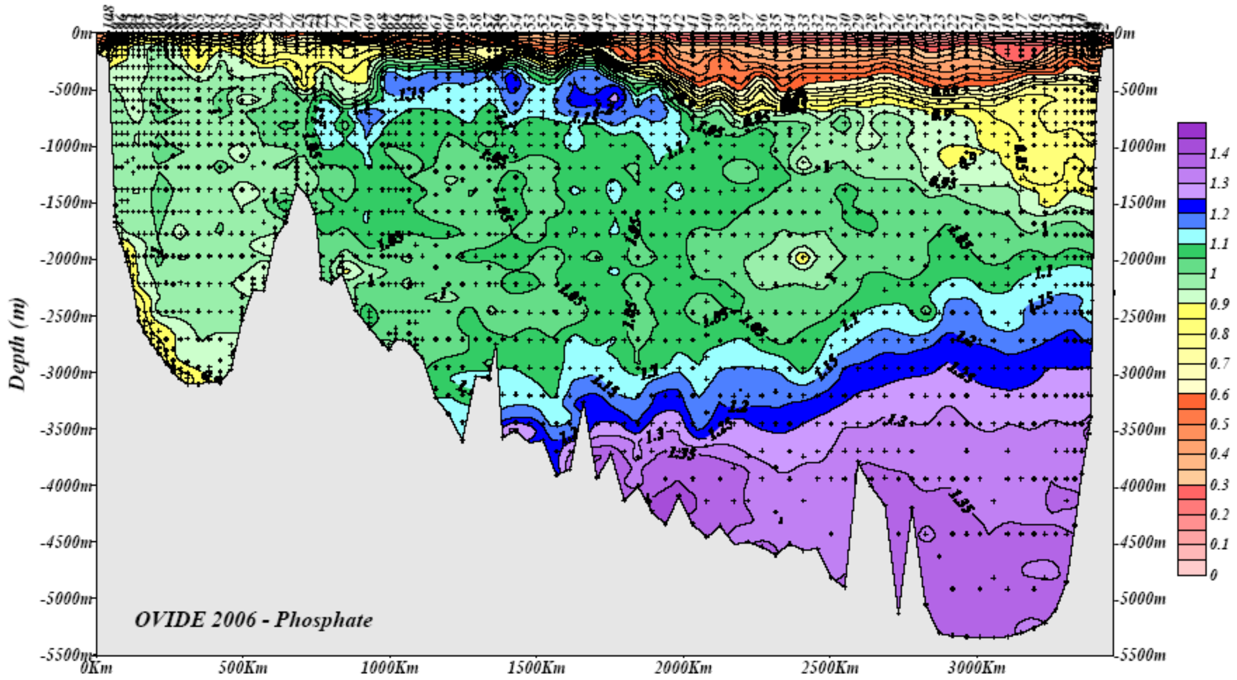


Fig. 1.19: Phosphate vertical section (µmol.l^{-1})

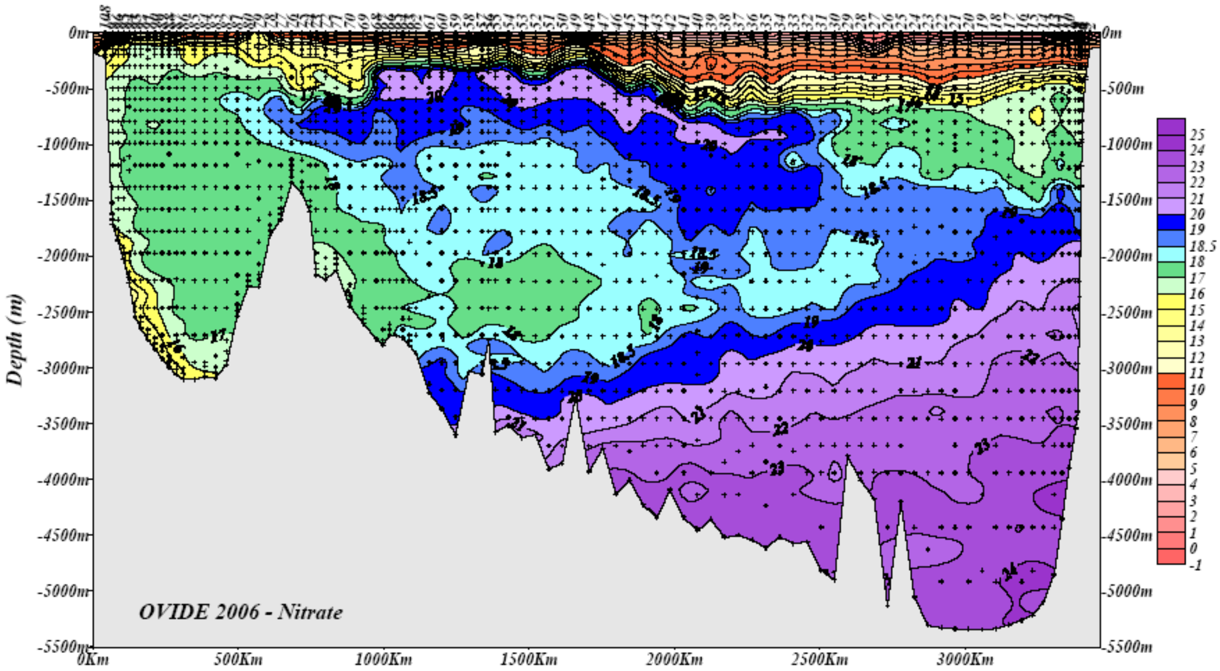


Fig. 1.20: Nitrate vertical section (µmol.l^{-1})

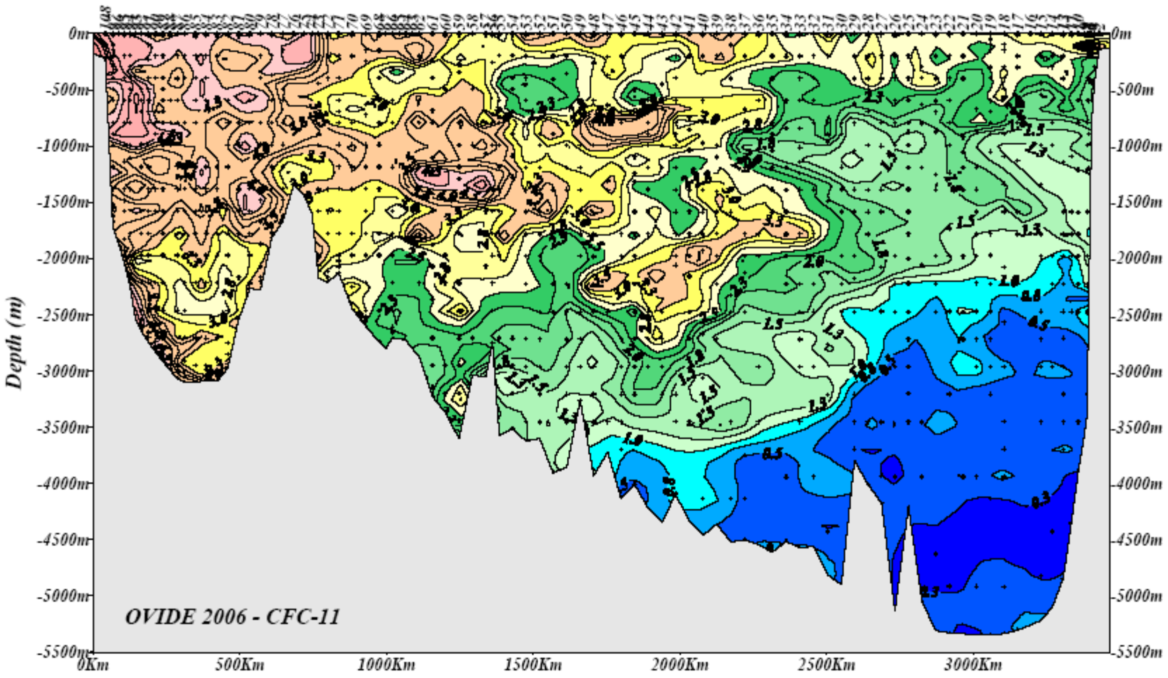
1.4.3.2 CFC

Dissolved chlorofluorocarbons CFC-11, CFC-12, CFC-113 and CCl_4 were measured by by purge-and-trap gas chromatography following the protocol described in Connan et al. (1996). As CFC concentrations are much higher in the air than in most of the analysed water masses, this tracer is sampled first and suitable techniques (described in Morin et al., 2007) are used to avoid any contact between the sampled water and the air.

During the cruise, repeatability obtained on several duplicates (2 samples from the same bottle) led to the following precisions:

CFC-12 : ± 4.45%, CFC-11 : ± 5.41%, CFC-113 : ± 6.25% and CCl_4 : ± 5.20%.

Freons are conservatives tracers that could be used to estimate the “age” of a watermass, i.e. the last time when it was in contact with the atmosphere. In Ovide, they are particularly valuable to trace the different vintages of LSW and their possible sites of ventilation.



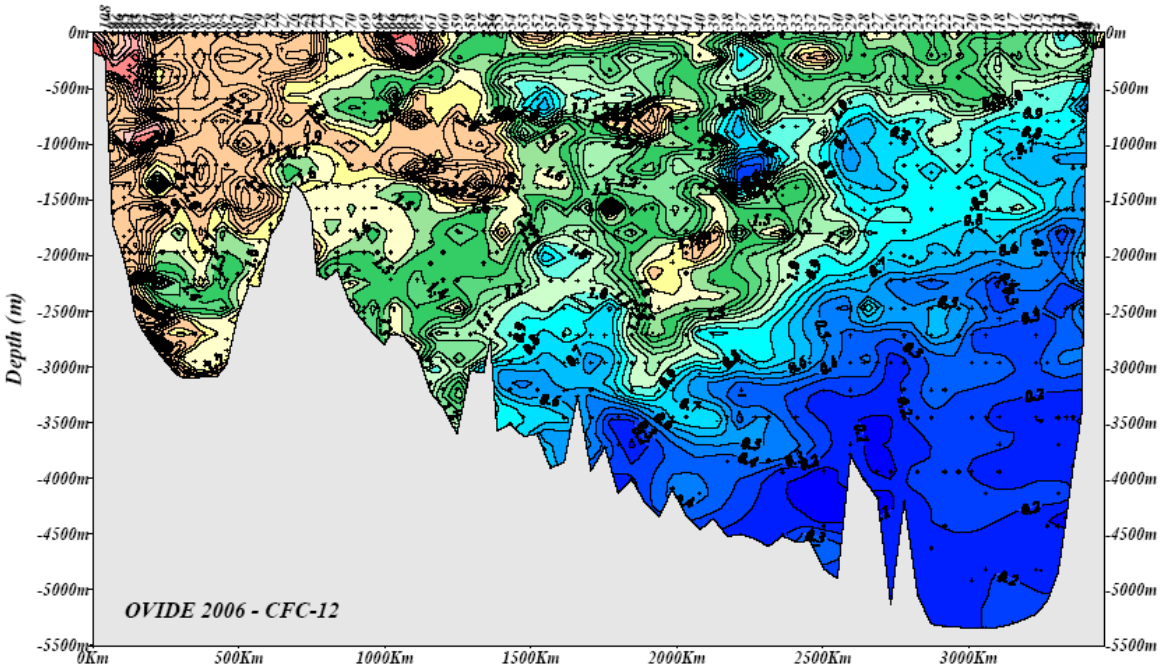


Fig. 1.21: CFC-11 and CFC-12 vertical sections (pmol.l^{-1})

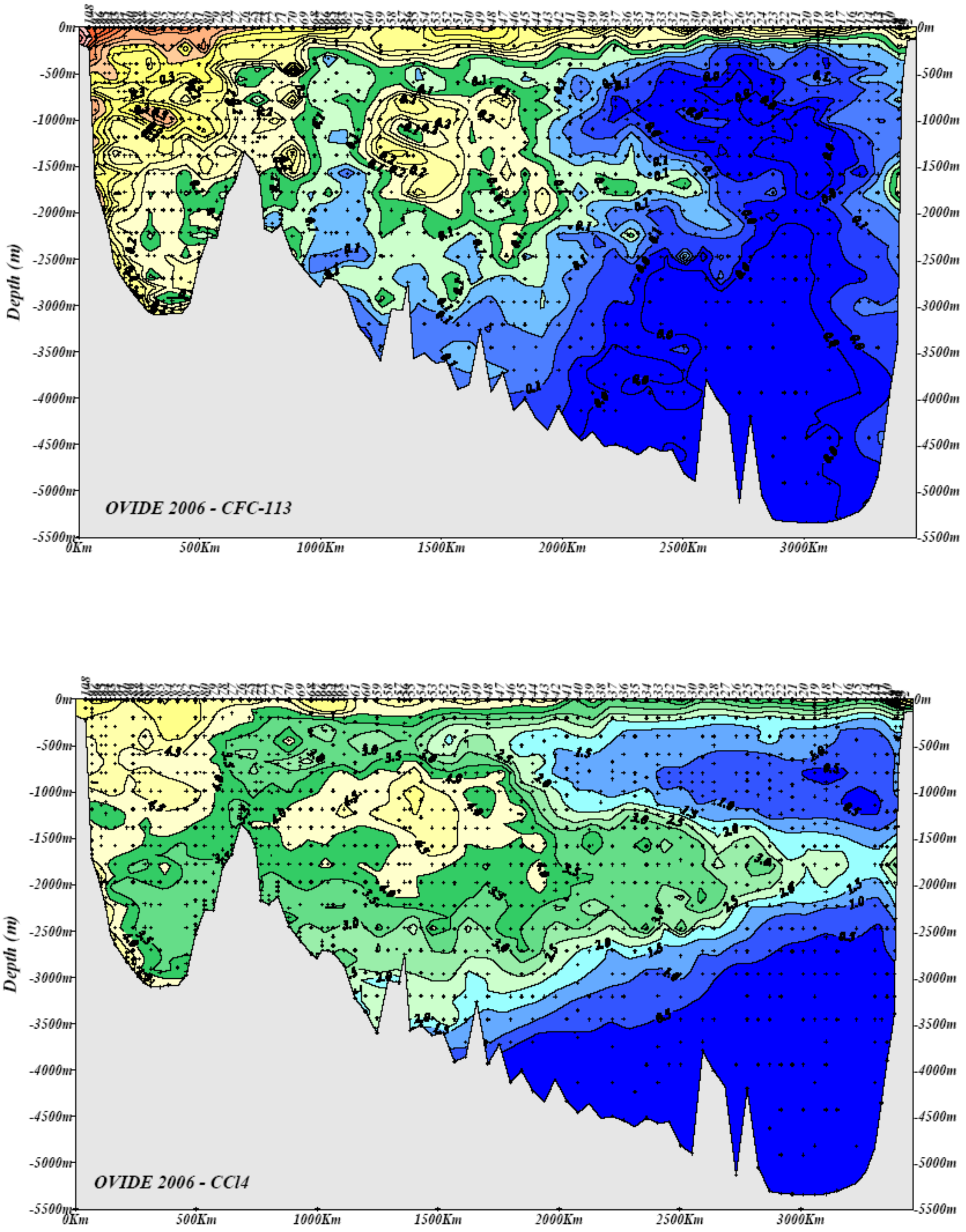


Fig. 1.22: CFC-113 and CCl4 vertical sections (pmol.l^{-1})

1.4.3.3 pH, Alkalinity and Anthropogenic Carbon

The carbonic system measurement:

The total carbon (C_T or DIC) and the total alkalinity (A_T) are two independent variables of temperature and pressure.

$$\boldsymbol{C_T} = CO2 + HCO_3^- + CO_3^{2-}$$

$$\boldsymbol{A_T} = HCO_3^- + 2 \cdot CO_3^{2-} + B(OH)_4^- + A_{Si(OH)4} + A_{H2PO4} + OH^- - H^+$$

$fCO2$ = Solu(T,S).CO_2 and $\boldsymbol{pH_{T25}}$ ($H = 10^{-pH}{}_{T25}$) are dependent on temperature and pressure :

$\boldsymbol{C_T}$ is determined from $\boldsymbol{A_T}$ and $\boldsymbol{pH_{T25}}$

$$C_T = A_C \frac{\left(1 + H/k_1(S,T) + k_2(S,T)/H\right)}{(1 + 2{\cdot}k_2(S,T)/H)} = f(S,T,pH,A_T)$$

The alkalinity was measured with a accuracy about 1 µmol·kg^{-1}

The pH was determined with a accuracy better than 0.002.

The C_T was calculated from A_T and pH with an error of 2 µmol·kg^{-1}

The alkalinity measurements:

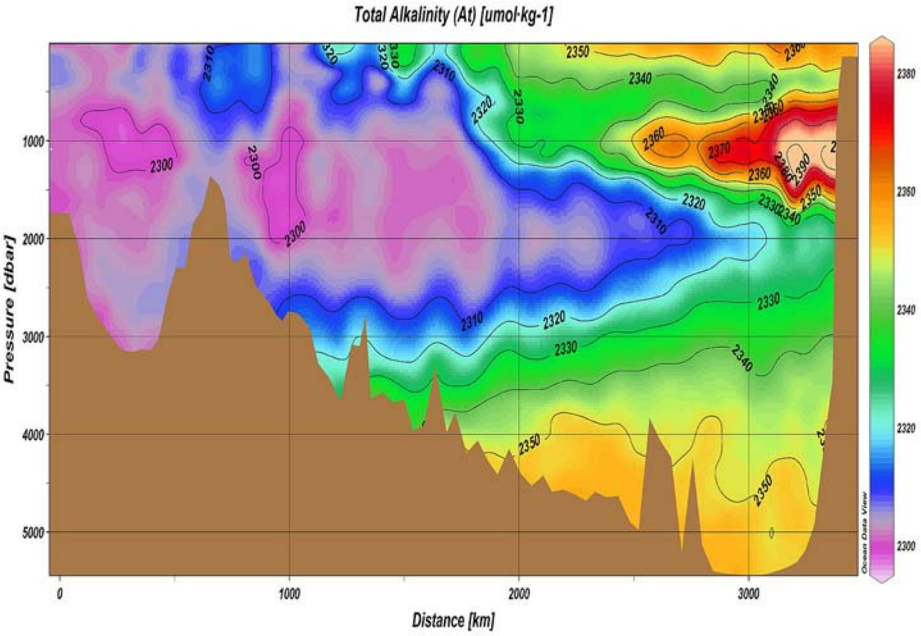


Fig. 1.23: Total Alkalinity vertical section (µmol.kg^{-1})

A_T was measured by single point potentiometric titration:

1123 samples were collected and measured over 58 stations. A_T profiles were usually sampled and analyzed every two stations. 24 samples were taken at each station. Seawater samples were collected after pH samples in 600 ml glass bottles.

Potentiometric titrations were performed with HCl (0.1 N) to an endpoint of pH=4.40 using an automatic titrator "Titrino Metrohm" and a pH-glass electrode. The electrode was standardised with a pH 4.41 buffer solution. The 0.1 N HCl was prepared with 0.5 mol of HCl (Riedel-deHaën® with mili-Q water into a graduated 5-L beaker at a known temperature).

Stations 1 through 20: samples were taken for accuracy estimation ± 1.1µmol.kg^{-1}

23 duplicates show an average reproducibility of 0.7 ± 1.0µmol.kg^{-1}

The pH measurements:

pH was measured spectrophotometrically (Clayton and Byrne;1993). On average, 2575 samples collected in 114 stations. Samples were collected after oxygen sampling, using cylindrical optical glass cells of 10 cm path-length. These were filled to overflowing to avoid bubbles and immediately closed after. Then, they were placed in a 25°C isotherm bath.

Once a baseline is determined, an m-cresol purple indicator dye solution is added to the seawater sample. After homogenisation, a *SHIMADZU UV-2401PC* spectrophotometer is used to measure the ratio (R) between the absorbencies at two different wavelengths at 25±0.2 ºC.

$pH_T = 1245.69/T + 3.8275 + (2.11.10^{-3})(35-S) + \log((R-0.0069)/(2.222-R*0.133))$The replication, using 77 samples taken along the cruise, was 0.0015+0.0016 for pH. This is the equivalent to a replication in C_T of 0.6+0.7 µmol·kg^{-1}.

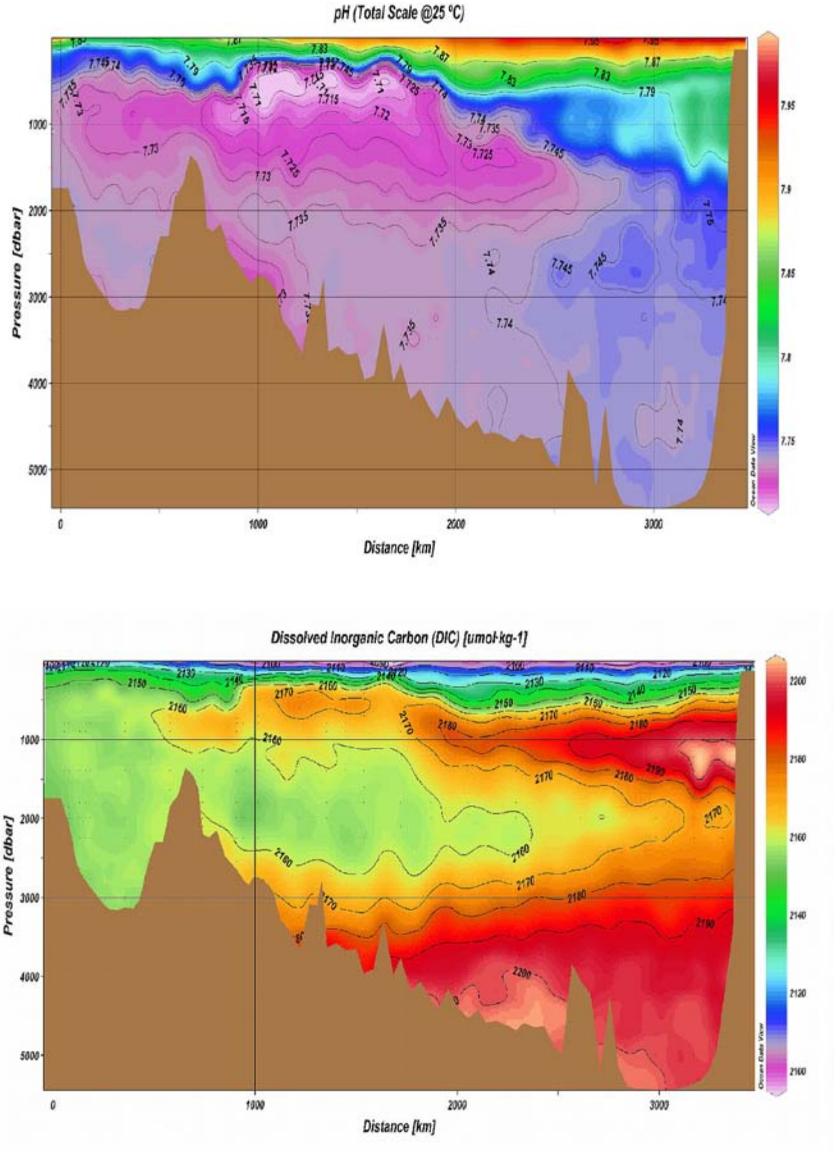


Fig. 1.24: pH and DIC (µmol.kg-1) vertical sections

The anthropogenic Carbon

The method to derive anthropogenic carbon is detailed in Vázquez-Rodríguez et al. (subm. DSR). The resulting C_{ant} evolution is shown on Fig. 1.25. A remarkable variability is found, particularly in the Irminger Basin and the Iberian Abyssal Plain, where values are the lowest in 2002 and 2006. It is presently investigated.

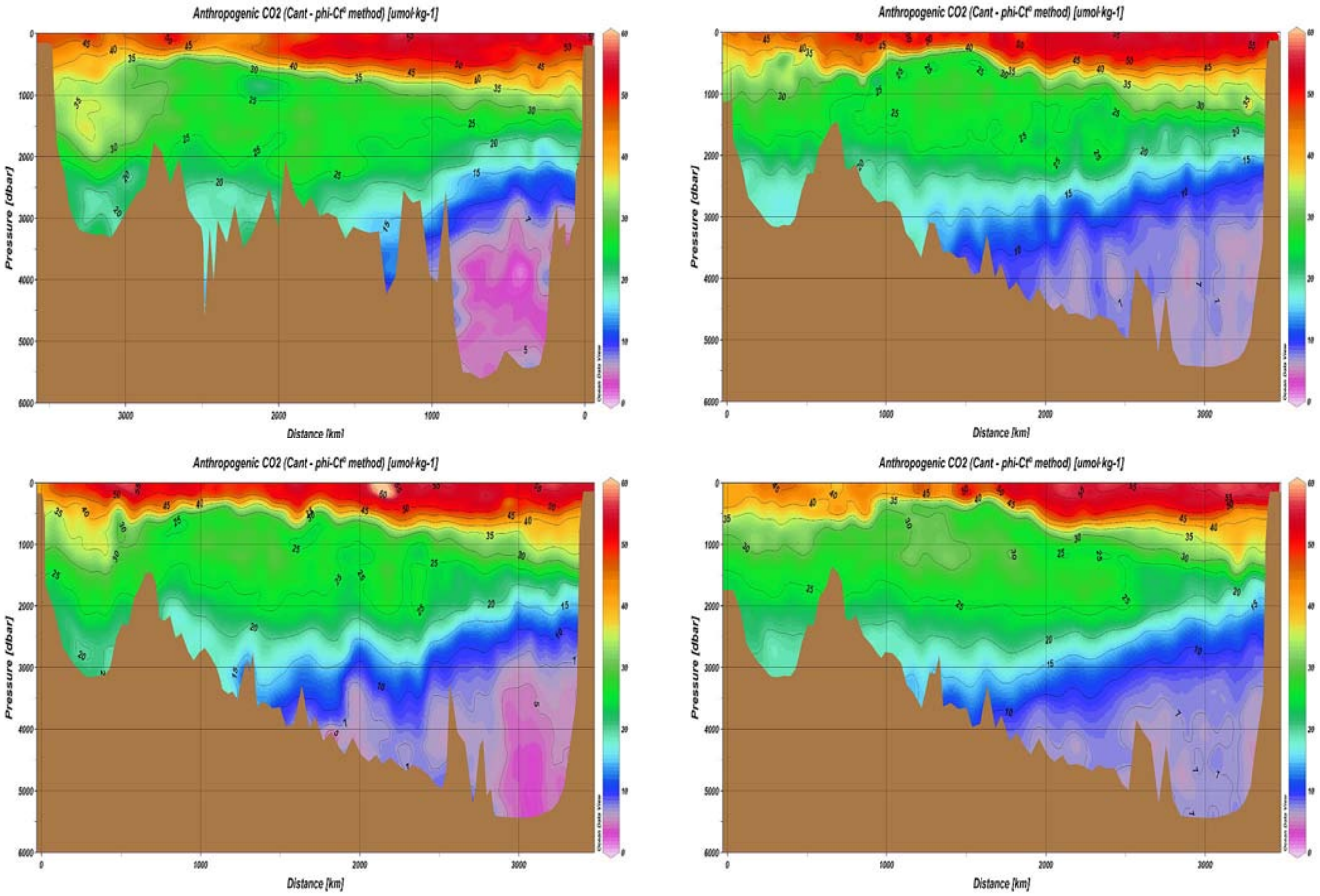


Fig. 1.25: The evolution of Anthropogenic Carbon contents on the A25/Ovide line (µmol.kg-1)

1.4.4 Mooring operations

Pascale Lherminier

The 4 moorings could be recovered at the following positions. Moorings A, B and D had been in the water for 2 years. Cb was maintained in Sept. 2005 on the Discovery cruise D298 (Bacon 2006). Mooring A gave us some difficulties since it appeared that it was released during our first visit in the surroundings, i.e. several hours before the actual recovery. That is why it took nearly an hour to find it. Did the EM120 send the release signal to the mooring? Although it seems unlikely, this is the only hypothesis we have now.

Tab. 1.2: Information on the four recovered moorings

	LATITUDE	***LONGITUDE***	***DEPTH***	***LENGTH***	***HEAD***	***ON DECK*** *(UTC)*
A	N59°39.223'	W41°47.596'	1894m	1718m	-176m	2006/06/17 22:23
B	N59°45.215'	W42°07.454'	1732m	1517m	-215m	2006/06/22 02:23
Cb	N59°47.620'	W42°15.922'	1112m	810m	-301m	2006/06/22 07:21
D	N59°48.949'	W42°19.122'	490m	332m	-158m	2006/06/22 04:59

Recovered instruments:

Mooring A

Seacat #2345, RCM8 #9940, #10229, #10230, #10231 and #10234, Argos Beacon #11261, acoustic release #445.

Mooring B

RCM8 #10238, #10240, #10243, #10244 and #10245, Argos #11262, acoustic release #446.

Mooring Cb

Microcat #4008, ADCP 75kHz #881, RCM8 #10743, #10233and #10232, RCM11 #454, Aquadopp #1337, Argos #11263, acoustic releases #294 and #447.

Mooring D

Seacat #4611, RCM8 #12678 and #12679, Argos #11264, acoustic release #375.

Lost instruments: Seacat #4609 on mooring B

Apart from the Aquadopp that did not start (configuration issue), all the instruments show the correct amount of data in their memory. A first look at ADCP and Seacat data is satisfying.

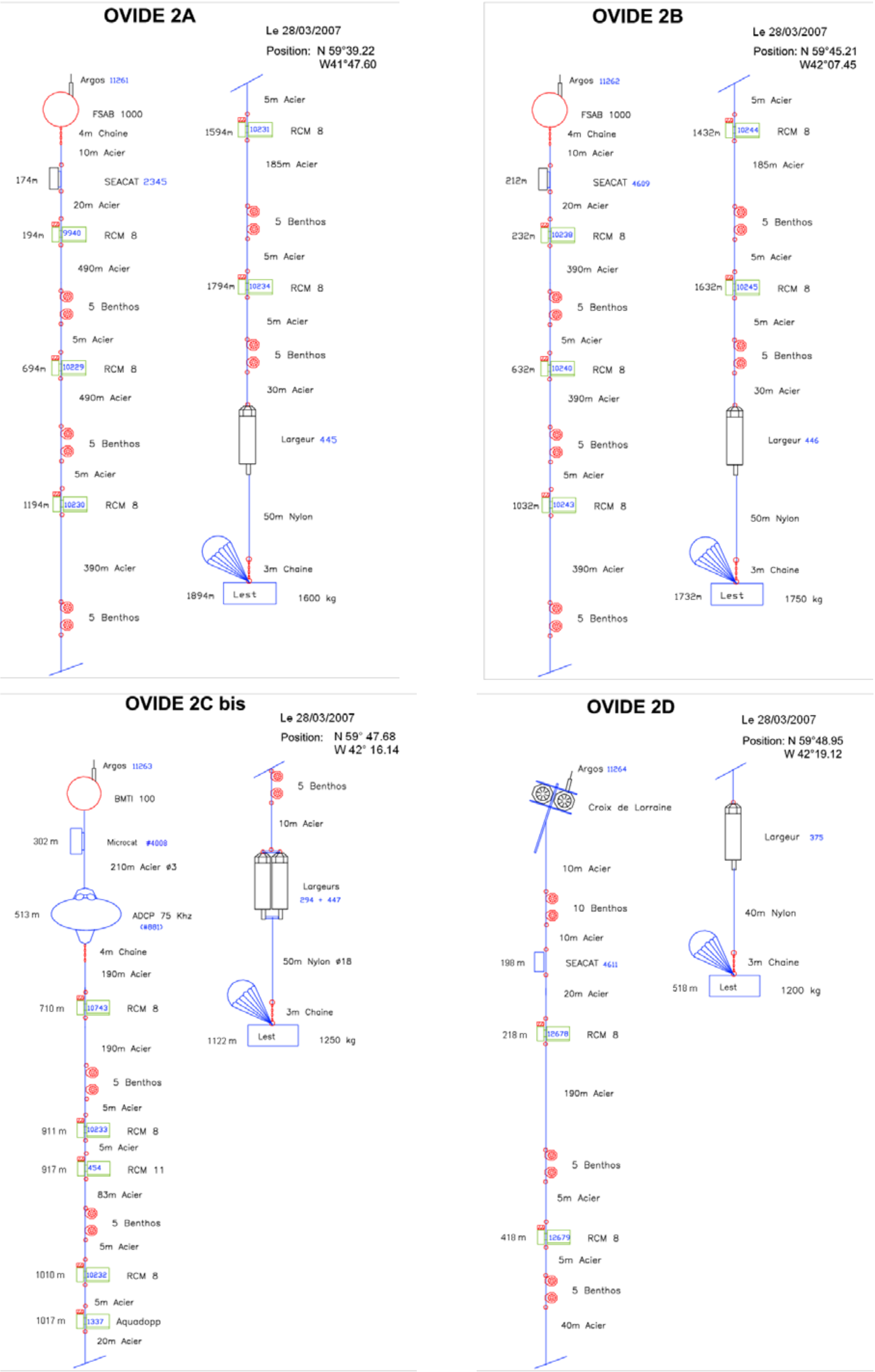


Fig. 1.26: Design of the four recovered moorings

A precise bathymetric chart could be drawn with the multibeam sounder EM120 of the Merian (Fig. 1.27).

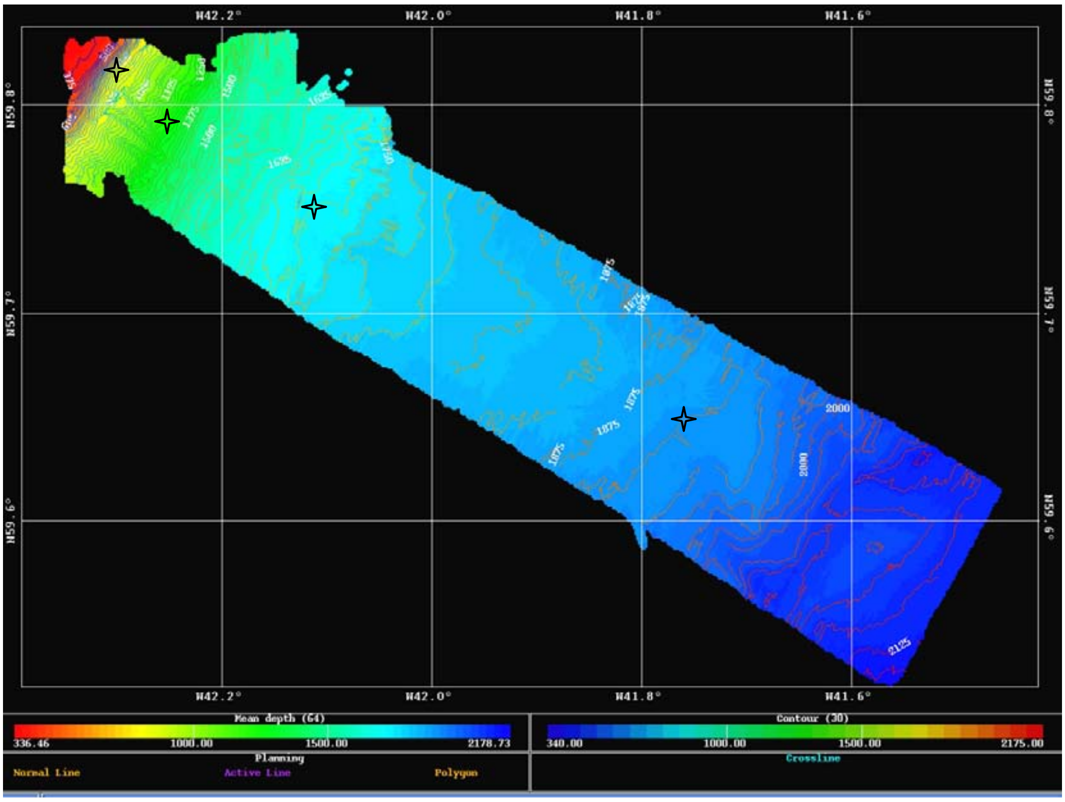


Fig. 1.27: The bathymetry of the mooring area. Moorings A, B, C and D are represented with black stars

1.4.5 Float Deployments

Virginie Thierry, Pascale Lherminier

16 profiling floats were deployed on the way at positions shown by green stars on Fig. 1.1 (Provor CTS3). The serial number of each float and the position and date of deployment are indicated in section 1.6. They were programmed as indicated on the table below:

Tab. 1.3: Parameters implemented in all the profiling floats

	Choice		Choice
Nomber of cycles	255	Aquisition period during drift	24h
Depth of drift	1000 dbar	Measurem.: upcast +1st downcast	yes
Cycle periodicity	10 days	Depth of the surface layer	500 dbar
Max depth of the upcast	2000 dbar	Sampling in the surface layer	50 dbar
Stalling mode	Stays at the bottom	Sampling below	60 dbar

The deployment is a participation to the ARGO program via the Coriolis project at Ifremer. In addition, floats are expected to sample the formation and advection of the SPMW, although a mistake in the parameters (50 dbars instead of 20 in the surface layer) may complicate this study. All floats were deployed nominally and their first profiles were checked.

1.4.6 XBT Section

Pascale Lherminier, Johanna Lerebourg

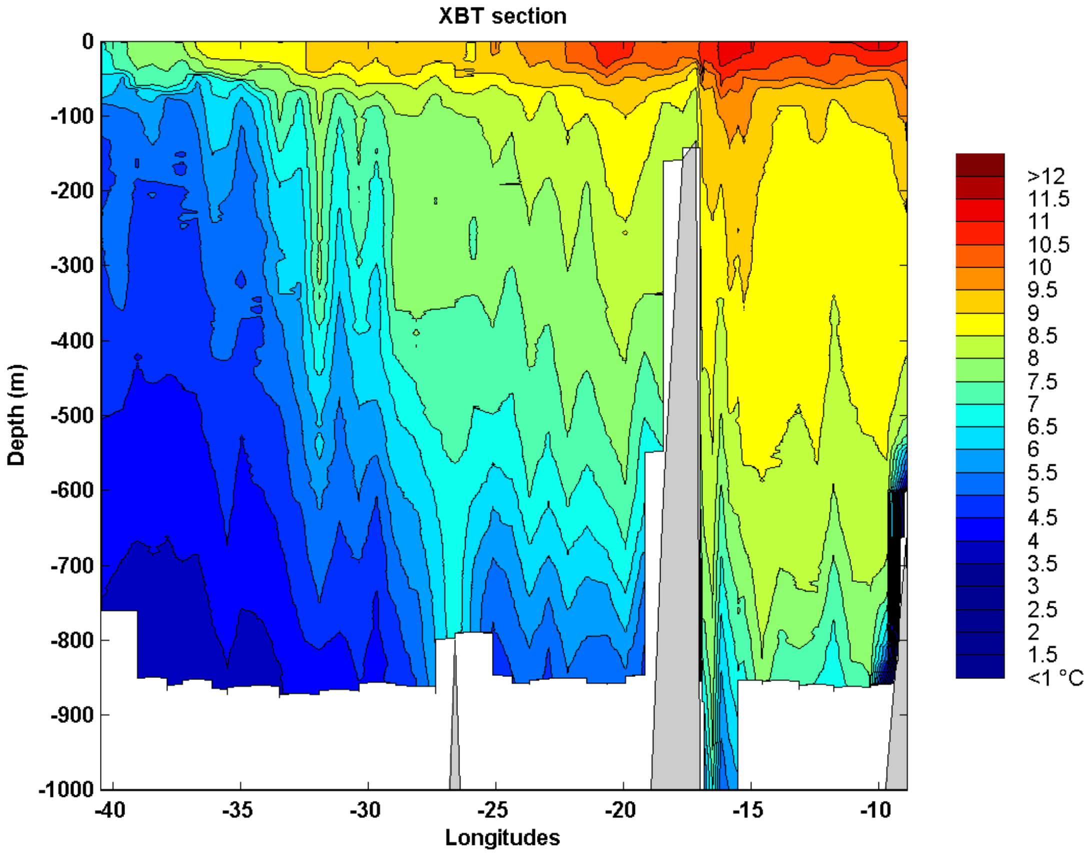


Fig. 1.28: Temperature section from Greenland to Faeroe Islands. RR: Reykjanes Ridge. IS: Iceland Shelf

During the transit back to Tórshavn, Expandable BathyThermographs (XBT) were launched every 2 hours, i.e. about 20nm (Fig. 1.1). CTD stations 116 to 120 were used off the Icelandic shelf to sample the ISOW, which is more clearly seen cascading off the Faeroes on the shallow section of Fig. 1.28.

1.5 The Web Site

During the whole mission, a French web site was maintained on shore and updated every 3 days:
http://www.ifremer.fr/lpo/ovide/ovide06/index.htm
Further results on the Ovide project can be found on
http://www.ifremer.fr/lpo/ovide/

All the data collected by the PROVOR floats, the glider, the XBT and a vertically subsampled CTD dataset have been sent to the Coriolis Regional Data Center [http://www.coriolis.eu.org/] in real time.

1.6 Station list

Tab. 1.4: List of stations of R/V MARIA S. MERIAN Cruise MSM02/1

MSM station name	Task	Latitude deg N	min	Longitude deg W	min	Dec. Latitude	Dec. Longitude	Depth (m)	Dura-tion (h)	Dist from n-1 (nm)	time to be reached (h)	Task	Day of arrival	mo.	Time of arrival	Time of depar-ture	Time reference
	Lisbon	38	42.75	9	7.34	38.713	-9.122			0.0		Port	23	5	22:00		UTC-1
MSM2/359-1	sta 0	38	26.00	10	42.00	38.433	-10.700	4500	5:30	76.0	7:18	Test Seabird	24	5	6:00		
MSM2/360-1	sta 1	38	26.00	10	42.00	38.433	-10.700	4500	6:30	0.0	0:00	Test NeilBrown	24	5	12:30	19:00	
MSM2/361-1	sta 2	40	20.00	9	27.56	40.333	-9.459	150	1:58	127.3	11:58	Station CTD	25	5	6:58	8:56	
MSM2/362-1	sta 3	40	20.00	9	38.57	40.333	-9.643	427	1:07	8.4	1:09	Station CTD	25	5	11:15	12:22	
MSM2/363-1	sta 4	40	20.06	9	45.85	40.334	-9.764	805	1:19	5.6	0:54	Station CTD	25	5	13:16	14:36	
MSM2/364-1	vmp 4-1	40	18.30	9	45.29	40.305	-9.755	798	1:14	1.8	0:09	Station VMP	25	5	14:46	16:00	
MSM2/365-1	sta 5	40	20.00	9	47.00	40.333	-9.784	975	1:43	2.1	0:35	Station CTD	25	5	16:36	18:19	
MSM2/366-1	sta 6	40	20.00	9	48.09	40.333	-9.802	1368	1:56	1.7	0:33	Station CTD	25	5	18:53	20:49	
MSM2/367-1	sta 7	40	20.00	9	52.56	40.333	-9.876	2352	2:29	3.4	0:42	Station CTD	25	5	21:32	0:01	
MSM2/368-1	sta 8	40	20.00	9	56.56	40.333	-9.943	3399	4:46	3.0	0:40	Station CTD	26	5	0:42	5:28	
MSM2/369-1	sta 9	40	20.00	10	1.94	40.333	-10.032	3549	3:09	4.1	0:46	Station CTD	26	5	6:14	9:24	
MSM2/370-1	sta 10	40	20.00	10	17.97	40.333	-10.300	3898	3:02	12.2	1:30	Station CTD	26	5	10:54	13:57	
MSM2/371-1	sta 11	40	20.00	10	34.54	40.333	-10.576	4361	3:18	12.6	1:32	Station CTD	26	5	15:30	18:49	
MSM2/372-1	sta 12	40	20.00	10	54.25	40.333	-10.904	4850	3:34	15.0	1:45	Station CTD	26	5	20:35	0:09	
	Figuera da Foz	40	8.50	8	53.10	40.142	-8.885	60	3:00	93.3	8:10	take spare part	27	6	8:20	11:20	
MSM2/373-1	sta 13	40	20.00	10	54.25	40.333	-10.904	4853	3:34	93.1	8:09	Station CTD	27	6	19:29	23:04	
MSM2/374-1	sta 14	40	20.00	11	20.45	40.333	-11.341	5104	3:43	20.0	2:12	Station CTD	28	5	1:17	5:00	
MSM2/375-1	sta 15	40	20.00	11	46.72	40.333	-11.779	5116	3:43	20.0	2:13	Station CTD	28	5	7:13	10:57	
MSM2/375-2	PV530	40	20.09	11	46.71	40.335	-11.779	5112	0:10	0.0	0:00	Provor deployt	28	5	10:57	11:07	
MSM2/376-1	sta 16	40	20.00	12	13.22	40.333	-12.220	5263	3:48	20.2	2:14	Station CTD	28	5	13:11	16:59	
MSM2/377-1	sta 17	40	33.06	12	38.76	40.551	-12.646	5310	3:50	23.4	2:31	Station CTD	28	5	19:31	23:21	
MSM2/378-1	sta 18	40	47.16	13	5.88	40.786	-13.098	5340	3:51	24.9	2:39	Station CTD	29	5	2:01	5:52	
MSM2/379-1	sta 19	41	5.04	13	29.46	41.084	-13.491	5344	3:51	25.2	6:23	Station CTD	29	5	12:15	16:07	
MSM2/380-1	vmp 19-2	41	5.04	13	29.46	41.084	-13.491	5360	5:27	0.0	0:00	Station VMP	29	5	16:07	21:34	

MSM station name	Task	Latitude deg N	min	Longitude deg W	min	Dec. Latitude	Dec. Longitude	Depth (m)	Dura-tion (h)	Dist from n-1 (nm)	time to be reached (h)	Task	Day of arrival	mo.	Time of arrival	Time of depar-ture	Time reference
MSM2/380-2	free-ctd-1	41	5.06	13	29.51	41.084	-13.492	5361	0:35	0.0	0:00	free-fall ctd	29	5	16:22	16:57	
MSM2/380-3	free-ctd-2	41	4.89	13	29.73	41.082	-13.496	5361	0:35	0.0	0:00	free-fall ctd	29	6	18:42	20:17	
MSM2/381-1	sta 20	41	23.01	13	53.31	41.384	-13.889	5355	3:51	25.4	2:42	Station CTD	30	5	0:16	4:08	
MSM2/382-1	sta 21	41	40.98	14	16.62	41.683	-14.277	5347	3:51	25.0	2:40	Station CTD	30	5	6:48	10:39	
MSM2/382-2	PV533	41	41.15	14	16.50	41.686	-14.275	5347	0:10	0.0	0:00	Provor deployt	30	5	10:39	10:49	
MSM2/383-1	sta 22	41	58.90	14	40.32	41.982	-14.672	5337	3:50	25.1	2:41	Station CTD	30	5	13:20	17:11	
MSM2/384-1	sta 23	42	16.86	15	3.90	42.281	-15.065	5311	3:50	25.0	2:40	Station CTD	30	5	19:52	23:42	
MSM2/385-1	sta 24	42	34.86	15	27.48	42.581	-15.458	5056	4:11	25.0	2:40	Station CTD	31	5	2:22	6:34	
MSM2/386-1	sta 25	42	52.86	15	51.00	42.881	-15.850	4201	3:13	24.9	5:27	Station CTD	31	5	12:02	15:15	
MSM2/387-1	sta 26	43	10.80	16	14.76	43.180	-16.246	5132	3:44	24.9	2:40	Station CTD	31	5	17:55	21:39	
MSM2/388-1	sta 27	43	28.74	16	38.34	43.479	-16.639	4173	2:57	24.8	2:27	Station CTD	1	6	0:07	3:04	
MSM2/388-2	PV535	43	28.74	16	38.34	43.479	-16.639	4173	0:15	0.0	0:00	Provor deployt	1	6	3:04	3:19	
MSM2/389-1	sta 28	43	46.68	17	1.92	43.778	-17.032	4010	3:06	24.7	2:33	Station CTD	1	6	5:52	8:59	
MSM2/390-1	sta 29	44	4.62	17	25.56	44.077	-17.426	3764	2:58	24.7	2:32	Station CTD	1	6	11:32	14:30	
MSM2/391-1	sta 30	44	22.62	17	49.02	44.377	-17.817	4899	3:36	24.6	2:32	Station CTD	1	6	17:02	20:39	
MSM2/392-1	sta 31	44	40.50	18	12.72	44.675	-18.212	4836	3:24	24.6	2:32	Station CTD	1	6	23:11	2:35	
MSM2/393-1	sta 32	45	2.94	18	30.24	45.049	-18.504	4613	3:16	25.6	2:37	Station CTD	2	6	5:13	8:30	
MSM2/394-1	sta 33	45	25.32	18	47.82	45.422	-18.797	4565	3:15	25.6	2:37	Station CTD	2	6	11:07	14:22	
MSM2/395-1	sta 34	45	47.70	19	5.46	45.795	-19.091	4511	3:13	25.5	2:37	Station CTD	2	6	16:59	20:13	
MSM2/395-2	PV531	45	47.70	19	5.46	45.795	-19.091	4511	0:15	0.0	0:00	Provor deployt	2	6	20:13	20:28	
MSM2/396-1	sta 35	46	10.20	19	23.10	46.170	-19.385	4602	3:26	25.6	2:37	Station CTD	2	6	23:05	2:32	
MSM2/397-1	sta 36	46	32.52	19	40.44	46.542	-19.674	4537	3:24	25.3	2:36	Station CTD	3	6	5:08	8:32	
MSM2/398-1	sta 37	46	54.96	19	58.14	46.916	-19.969	4491	3:22	25.5	2:36	Station CTD	3	6	11:09	14:32	
MSM2/399-1	sta 38	47	17.52	20	15.78	47.292	-20.263	4507	5:13	25.5	2:37	Station CTD	3	6	17:09	22:22	
MSM2/400-1	sta 39	47	39.90	20	33.36	47.665	-20.556	4341	3:17	25.3	2:36	Station CTD	4	6	0:58	4:16	
MSM2/401-1	sta 40	48	2.28	20	51.06	48.038	-20.851	4447	3:21	25.3	2:36	Station CTD	4	6	6:52	10:13	

MSM station name	Task	Latitude deg N	min	Longitude deg W	min	Dec. Latitude	Dec. Longitude	Depth (m)	Dura-tion (h)	Dist from n-1 (nm)	time to be reached (h)	Task	Day of arrival	mo.	Time of arrival	Time of depar-ture	Time reference
MSM2/402-1	sta 41	48	24.72	21	8.52	48.412	-21.142	4327	3:17	25.3	2:35	Station CTD	4	6	12:49	16:06	
MSM2/402-2	PV534	48	24.72	21	8.52	48.412	-21.142	4327	0:05	0.0	0:00	Provor deployt	4	6	16:06	16:11	
MSM2/403-1	sta 42	48	47.16	21	25.98	48.786	-21.433	4080	2:54	25.2	2:23	Station CTD	4	6	18:35	21:29	
MSM2/404-1	sta 43	49	9.48	21	43.62	49.158	-21.727	4336	3:12	25.1	2:41	Station CTD	5	6	0:10	3:22	
MSM2/405-1	sta 44	49	31.92	22	1.20	49.532	-22.020	4223	3:08	25.2	2:43	Station CTD	5	6	5:05	8:14	time change: UTC
MSM2/406-1	sta 45	49	54.36	22	18.84	49.906	-22.314	3993	3:01	25.2	2:59	Station CTD	5	6	11:14	14:15	
MSM2/407-1	sta 46	50	16.74	22	36.36	50.279	-22.606	4129	3:05	25.0	2:58	Station CTD	5	6	17:14	20:19	
MSM2/408-1	sta 47	50	38.52	22	54.06	50.642	-22.901	3713	2:51	24.5	2:55	Station CTD	5	6	23:15	2:06	
MSM2/409-1	sta 48	51	1.62	23	11.64	51.027	-23.194	3924	2:58	25.6	3:02	Station CTD	6	6	5:09	8:08	
MSM2/409-2	vmp 48-3	51	1.62	23	11.64	51.027	-23.194	3924	5:20	0.0	0:00	Station VMP	6	6	8:08	13:28	
MSM2/409-3	PV528	51	1.62	23	11.64	51.027	-23.194	3924	0:15	0.0	0:00	Provor deployt	6	6	8:13	8:28	
MSM2/410-1	sta 49	51	24.06	23	29.10	51.401	-23.485	3252	2:26	24.9	2:58	Station CTD	6	6	16:26	18:53	
MSM2/411-1	sta 50	51	46.38	23	46.62	51.773	-23.777	3851	2:56	24.8	2:48	Station CTD	6	6	21:41	0:38	
MSM2/411-2	PV537	51	46.38	23	46.62	51.773	-23.777	3851	0:10	0.0	0:00	Provor deployt	7	6	0:38	0:48	
MSM2/412-1	sta 51	52	8.82	24	4.26	52.147	-24.071	3897	2:57	24.9	2:58	Station CTD	7	6	3:46	6:44	
MSM2/413-1	sta 52	52	31.26	24	21.78	52.521	-24.363	3594	2:47	24.8	2:57	Station CTD	7	6	9:41	12:29	
MSM2/413-2	PV529	52	31.26	24	21.78	52.521	-24.363	3594	0:10	0.0	0:00	Provor deployt	7	6	12:29	12:39	
MSM2/414-1	sta 53	52	53.58	24	39.36	52.893	-24.656	3617	2:48	24.7	4:44	Station CTD+ glider calib	7	6	17:24	20:12	
MSM2/415-1	sta 54	53	16.14	24	57.00	53.269	-24.950	3519	2:45	24.9	3:14	Station CTD	7	6	23:27	2:12	
MSM2/416-1	sta 55	53	38.40	25	14.40	53.640	-25.240	3516	2:45	24.5	2:55	Station CTD	8	6	5:08	7:53	
MSM2/417-1	sta 56	53	49.70	25	23.25	53.828	-25.388	3250	2:36	12.4	1:35	Station CTD	8	6	9:28	12:04	
MSM2/417-2	PV527	53	49.70	25	23.25	53.828	-25.388	3251	0:10	0.0	0:00	Provor deployt	8	6	12:04	12:14	
MSM2/418-1	sta 57	54	0.96	25	32.10	54.016	-25.535	3068	2:30	12.4	1:34	Station CTD	8	6	13:49	16:19	
MSM2/419-1	sta 58	54	23.22	25	49.68	54.387	-25.828	3047	2:29	24.5	2:55	Station CTD	8	6	19:14	21:44	
MSM2/420-1	sta 59	54	45.72	26	7.38	54.762	-26.123	3610	2:48	24.7	4:08	Station CTD	9	6	1:53	4:41	

MSM station name	Task	Latitude deg N	min	Longitude deg W	min	Dec. Latitude	Dec. Longitude	Depth (m)	Duration (h)	Dist from n-1 (nm)	time to be reached (h)	Task	Day of arrival	mo.	Time of arrival	Time of departure	Time reference
MSM2/421-1	sta 60	55	8.94	26	24.66	55.149	-26.411	3375	2:40	25.2	3:00	Station CTD	9	6	7:41	10:22	
MSM2/421-2	PV532	55	8.94	26	24.66	55.149	-26.411	3375	0:10	0.0	0:00	Provor deployt	9	6	10:22	10:32	
MSM2/422-2	vmp 61-4	55	31.06	26	40.47	55.518	-26.675	3234	5:11	23.9	3:27	Station VMP	9	6	13:59	18:10	
MSM2/422-1	sta 61	55	30.36	26	42.36	55.506	-26.706	3234	2:35	1.3	0:24	Station CTD	9	6	14:24	16:59	
MSM2/423-1	sta 62	55	52.98	26	59.88	55.883	-26.998	2879	2:23	24.7	2:56	Station CTD	9	6	22:07	0:31	
MSM2/424-1	sta 63	56	4.14	27	8.64	56.069	-27.144	2812	1:53	12.2	1:33	Station CTD	10	6	2:04	3:58	
MSM2/425-1	sta 64	56	15.24	27	17.40	56.254	-27.290	2733	2:09	12.1	1:38	Station CTD	10	6	5:37	7:46	
MSM2/426-1	sta 65	56	26.46	27	26.10	56.441	-27.435	2726	2:18	12.2	1:33	Station CTD	10	6	9:19	11:38	
MSM2/427-1	sta 66	56	37.74	27	34.80	56.629	-27.580	2721	2:18	12.3	1:33	Station CTD	10	6	13:12	15:30	
MSM2/428-1	sta 67	56	49.02	27	43.77	56.817	-27.730	2813	2:21	12.3	1:34	Station CTD	10	6	17:04	19:26	
MSM2/429-1	sta 68	57	0.30	27	52.74	57.005	-27.879	2747	2:19	12.3	1:33	Station CTD	10	6	21:00	23:20	
MSM2/429-2	PV536	57	0.30	27	52.74	57.005	-27.879	2747	0:10	0.0	0:00	Provor deployt	10	6	23:20	23:30	
MSM2/430-1	sta 69	57	22.62	28	10.32	57.377	-28.172	2594	1:56	24.2	3:13	Station CTD	11	6	2:44	4:40	
MSM2/431-1	sta 70	57	40.44	28	43.56	57.674	-28.726	2460	1:52	25.2	3:33	Station CTD	11	6	8:13	10:05	
MSM2/432-1	sta 71	57	58.26	29	16.62	57.971	-29.277	2126	1:40	25.0	4:49	Station CTD	11	6	14:55	16:36	
MSM2/432-2	PV538	57	58.26	29	16.62	57.971	-29.277	2126	0:10	0.0	0:00	Provor deployt	11	6	16:36	16:46	
MSM2/433-1	sta 72	58	12.48	29	43.44	58.208	-29.724	2224	1:44	20.0	3:17	Station CTD	11	6	20:03	21:47	
MSM2/434-1	sta 73	58	24.60	30	6.12	58.410	-30.102	2176	2:05	17.0	2:37	Station CTD	12	6	0:25	2:30	
MSM2/435-1	sta 74	58	33.00	30	21.90	58.550	-30.365	1702	1:49	11.8	1:40	Station CTD	12	6	4:10	6:00	
MSM2/436-1	sta 75	58	43.62	30	41.76	58.727	-30.696	1453	1:41	14.8	2:03	Station CTD	12	6	8:03	9:45	
MSM2/437-1	sta 76	58	50.64	31	16.08	58.844	-31.268	1484	1:27	19.1	2:35	Station CTD	12	6	12:20	13:47	
MSM2/438-1	sta 77	58	54.60	31	54.66	58.910	-31.911	1689	1:26	20.3	2:35	Station CTD	12	6	16:23	17:49	
MSM2/439-1	sta 78	58	58.32	32	33.18	58.972	-32.553	1873	1:32	20.2	2:26	Station CTD	12	6	20:16	21:48	
MSM2/440-1	sta 79	59	2.34	33	11.58	59.039	-33.193	2279	1:45	20.2	2:26	Station CTD	13	6	0:14	2:00	
MSM2/441-1	sta 80	59	6.18	33	49.86	59.103	-33.831	2273	1:45	20.0	2:33	Station CTD	13	6	4:34	6:20	
MSM2/441-2	PV526	59	6.18	33	49.86	59.103	-33.831	2273	0:10	0.0	0:00	Provor deployt	13	6	6:20	6:30	

MSM station name	Task	Latitude deg N	min	Longitude deg W	min	Dec. Latitude	Dec. Longitude	Depth (m)	Dura-tion (h)	Dist from n-1 (nm)	time to be reached (h)	Task	Day of arrival	mo.	Time of arrival	Time of depar-ture	Time reference
MSM2/442-1	sta 81	59	9.90	34	28.56	59.165	-34.476	2538	2:17	20.2	2:43	Station CTD	13	6	9:13	11:30	
MSM2/443-1	sta 82	59	13.92	35	6.90	59.232	-35.115	2985	2:17	20.0	2:42	Station CTD	13	6	14:13	16:30	
MSM2/444-1	sta 83	59	17.94	35	45.72	59.299	-35.762	3093	2:51	20.2	2:34	Station CTD	13	6	19:05	21:56	
MSM2/445-1	sta 84	59	21.84	36	23.76	59.364	-36.396	3089	2:20	19.8	2:31	Station CTD	14	6	0:28	2:49	
MSM2/446-1	sta 85	59	25.68	37	2.22	59.428	-37.037	3120	2:22	19.9	2:47	Station CTD	14	6	5:36	7:58	
MSM2/447-1	sta 86	59	29.52	37	40.80	59.492	-37.680	3107	2:21	20.0	2:49	Station CTD	14	6	10:47	13:09	
MSM2/448-1	sta 87	59	32.16	38	6.38	59.536	-38.106	3090	2:21	13.2	2:36	Station CTD	14	6	15:45	18:06	
MSM2/449-1	sta 88	59	34.80	38	31.96	59.580	-38.533	3000	2:18	13.2	15:34	Station CTD	15	6	9:41	11:59	
MSM2/450-1	sta 89	59	37.44	38	57.54	59.624	-38.959	2889	2:14	13.2	2:24	Station CTD	15	6	14:23	16:37	
MSM2/451-1	sta 90	59	39.44	39	23.40	59.657	-39.390	2830	2:12	13.2	2:24	Station CTD	15	6	19:01	21:13	
MSM2/452-1	sta 91	59	41.44	39	49.26	59.691	-39.821	2730	2:09	13.2	2:24	Station CTD	15	6	23:37	1:46	
MSM2/453-1	sta 92	59	43.44	40	15.12	59.724	-40.252	2649	2:06	13.2	1:39	Station CTD	16	6	3:26	5:33	
MSM2/454-1	sta 93	59	44.39	40	36.09	59.740	-40.602	2510	2:01	10.6	1:22	Station CTD	16	6	6:55	8:57	
MSM2/455-1	sta 94	59	45.33	40	57.06	59.756	-40.951	2225	1:52	10.6	1:22	Station CTD	16	6	10:20	12:12	
MSM2/456-1	sta 95	59	46.27	41	18.03	59.771	-41.301	2065	1:46	10.6	1:22	Station CTD	16	6	13:35	15:21	
MSM2/457-1	sta 96	59	47.22	41	39.00	59.787	-41.650	1890	1:41	10.6	1:22	Station CTD	16	6	16:44	18:25	
MSM2/458-1	sta 97	59	51.95	41	56.61	59.866	-41.944	1735	1:35	10.0	1:52	Station CTD	16	6	20:17	21:53	
MSM2/459-1	sta 98	59	47.22	41	38.71	59.787	-41.645	1880	1:40	10.2	8:23	Station CTD	17	6	6:17	7:58	
MSM2/460-1	sta 99	59	46.26	41	17.97	59.771	-41.300	2044	1:56	10.5	1:21	Station CTD	17	6	9:19	11:16	
MSM2/460-2	glider 004	59	46.26	41	17.97	59.771	-41.300	2044	03:00	0.0	0:00	Glider deployt	17	6	11:16	14:16	
MSM2/461-1	mooring A	59	39.22	41	47.60	59.654	-41.793	1894	04:30	16.5	3:42	Mooring recovery	17	6	17:58	22:28	
MSM2/461-2	sta 100	59	39.25	41	47.81	59.654	-41.797	1881	1:40	0.1	0:25	Station CTD	17	6	22:53	0:34	
MSM2/462-1	sta 101	59	1.50	39	49.00	59.025	-39.817	3033	2:34	71.9	7:31	Station CTD	19	6	8:06	10:40	
MSM2/463-1	sta 102	59	9.80	40	14.00	59.163	-40.233	2985	2:17	15.3	1:53	Station CTD	19	6	12:34	14:51	
MSM2/464-1	sta 103	59	17.50	40	39.50	59.292	-40.658	2727	2:08	15.1	1:52	Station CTD	19	6	16:44	18:53	
MSM2/465-1	sta 104	59	23.00	40	56.50	59.383	-40.942	2631	2:05	10.3	1:58	Station CTD	19	6	20:51	22:57	

MSM station name	Task	Latitude deg N	min	Longitude deg W	min	Dec. Latitude	Dec. Longitude	Depth (m)	Dura-tion (h)	Dist from n-1 (nm)	time to be reached (h)	Task	Day of arrival	mo.	Time of arrival	Time of depar-ture	Time reference
MSM2/466-1	sta 105	59	28.00	41	14.00	59.467	-41.233	2367	1:56	10.2	1:51	Station CTD	20	6	0:48	2:45	
		61	0.00	35	17.00	61.000	-35.283		0:15	196.0	19:13	Rescue op.	20	6	21:59	22:14	
MSM2/467-1	sta 106	59	44.74	42	3.41	59.746	-42.057	1755	1:36	218.2	21:10	Station CTD	21	6	19:25	21:01	
MSM2/467-2	mooring B	59	45.22	42	7.70	59.754	-42.128	1733	02:40	2.2	0:38	Mooring recovery	21	6	21:40	0:20	
MSM2/468-1	sta 107	59	49.31	42	20.11	59.822	-42.335	375	0:32	7.5	1:08	Station CTD	22	6	1:29	2:01	
MSM2/469-1	sta 108	59	54.31	42	23.85	59.905	-42.398	229	0:32	5.3	0:44	Station CTD	22	6	2:45	3:18	
MSM2/470-1	mooring D	59	48.95	42	19.12	59.816	-42.319	491	01:00	5.9	0:47	Mooring recovery	22	6	4:05	5:05	
MSM2/471-1	mooring Cb	59	47.62	42	15.92	59.794	-42.265	1113	02:40	2.1	0:24	Mooring recovery	22	6	5:30	8:10	
MSM2/472-1	sta 109	59	48.56	42	18.11	59.809	-42.302	820	1:20	1.4	1:03	Station CTD	22	6	9:13	10:34	
MSM2/474-1	sta 110	59	49.03	42	19.07	59.817	-42.318	500	0:44	0.7	0:44	Station CTD	22	6	11:18	12:02	
MSM2/476-1	sta 111	59	47.64	42	15.95	59.794	-42.266	1115	1:05	2.1	1:38	Station CTD	22	6	13:41	14:47	
MSM2/477-1	sta 112	59	46.20	42	11.50	59.770	-42.192	1590	1:31	2.7	0:50	Station CTD	22	6	15:37	17:08	
MSM2/478-1	sta 113	59	43.00	42	0.00	59.717	-42.000	1730	1:35	6.6	1:30	Station CTD	22	6	18:38	20:14	
MSM2/478-2	sta 114	59	39.20	41	47.60	59.653	-41.793	1880	1:32	7.3	1:12	Station CTD	22	6	21:27	23:00	
MSM2/479-1	sta 115	59	33.60	41	29.10	59.560	-41.485	2128	1:25	10.9	1:36	Station CTD	23	6	0:36	2:02	
MSM2/480-1	PV540	62	0.00	35	0.00	62.000	-35.000	2870	0:10	234.1	22:41	Provor deployt	24	6	0:44	0:54	
		62	0.00	26	35.00	62.000	-26.583	775	0:00	237.1	22:33	change route	24	6	23:27	23:27	
		63	20.00	17	10.00	63.333	-17.167	967	0:00	265.9	1.04	change route	26	6	0:22	0:22	
MSM2/481-1	sta 116	63	0.00	16	50.00	63.000	-16.833	1450	1:12	22.0	2:25	Station CTD	26	6	2:47	4:00	
MSM2/482-1	sta 117	62	40.00	16	30.00	62.667	-16.500	1910	1:27	22.0	2:26	Station CTD	26	6	6:26	7:54	
MSM2/482-2	free-ctd-3	62	40.00	16	30.00	62.667	-16.500	1910	1:42	0.0	0:00	free-fall ctd	26	6	7:54	9:36	
MSM2/483-1	sta 118	62	20.00	16	10.00	62.333	-16.167	2100	1:34	22.1	2:36	Station CTD	26	6	12:12	13:46	
MSM2/483-2	PV541	62	20.00	16	10.00	62.333	-16.167	2100	0:10	0.0	0:00	Provor deployt	26	6	13:46	13:56	
MSM2/484-1	sta 119	62	0.00	15	50.00	62.000	-15.833	2240	1:38	22.1	2:43	Station CTD	26	6	16:40	18:18	
MSM2/485-1	sta 120	61	40.00	15	30.00	61.667	-15.500	2340	1:56	22.1	2:36	Station CTD	26	6	20:55	22:51	
MSM2/485-2	sta 121	61	40.00	15	30.00	61.667	-15.500	100	0:28	0.0	0:24	Test Seabird	26	6	23:15	23:44	

MSM station name	Task	Latitude deg N	min	Longitude deg W	min	Dec. Latitude	Dec. Longitude	Depth (m)	Dura-tion (h)	Dist from n-1 (nm)	time to be reached (h)	Task	Day of arrival	mo.	Time of arrival	Time of depar-ture	Time reference
MSM2/485-3	sta 122	61	40.00	15	30.00	61.667	-15.500	2340	1:28	0.0	0:00	Test Seabird	26	6	23:44	1:12	
MSM2/485-4	PV	61	40.00	15	30.00	61.667	-15.500	2340	0:10	0.0	0:00	Provor deployt	27	6	1:12	1:22	
Thorshavn		62	0.00	6	47.00	62.000	-6.783	0		246.3	1.03	Arrival	28	6	3:00		time change: UTC-1

1.7 Concluding Remarks

Several technical issues mainly due to the ship youth delayed the work by 6 days. An accident was deplored. However, tenacity and competence of the crew led by Captain von Staa was determinant in the achievement of this cruise. The only unperformed work was the mooring deployment planned on the shelf at 63°N for our German colleagues. Reasons were both difficult sea-ice conditions and a broken pod. The thermosalinograph data may also be difficult to use, due to intermittent pump problems. Despite this, the Spanish GASPAR system, used to measure surface pCO_2 along the route, could provide relatively good data.

We gathered an impressive harvest of good quality data, including CTD, tracers and direct current measurements. In terms of transports, first estimates show a MOC that is 40% weaker than 1997 estimate. This quite striking result goes with a weakening of all the main currents of the North Atlantic that are crossed by Ovide section (NAC, EGC, DWBC). This result needs to be explained by a more detailed analysis of the Subpolar Gyre dynamics. Particularly, the disagreement with some recent data synthesis assessing a relatively stability of the MOC needs to be thoroughly discussed in terms of the time scale of the anomalies for example.

The situation near Greenland was quite unusual. After a decade of sea-ice retreat at this latitude, a large pack of multiyear ice drifted through Fram Strait at the beginning of the year (seen by satellite images) and was found a few month later along the south-east coast of Greenland. Recovering the four moorings turned out to be a patience game, followed by an intensive day of work, when easterlies finally pushed the ice against the coast for a few hours. All four moorings were recovered, with a 90% data return. First estimates of the current near Greenland indicate an unusually weak East Greenland Current while we were on site, and the EGCC could not be sampled at all unfortunately.

During the cruise, several instruments were tested: an autonomous CTD performed 2 profiles, a brand new Vertical Micro Profiler performed 3 profiles, including one at more than 5-km depth. The VMP was lost at the fourth profile east of Reykjanes Ridge, and different elements let us think that it stayed stuck at the bottom, despite several safeties to release the lest. A specific report was written.

Along the Ovide section and on our way to the Faeroe Islands, 16 profiling floats (PROVOR) were deployed in the frame of the ARGO program. They are programmed to drift at 1000m depth and collect temperature and salinity profiles from 2000m and surface every 10 days. They should be active for about 4 years. The passage near the Central Irminger Sea mooring was also the occasion to deploy a Spray glider from the European MERSEA project in order to complement the mooring measurements. The glider was recovered by the Discovery 2 months later. Finally, on our way back, 48 Expendable BathyThermographs (XBT) were launched. All the data collected by the PROVOR, the glider, the XBT and a vertically subsampled CTD dataset have been sent to the Coriolis Regional Data Center [http://www.coriolis.eu.org/] in real time.

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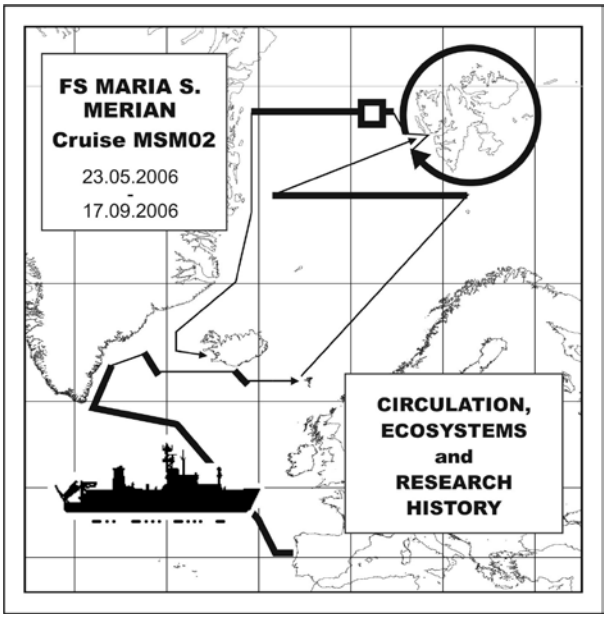
MARIA S. MERIAN-Berichte 09-1

Circulation and Ecosytems in the Subpolar and Polar North Atlantic

Part 2

Cruise No. 2, Leg 2

July 2 to July 26, 2006
Tórshavn – Longyearbyen



J. Meincke, G. Budéus, K. Latarius

Table of Contents, Part 2 (MSM02/2)

2.1 Participants

Tab. 2.1: List of Participants on Leg MSM02/2 and Abbreviations

Name	Discipline	Institute
Meincke, Jens	Fahrtleitung/Chief Scientist	IFMH
Budéus, Gereon	Scientist	AWI
Devis, Andrea	Scientist	AWI
Drübbisch, Ulrich	Technician	IFMH
Latarius, Katrin	Scientist	IFMH
Majer, Claudia	Student	IFMH
Marnela, Marika	Scientist	FIMR
Monsees, Matthias	Technician	Optimare
Plugge, Rainer	Technician	AWI
Ronski, Stephanie	Scientist	AWI
Verch, Norbert	Technician	IFMH
Renault, Alice	Scientist	GUIB

Participating Institutions

AWI	Alfred-Wegener-Institut für Polar- und Meeresforschung, Am Handelshafen 12, 27570 Bremerhaven, Germany
IFMH	Institut für Meereskunde der Universität Hamburg, Bundesstr. 53, 20146 Hamburg
Optimare	Optimare Sensorsysteme, Am Luneort 15a, 27572 Bremerhaven, Germany
GUIB	Geophysical Institute, University of Bergen, Allégata 55, 5007 Bergen, Norway

Fig. 2.1: Scientific Party of R/V Maria S. Merian Cruise MSM02-2

2.2 Objectives

There were three scientific components (i) Deployment of a bottom current meter at the sill of the Jan Mayen Channel for our colleagues at the Geophysical Institute of the University of Bergen/Norway; (ii) Hydrographic section and recovery/redeployment of moored current meters on the shelf and the slope off Eastgreenland near 74° N for the University of Hamburg and (iii) Hydrographic sections and recovery/redeployment of moored profiling CTDs along 75° N from the shelf off Eastgreenland to the shelf north of Bear Island for the Alfred-Wegener-Institute for Polar and Marine Research in Bremerhaven.

2.3 Narrative of the cruise

The vessel left Tórshavn on 2nd July and headed for the Jan Mayen Channel. This deep connection between the Greenland Sea base and the Lofoten basin is an import conduct for deep water exchange in the Nordic Seas, which is monitored by time series measurements of colleagues at the Geophysical Institute in Bergen. Following a short multibeam bathymetric survey in the night from July 3/4 for the exact location of the sill the mooring was deployed in the morning of July 4th in fine weather. The ship proceeded to the eastward end of the hydrographic section at 74° N, working its way to the Eastgreenland slope and shelf with CTD-stations and mooring work. The sea ice border was crossed on July 6th and the section could be worked westward until the fast ice edge at 17° W. All moorings were recovered except the one at 18° W, which was under fast ice and was recovered during the cruise leg MSM 02/4 in August 2006. The program 74° N was finished on July 8th. The vessel left the ice and turned northward to 75° N. To start the hydrographic work along 75° N, a most westward position on the shelf was reached at 14° W in heavy ice. From then on the course was eastward with 10 nm station spacing. In the central Greenland Sea Basis 5 moorings were successfully recovered and 3 redeployed.

An interrupt of the planned program was caused by a mooring in the Fram Strait, which had broken loose and was drifting SW-wards along the Eastgreenland ice edge. It was decided to recover it and use the route to and from the position near 77° N, 11° W for two additional CTD-sections. The drifting mooring was successfully found and recovered, but unfortunately it consisted of the satellite beacon only. Upon return to the central Greenland Sea at 75° N a deep reaching eddy was detected from one of the CTD-stations. Since time was available, a 12 hour small-scale hydrographic survey was added to the program, before the section work towards the shelf north of Bear Island resumed. The scientific activities ended on 24th of July north of Bear Island. The vessel headed northward and reached Longyearbyen two days ahead of the scheduled arrival, in order to allow a German shipyard-crew to handle repairs and guarantee items on the new vessel, before it leaves for the next cruise leg.

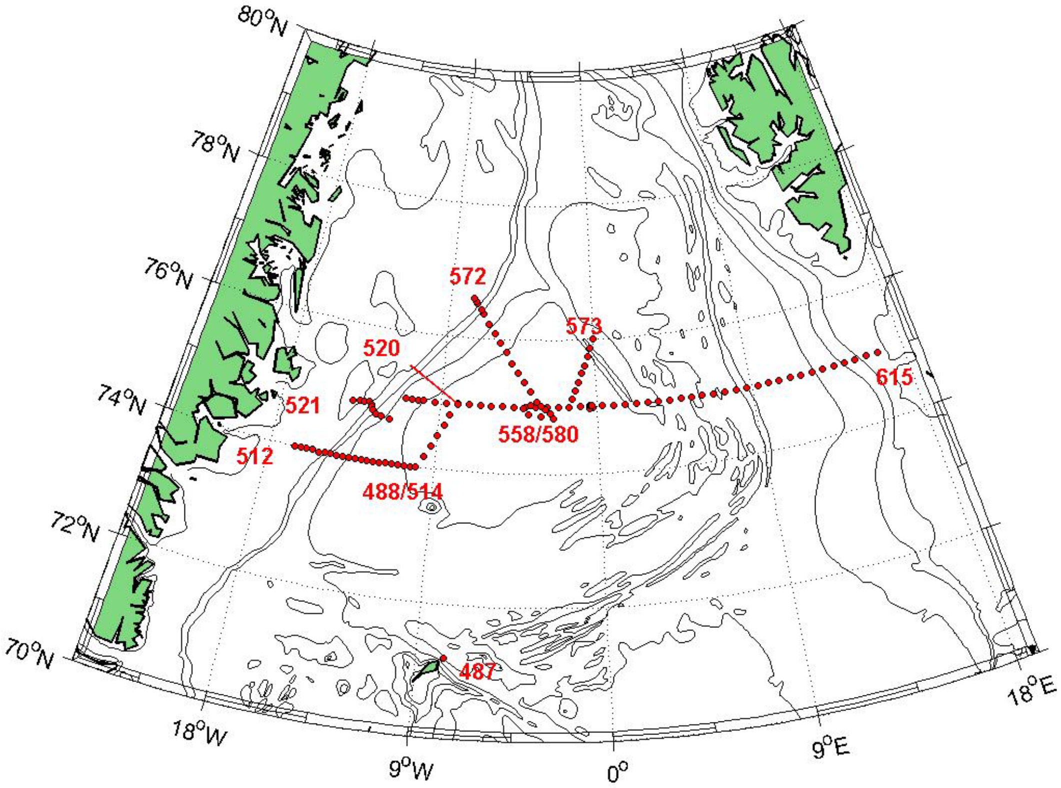


Fig. 2.2: Ship track of R/V MARIA S. MERIAN cruise MSM02-2 with locations of moorings and CTD casts

2.4. Technical Information

CTD system

105 CTD casts were completed on this cruise using a Sea-Bird equipment. Together with a 12 bottle rosette frame it was configured in the following way:
The configuration of AWI CTD was:
SBE 9+ underwater unit

SBE 9/11 plus CTD, AWI
SBE 32, 12 position carousel 12 x 2.5 L "Niskin" bottles

SBE 3 temperature primary sensor s/n 1338, calibrated 04-jan-2006
SBE 3 temperature secondary sensor s/n 1491, calibrated 04-jan-2006
SBE 4 Conductivity sensor primary, 1199, calibrated 07-mar-2006, to incl. station 520
SBE 4 Conductivity sensor s/n primary, 1053, calibrated 23-jun-2005 from incl. station 521
SBE 4 Conductivity sensor s/n secondary, 1198, calibrated 04-jan-2006
SBE 43 Oxygen sensor SN: 48, calibrated 14-may-04
Digiquartz temperature compensated pressure sensor s/n 53962
SBE 5T submersible pump
Benthos Altimeter
SBE 32 carousel, 12 position
SBE 11+ deck unit

Casts were initiated and terminated on deck. Between 0 and 4 water samples were taken per cast for calibration of the conductivity sensor at carefully selected locations where in situ calibration is acceptable.

Thanks to the duplicate sensor configuration utilized, it became quickly evident that one of the conductivity sensors showed a small drift (below Autosal accuracy). It was identified that the primary sensor SBE4-1199 was the drifting one. This sensor was applied from the beginning of the cruise to station 520 incl., from station 521 incl. it had been replaced by SBE4-1053. The secondary sensor set has been assigned as the valid set.

ADCP

The Acoustic Doppler Current Profiler (ADCP) had been running almost constantly during the cruise without any problems. The instrument, which has been manufactured by RD Instruments (Poway, Ca., USA), has a working frequency of 75 kHz, ping rate of 0.7 Hz, and is specified for a maximal ship speed of 22 knots.

Thermosalinograph

The Thermosalinograph is permanently flushed by sea water. The manufacturers are Sea & Sun Technology GmbH (salinity sensor, type: CT 48) and Isotech (temperature sensor, type: PT100-1509). These sensors have a working range of 0-65 mS/cm and –3° C to 36° C.

Data Logging

Numerous sensors, which collect scientific relevant data at different locations on the ship, send their data via the ship's network into a central data base with a frequency of 1 Hz. Furthermore, also ship specific data like cruise direction and speed over ground are integrated into the data base. In total, roughly 250 single sensors contribute to the date base, ranging from meteorological data, like air temperature, wind speed and direction, over oceanographic data, like surface water temperature and salinity, to water column thickness data, like echo sounding. The actual hardware hosting the data base is a pair of two SUNFire V.210-Server, which are configured as a fail-over pair working in loadsharing operation.

The data of the data base can be extracted easily through a web interface from all computers attached to the ships network from all cabins or laboratories. The result of guided data base queries are stored as ASCII text files, which can be downloaded after the query has been proceeded. The here described data base service is only a small part of an integrated data collecting, accessing, and storing system, which is called DavisShip (Datensammel-, -verteilungs- und speichersystem).

2.5. Scientific programmes – preliminary results

2.5.1 The East Greenland Current – an indicator for low frequency variability of the outflow from the NordicSeas/Arctic Ocean (SFB 512 – E2)

Katrin Latarius

2.5.1.1 Tube moorings

The major flux of freshwater from the Arctic Ocean to the convective regions in the Nordic Seas and the Northern North Atlantic is linked to the shelf branches of the East Greenland Current (Dickson et al, 2006). This flux is partitioned into a solid (ice) and a liquid phase. Time Series measurements of the liquid component are hard to obtain since the seasonally varying ice cover prevents the use of standard moored instrumentation in the near surface gradient layer where most of the freshwater transport takes place. Using 40m-polyethylene tubes to protect sensors and buoyancy in the upper portion of the moorings and employing a bottom-mounted acoustic Doppler current profiler have yielded the first time series of the upper layer temperatures, salinities and currents for a location at the outer East Greenland shelf at 74°N (Holfort and Meincke, 2005).

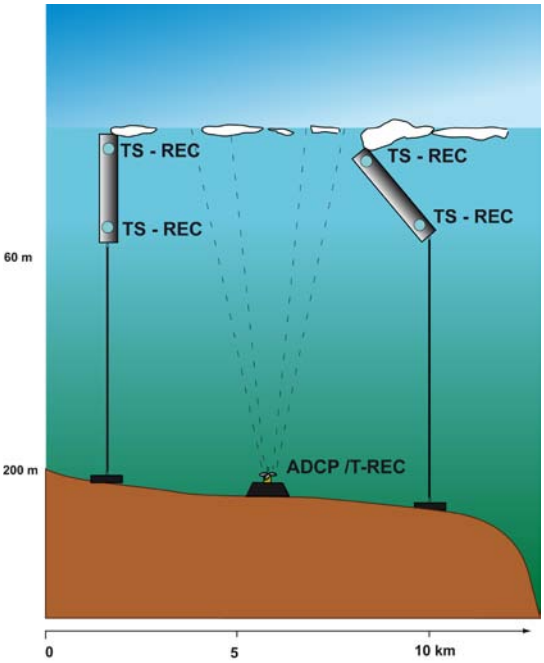


Fig. 2.3:
Schematic figure of an array of tube moorings and bottom-mounted ADCP at 74° N over the East-greenland Shelf

The mooring array was deployed for the first time summer 2000 and from then onward recovered/deployed every summer. During the MSM02-2 it was recovered successfully for the seventh time and after servicing and data retrieval redeployed again. In the future this mooring area will be financed by the EU-project DAMOCLES.

Figure 2.4 shows the longest continuous time series existing from the near surface Polar Water (PW) on the East Greenland shelf. The data from the last year are read out and preliminary processed during the cruise.

Obviously water properties near the surface (blue curve) developed towards lower temperature and higher salinity since the extreme values in autumn 2002, indicative for changing conditions in the arctic or shift in the source area as already mentioned in the cruise report Lance 18/2005 (IFM-Hamburg).

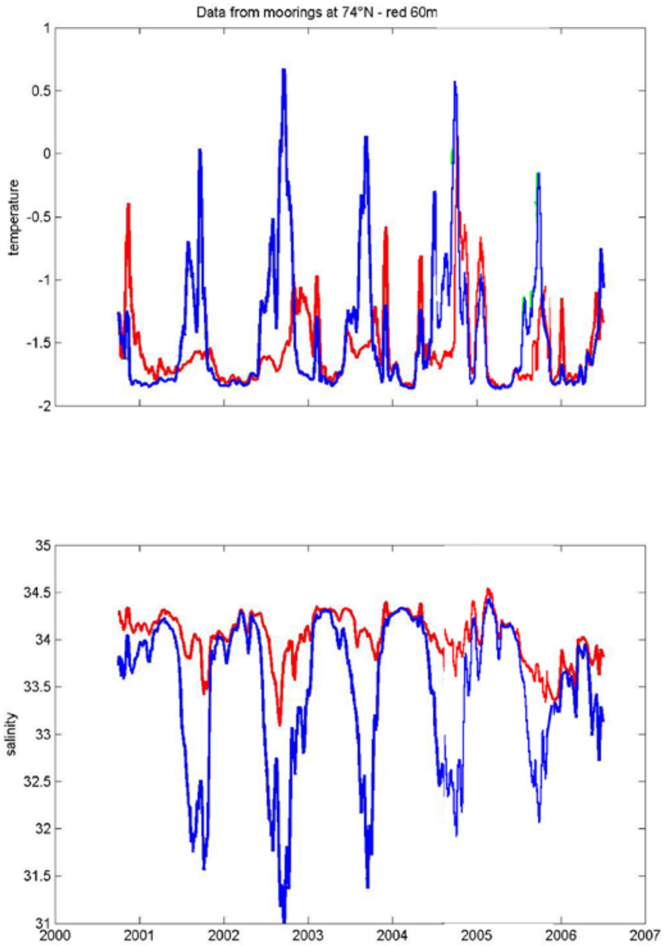


Fig. 2.4: Measurements from the Tube mooring at 74°02N and 15°31W in the nominal depth of ~16m (blue) and ~46m (red). Top: temperature, bottom: salinity

2.5.1.2 CTD section 74°N

The CTD section along 74°N from the rim of the Greenland Sea Basin to the East Greenland continental slope and shelf was repeated together with the mooring service every summer since 2000. For the figure shown here the state of the data is the same as described at the beginning of the next section.

The section from July 2006 shows the typical distribution of water masses with cold and fresh Polar Water in the western part on the shelf reaching a layer thickness of approx. 100 m from the surface downward, father east on the slope only covering the upper 10 to 20m. Below the Recirculating Atlantic Water (RAW) is observed, consisting of the warmest and most saline water in that region. In the past year there was a distinct core of RAW above the slope, but in summer 2006 the layer has extended from the slope (14°W) to as far east as 11°W with a depth of 800 to 1000m, demonstrating the untypical high amount of RAW on the section. Below the Arctic Intermediate Water (AIW) – marked by the lower salinity – and the Arctic Deep Water occurred.

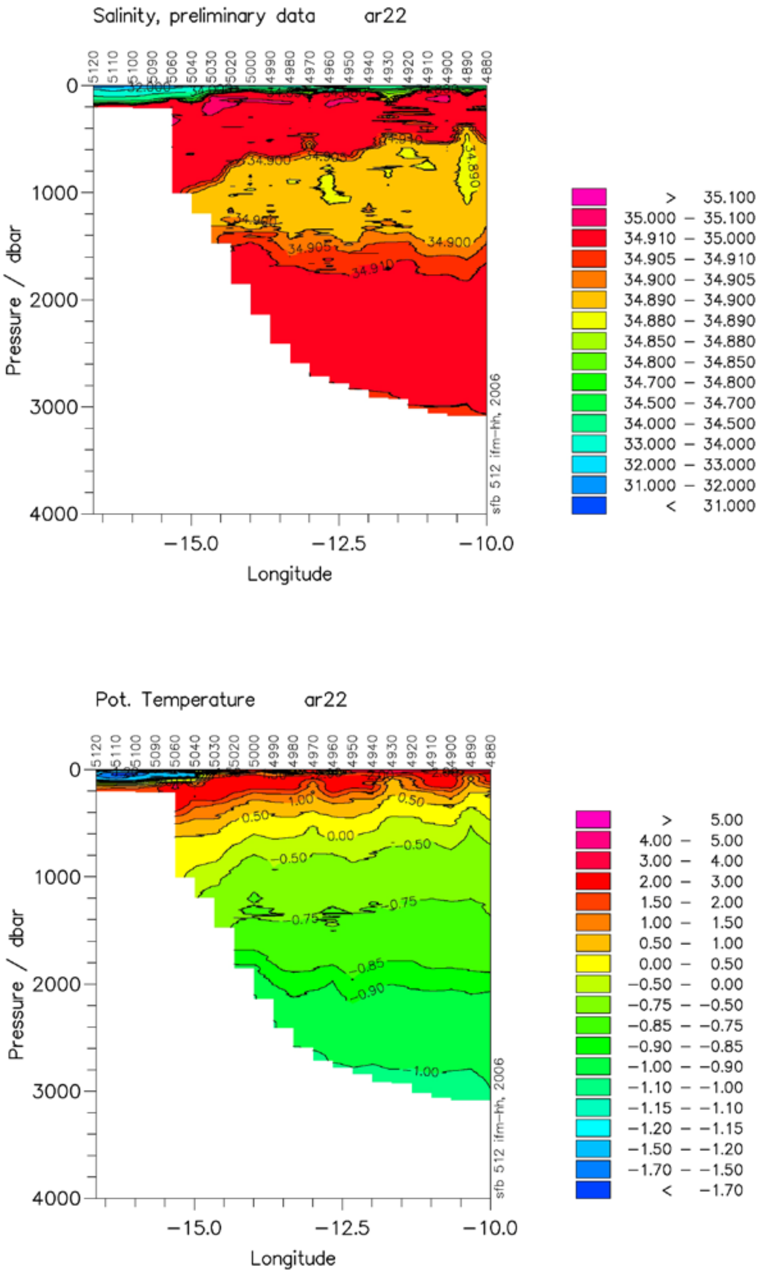


Fig. 2.5: Hydrographic section along 74°N from the East Greenland shelf into the deep basin of the Greenland Sea. Top: salinity, bottom: temperature

2.5.2 Long term variability of the hydrographic structure, convection and transports in the Greenland Sea (LOTEVA-GS)

Gereon Budéus

The Greenland Sea is one of the few open ocean sites worldwide where waters, which have recently been in contact with the atmosphere, can sink to great depth or to the ocean bottom. These sites, including the Weddell Sea, the Labrador Sea, and the European Mediterranean, supply most of the deep waters of the world ocean and receive increasing interest with the focus of earth sciences on climate changes because of their role with respect to the global oceanic conveyor belt.

Physical processes in the Polar Oceans receive increased attention also because of their high sensibility and positive feedback mechanisms against climatic changes. This includes the hydrographic development in the Greenland Sea, where parent end members (in the TS-space) of a number of Arctic water masses are found. Oceanic field work in the Greenland Sea has long been conducted only sporadically because the dynamic nature of changes in the Arctic had not been recognized. Since the late 80s, field observations have been performed on a more regular basis (GSP, EU-projects ESOP I and II, CONVECTION, TRACTOR) revealing unexpected results with respect to most initial assumptions.

The classical view had to be altered with respect to the regularity of the ventilation events in the late eighties, when it became evident that deep reaching convection did not occur since the early eighties. Later, namely during the late nineties, also the concept of a vertically homogeneous deep water dome reaching close to the surface had to be skipped because observations showed a prevailing density stratification at intermediate depth. The vertical structure is now dominated by an intermediate temperature maximum which is combined with an enhanced salinity and density gradient. Observations show that this density gradient is not static but is slowly displaced vertically. It was found at about 900 m in 1993 and descended to roughly 1800 m in 2005. This interface between the upper and lower layer of the two-parted structure limits convection depths by the increased stability associated with the enhanced density/salinity gradient.

With this situation, the main modification processes in the upper layer are winter convection, succeeded by lateral exchange for which the most important constituents are the import of Atlantic Waters, Return Atlantic Waters, and Polar Waters. These inputs are then distributed vertically during the next winter convection phase. It is clear from this cycle, that a correct determination of winter convection depths is essential in order to attribute observed modifications to the related process. Changes in the deep waters can be explained by the combined action of lateral exchange (responsible for a salinity increase due to the input of deep Arctic Waters which are introduced from the rims surroundig the Greenland Basin) and vertical processes. It is proposed that a vertical shift of the water column is the main cause for the deep water changes in temperature.

Winter convection in the 'background', i.e. in the prevailing hydrographic conditions of the basin, is contrasted by convection within so called Submesoscale Coherent Vortices (SCVs). These are remarkably small eddies with diameters of only about 20 km, so that their size is adverse to their easy detection, but they severely spoil averaged profiles when accidentally met by a station or two. First indications of their occurance stem from drifter data, floating in about 1000 m depth and showing long periods of constant speed rotations (Gascard, 2002). Subsequent CTD investigations showed their hydrographic structure which departs largely from the background (Wadhams 2002, Budéus 2004). The interiour is outstandingly homogeneous with respect to all measured physical, biological and chemical properties in the upper part (i.e.: above the pycnocline) of the eddy (Budéus 2004, Wadhams 2004). This part extends to depths considerably below the level of the pycnocline in the background. Typical recent depth levels of the pycnocline are 1800 m for the background versus 2700 m for the SCV.

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 small station spacing. Otherwise spatial and temporal differences cannot be distinguished and any derived trend is most likely heavily biased. According to this, the transects are performed with a station spacing of 10 nautical miles or less. Naturally, the survey of the SCV involves much smaller spatial scales according to its above mentioned diameter.

2.5.2.1 Zonal transect at 75ºN

The CTD data have to be finally calibrated for a precise evaluation. Due to the high primary data quality, preliminary conclusions can be stated already to date. The distribution of the basic physical parameters is shown below, complemented by the oxygen distribution (uncorrected sensor values).

To start with the oxygen distribution, there are three features which are immediately evident. The first is the slow sensor time drift which is evident from the gradient deep sea, which is artificial. As no chemical analysis has been possible during the cruise, suitable assumptions have to be made in order to correct for the drift. As it is smooth and shows no jumps this poses no problem. The second is the interruption of the even structure at about 0ºE which belongs to an SCV. here, the higher oxygen contents extend to a depth of about 2500 m. This proofs that the waters within the deep part of the SCV are ventilated more recently than its surroundings. The third, and most important, feature is the two layer structure with an efficient vertical isolation of the deeper layer (below 2000 m). No direct evidence for last winter's convection depth is given by this distribution. For a determination of this, a comparison to the structure of the previous year is necessary.

The temperature distribution, too, shows no evidence of winter convection. the waters in the upper layer (down to about 2000 m) show increasing temperatures to such a degree, that the persistent temperature maximum at the interface between the upper and the lower layer cannot be discerned in the contour plot. This is no sign of a lacking winter convection, as this may result in an input of warmer waters to the ventilated water volumes. A slight depression of the isotherms in the centre of the gyre can be recognised, corroborating a downward vertical velocity component there.

The salinity distribution is striking with respect to several aspects. First, the deep waters show almost no waters any more with salinities below 34.910. Only a small remnant close to the bottom remains which posesses slightly lower salinities. Second is the low salinities within the SCV, third is the increasingly saline upper layer of the two parted structure (again, this being of no evidence for winter convection or its absence, as waters of higher salintiy can be distributed to greater depth by winter convection), and forth is the large amout of Atlantic water derivatives in the layer between the surface and about 400 m. Also, the area coverd by Return Atlantic Waters and Atlantic Waters is remarkably large. The time evolution of the salinity field (mean between 40 and 200m) shows that a trend to extremely high amounts of Atlantic Water derivatives (high salinities) started already between 2004 and 2005.

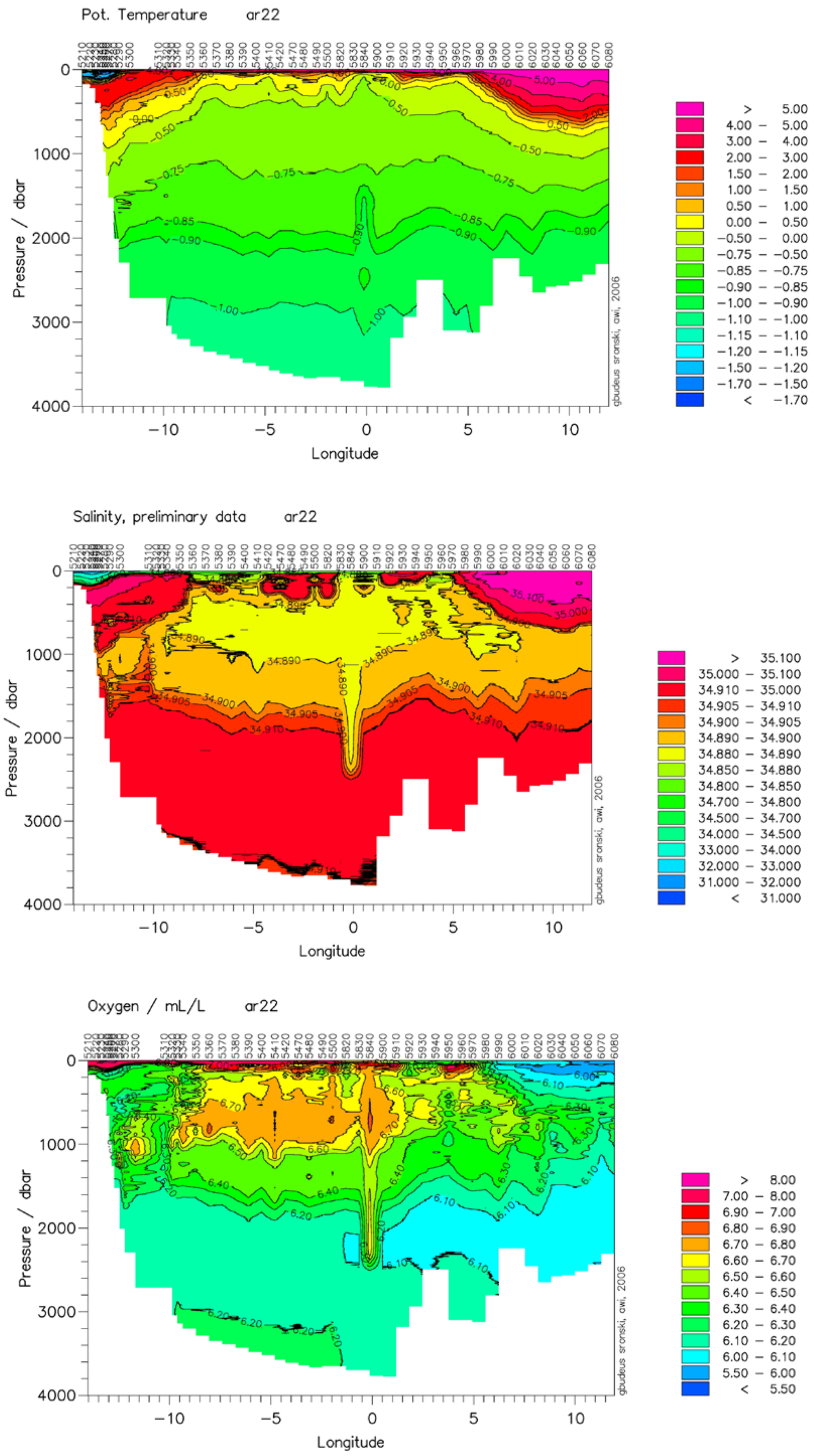


Fig. 2.6: Distribution of temperature, salinity and oxygen on the zonal transect at 75°N

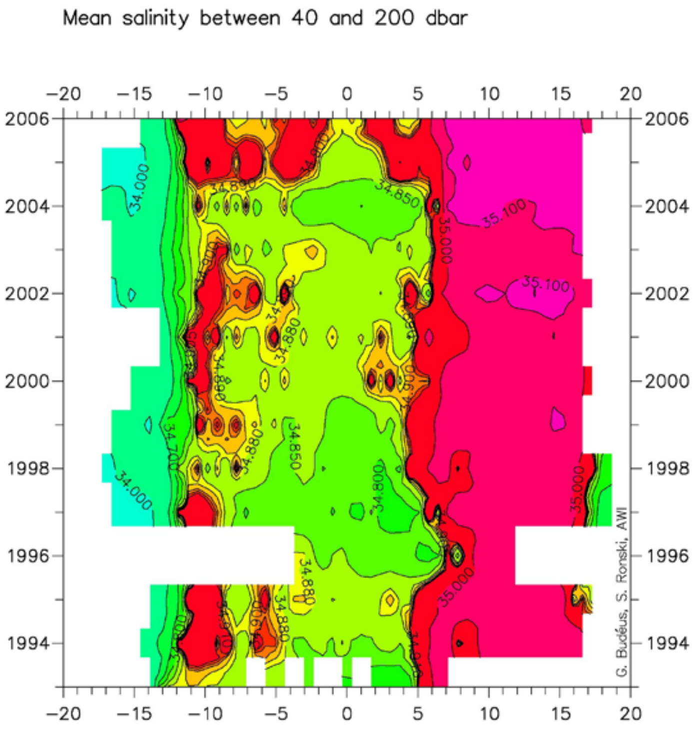


Fig. 2.7: Salinity development on the zonal transect at 75°N from 1993 to 2006

Winter convection depths for this year can be inferred only from the stability evolution. The comparison between multiple profiles performed in 2005 and 2006 shows the there is an area between 500 and 1200 m with smaller stabilities in 2006 than found in 2005. The downward limit of this low stability area shows a local stability maximum which is slightly more stable than the water column at the interface between the two main layers. Future convection is therefore affected already at relatively shallow levels with the resistance of considerably stable waters.

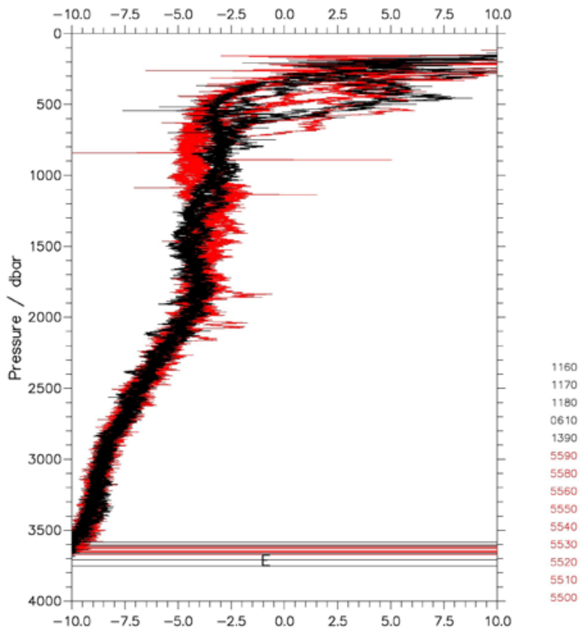


Fig. 2.8: Stability profiles for 2005 (black) and 2006 (red) from the central gyre

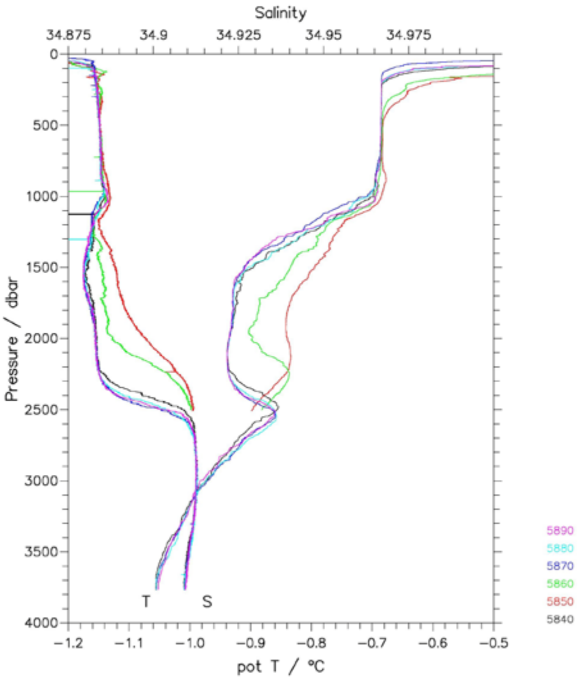


Fig. 2.9: Profiles of potential temperature and salinity within the SCV and on its boundary

2.5.2.2 SCV

Due to the late stage of the cruise, little time could be afforded for a survey of the accidentally met SCV. Profiles on the border of the SCV have been stopped when the vertical interface was met. Only the main properties of the SCV shall be outlined here. Its extent down to 2500 m has already been mentioned above. More interesting is the fact that the feature has not been homogenised vertically during the last winter, as is evidenced by the structured profile below 1200m. It seems that the upper 1200 m have been ventilated recently - this depth resembling the background ventilation depth. Nevertheless, the SCV is intact, indicating directly a lifetime longer than a year.

2.5.2.3 EP/CC Moorings

The autonomously profiling EP/CC moorings 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 3700m. Vertical speed is about 1 m/s during the downcast and much less during the upcast. Measurements are recorded during the downcast only. The demand for profiling instruments in the ocean has increased in recognition that the description of oceanic processses based on only a few instruments located at fixed depths in the water column is not adequate to most problems investigated today. While some 15 years ago there were few attempts to construct and utilize autonomous profiling instruments, there exists a large variety of designs today. Applications range from infrequently profiling drifters (e.g. ARGOS floats) and futile attempts to combine these with mooring ropes or tethered platforms to dedicated instruments intended originally for moorings. Deep sea applications frequently dictate a particular design. Small depth ranges can be covered by designs which incorporate a winch or which are driven by near surface forcings (like the Seahorse moored profiler). Profilers for deep sea applications make use of bouyance changes or propell themselves along the mooring line (WHOI/McLane moored profiler). All solutions have different advantages and shortcomings, but when thinking in terms of many profiles (typically 200-400) to great depths (typically 3000 to 6000 m) a problem common to all designs is energy consumption. The mutual tradeoffs are immediately apparent, as, e.g., more energy carried along inside the profiling vehicle implies greater vehicle volumes in order to balance the additional weight, and this in turn implies smaller velocities for the same applied force, leading to higher energy consumption. We use here a design for an autonomous deep sea profiler which is intended for many fast and deep casts and departs substantially from previous solutions with respect to the energy management. It is designed and built by AWI.

One of the particular properties of the instrument is its high velocity during the downcast which is achieved by the smallest cross section area possible. This dimension is determined mainly by the SBE-16 diameter of 99mm. When thinking about a design for an autonomous deep sea profiler, we considered it somewhat impractical to store the whole energy needed for all of the up- and downcasts of the profiler within the vehicle and carry it along on the many profiles up and down. A considerable amount of additional energy is needed when doing so. The weight of the batteries (as the common storing means of energy) implies an increase of required buoyancy through a bigger volume, which in turn increases the flow resistance. With a given force to drive the movement, this reduces the velocity of the vehicle and results therefore in a a longer profiling time to span the water column which increases the necessary battery power. To alternatively remain at the same speed while increasing the flow resistance also requires more battery power. Consequently, much care has been applied to the design to realize a slim, low drag, and low mass device.

It is indeed not really necessary to carry more energy along with the vehicle than is needed for one single profile. The only complication in comparison to a self contained internally powered design is the transfer of energy from an energy storage unit to the profiling vehicle. While this problem is not easily solved under subsurface ocean conditions as long as one thinks in terms of electricity, a mechanical solution provides little difficulty. In addition, gravity serves as a highly reliable driving means.

Therefore, a vehicle/control unit-pair has been constructed which consists of a bouyant vehicle that is ballasted by a weight which is supplied by the control unit, one weight for each profiling cast. With this weight, the downcast is performed with the potential energy of the weight providing the driving means. At the bottom, the weight is detached from the vehicle and the latter moves back to the surface, driven by its own buoyancy. Back at the control unit, the vehicle waits for the next supply of a weight which is dispensed according to the chosen time schedule. It is immediately apparent that this method is particularly well suited for deep-sea applications since the size of the driving weights needs no alteration for increasingly deeper dives because the available energy increases automatically with greater depths.

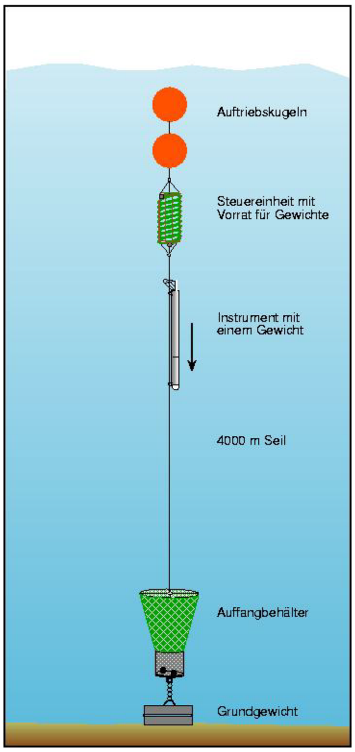


Fig. 2.10:
Schematic figure of the deep sea profiler moored in the central Greenland Sea

With this design, only one electrical consumer exists in the vehicle, namely the measuring instrument. Its total electrical consumption for one profile is directly dependent on the profile duration and hence on the profiling speed. A high profiling speed is therefore desirable in order to maximize the number of possible profiles for a given on-board battery. As measurements are taken only during the downcast, the use of mechanical force available for driving the vehicle can be optimized. Specifically, a larger force can be used for the downcast than for the upcast (which will be correspondingly slower). When thinking of daily profiles with a time period of about 1.5 h for a downcast to 4000 m, 22.5 hours would in principal be available for the upcast. For deep sea applications, it is very advantageous to adjust the vehicle's overall compressibility to compensate for the in situ density stratification in the ocean, and consequently this has been done.

The instrument works with a 1 Hz sampling rate. With 1 dbar bins, the noise is larger than for the pumped ship based CTDs but overall accuracy is high, in part due to the precision pressure sensor. It has been recognised that drifts of all sensors are extremely small, partly due to the quality of the instrument, partly due to the parking position below the euphotic zone.

The time series contain extremely detailed information about the prevailing processes which modify the hydrographic situation. The Hovmoeller diagramms of temperature and salinity reveal only a rough outline of these. Profiles are indicated by tickmarks on the upper axis. The most pronounced signal during the shown year is the salt input from above by winter convection into the deeper parts of the ventilated volumes. Another remarkable signal is the disappearance of the cold water pool above the interface between the upper and lower main layer. The latter is an outstandingly smooth process which shows no particular events or seasonal dependencies.

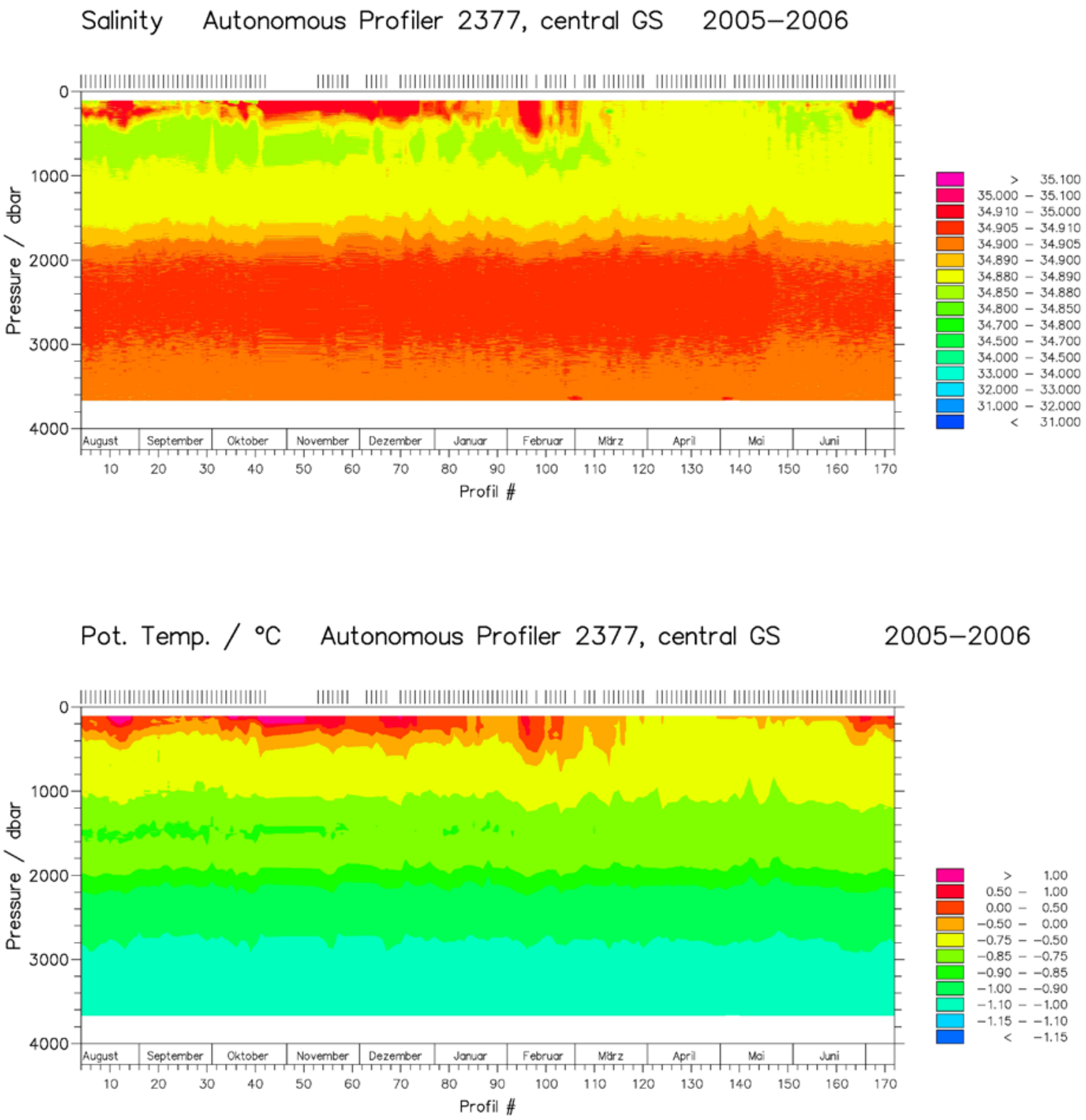


Fig. 2.11: Salinity and temperature development from the EP/CC-JoJo. Tick marks indicate individual casts

2.6 Station list

Tab. 2.2: List of stations of R/V MARIA S. MERIAN cruise MSM02/2

Station	**Date**	**Time**	**PositionLat**	**PositionLon**	**Depth [m]**	**Gear Abbreviation**	**Action**
MSM2/486-1	04.07.2006	01:08	70° 59,76' N	7° 29,88' W	1451,7	MB_PS	start track
MSM2/486-1	04.07.2006	02:56	71° 13,49' N	7° 29,83' W	1838,6	MB_PS	alter course
MSM2/486-1	04.07.2006	04:18	71° 11,93' N	7° 59,94' W	1542,1	MB_PS	alter course
MSM2/486-1	04.07.2006	05:46	71° 23,11' N	7° 59,56' W	1943,3	MB_PS	alter course
MSM2/486-1	04.07.2006	07:30	71° 10,15' N	7° 39,13' W	2138,5	MB_PS	profile end
MSM2/486-2	04.07.2006	08:06	71° 12,25' N	7° 42,25' W	1884,2	CTD/RO	surface
MSM2/486-2	04.07.2006	08:53	71° 12,25' N	7° 42,22' W	1883,6	CTD/RO	at depth
MSM2/486-2	04.07.2006	09:35	71° 12,25' N	7° 42,22' W	1883,8	CTD/RO	on deck
MSM2/486-3	04.07.2006	09:54	71° 12,20' N	7° 39,09' W	1943,1	MOORY	at surface
MSM2/486-3	04.07.2006	10:23	71° 12,27' N	7° 42,37' W	1885,5	MOORY	released
MSM2/487-1	05.07.2006	00:48	74° 0,01' N	10° 0,00' W	3117,2	CTD/RO	surface
MSM2/487-1	05.07.2006	01:50	74° 0,12' N	9° 58,94' W	3119,2	CTD/RO	at depth
MSM2/487-1	05.07.2006	02:39	73° 59,96' N	9° 58,14' W	3118,5	CTD/RO	on deck
MSM2/488-1	05.07.2006	03:35	73° 59,98' N	10° 19,92' W	3083,7	CTD/RO	surface
MSM2/488-1	05.07.2006	04:32	73° 59,79' N	10° 20,05' W	3085,2	CTD/RO	at depth
MSM2/488-1	05.07.2006	05:19	73° 59,57' N	10° 20,32' W	3085,6	CTD/RO	on deck
MSM2/489-1	05.07.2006	06:00	73° 59,98' N	10° 40,07' W	3098,2	CTD/RO	surface
MSM2/489-1	05.07.2006	06:57	73° 59,72' N	10° 40,63' W	3068,4	CTD/RO	at depth
MSM2/489-1	05.07.2006	07:57	73° 59,34' N	10° 42,06' W	3051,9	CTD/RO	on deck
MSM2/490-1	05.07.2006	08:34	74° 0,01' N	11° 0,59' W	3062,6	CTD/RO	surface
MSM2/490-1	05.07.2006	09:31	73° 59,76' N	11° 3,05' W	3045,5	CTD/RO	at depth
MSM2/490-1	05.07.2006	10:30	73° 59,59' N	11° 5,41' W	3021,7	CTD/RO	on deck
MSM2/491-1	05.07.2006	10:37	73° 59,62' N	11° 6,57' W	3021,2	CTD/RO	surface
MSM2/492-1	05.07.2006	11:05	74° 0,07' N	11° 20,02' W	3014	CTD/RO	surface
MSM2/492-1	05.07.2006	11:59	73° 59,96' N	11° 22,08' W	3008,4	CTD/RO	at depth
MSM2/492-1	05.07.2006	12:45	74° 0,05' N	11° 23,31' W	3002,7	CTD/RO	on deck
MSM2/493-1	05.07.2006	13:25	74° 0,00' N	11° 40,15' W	2929,5	CTD/RO	surface
MSM2/493-1	05.07.2006	14:19	73° 59,94' N	11° 41,23' W	2924,4	CTD/RO	at depth
MSM2/493-1	05.07.2006	15:15	73° 59,94' N	11° 41,23' W	2924,5	CTD/RO	on deck
MSM2/494-1	05.07.2006	15:59	73° 59,89' N	12° 0,33' W	2916,7	CTD/RO	surface
MSM2/494-1	05.07.2006	16:54	73° 59,50' N	12° 1,35' W	2911,8	CTD/RO	at depth
MSM2/494-1	05.07.2006	17:42	73° 59,15' N	12° 2,60' W	2907,5	CTD/RO	on deck
MSM2/495-1	05.07.2006	18:19	73° 59,95' N	12° 20,42' W	2847,1	CTD/RO	surface
MSM2/495-1	05.07.2006	19:13	73° 59,72' N	12° 22,40' W	2839,9	CTD/RO	at depth
MSM2/495-1	05.07.2006	20:07	73° 59,60' N	12° 24,58' W	2830,8	CTD/RO	on deck
MSM2/496-1	05.07.2006	20:47	73° 59,95' N	12° 40,21' W	2780,7	CTD/RO	surface
MSM2/496-1	05.07.2006	21:38	73° 59,45' N	12° 41,27' W	2769,7	CTD/RO	at depth

Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear Abbreviation	Action
MSM2/496-1	05.07.2006	22:30	73° 59,45' N	12° 42,50' W	2754,3	CTD/RO	on deck
MSM2/497-1	05.07.2006	23:03	74° 0,05' N	13° 0,09' W	2725,5	CTD/RO	surface
MSM2/497-1	05.07.2006	23:51	74° 0,13' N	13° 1,50' W	2717,9	CTD/RO	at depth
MSM2/497-1	06.07.2006	00:42	74° 0,11' N	13° 1,59' W	2717,4	CTD/RO	on deck
MSM2/498-1	06.07.2006	01:23	74° 0,01' N	13° 19,71' W	2595,9	CTD/RO	surface
MSM2/498-1	06.07.2006	02:13	73° 59,89' N	13° 20,18' W	2594,2	CTD/RO	at depth
MSM2/498-1	06.07.2006	02:56	73° 59,77' N	13° 20,59' W	2588,9	CTD/RO	on deck
MSM2/499-1	06.07.2006	03:38	74° 0,03' N	13° 39,88' W	2408,6	CTD/RO	surface
MSM2/499-1	06.07.2006	04:27	73° 59,92' N	13° 39,69' W	2413	CTD/RO	at depth
MSM2/499-1	06.07.2006	05:09	73° 59,84' N	13° 39,58' W	2415,3	CTD/RO	on deck
MSM2/500-1	06.07.2006	05:58	73° 59,94' N	14° 0,11' W	2150,3	CTD/RO	surface
MSM2/500-1	06.07.2006	06:42	73° 59,74' N	14° 1,05' W	2144,8	CTD/RO	at depth
MSM2/500-1	06.07.2006	07:22	73° 59,65' N	14° 2,03' W	2138,3	CTD/RO	on deck
MSM2/501-1	06.07.2006	08:30	74° 0,04' N	14° 3,78' W	0	MOORY	released
MSM2/501-1	06.07.2006	08:32	74° 0,04' N	14° 3,80' W	0	MOORY	sighted
MSM2/501-1	06.07.2006	08:57	73° 59,95' N	14° 3,18' W	0	MOORY	start heaving on deck
MSM2/501-1	06.07.2006	10:00	74° 0,33' N	14° 7,55' W	2043,6	MOORY	on deck
MSM2/502-1	06.07.2006	10:38	73° 59,81' N	14° 20,60' W	1859,8	CTD/RO	surface
MSM2/502-1	06.07.2006	11:14	73° 59,65' N	14° 21,05' W	1859,3	CTD/RO	at depth
MSM2/502-1	06.07.2006	11:48	73° 59,44' N	14° 21,81' W	1850,7	CTD/RO	on deck
MSM2/503-1	06.07.2006	12:40	74° 0,01' N	14° 39,90' W	1479,3	CTD/RO	surface
MSM2/503-1	06.07.2006	13:12	73° 59,79' N	14° 40,80' W	1481,2	CTD/RO	at depth
MSM2/503-1	06.07.2006	13:38	73° 59,69' N	14° 41,63' W	1473,9	CTD/RO	on deck
MSM2/504-1	06.07.2006	15:09	73° 59,97' N	15° 0,34' W	1199,3	CTD/RO	surface
MSM2/504-1	06.07.2006	15:30	73° 59,98' N	15° 0,34' W	1200,4	CTD/RO	at depth
MSM2/504-1	06.07.2006	15:54	73° 59,84' N	15° 0,44' W	1215	CTD/RO	on deck
MSM2/505-1	06.07.2006	23:06	73° 59,44' N	15° 12,56' W	0	MOORY	released
MSM2/505-1	06.07.2006	23:29	73° 59,19' N	15° 13,61' W	1075,8	MOORY	start heaving on deck
MSM2/505-1	07.07.2006	00:14	73° 58,75' N	15° 15,22' W	1080,6	MOORY	on deck
MSM2/506-1	07.07.2006	01:02	73° 59,11' N	15° 19,09' W	1009,5	CTD/RO	surface
MSM2/506-1	07.07.2006	01:23	73° 58,94' N	15° 19,30' W	1013	CTD/RO	at depth
MSM2/506-1	07.07.2006	01:39	73° 58,80' N	15° 19,58' W	1011,8	CTD/RO	on deck
MSM2/507-1	07.07.2006	08:34	74° 2,52' N	15° 37,86' W	206,8	MOORY	at surface
MSM2/507-1	07.07.2006	08:54	74° 2,81' N	15° 38,32' W	204,8	MOORY	action
MSM2/507-1	07.07.2006	10:45	74° 3,11' N	15° 37,47' W	209,4	MOORY	start heaving on deck
MSM2/507-1	07.07.2006	10:46	74° 3,11' N	15° 37,46' W	209,5	MOORY	on deck
MSM2/507-2	07.07.2006	12:40	74° 2,60' N	15° 37,32' W	207,8	MOORY	at surface
MSM2/507-2	07.07.2006	12:48	74° 2,59' N	15° 37,63' W	207,5	MOORY	at depth

Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear Abbreviation	Action
MSM2/507-2	07.07.2006	13:13	74° 2,60' N	15° 38,42' W	201,3	MOORY	action
MSM2/507-2	07.07.2006	13:26	74° 2,58' N	15° 38,76' W	199,7	MOORY	released
MSM2/508-1	07.07.2006	15:18	74° 1,57' N	15° 31,29' W	367,2	MOORY	released
MSM2/508-1	07.07.2006	15:21	74° 1,56' N	15° 31,30' W	369,1	MOORY	sighted
MSM2/508-1	07.07.2006	15:44	74° 1,54' N	15° 31,51' W	368,9	MOORY	start heaving on deck
MSM2/508-1	07.07.2006	16:15	74° 1,33' N	15° 31,25' W	421,5	MOORY	on deck
MSM2/508-2	07.07.2006	16:42	74° 1,29' N	15° 30,85' W	441,1	MOORY	at surface
MSM2/508-2	07.07.2006	17:11	74° 1,67' N	15° 30,86' W	374,4	MOORY	released
MSM2/509-1	07.07.2006	18:40	74° 0,35' N	15° 39,30' W	226,6	CTD/RO	surface
MSM2/509-1	07.07.2006	18:50	74° 0,35' N	15° 39,37' W	224	CTD/RO	at depth
MSM2/509-1	07.07.2006	18:59	74° 0,35' N	15° 39,47' W	221,8	CTD/RO	on deck
MSM2/510-1	07.07.2006	22:00	74° 0,03' N	15° 59,77' W	221	CTD/RO	surface
MSM2/510-1	07.07.2006	22:09	74° 0,06' N	16° 0,17' W	225,1	CTD/RO	at depth
MSM2/510-1	07.07.2006	22:16	74° 0,04' N	16° 0,40' W	226,5	CTD/RO	on deck
MSM2/511-1	08.07.2006	02:20	74° 0,18' N	16° 19,78' W	213,7	CTD/RO	surface
MSM2/511-1	08.07.2006	02:29	74° 0,21' N	16° 19,75' W	213,9	CTD/RO	at depth
MSM2/511-1	08.07.2006	02:37	74° 0,25' N	16° 19,79' W	214,7	CTD/RO	on deck
MSM2/512-1	08.07.2006	06:15	74° 0,14' N	16° 39,70' W	230,5	CTD/RO	surface
MSM2/512-1	08.07.2006	06:25	74° 0,12' N	16° 39,81' W	229,8	CTD/RO	at depth
MSM2/512-1	08.07.2006	06:34	74° 0,09' N	16° 39,91' W	229,3	CTD/RO	on deck
MSM2/513-1	08.07.2006	15:18	73° 59,98' N	15° 59,03' W	226,2	MOORY	at surface
MSM2/513-1	08.07.2006	15:27	73° 59,98' N	15° 58,89' W	224,6	MOORY	released
MSM2/514-1	09.07.2006	09:46	74° 0,05' N	10° 0,81' W	0	CTD/RO	surface
MSM2/514-1	09.07.2006	10:43	73° 59,88' N	10° 1,51' W	3118,4	CTD/RO	at depth
MSM2/514-1	09.07.2006	11:42	73° 59,81' N	10° 2,33' W	3117,2	CTD/RO	on deck
MSM2/515-1	09.07.2006	13:02	74° 9,97' N	9° 39,09' W	3184,4	CTD/RO	surface
MSM2/515-1	09.07.2006	14:02	74° 9,88' N	9° 40,60' W	3180	CTD/RO	at depth
MSM2/515-1	09.07.2006	14:52	74° 9,89' N	9° 41,97' W	3177,1	CTD/RO	on deck
MSM2/516-1	09.07.2006	16:19	74° 19,91' N	9° 19,92' W	3244,3	CTD/RO	surface
MSM2/516-1	09.07.2006	17:18	74° 20,18' N	9° 20,93' W	3242,7	CTD/RO	at depth
MSM2/516-1	09.07.2006	18:14	74° 20,23' N	9° 21,74' W	3238,8	CTD/RO	on deck
MSM2/517-1	09.07.2006	19:34	74° 29,89' N	9° 0,10' W	3284,8	CTD/RO	surface
MSM2/517-1	09.07.2006	20:33	74° 29,96' N	9° 0,50' W	3284,3	CTD/RO	at depth
MSM2/517-1	09.07.2006	21:29	74° 30,09' N	9° 1,00' W	3282,9	CTD/RO	on deck
MSM2/518-1	09.07.2006	22:42	74° 40,04' N	8° 41,89' W	3317,5	CTD/RO	surface
MSM2/518-1	09.07.2006	23:41	74° 39,84' N	8° 42,17' W	3317,7	CTD/RO	at depth
MSM2/518-1	10.07.2006	00:32	74° 39,65' N	8° 42,04' W	3317,9	CTD/RO	on deck
MSM2/519-1	10.07.2006	02:02	74° 49,95' N	8° 25,40' W	3349,5	CTD/RO	surface
MSM2/519-1	10.07.2006	03:05	74° 49,72' N	8° 25,79' W	3340,8	CTD/RO	at depth
MSM2/519-1	10.07.2006	03:56	74° 49,74' N	8° 25,95' W	3340,8	CTD/RO	on deck

Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear Abbreviation	Action
MSM2/520-1	10.07.2006	05:14	75° 0,05' N	8° 0,00' W	3384,1	CTD/RO	surface
MSM2/520-1	10.07.2006	06:16	74° 59,92' N	8° 1,19' W	3382,3	CTD/RO	at depth
MSM2/520-1	10.07.2006	07:18	74° 59,74' N	8° 2,89' W	3380,7	CTD/RO	on deck
MSM2/521-1	10.07.2006	20:54	74° 50,51' N	14° 1,49' W	182,6	CTD/RO	surface
MSM2/521-1	10.07.2006	21:02	74° 50,48' N	14° 1,64' W	179,9	CTD/RO	at depth
MSM2/521-1	10.07.2006	21:08	74° 50,48' N	14° 1,79' W	182,2	CTD/RO	on deck
MSM2/522-1	11.07.2006	00:00	74° 52,11' N	13° 37,80' W	233,1	CTD/RO	surface
MSM2/522-1	11.07.2006	00:11	74° 52,25' N	13° 38,03' W	228,7	CTD/RO	at depth
MSM2/522-1	11.07.2006	00:19	74° 52,34' N	13° 38,21' W	227,1	CTD/RO	on deck
MSM2/523-1	11.07.2006	01:09	74° 51,96' N	13° 20,37' W	410,7	CTD/RO	surface
MSM2/523-1	11.07.2006	01:22	74° 52,10' N	13° 20,57' W	406,5	CTD/RO	at depth
MSM2/523-1	11.07.2006	01:31	74° 52,15' N	13° 20,69' W	406,1	CTD/RO	on deck
MSM2/524-1	11.07.2006	02:19	74° 52,22' N	13° 2,24' W	664,3	CTD/RO	surface
MSM2/524-1	11.07.2006	02:36	74° 52,21' N	13° 2,26' W	663,2	CTD/RO	at depth
MSM2/524-1	11.07.2006	02:48	74° 52,20' N	13° 2,31' W	663,2	CTD/RO	on deck
MSM2/525-1	11.07.2006	03:23	74° 49,94' N	12° 56,74' W	1001,3	CTD/RO	surface
MSM2/525-1	11.07.2006	03:41	74° 49,94' N	12° 57,18' W	988	CTD/RO	at depth
MSM2/525-1	11.07.2006	04:00	74° 49,93' N	12° 57,65' W	973,4	CTD/RO	on deck
MSM2/526-1	11.07.2006	04:28	74° 47,88' N	12° 53,48' W	1276,2	CTD/RO	surface
MSM2/526-1	11.07.2006	04:54	74° 47,79' N	12° 54,31' W	1261,6	CTD/RO	at depth
MSM2/526-1	11.07.2006	05:17	74° 47,72' N	12° 55,08' W	1242	CTD/RO	on deck
MSM2/527-1	11.07.2006	05:45	74° 45,68' N	12° 50,53' W	1523,2	CTD/RO	surface
MSM2/527-1	11.07.2006	06:18	74° 45,41' N	12° 51,48' W	1526,5	CTD/RO	at depth
MSM2/527-1	11.07.2006	06:49	74° 45,22' N	12° 52,28' W	1534,6	CTD/RO	on deck
MSM2/528-1	11.07.2006	07:37	74° 42,52' N	12° 36,89' W	2009,9	CTD/RO	surface
MSM2/528-1	11.07.2006	08:17	74° 42,33' N	12° 38,45' W	2009	CTD/RO	at depth
MSM2/528-1	11.07.2006	08:56	74° 42,15' N	12° 40,20' W	1999,8	CTD/RO	on deck
MSM2/529-1	11.07.2006	10:00	74° 41,04' N	12° 18,54' W	2301,4	CTD/RO	surface
MSM2/529-1	11.07.2006	10:48	74° 40,74' N	12° 20,26' W	2297,7	CTD/RO	at depth
MSM2/529-1	11.07.2006	10:48	74° 40,74' N	12° 20,26' W	2297,7	CTD/RO	on deck
MSM2/530-1	11.07.2006	12:54	74° 39,73' N	11° 49,36' W	2731,7	CTD/RO	surface
MSM2/530-1	11.07.2006	13:44	74° 39,61' N	11° 50,24' W	2729	CTD/RO	at depth
MSM2/530-1	11.07.2006	14:32	74° 39,53' N	11° 51,00' W	2723,4	CTD/RO	on deck
MSM2/531-1	11.07.2006	16:41	74° 59,99' N	11° 2,07' W	2713,7	CTD/RO	surface
MSM2/531-1	11.07.2006	17:31	74° 59,97' N	11° 2,51' W	2710,4	CTD/RO	at depth
MSM2/531-1	11.07.2006	18:21	74° 59,75' N	11° 3,31' W	2711,5	CTD/RO	on deck
MSM2/532-1	11.07.2006	19:00	74° 59,99' N	10° 40,15' W	3345,7	CTD/RO	surface
MSM2/532-1	11.07.2006	20:00	75° 0,16' N	10° 39,70' W	3039,5	CTD/RO	at depth
MSM2/532-1	11.07.2006	20:59	75° 0,32' N	10° 39,18' W	3041	CTD/RO	on deck
MSM2/533-1	11.07.2006	21:39	74° 59,86' N	10° 19,16' W	3135	CTD/RO	surface
MSM2/533-1	11.07.2006	22:36	74° 59,90' N	10° 19,23' W	3134,3	CTD/RO	at depth

Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear Abbreviation	Action
MSM2/533-1	11.07.2006	23:37	75° 0,05' N	10° 19,38' W	3133,4	CTD/RO	on deck
MSM2/534-1	12.07.2006	00:25	74° 59,99' N	10° 0,00' W	3194,5	CTD/RO	surface
MSM2/534-1	12.07.2006	01:25	74° 59,92' N	9° 59,96' W	3195,5	CTD/RO	at depth
MSM2/534-1	12.07.2006	02:16	74° 59,86' N	10° 0,12' W	3194,7	CTD/RO	on deck
MSM2/535-1	12.07.2006	03:33	74° 59,94' N	9° 19,32' W	3280,3	CTD/RO	surface
MSM2/535-1	12.07.2006	04:33	74° 59,86' N	9° 19,46' W	3278,7	CTD/RO	at depth
MSM2/535-1	12.07.2006	05:26	74° 59,84' N	9° 19,28' W	3280,1	CTD/RO	on deck
MSM2/536-1	12.07.2006	06:34	75° 0,00' N	8° 40,32' W	3344,3	CTD/RO	surface
MSM2/536-1	12.07.2006	07:35	75° 0,25' N	8° 41,00' W	3341,5	CTD/RO	at depth
MSM2/536-1	12.07.2006	08:39	75° 0,37' N	8° 41,79' W	3340,1	CTD/RO	on deck
MSM2/537-1	12.07.2006	09:54	74° 59,91' N	8° 1,31' W	3413,5	CTD/RO	surface
MSM2/537-1	12.07.2006	10:55	74° 59,81' N	8° 3,44' W	3411,8	CTD/RO	at depth
MSM2/537-1	12.07.2006	11:59	74° 59,39' N	8° 5,75' W	3409,4	CTD/RO	on deck
MSM2/538-1	12.07.2006	13:32	75° 0,01' N	7° 22,06' W	3453,9	CTD/RO	surface
MSM2/538-1	12.07.2006	14:34	75° 0,17' N	7° 23,91' W	3451,8	CTD/RO	at depth
MSM2/538-1	12.07.2006	15:30	75° 0,27' N	7° 25,12' W	3450,2	CTD/RO	on deck
MSM2/539-1	12.07.2006	16:59	75° 0,04' N	6° 43,17' W	3503,6	CTD/RO	surface
MSM2/539-1	12.07.2006	18:03	75° 0,53' N	6° 44,46' W	3501,4	CTD/RO	at depth
MSM2/539-1	12.07.2006	19:12	75° 0,89' N	6° 46,44' W	3499,3	CTD/RO	on deck
MSM2/540-1	12.07.2006	20:40	74° 59,95' N	6° 4,40' W	3540,1	CTD/RO	surface
MSM2/540-1	12.07.2006	21:43	75° 0,08' N	6° 5,42' W	3538,5	CTD/RO	at depth
MSM2/540-1	12.07.2006	22:52	74° 59,92' N	6° 6,18' W	3538,7	CTD/RO	on deck
MSM2/541-1	13.07.2006	00:10	74° 59,91' N	5° 25,08' W	3591,5	CTD/RO	surface
MSM2/541-1	13.07.2006	01:18	74° 59,87' N	5° 25,33' W	3591,4	CTD/RO	at depth
MSM2/541-1	13.07.2006	02:23	74° 59,86' N	5° 25,84' W	3590,9	CTD/RO	on deck
MSM2/542-1	13.07.2006	03:46	75° 0,01' N	4° 47,11' W	3629,1	CTD/RO	surface
MSM2/542-1	13.07.2006	04:52	75° 0,01' N	4° 47,12' W	3628,6	CTD/RO	at depth
MSM2/542-1	13.07.2006	04:56	75° 0,01' N	4° 47,12' W	3628,5	CTD/RO	on deck
MSM2/543-1	13.07.2006	06:40	74° 54,79' N	4° 33,22' W	3633,3	MOORY	released
MSM2/543-1	13.07.2006	06:41	74° 54,77' N	4° 33,28' W	3632,8	MOORY	sighted
MSM2/543-1	13.07.2006	07:09	74° 54,82' N	4° 33,05' W	3508,4	MOORY	start heaving on deck
MSM2/543-1	13.07.2006	07:31	74° 54,79' N	4° 33,31' W	3592,1	MOORY	start heaving on deck
MSM2/543-1	13.07.2006	10:00	74° 56,21' N	4° 40,34' W	3631,6	MOORY	on deck
MSM2/544-1	13.07.2006	10:49	74° 54,74' N	4° 26,04' W	3640,5	MOORY	released
MSM2/544-1	13.07.2006	10:52	74° 54,69' N	4° 26,18' W	3640,4	MOORY	sighted
MSM2/544-1	13.07.2006	11:13	74° 54,82' N	4° 25,62' W	3641,2	MOORY	start heaving on deck
MSM2/544-1	13.07.2006	11:43	74° 55,13' N	4° 26,00' W	3638,2	MOORY	on deck
MSM2/545-1	13.07.2006	13:05	74° 54,81' N	4° 17,90' W	3650,2	MOORY	released

Station	**Date**	**Time**	**PositionLat**	**PositionLon**	**Depth [m]**	**Gear Abbreviation**	**Action**
MSM2/545-1	13.07.2006	13:08	74° 54,80' N	4° 17,89' W	3650,2	MOORY	sighted
MSM2/545-1	13.07.2006	13:25	74° 54,88' N	4° 18,06' W	3650,4	MOORY	start heaving on deck
MSM2/545-1	13.07.2006	13:47	74° 54,56' N	4° 15,93' W	3651,3	MOORY	on deck
MSM2/546-1	13.07.2006	14:40	74° 55,11' N	4° 37,27' W	3631,2	MOORY	at surface
MSM2/546-1	13.07.2006	17:15	74° 55,17' N	4° 37,45' W	3630,8	MOORY	released
MSM2/547-1	13.07.2006	18:28	74° 59,93' N	4° 8,12' W	3654,6	CTD/RO	surface
MSM2/547-1	13.07.2006	20:40	74° 59,93' N	4° 8,11' W	3657,6	CTD/RO	at depth
MSM2/547-1	13.07.2006	20:40	74° 59,93' N	4° 8,11' W	3657,6	CTD/RO	on deck
MSM2/548-1	13.07.2006	21:44	75° 0,00' N	3° 30,64' W	3682,1	CTD/RO	surface
MSM2/548-1	13.07.2006	22:50	75° 0,00' N	3° 30,63' W	3682,2	CTD/RO	at depth
MSM2/548-1	13.07.2006	23:55	75° 0,00' N	3° 30,64' W	3683,2	CTD/RO	on deck
MSM2/549-1	14.07.2006	01:09	74° 59,92' N	2° 51,06' W	3708,9	CTD/RO	surface
MSM2/549-1	14.07.2006	02:08	74° 59,92' N	2° 51,06' W	3708	CTD/RO	at depth
MSM2/549-1	14.07.2006	03:13	74° 59,92' N	2° 51,06' W	3706,3	CTD/RO	on deck
MSM2/550-1	14.07.2006	04:22	74° 59,89' N	2° 13,22' W	3664,1	CTD/RO	surface
MSM2/550-1	14.07.2006	05:20	74° 59,89' N	2° 13,22' W	3662,7	CTD/RO	at depth
MSM2/550-1	14.07.2006	06:28	74° 59,89' N	2° 13,22' W	3663	CTD/RO	on deck
MSM2/551-1	14.07.2006	08:25	75° 5,07' N	3° 27,52' W	0	MOORY	released
MSM2/551-1	14.07.2006	08:27	75° 5,05' N	3° 27,50' W	3680,9	MOORY	sighted
MSM2/551-1	14.07.2006	08:44	75° 4,79' N	3° 27,21' W	3681,1	MOORY	start heaving on deck
MSM2/551-1	14.07.2006	10:56	75° 5,11' N	3° 27,03' W	3681,1	MOORY	on deck
MSM2/551-2	14.07.2006	11:06	75° 5,00' N	3° 27,01' W	3681,6	CTD/RO	surface
MSM2/551-2	14.07.2006	12:13	75° 4,99' N	3° 27,06' W	3682,1	CTD/RO	at depth
MSM2/551-2	14.07.2006	13:14	75° 4,96' N	3° 27,14' W	3682,3	CTD/RO	on deck
MSM2/551-3	14.07.2006	13:33	75° 4,96' N	3° 27,16' W	3682,4	MOORY	at surface
MSM2/551-3	14.07.2006	16:03	75° 4,96' N	3° 27,17' W	3682,2	MOORY	released
MSM2/552-1	14.07.2006	16:56	75° 1,56' N	3° 50,51' W	3665,9	CTD/RO	surface
MSM2/552-1	14.07.2006	18:01	75° 1,56' N	3° 50,51' W	3665,8	CTD/RO	at depth
MSM2/552-1	14.07.2006	19:10	75° 1,56' N	3° 50,50' W	3665,4	CTD/RO	on deck
MSM2/553-1	14.07.2006	20:04	74° 58,51' N	4° 14,86' W	3652,1	CTD/RO	surface
MSM2/553-1	14.07.2006	21:09	74° 58,51' N	4° 14,86' W	3652	CTD/RO	at depth
MSM2/553-1	14.07.2006	22:17	74° 58,51' N	4° 14,86' W	3652,4	CTD/RO	on deck
MSM2/554-1	14.07.2006	23:07	74° 53,83' N	3° 55,59' W	3649	CTD/RO	surface
MSM2/554-1	15.07.2006	00:12	74° 53,83' N	3° 55,58' W	3634,5	CTD/RO	at depth
MSM2/554-1	15.07.2006	01:13	74° 53,83' N	3° 55,58' W	3648,5	CTD/RO	on deck
MSM2/555-1	15.07.2006	02:25	74° 52,01' N	3° 14,16' W	3691,5	CTD/RO	surface
MSM2/555-1	15.07.2006	03:31	74° 52,01' N	3° 14,14' W	3690,6	CTD/RO	at depth
MSM2/555-1	15.07.2006	04:30	74° 52,01' N	3° 14,15' W	3690,4	CTD/RO	on deck
MSM2/556-1	15.07.2006	05:30	74° 54,09' N	2° 42,38' W	3710,7	CTD/RO	surface

Station	**Date**	**Time**	**PositionLat**	**PositionLon**	**Depth [m]**	**Gear Abbreviation**	**Action**
MSM2/556-1	15.07.2006	06:30	74° 54,09' N	2° 42,38' W	3710,5	CTD/RO	at depth
MSM2/556-1	15.07.2006	07:35	74° 54,09' N	2° 42,38' W	3710,3	CTD/RO	on deck
MSM2/557-1	15.07.2006	08:20	74° 50,36' N	2° 28,01' W	3771,8	MOORY	released
MSM2/557-1	15.07.2006	08:22	74° 50,39' N	2° 28,16' W	3638,3	MOORY	sighted
MSM2/557-1	15.07.2006	08:32	74° 50,27' N	2° 28,68' W	3713,7	MOORY	start heaving on deck
MSM2/557-1	15.07.2006	10:45	74° 49,27' N	2° 30,78' W	3710,3	MOORY	on deck
MSM2/557-2	15.07.2006	11:03	74° 49,73' N	2° 29,37' W	3712,7	CTD/RO	surface
MSM2/557-2	15.07.2006	12:04	74° 49,73' N	2° 29,37' W	3712,5	CTD/RO	at depth
MSM2/557-2	15.07.2006	13:05	74° 49,73' N	2° 29,37' W	3713,4	CTD/RO	on deck
MSM2/557-3	15.07.2006	13:18	74° 49,73' N	2° 29,37' W	3713,7	MOORY	at surface
MSM2/557-3	15.07.2006	15:47	74° 49,73' N	2° 29,38' W	3705,9	MOORY	released
MSM2/558-1	15.07.2006	17:06	74° 57,80' N	2° 56,96' W	3302,9	CTD/RO	surface
MSM2/558-1	15.07.2006	18:12	74° 57,80' N	2° 56,96' W	3703,3	CTD/RO	at depth
MSM2/558-1	15.07.2006	19:18	74° 57,80' N	2° 56,96' W	3703,5	CTD/RO	on deck
MSM2/559-1	15.07.2006	19:54	75° 1,21' N	3° 11,89' W	3692,6	CTD/RO	surface
MSM2/559-1	15.07.2006	21:05	75° 1,21' N	3° 11,89' W	3692,4	CTD/RO	at depth
MSM2/559-1	15.07.2006	22:07	75° 1,21' N	3° 11,89' W	3692,1	CTD/RO	on deck
MSM2/560-1	15.07.2006	23:50	75° 14,10' N	3° 51,03' W	3664,4	CTD/RO	surface
MSM2/560-1	16.07.2006	00:49	75° 14,22' N	3° 51,03' W	3665	CTD/RO	at depth
MSM2/560-1	16.07.2006	01:47	75° 14,22' N	3° 51,03' W	3665	CTD/RO	on deck
MSM2/561-1	16.07.2006	02:56	75° 22,62' N	4° 12,93' W	3667,2	CTD/RO	surface
MSM2/561-1	16.07.2006	03:54	75° 22,62' N	4° 12,93' W	3667,5	CTD/RO	at depth
MSM2/561-1	16.07.2006	04:55	75° 22,62' N	4° 12,93' W	3667,5	CTD/RO	on deck
MSM2/562-1	16.07.2006	05:59	75° 30,85' N	4° 34,73' W	3625,6	CTD/RO	surface
MSM2/562-1	16.07.2006	06:55	75° 30,85' N	4° 34,73' W	3625,1	CTD/RO	at depth
MSM2/562-1	16.07.2006	08:01	75° 30,85' N	4° 34,73' W	3624,5	CTD/RO	on deck
MSM2/563-1	16.07.2006	09:05	75° 38,98' N	4° 56,90' W	3568	CTD/RO	surface
MSM2/563-1	16.07.2006	10:01	75° 38,98' N	4° 56,90' W	3512,3	CTD/RO	at depth
MSM2/563-1	16.07.2006	11:02	75° 38,98' N	4° 56,90' W	3512,4	CTD/RO	on deck
MSM2/564-1	16.07.2006	12:22	75° 48,32' N	5° 20,44' W	3356,3	CTD/RO	surface
MSM2/564-1	16.07.2006	13:15	75° 48,32' N	5° 20,43' W	3356,1	CTD/RO	at depth
MSM2/564-1	16.07.2006	14:15	75° 48,32' N	5° 20,43' W	3356,3	CTD/RO	on deck
MSM2/565-1	16.07.2006	15:45	75° 56,73' N	5° 42,76' E	3057,2	CTD/RO	surface
MSM2/565-1	16.07.2006	16:35	75° 56,73' N	5° 42,76' W	3057,2	CTD/RO	at depth
MSM2/565-1	16.07.2006	17:32	75° 56,73' N	5° 42,76' W	3057,3	CTD/RO	on deck
MSM2/566-1	16.07.2006	18:41	76° 5,16' N	6° 5,16' W	3673	CTD/RO	surface
MSM2/566-1	16.07.2006	19:25	76° 5,16' N	6° 5,16' W	2828,3	CTD/RO	at depth
MSM2/566-1	16.07.2006	20:15	76° 5,16' N	6° 5,16' W	2828,4	CTD/RO	on deck
MSM2/567-1	16.07.2006	21:25	76° 13,42' N	6° 27,73' W	2466,3	CTD/RO	surface
MSM2/567-1	16.07.2006	22:11	76° 13,07' N	6° 29,04' W	2469,3	CTD/RO	at depth

Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear Abbreviation	Action
MSM2/567-1	16.07.2006	22:57	76° 12,63' N	6° 30,41' W	2452,8	CTD/RO	on deck
MSM2/568-1	17.07.2006	00:16	76° 21,85' N	6° 50,56' W	1877,7	CTD/RO	surface
MSM2/568-1	17.07.2006	00:51	76° 21,56' N	6° 51,09' W	1903,6	CTD/RO	at depth
MSM2/568-1	17.07.2006	01:20	76° 21,32' N	6° 51,63' W	1744,3	CTD/RO	on deck
MSM2/569-1	17.07.2006	02:02	76° 25,23' N	7° 0,43' W	1505,4	CTD/RO	surface
MSM2/569-1	17.07.2006	02:41	76° 25,12' N	7° 1,23' W	1492,2	CTD/RO	at depth
MSM2/569-1	17.07.2006	03:03	76° 25,09' N	7° 1,36' W	1489,1	CTD/RO	on deck
MSM2/570-1	17.07.2006	04:13	76° 30,55' N	7° 16,86' W	999,9	CTD/RO	surface
MSM2/570-1	17.07.2006	04:33	76° 30,55' N	7° 16,86' W	1000,2	CTD/RO	at depth
MSM2/570-1	17.07.2006	04:50	76° 30,55' N	7° 16,86' W	1000,3	CTD/RO	on deck
MSM2/571-1	17.07.2006	05:34	76° 33,03' N	7° 24,02' W	751,1	CTD/RO	surface
MSM2/571-1	17.07.2006	05:52	76° 32,93' N	7° 24,33' W	753,5	CTD/RO	at depth
MSM2/571-1	17.07.2006	06:08	76° 32,91' N	7° 24,55' W	750,7	CTD/RO	on deck
MSM2/572-1	17.07.2006	07:17	76° 35,59' N	7° 31,44' W	395,8	CTD/RO	surface
MSM2/572-1	17.07.2006	07:30	76° 35,49' N	7° 31,62' W	401,5	CTD/RO	at depth
MSM2/572-1	17.07.2006	07:40	76° 35,42' N	7° 31,65' W	408,1	CTD/RO	on deck
MSM2/573-1	20.07.2006	01:55	76° 0,04' N	0° 0,10' E	2646,2	CTD/RO	surface
MSM2/573-1	20.07.2006	02:37	76° 0,04' N	0° 0,10' E	2646,5	CTD/RO	at depth
MSM2/573-1	20.07.2006	03:24	76° 0,04' N	0° 0,10' E	2648	CTD/RO	on deck
MSM2/574-1	20.07.2006	04:20	75° 52,01' N	0° 12,76' W	4098,3	CTD/RO	surface
MSM2/574-1	20.07.2006	04:57	75° 52,01' N	0° 12,76' W	4092,8	CTD/RO	at depth
MSM2/574-1	20.07.2006	05:34	75° 52,01' N	0° 12,76' W	2049,3	CTD/RO	on deck
MSM2/575-1	20.07.2006	06:33	75° 45,01' N	0° 24,93' W	3703,8	CTD/RO	surface
MSM2/575-1	20.07.2006	07:32	75° 45,01' N	0° 24,94' W	3703,2	CTD/RO	at depth
MSM2/575-1	20.07.2006	08:41	75° 45,01' N	0° 24,94' W	3703	CTD/RO	on deck
MSM2/576-1	20.07.2006	09:48	75° 37,02' N	0° 36,62' W	3702,6	CTD/RO	surface
MSM2/576-1	20.07.2006	10:44	75° 37,01' N	0° 36,63' W	3702,9	CTD/RO	at depth
MSM2/576-1	20.07.2006	10:44	75° 37,01' N	0° 36,63' W	3702,9	CTD/RO	on deck
MSM2/577-1	20.07.2006	12:48	75° 29,98' N	0° 48,98' W	3695,3	CTD/RO	surface
MSM2/577-1	20.07.2006	13:47	75° 29,98' N	0° 48,99' W	3695,4	CTD/RO	at depth
MSM2/577-1	20.07.2006	14:58	75° 29,98' N	0° 48,99' W	3695,8	CTD/RO	on deck
MSM2/578-1	20.07.2006	15:58	75° 22,02' N	0° 59,68' W	3691,7	CTD/RO	surface
MSM2/578-1	20.07.2006	16:57	75° 22,02' N	0° 59,68' W	3692	CTD/RO	at depth
MSM2/578-1	20.07.2006	18:09	75° 22,02' N	0° 59,68' W	3691,8	CTD/RO	on deck
MSM2/579-1	20.07.2006	19:00	75° 15,00' N	1° 12,94' W	3970,4	CTD/RO	surface
MSM2/579-1	20.07.2006	20:06	75° 15,00' N	1° 12,94' W	3684,7	CTD/RO	at depth
MSM2/579-1	20.07.2006	21:07	75° 15,00' N	1° 12,94' W	3684,7	CTD/RO	on deck
MSM2/580-1	20.07.2006	21:08	75° 15,00' N	1° 12,94' W	3684,7	CTD/RO	surface
MSM2/580-1	20.07.2006	22:58	75° 7,58' N	1° 23,85' W	3673,8	CTD/RO	at depth
MSM2/580-1	21.07.2006	00:07	75° 7,59' N	1° 23,85' W	3673,6	CTD/RO	on deck
MSM2/581-1	21.07.2006	01:51	75° 0,03' N	2° 12,93' W	3587,4	CTD/RO	surface

Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear Abbreviation	Action
MSM2/581-1	21.07.2006	02:48	75° 0,04' N	2° 12,91' W	3573,2	CTD/RO	at depth
MSM2/581-1	21.07.2006	03:53	75° 0,03' N	2° 12,91' W	3574	CTD/RO	on deck
MSM2/582-1	21.07.2006	04:59	74° 59,93' N	1° 34,96' W	3668	CTD/RO	surface
MSM2/582-1	21.07.2006	05:57	74° 59,93' N	1° 34,96' W	3667,6	CTD/RO	at depth
MSM2/582-1	21.07.2006	07:08	74° 59,93' N	1° 34,96' W	3667,3	CTD/RO	on deck
MSM2/583-1	21.07.2006	08:10	75° 0,08' N	0° 56,10' W	3613,8	CTD/RO	surface
MSM2/583-1	21.07.2006	09:12	75° 0,08' N	0° 56,11' W	3614,7	CTD/RO	at depth
MSM2/583-1	21.07.2006	10:17	75° 0,08' N	0° 56,11' W	3690,7	CTD/RO	on deck
MSM2/584-1	21.07.2006	11:25	75° 0,02' N	0° 18,27' W	3703,4	CTD/RO	surface
MSM2/584-1	21.07.2006	12:22	75° 0,02' N	0° 18,28' W	3701,2	CTD/RO	at depth
MSM2/584-1	21.07.2006	13:28	75° 0,02' N	0° 18,28' W	3701,7	CTD/RO	on deck
MSM2/585-1	21.07.2006	14:23	74° 58,63' N	0° 12,37' W	3703,8	CTD/RO	surface
MSM2/585-1	21.07.2006	15:08	74° 58,63' N	0° 12,37' W	3704,6	CTD/RO	at depth
MSM2/585-1	21.07.2006	15:45	74° 58,63' N	0° 12,36' W	3703,9	CTD/RO	on deck
MSM2/586-1	21.07.2006	16:19	74° 58,64' N	0° 23,29' W	3700,4	CTD/RO	surface
MSM2/586-1	21.07.2006	17:06	74° 58,64' N	0° 23,30' W	3700,7	CTD/RO	at depth
MSM2/586-1	21.07.2006	17:48	74° 58,64' N	0° 23,30' W	3700,4	CTD/RO	on deck
MSM2/587-1	21.07.2006	18:15	75° 1,34' N	0° 24,00' W	3698,5	CTD/RO	surface
MSM2/587-1	21.07.2006	19:13	75° 1,34' N	0° 23,99' W	3700,1	CTD/RO	at depth
MSM2/587-1	21.07.2006	20:20	75° 1,34' N	0° 23,99' W	3699,4	CTD/RO	on deck
MSM2/588-1	21.07.2006	20:41	75° 0,79' N	0° 20,53' W	3701,8	CTD/RO	surface
MSM2/588-1	21.07.2006	21:40	75° 0,79' N	0° 20,53' W	3701,3	CTD/RO	at depth
MSM2/588-1	21.07.2006	22:46	75° 0,79' N	0° 20,52' W	3701	CTD/RO	on deck
MSM2/589-1	21.07.2006	23:02	75° 1,38' N	0° 17,73' W	3702,5	CTD/RO	surface
MSM2/589-1	22.07.2006	00:02	75° 1,38' N	0° 17,74' W	3701,1	CTD/RO	at depth
MSM2/589-1	22.07.2006	01:08	75° 1,38' N	0° 17,73' W	3702	CTD/RO	on deck
MSM2/590-1	22.07.2006	02:19	75° 0,08' N	0° 21,08' E	3710,5	CTD/RO	surface
MSM2/590-1	22.07.2006	03:25	75° 0,08' N	0° 21,08' E	3708,5	CTD/RO	at depth
MSM2/590-1	22.07.2006	04:03	75° 0,08' N	0° 21,08' E	3710	CTD/RO	on deck
MSM2/591-1	22.07.2006	05:30	75° 0,07' N	0° 59,28' E	3712,5	CTD/RO	surface
MSM2/591-1	22.07.2006	06:28	75° 0,07' N	0° 59,28' E	3712,8	CTD/RO	at depth
MSM2/591-1	22.07.2006	07:41	75° 0,07' N	0° 59,28' E	3712,4	CTD/RO	on deck
MSM2/592-1	22.07.2006	08:47	75° 0,07' N	1° 37,94' E	0	CTD/RO	surface
MSM2/592-1	22.07.2006	09:41	75° 0,07' N	1° 37,94' E	3079,6	CTD/RO	at depth
MSM2/592-1	22.07.2006	10:39	75° 0,07' N	1° 37,94' E	3079,7	CTD/RO	on deck
MSM2/593-1	22.07.2006	11:45	74° 59,97' N	2° 16,64' E	2905,3	CTD/RO	surface
MSM2/593-1	22.07.2006	12:34	74° 59,97' N	2° 16,64' E	2905,1	CTD/RO	at depth
MSM2/593-1	22.07.2006	13:31	74° 59,97' N	2° 16,64' E	2904,8	CTD/RO	on deck
MSM2/594-1	22.07.2006	14:39	74° 59,99' N	2° 56,29' E	2477,7	CTD/RO	surface
MSM2/594-1	22.07.2006	15:20	75° 0,00' N	2° 56,26' E	2475,7	CTD/RO	at depth
MSM2/594-1	22.07.2006	16:09	75° 0,00' N	2° 56,26' E	2475,7	CTD/RO	on deck

Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear Abbreviation	Action
MSM2/595-1	22.07.2006	17:21	75° 0,06' N	3° 35,38' E	3425,6	CTD/RO	surface
MSM2/595-1	22.07.2006	18:15	75° 0,07' N	3° 35,38' E	3426,2	CTD/RO	at depth
MSM2/595-1	22.07.2006	19:24	75° 0,07' N	3° 35,39' E	3425,9	CTD/RO	on deck
MSM2/596-1	22.07.2006	19:37	74° 59,98' N	3° 40,09' E	3491,9	CTD/RO	surface
MSM2/596-1	22.07.2006	21:25	74° 59,97' N	4° 13,96' E	3042,9	CTD/RO	at depth
MSM2/596-1	22.07.2006	22:23	74° 59,97' N	4° 13,96' E	3042,1	CTD/RO	on deck
MSM2/597-1	22.07.2006	22:25	74° 59,97' N	4° 13,97' E	3042,7	CTD/RO	surface
MSM2/597-1	23.07.2006	00:25	74° 59,95' N	4° 51,77' E	3170,9	CTD/RO	at depth
MSM2/597-1	23.07.2006	01:27	74° 59,95' N	4° 51,77' E	3187,8	CTD/RO	on deck
MSM2/598-1	23.07.2006	02:41	75° 0,01' N	5° 30,14' E	3067,5	CTD/RO	surface
MSM2/598-1	23.07.2006	03:31	75° 0,01' N	5° 30,14' E	3067,4	CTD/RO	at depth
MSM2/598-1	23.07.2006	04:27	75° 0,01' N	5° 30,14' E	3067,4	CTD/RO	on deck
MSM2/599-1	23.07.2006	05:33	75° 0,14' N	6° 8,36' E	2769,5	CTD/RO	surface
MSM2/599-1	23.07.2006	06:18	75° 0,14' N	6° 8,36' E	2769,5	CTD/RO	at depth
MSM2/599-1	23.07.2006	07:11	75° 0,14' N	6° 8,36' E	2769,4	CTD/RO	on deck
MSM2/600-1	23.07.2006	08:15	75° 0,01' N	6° 47,25' E	2211,7	CTD/RO	surface
MSM2/600-1	23.07.2006	08:54	75° 0,01' N	6° 47,25' E	2212	CTD/RO	at depth
MSM2/600-1	23.07.2006	09:37	75° 0,01' N	6° 47,25' E	2212,9	CTD/RO	on deck
MSM2/601-1	23.07.2006	10:44	75° 0,01' N	7° 25,94' E	2434,6	CTD/RO	surface
MSM2/601-1	23.07.2006	11:26	75° 0,02' N	7° 25,94' E	2434,7	CTD/RO	at depth
MSM2/601-1	23.07.2006	12:07	75° 0,01' N	7° 25,94' E	2434,6	CTD/RO	on deck
MSM2/602-1	23.07.2006	13:15	75° 0,08' N	8° 5,02' E	3474,8	CTD/RO	surface
MSM2/602-1	23.07.2006	14:10	75° 0,08' N	8° 5,02' E	3474,4	CTD/RO	at depth
MSM2/602-1	23.07.2006	15:12	75° 0,08' N	8° 5,02' E	3474,3	CTD/RO	on deck
MSM2/603-1	23.07.2006	16:18	75° 0,00' N	8° 44,16' E	2621,7	CTD/RO	surface
MSM2/603-1	23.07.2006	17:01	75° 0,00' N	8° 44,16' E	2621,8	CTD/RO	at depth
MSM2/603-1	23.07.2006	17:48	75° 0,00' N	8° 44,16' E	2621,8	CTD/RO	on deck
MSM2/604-1	23.07.2006	18:54	75° 0,03' N	9° 21,83' E	2551,5	CTD/RO	surface
MSM2/604-1	23.07.2006	19:38	75° 0,03' N	9° 21,83' E	2551,6	CTD/RO	at depth
MSM2/604-1	23.07.2006	20:26	75° 0,03' N	9° 21,83' E	2551,8	CTD/RO	on deck
MSM2/605-1	23.07.2006	21:26	75° 0,03' N	10° 0,03' E	2617,1	CTD/RO	surface
MSM2/605-1	23.07.2006	22:10	75° 0,03' N	10° 0,04' E	2536,5	CTD/RO	at depth
MSM2/605-1	23.07.2006	22:57	75° 0,03' N	10° 0,04' E	2536,6	CTD/RO	on deck
MSM2/606-1	24.07.2006	00:00	75° 0,04' N	10° 39,04' E	2492,5	CTD/RO	surface
MSM2/606-1	24.07.2006	00:39	75° 0,03' N	10° 39,04' E	2492,5	CTD/RO	at depth
MSM2/606-1	24.07.2006	01:23	75° 0,03' N	10° 39,04' E	2492,3	CTD/RO	on deck
MSM2/607-1	24.07.2006	02:28	74° 59,99' N	11° 18,13' E	2414,9	CTD/RO	surface
MSM2/607-1	24.07.2006	03:07	74° 59,99' N	11° 18,54' E	2412,9	CTD/RO	at depth
MSM2/607-1	24.07.2006	03:52	74° 59,99' N	11° 18,54' E	2412,8	CTD/RO	on deck
MSM2/608-1	24.07.2006	05:17	75° 0,01' N	11° 56,28' E	2294	CTD/RO	surface
MSM2/608-1	24.07.2006	05:57	75° 0,01' N	11° 56,28' E	2292,8	CTD/RO	at depth

Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear Abbreviation	Action
MSM2/608-1	24.07.2006	06:40	75° 0,01' N	11° 56,28' E	2292,9	CTD/RO	on deck
MSM2/609-1	24.07.2006	07:42	74° 59,94' N	12° 35,08' E	2148,5	CTD/RO	surface
MSM2/609-1	24.07.2006	08:19	74° 59,94' N	12° 35,08' E	2148,4	CTD/RO	at depth
MSM2/609-1	24.07.2006	08:55	74° 59,94' N	12° 35,08' E	2146,6	CTD/RO	on deck
MSM2/610-1	24.07.2006	09:58	74° 59,97' N	13° 12,87' E	1983,7	CTD/RO	surface
MSM2/610-1	24.07.2006	10:33	74° 59,97' N	13° 12,87' E	1984,3	CTD/RO	at depth
MSM2/610-1	24.07.2006	11:07	74° 59,97' N	13° 12,87' E	1982,7	CTD/RO	on deck
MSM2/611-1	24.07.2006	12:10	74° 59,96' N	13° 51,71' E	1774,6	CTD/RO	surface
MSM2/611-1	24.07.2006	12:40	74° 59,96' N	13° 51,71' E	1772,6	CTD/RO	at depth
MSM2/611-1	24.07.2006	13:10	74° 59,96' N	13° 51,70' E	1772,3	CTD/RO	on deck
MSM2/612-1	24.07.2006	14:20	75° 0,00' N	14° 31,09' E	1403,4	CTD/RO	surface
MSM2/612-1	24.07.2006	14:46	75° 0,00' N	14° 31,09' E	1406,7	CTD/RO	at depth
MSM2/612-1	24.07.2006	15:10	75° 0,00' N	14° 31,09' E	1403,2	CTD/RO	on deck
MSM2/613-1	24.07.2006	16:18	75° 0,12' N	15° 9,43' E	1009,7	CTD/RO	surface
MSM2/613-1	24.07.2006	16:39	75° 0,12' N	15° 9,43' E	1009,1	CTD/RO	at depth
MSM2/613-1	24.07.2006	16:57	75° 0,12' N	15° 9,43' E	1009,6	CTD/RO	on deck
MSM2/614-1	24.07.2006	18:04	75° 0,01' N	15° 50,29' E	258,9	CTD/RO	surface
MSM2/614-1	24.07.2006	18:14	75° 0,00' N	15° 50,29' E	258,8	CTD/RO	at depth
MSM2/614-1	24.07.2006	18:24	75° 0,00' N	15° 50,29' E	259,1	CTD/RO	on deck
MSM2/615-1	24.07.2006	19:31	74° 59,98' N	16° 30,03' E	228,3	CTD/RO	surface
MSM2/615-1	24.07.2006	19:40	74° 59,98' N	16° 30,03' E	229,6	CTD/RO	at depth
MSM2/615-1	24.07.2006	19:48	74° 59,98' N	16° 30,03' E	229,1	CTD/RO	on deck

2.7 Acknowledgements

We like to thank captain Klaus Bergmann, his officers and crew of R/V MARIA S. MERIAN for their support of our measurement programme and for creating a very friendly atmosphere on board. The ship time of MERIAN was provided by the Deutsche Forschungsgemeinschaft within the programme for METEOR/MERIAN-Expeditions. We also benefited from financial contributions from the AWI budget and from the project funds provided by the SFB 512.

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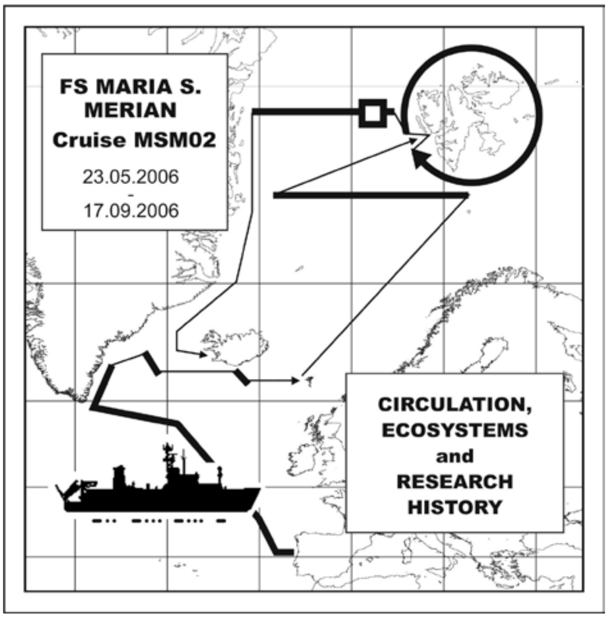
MARIA S. MERIAN-Berichte 09-1

Circulation and Ecosystems in the Subpolar and Polar North Atlantic

Part 3

Cruise No. 2, Leg 3

July 31 to August 17, 2006
Longyearbyen – Longyearbyen



Geo- and biological investigations on polar benthic ecosystems, palaeoceanography and polar history around Svalbard

A. Freiwald, S. Becker, T. Bergmann, D. Cordts, B. Dorschel, M. Eisele, D. Fleischer, A. Form, J. Freiwald, H. Fricke, S. Fricke, D. Hebbeln, K. Hissmann, G. Landmann, S.-B. Löffler, C. Lüdecke, M. Meyerhöfer, B. Meyer-Schack, D. Piepenburg, A. Rüggeberg, R. Schäfer, J. Schauer, M. Wisshak

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3.1 Participants

Tab. 3.1: List of Participants on Leg MSM02/3 and Abbreviations

Name	Discipline	Institute
Freiwald, André, Prof. Dr.	Chief scientist	IPAL
Becker, Stefan	Public outreach	Journalist
Bergmann, Tim	Geology	IPAL
Cordts, Detlev	Public outreach	TV Filmmaker
Dorschel, Boris, Dr.	Geology	UCC
Eisele, Markus	Technician	MARUM
Fleischer, Dirk	Biology	IPÖ
Form, Armin, Dr.	Marine Chemistry	IFM-Geomar
Freiwald, Jannik	Trainee	Gymnasium Herzogenaurach
Fricke, Hans, Prof. Dr.	Polar History	MPI-Seewiesen
Fricke, Sebastian	Technician	MPI-Seewiesen
Hebbeln, Dierk, Prof. Dr.	Geology	MARUM
Hissman, Karen, Dr.	JAGO navigation	IFM-Geomar
Landmann, Günter, Dr.	Seabed mapping	MPI-Seewiesen
Löffler, Sonja-Bettina, Dr.	Palaeontology	IPAL
Lüdecke, Cornelia, PD Dr.	Polar History	LMU
Meyerhöfer, Michael, Dr.	Marine Chemistry	IFM-Geomar
Meyer-Schack, Birgit	Technician	MARUM
Piepenburg, Dieter, Prof. Dr.	Biology	IPÖ
Rüggeberg, Andres, Dr.	Seabed mapping	IFM-Geomar
Schäfer, Rafael	Technician	MARUM
Schauer, Jürgen	JAGO Pilot	IFM-Geomar
Wisshak, Max, Dr.	Geology, Photonics	IPAL

Participating Institutions

IFM-Geomar	Leibniz-Institute of Marine Sciences, University of Kiel, Germany
IPAL	Geo-Center of Northern Bavaria, University Erlangen-Nürnberg, Germany
IPÖ	Institute for Polar Ecology, University of Kiel, Germany
MARUM	Center for Marine Environmental Sciences, University of Bremen, Germany
MPI-Seewiesen	Max Planck Institute for Ornithology, Starnberg/Seewiesen, Germany
UCC	University College Cork, Cork, Ireland
LMU	Ludwig-Maximilians-University, Munich, Germany

3.2 Research Program

The Arctic belongs to the area where the effects of the predicted climate change related to global warming show evident footprints. Such signals are — amongst many more — a thinning sea-ice cover, melting tidewater glaciers and increasing meltwater discharge and siltation to the marine realm. In spring 2006, the warmest air temperatures ever where recorded from meteorological stations on Spitsbergen. If this warming trend continues, it will definitively alter the functioning and diversity of the polar ecosystem, both on land and in the sea. While scientists still debate about the effects of this environmental change, oil and gas industry has already taken measures to exploit the hydrocarbon resources in the Barents Sea around the Svalbard archipelago. One of the benefits of more mild climate conditions is the easier and less expensive access to the resources of the Barents Sea. This MERIAN cruise will analyse environmental controls and post-glacial climate variability of biosedimentary systems on the shelves around Svalbard. Special emphasis is laid on the evolution of polar carbonates – the least known system of non-tropical carbonate factories – and their potential as palaeo-environment recorder. This scenario sets the frame for the highly interdisciplinary scientific cruise programme which aims to:

- **Investigate the neritic and fjordic benthic ecosystems with a focus on hard-bottom and steep sloping seabeds.** Such marine environments generally are difficult to sample quantitatively and complement the many existing and on-going soft-bottom related studies around Svalbard. To meet this challenge, we chartered the German manned submersible JAGO. While the polar benthic biologists from the IPÖ concentrated on the living ecosystem, their species diversity, biomass and climate related modifications (compared to earlier studies in the same area), the sedimentologists and palaeontologists from the IPAL focus on hardpart-secreting communities that form carbonate deposits. Despite the increased research efforts to better understand cool-water carbonates, the polar realm is the least understood carbonate factory to date.
- **Measure the physical oceanographic parameter with special emphasis on the carbonate saturation of both the Atlantic and polar water masses around Svalbard.** Marine chemists from the IFM-Geomar analysed the water column and bottom water (sampled with JAGO) with a CTD mounted on a rosette-sampler. This group will figure out the influence of increasing input of anthropogenic carbon dioxide via atmosphere-ocean mixing, which will lead to undersaturated conditions of the seawater with respect to calcium carbonate. The predicted consequences of carbonate undersaturation in the marine realm are manifold and will weaken biomineralisation of pelagic and benthic calcifiers. Undersaturated seawater will also limit the preservation potential of shelly carbonates as this source is then going to be dissolved in order to buffer the increasingly less alkaline waters. This cruise provided probably the most complete data set of the present-day carbonate saturation state of the waters around Svalbard. IPAL also measured the photosynthetic active radiation with a Quantum-lightsensor to depict the depth of the photic zone during the summer period in the neritic realm.
- **Unravel the postglacial palaeoceanography.** Especially the sedimentary environments off northern Svalbard are poorly explored. Palaeoceanographers from Bremen University collected box- and gravity-cores from shelf troughs and fjord basins in the northern Barents Sea. We anticipate a better understanding of the interplay between the

northernmost derivates of the North Atlantic Current, polar water masses and the climate sensitive detrital input from melting glaciers. These data extend our environmental change programme from the present-day and historical time frame obtained from long-lived shelly benthos to geological time scales.

- **Contribute to polar history.** Researchers from the MPI-Seewiesen and the LMU Munich used the opportunity of the cruise to visit a couple of historical sites along the cruise track to document their preservation and to further find evidences of the fate of the Deutsche Arktis Expedition failed in 1912 as well as for the rescue expedition in 1913.

3.3 Narrative of the cruise

This cruise led us around Spitsbergen and along the northern coast of Nordaustlandet. We explored a couple of coastal embayments and fjords. Figure 3.1 provides an overview of the sites we surveyed during MSM02/3.

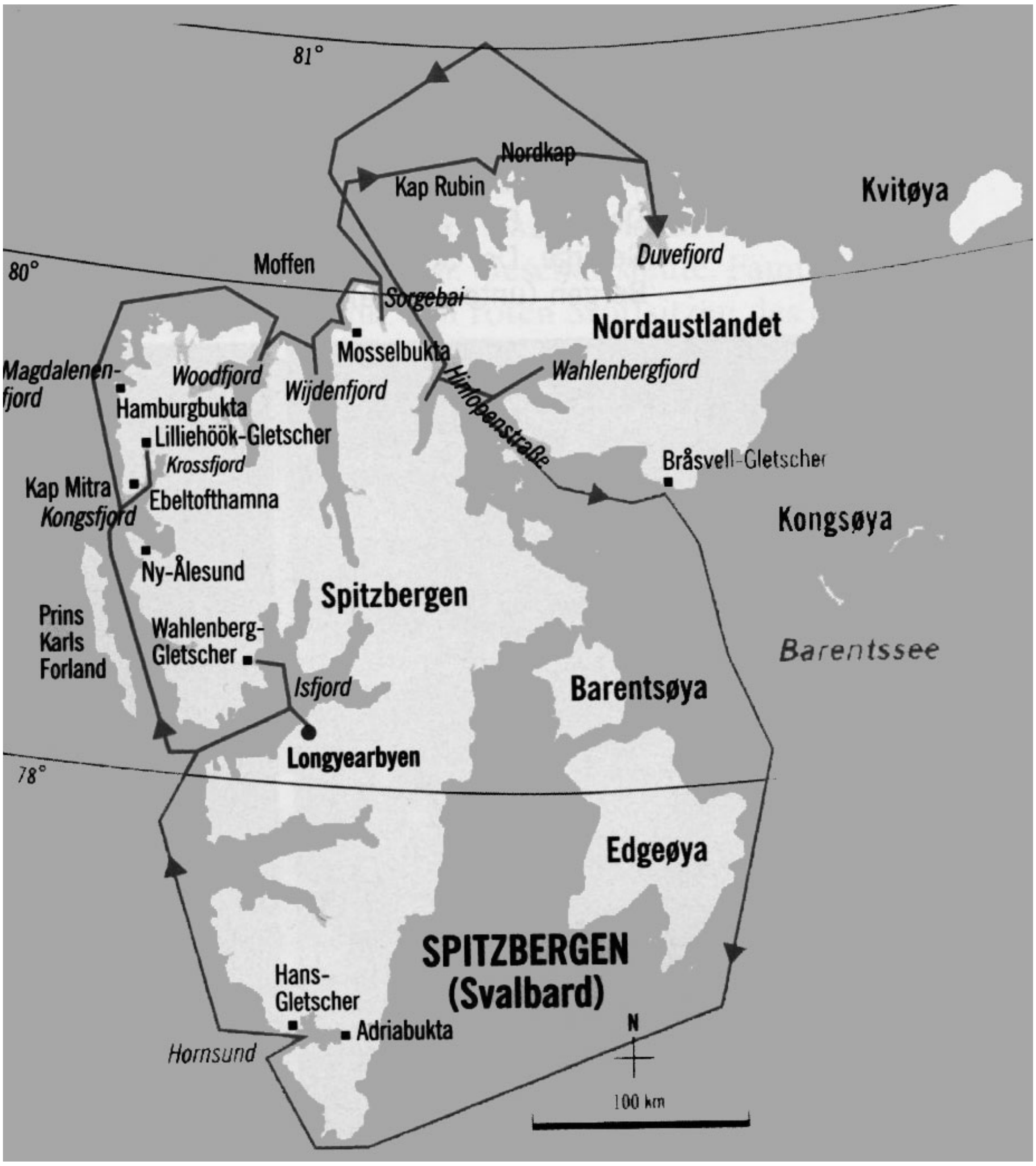

Fig. 3.1: Overview of MSM02/3 survey sites and cruise track in the Svalbard archipelago (modified from MERIAN Norwegen Heft 10, 2007)

Monday, 31.07.06

We left Longyearbyen in the early morning and immediately started a CTD profile consisting of 6 stations (#616-621) along the main axis of the Isfjord trough. The profile started in the outer Isfjord and ended at the continental margin.

Tuesday, 01.08.06

In the night we moved on to Sentinelleflaket, a shallow shelf bank south of the Isfjord trough and started in the early morning with multibeam mapping (#622). Along 2 profiles, the NE slope of the bank was plotted from 146 to 33 m water depth. In the channel between Sentinelleflaket and the Nordenskjöld coast off Svalbard we launched the box-corer and the gravity-corer with a 3-m-barrel (#623), followed by 6 Van Veen grabs along the mapped area up to the top of the bank (#624-629). In the late afternoon, the JAGO-manoeuvre started under increasing wind conditions. Underwater light-level measurements were taken using the MERIAN rubber dinghy (#630). Last station on the Sentinelleflaket was the first ROV-mission (#631), which had to be cancelled because of technical problems. We passed to Mitragrunnen in front of the Kongsfjord in the evening.

Wednesday, 02.08.06

After midnight the scientific programme started with a CTD station (#632) in the outer Kongsfjord south of Mitragrunnen, followed by multibeam mapping (#633) of the slope area from 300 to 30 m water depth. On the first scientific JAGO dive (#634), the lower slope section of Mitragrunnen was mapped between 250 to 148 m water depth. Here, the box-corer and gravity-corer with a 6 m-barrel (#635) were used successfully in the soft sediments of the trough. Two dredges (#636-637) from 100 m and 50 m depth yielded valuable information on the hardsubstrate community. In the early evening we mapped selected profiles (#638) to extend the multibeam grid through the entire Krossfjord and Lilliehöökfjord (#639). We reached the huge calving front of the spectacular Lilliehöök glacier at midnight.

Thursday, 03.08.06

Back towards Mitragrunnen, a CTD profile was taken through the Krossfjord (#640-643). The second JAGO dive was conducted in the shallow-photic zone of the mapped Mitragrunnen area (#644) in the morning. A 9 m-barrel gravity-corer (#645) improved our depth penetration at the site we cored yesterday. In the afternoon we steamed back into the Krossfjord, taking a box-corer and a gravity-corer with a 6 m-barrel (#646) from the 352 m deep trough. At the same time, the polar-historical landing party explored the remains of a German geophysical-meteorological station at Ebeltoftholmen. In the evening, we reached again the Lilliehöök glacier front, combining the preparations for JAGO dive (#647) close to the glacier. JAGO had to be towed carefully around floating growlers by the MERIAN's rescue boat. While leaving the fjord, a box-corer sample and a 6 m-barrel gravity-corer (#648) were taken before midnight.

Friday, 04.08.06

Short after midnight, a second box-corer/6 m-barrel gravity-corer station (#649) was carried out. Early in the morning a second ROV functional test (#650) was made and the multibeam map of this area was completed on Mitragrunnen (#651). Later on, a JAGO dive at the outer Krossfjord (#652) was launched. On the track of the Mitragrunnen JAGO dive #644, the towed photo sledge was used to expose every 15 m over ground one medium-format colour slide (#653). Underwater light-level measurements (#654) completed the programme at Mitragrunnen. We started our way to Moffen island in the afternoon, a sandy accumulation with a central lagoon north off

Woodfjorden. In the night and under best weather conditions we reached our working area for multibeam mapping southwest of Moffen (#656). But prior to mapping, we took a CTD for getting a proper sound velocity profile (#655).

Saturday, 05.08.06

The investigations at Moffen started with a JAGO dive (#657) and underwater light-level measurements (#658). At the deepest part, a box-corer sample (#659) was taken. Along the JAGO track, the photo sledge (#660) was used for generating sea floor photographs, followed by a dredge (#661) for collecting the key species. With two Van Veen grabs (#662-663) the sampling was concluded at Moffen. In the evening, some time was invested to close the last gaps of the multibeam map (#664). Later on we reached a geologic station in the outer Woodfjord, which was mapped by multibeam (#665), and sampled with box-corer, 6 m-barrel gravity-corer and CTD (#666).

Sunday, 06.08.06

Further CTD transects were launched in the area around Woodfjorden (#667-669). Early in the morning we reached Mosselbukta, and explored this bay with multibeam mapping (#670), followed by the 6th JAGO dive (#671). By means of underwater light-level measurements (#672) the depth of the photic zone was investigated. Afterwards, an expert group for polar-historical studies went ashore to survey the overwintering lodging ‘Polhem’ of Nordenskjöld in the inner bay of Mosselbukta. In the meantime, a corer site (#673) in the outer Wijdefjord was explored. Back in Mosselbukta the photo sledge (#674), dredge (#675) and 2 Van Veen grabs (#676-677) were launched.

Monday, 07.08.06

After midnight we filled the last gaps in the multibeam map (#678) at Moffen, followed by a further CTD station in the outer Wijdefjord (#679). In the morning, we deployed 3 experimental bioerosion and carbonate-accretion panels in the photic, dysphotic and aphotic zones, respectively, in Mosselbukta with JAGO (#680-682). These bioerosion panels will be recovered in two years time. The battery-recharge time of JAGO was used for multibeam mapping (#683). In the evening, the 10th scientific JAGO dive (#684) led from the lower slope up to the zone with rhodoliths. Final task in the Mosselbukta were underwater light-level measurements (#685). After a short transect we reached a further geology station west off Verlegenhuken in the outer Wijdefjord, which was investigated by a short multibeam transect (#686), as well as box-corer and gravity-corer sampling plus a CTD (#687).

Tuesday, 08.08.06

On the way to Sorgfjorden two further CTD transects were carried out (#688-689). A detailed multibeam grid was mapped in front of the Sorgfjord (#690) as well as within the inner bay (#691). In 1693, a French naval raid took place here with high losses amongst Dutch whalers and their ships. Our 11th JAGO dive (#692) was carried out in the Sorgfjord. At the same time, a group of specialists visited a grave field on the outlet of the bay. The first polar bear was sighted. In the bay the scientific programme was concluded with underwater light-level measurements (#693) and a CTD station (#694). With best weather conditions we headed towards Hinlopenstretet and – after multibeam mapping (#695) – started with some heavy gear (box-corer, gravity-corers with 6 m- and 9 m-barrel, CTD and 3 Van Veen grabs; #696).

Wednesday, 09.08.06

The outer Hinlopenstretet was explored by multibeam mapping (#697) and than sampled by box-corer and gravity-corer as well as CTD (#698). We reached Kapp Rubin in the north of Nordaustlandet in the morning, launching a CTD (#699). The stretch between Kapp Rubin and Nordkapp was covered with a multibeam grid (#700). Along the steep slope, a first submersible dive (#701) was undertaken. At the same time underwater light-level measurements (#702) took place, followed by a further short JAGO dive (#703). Along the track of the 12th JAGO dive (#701) the dredge (#704), photo sledge (#705) and CTD (#706) were launched. Subsequently, some short tracks were mapped (#707). Shortly before midnight we left Kapp Rubin to move towards north off Lågøya to a new geologic station. This area was explored by multibeam (#708), followed by a CTD profile (#709-1). Because of the pebbly seafloor, only the box-corer was applied (#709-2).

Thursday, 10.08.06

Back at Kapp Rubin we continued with the multibeam mapping until the morning (#710). After breakfast a new JAGO dive (#711) explored another steep slope off Kapp Rubin, followed by a further light measurement (#712). Other areas between Nordkapp and Kapp Rubin were mapped (#713) in the afternoon. The 15th submersible dive (#714) started in shallow waters very close to the coast in the evening. Shortly before midnight, we reached Kapp Wrede, starting there with a CTD profile (#715). The subsequent multibeam mapping (#716) offered a potential core station.

Friday, 11.08.06

Exactly at midnight this geologic station was investigated with box-corer and gravity-corer (#717). Hereafter we passed into the Duvefjord. There, a polar-historic excavation-team went ashore at Dokken (#718). At the same time the inner area of the Duvefjord was surveyed by multibeam (#719) and than sampled by CTD, box-corer, gravity-corer with a 9 m-barrel as well as 3 Van Veen grabs (#720). A detailed grid of the fjord at Dokken was subsequently mapped (#721) and the photo sledge (#722) was used. While heading towards 81°N we celebrated a joint barbeque with scientists and crew.

Saturday, 12.08.06

We reached 81°N at midnight, where a CTD (#723) on the open shelf north of the Nordkapp was launched. In Nordenskjöldbukta a further CTD (#724) was carried out. We completed our programme in the outer Duvefjord with multibeam (#725), box-corer and gravity-corer sampling (#726) and sailed northwest of Sjuøyane. Here, we launched a core station including multibeam (#727), box-corer and gravity-corer (#728) before heading into the Hinlopenstretet.

Sunday, 13.08.06

Short after midnight the CTD (#729) was launched in the central Hinlopenstretet in the outer Lomfjord and a multibeam grid (#730) was mapped. The scientific programme for this morning started with a JAGO dive (#731) within the mapped area, followed by light measurements (#732), CTD (#733), a dredge (# 734) and photo sledge (#735). Afterwards a further core station was surveyed with the approved methods such as multibeam (#736), box-corer, gravity-corer and Van Veen grabs (#737). In the evening we passed into the Wahlbergfjord with further multibeam mapping (#738), a CTD station and the geological standard programme (box-corer, gravity corer; #739).

Monday, 14.08.06

Back in the Hinlopenstretet, a submarine cliff was mapped (#740) near Fosteroyane. A JAGO dive (#741) had to be aborted after short time because of strong currents. Instead, light measurements (#742) and photo sledge (#743) were successfully applied. We cruised on to the southern Hinlopenstretet. Near Perthesoya some Van Veen grabs and a CTD (#744) were taken. In the evening, we made a short excursion to the very spectacular Brasvell glacier front, which is part of the huge Austfonna glacier of Nordaustlandet. In the late evening with the aid of multibeam (#745) we designated a scientific station for CTD, box-corer, gravity-corer and some Van Veen grabs (#746) in the Eriksenstretet. Here, the gravity-corer suffered heavy damage and there was no chance to repair it on board.

Tuesday, 15.08.06

Short after midnight we reached the Barents Sea with some further Van Veen grabs and CTD stations (#747) in the eastern Eriksenstretet as well as near the Kong Karls Islands (#748-749). In the afternoon we reached our last geologic station on this cruise in the Olgastretet with a CTD transect, box-corer sampler as well as Van Veen grabs (#750), before starting the long transit to the Hornsund.

Wednesday, 16.08.06

Just before lunch, the Hornsund was reached. First, a CTD profile (#751) was logged. Near Höferpynten the area was mapped by multibeam (#752), followed by a submersible dive (#753). Finally, the last light measurements (#754) and photo sledge (#755) investigations were carried out. At the same time, another group went ashore to explore the Hansbreen. In the evening, we visited the glaciers at the end of the Hornsund and than steamed back towards Isfjorden.

Thursday, 17.08.06

We reached Floskjeret in the central Isfjord after breakfast and mapped this area with multibeam (#756). With our 19th JAGO dive (#757) we concluded our station work on this cruise and reached Longyearbyen safely early in the evening.

3.4 Preliminary results

3.4.1 Multibeam mapping surveys

(A. Rüggeberg, G. Landmann)

System overview

During cruise MSM02/3 the Kongsberg EM 1002 multibeam echo sounder was used, designed for high-resolution seabed mapping from the shoreline down to a depth of approximately 1000 m. The complete system onboard has all necessary sensor interfaces, real-time compensation for vessel motion and ray bending, data displays for quality control including sensor calibration, and data logging included as standard. The maximum ping rate is more than 10 Hz, a large number of measurements per ping with 111 beams, 2x2 degrees bandwidth, and electronic roll stabilization. The system’s nominal sonar frequency is 95 kHz allowing for small dimensions, good range capability and high tolerance to turbid water, which was essentially in some parts of investigated areas during the cruise (e.g., in fjords or close to glaciers). The EM 1002 multibeam echo sounder consists of three main units:

- The transducer array, that is mounted in the pool on board of R/V MARIA S. MERIAN.
- The transceiver unit that has serial interfaces for all external sensors (e.g., vessel attitudes: roll, pitch, heading, heave; vessel position: DGPS; sound velocity probe, external clock).
- The operator station, a high performance dual-processor PC workstation (HWS 10), located in the data processing room, main deck at backboard side.

Good performance of the system is obtained by a swath width of up to about 1500 m in deeper waters, while in shallow waters the swath width may be up to 7.4 times water depth. The effective along track beam width is 2.3 degree. Depending on the pulse length (0.2, 1 or 2 ms) and the vertical angel of swath, the total depth accuracy is given between 0.2% and 0.5%. During our cruise, a hardware failure occurred at the transceiver unit and its interface card had to be replaced.

Operation software

The EM 1002 multibeam echo sounder is controlled from the HWS 10 Operator Station using the software *Seafloor Information System* (SIS). Its standard click and point graphical user interface enable viewing of gridded data in a geographically oriented 2D or 3D display. During cruise MSM02/3, the geographical window of SIS was copied to a monitor located on the bridge of R/V MARIA S. MERIAN (program VNC). Thus facilitating the helmsman to observe swath width and to navigate overlapping tracks.

The quality of the survey was controlled using SIS by setting several runtime parameters (e.g., sector coverage angle, max. coverage, filter and gains, parameters of data cleaning, etc.). Vertical sound speed profiles were measured prior to the surveys and data were imported to SIS. Unfortunately, during our cruise SIS runs not very stable. Frequently, a system failure occurred, leading to a loss of data till the program was restarted. Several times error notification ‘Grid Engine Interface Socket closed’ arise with no loss of data but swath track is not longer displayed on the geographical window. System error notification ‘Connection to sounder has been lost’ could be solved by a rescan, setting the forced depth to the actual water depth.

Data processing software

On board of R/V MARIA S. MERIAN, the two software packages *Neptune* and *Cfloor* were used to process multibeam raw data.

The *Neptune* bathymetric post-processing software is a tool to bring raw multibeam data - recorded by SIS- through a data correction and cleaning process. The system is designed for graphical description of raw data to identify problems. It provides tools to correct or remove errors in navigation data, depth soundings or sound speed profiles. The sequence of data processing with *Neptune* consist of:

- Directory organisation for raw data
- Position processing
- Installation offsets
- Depth correction processing
- Processing of survey blocks
- Statistical data cleaning

Neptune is designed being integrated with other software products, e.g., sonar mosaicing (*Poseidon*), seafloor classification (*Triton*) and terrain modelling (*Cfloor*). The xyz data resulting from the data cleaning process was taken as input to *Cfloor* as well as exported in ascii-format. During cruise MSM02/3 *Neptune* was also used to produce contour charts to select coring stations and navigational maps for the submersible JAGO (Fig. 3.2).

The *Cfloor* software package can be used in ordinary chart production starting with *Neptune* output data from which digital terrain models are generated. These models can then be used for production of charts, cross sections and profiles, as well as for volume calculations.

In total, 33 MB stations were carried out during the cruise (Tab. 3.2).

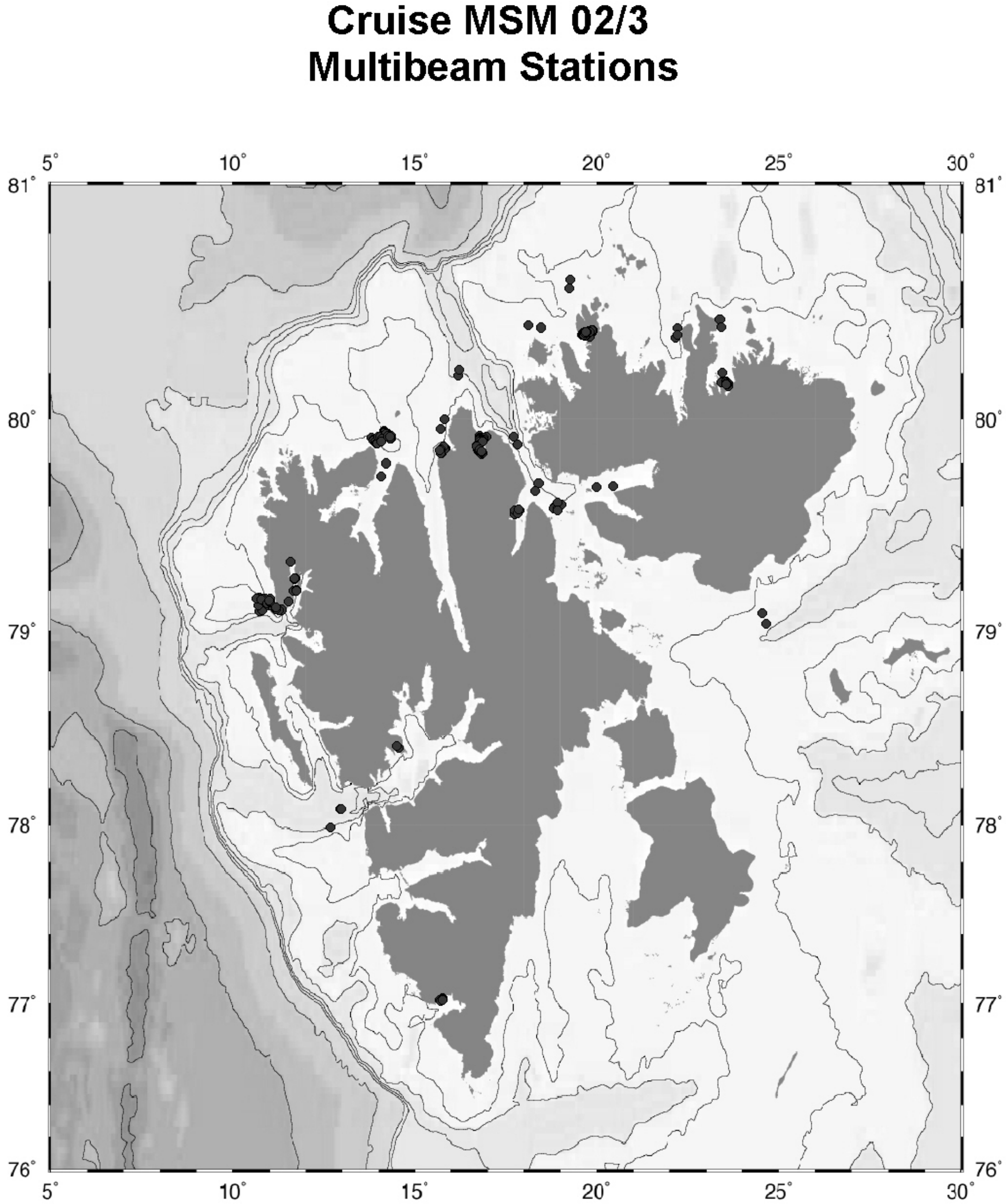

Fig. 3.2: Geographic spread of MB Stations during MSM02/3

Tab. 3.2: Basic information of multibeam stations during MSM02/3.

Station	No.	Site	Date	Start UTC	Lat. °N	Long °E	Depth [m]	End UTC	Lat. °N	Long °E	Depth [m]
622-1	1	Sentinelleflaket	01.08.06	4:43	77° 58,62'	12° 59,30'	150	5:47	77º 52,68'	12º 42,59'	40
622-2	1	Sentinelleflaket	01.08.06	5:57	77º 52,70'	12º 42,80'	40	6:55	77º 58,62'	13º 00,82'	149
633-1	2	Mitragrunnen	02.08.06	0:45	79° 02,65'	10° 45,57'	341	1:11	79° 05,80'	10° 43,26'	42
633-2	2	Mitragrunnen	02.08.06	1:17	79° 05,77'	10° 44,31'	49	1:46	79° 02,70'	10° 50,48'	332
633-3	2	Mitragrunnen	02.08.06	2:01	79° 02,96'	10° 54,97'	350	2:30	79° 05,79'	10° 44,91'	46
633-4	2	Mitragrunnen	02.08.06	2:35	79° 05,79'	10° 45,88'	53	3:06	79° 03,42'	10° 59,14'	308
633-5	2	Mitragrunnen	02.08.06	3:18	79° 04,22'	11° 01,06'	184	3:46	79° 05,86'	10° 46,47'	46
633-6	2	Mitragrunnen	02.08.06	3:52	79° 05,91'	10° 47,86'	53	4:17	79° 04,81'	11° 03,29'	110
633-7	2	Mitragrunnen	02.08.06	4:26	79° 05,30'	11° 04,03'	94	4:54	79° 06,03'	10° 48,37'	43
633-8	2	Mitragrunnen	02.08.06	5:01	79° 06,16'	10° 50,65'	n.d.	5:21	79° 05,69'	11° 03,93'	93
633-9	2	Mitragrunnen	02.08.06	5:28	79° 06,08'	11° 03,37'	115	6:05	79° 06,42'	10° 42,34'	36
633-10	2	Mitragrunnen	02.08.06	6:05	79° 06,42'	10° 42,34'	36	6:38	79° 06,37'	11° 03,68'	130
638-1	3	Mitragrunnen	02.08.06	17:27	79° 04,66'	10° 43,61'	213	19:53	79° 05,92'	10° 52,50'	136
638-2	3	Mitragrunnen	02.08.06	20:28	79° 05,11'	10° 56,19'	127	21:35	79° 04,23'	11° 25,67'	n.d.
639	4	Kongsfjorden	02.08.06	21:35	79° 04,23'	11° 25,67'	n.d.	8:00	79° 05,69'	10° 46,84'	70
651	5	Mitragrunnen	04.08.06	1:46	79° 12,87'	11° 44.37'	234	5:40	79° 03,64'	11° 14,86'	106
656	6	Moffen	04.08.06	22:11	79° 58,10'	13° 51,57'	128	6:10	79° 59,11'	14° 10,50'	78
664	7	Moffen	05.08.06	16:16	79° 58,12'	14° 19,40'	42	19:30	79° 57,77'	14° 19,40'	58
665	8	Moffen/Woodfj.	05.08.06	20:16	79° 49,50'	14° 13,54'	131	20:47	79° 45,99'	14° 07, 13'	190
670	9	Mosselbukta	06.08.06	6:28	79° 54,20'	15° 44,91'	81	10:33	79° 53,40'	15° 45,88'	42
678	10	Moffen	07.08.06	0:53	79° 58,23'	14° 19,42'	n.d.	4:15	79° 58,34'	14° 20,27'	n.d.
683	11	Wijdefjorden	07.08.06	14:10	79° 48,50'	15° 20,04'	140	14:36	79° 45,00'	15° 20,01'	135
686	12	Wijdefjorden	07.08.06	20:38	80° 01,35'	15° 43,90'	155	21:00	80° 03,80'	15° 50,27'	216
690	13	Sorgfjorden	08.08.06	3:34	79° 58,65'	16° 47,90'	75	6:50	79° 57,13'	16° 48,54'	94
691	14	Sorgfjorden	08.08.06	6:51	79° 57,13'	16° 48,54'	90	10:55	79° 54,89'	16° 42,31'	100
695	15	Hinlopenstretet	08.08.06	17:54	79° 56,01'	17° 50,74'	410	18:20	79° 58,50'	17° 42,84'	384
697	16	Hinlopenstretet	09.08.06	1:03	80° 18,12'	16° 11,86'	345	1:24	80° 20,24'	16° 14,00'	374
700	17	Kapp Rubin	09.08.06	7:59	80° 31,62'	19° 39,45'	n.d.	11:34	80° 31,00'	19° 44,09'	41
707	18	Kapp Rubin	09.08.06	20:39	80° 31,76'	19° 49,34'	87	21:16	80° 32,23'	19° 36,74'	84
708	19	Kapp Rubin	09.08.06	22:14	80° 33,89'	18° 27,07'	121	22:48	80° 34,36'	18° 06,29'	134
710	20	Kapp Rubin	10.08.06	1:54	80° 31,72'	19° 39,79'	69	7:55	80° 31,83'	19° 39,40'	41
713	21	Kapp Rubin	10.08.06	12:36	80° 32,09'	19° 43,49'	112	16:16	80° 31,76'	19° 44,06'	60
716	22	Kapp Wrede	10.08.06	22:52	80° 33,19'	22° 13,79'	225	23:43	80° 31,34'	22° 10,89'	265
719	23	Duvefjorden	11.08.06	7:38	80° 16,06'	23° 24,65'	321	8:14	80° 19,10'	23° 25,68'	334
721	24	Duvefjorden	11.08.06	11:52	80° 15,80'	23° 33,20'	41	13:33	80° 15,60'	23° 34,50'	56
725	25	Duvefjorden	12.08.06	7:51	80° 36,40'	23° 21,40'	278	8:18	80° 33,62'	23° 25,71'	309
727	26	Sjuøyane	12.08.06	14:01	80° 45,97'	19° 15,36'	134	14:32	80° 48,89'	19° 16,88'	145
730	27	Lomfjorden	13.08.06	2:05	79° 33,92'	17° 47,85'	122	6:02	79° 34,97'	17° 52,12'	86
736	28	Lomfjorden	13.08.06	12:52	79° 35,02'	17° 52,39'	85	14:30	79° 41,50'	18° 19,29'	426
738	29	Wahlbergfjorden	13.08.06	18:56	79° 42,30'	20° 00,90'	154	19:43	79° 42,92'	20° 29,68'	220
740	30	Hinlopenstretet	13.08.06	22:56	79° 36,17'	18° 51,71'	336	4:32	79° 34,78'	18° 55,24'	81
745	31	Eriksenstretet	14.08.06	19:07	79° 01,80'	24° 31,67'	183	19:39	78° 57,90'	24° 37,60'	210
752	32	Hornsund	16.08.06	13:08	76° 57,69'	15° 47,16'	210	13:57	76° 57,24'	15° 46,51'	n.d.
756	33	Isfjorden	17.08.06	8:17	78° 18,30'	14° 34,32'	127	8:58	78° 18,86'	14° 31,94'	54

3.4.2 CTD and water sampling

(M. Meyerhöfer, A. Form)

For the measurements of vertical profiles of the different physical, chemical and biological variables the following sensors were used (all attached to a rosette of 24 ten - litre water bottles): A Sea Bird CTD sensor (for **C**onductivity, **T**emperature and **D**epth), a 4π Licor light sensor (PAR; **P**hotosynthetic **A**ctive **R**adiation), detectors for the fluorescence of Chlorophyll-a and Phycoerythrin as well as sensors for oxygen, sound velocity and turbidity.

A total of 40 CTD profiles were carried out around the archipelago (see Fig. 3.3). At the maximum depths water samples were taken for the analysis of the carbonate system (Total Alkalinity and Dissolved Inorganic Carbon).

Nine additional benthic water samples were taken by a 5 l Niskin–bottle attached to the submersible JAGO.

Preliminary results

Physical oceanography

Of the extensive data set won by the profiling instruments only those which describe the general oceanographic situation encountered, will be discussed at this point.

The oceanographic physical environment around Svalbard is strongly influenced by three different sources of water masses. In addition to the two main sources (West Spitsbergen Current, WSC, and Arctic Waters, AW from the Barents Sea), seasonally changing amounts of freshwater from melting glaciers enter the fjords and surroundings of the archipelago. This results in a very “patchy” and diverse picture. Nevertheless, the stations may be organized roughly in the following categories (see Fig. 3.3 and 3.4):

Category 1

Stations with pure or nearly pure water of the West Spitsbergen Current with vertically almost unchanged high salinities (S) > 35 psu, high surface temperatures (T) > 7°C, and euphotic zone depths around 50 metres (stations 620 and 621).

Category 2

Stations with low to very low surface salinities due to freshwater input from the glaciers, ($S \leq 34$ psu: stations 616, 617, 618, 619, 632, 640, 641, 642, 643, 669, 679, 687, 694, 696, 720, 729, 733, 739, 751). Most of them are obviously influenced by the relative warm waters of the WSC, except stations 720 and 739, were cold AW entered deeper layers. Due to the strong input of suspended matter from the melting glaciers, the stations with the shallowest euphotic zones (1% light depths: < 30 m) belong to this group (stations 632, 640, 641, 642, 643, 694, 696, 729, 739, 751). Of these, station 640 had the shallowest one with only 10 m.

Category 3

Stations with no or very low input of glacier freshwater but still showing warmer waters of the WSC (stations 655, 666, 667, 668, 688, 689, 698, 699, 706, 709, 715, 723, 724). Euphotic zone depths varied between 30 and 50 metres.

Category 4

Stations with no or very low input of glacier freshwater but with very low temperatures beyond -1°C in deeper layers (stations 746, 747, 748, 749, 750). These are the typical Arctic water masses in the Barents Sea. Light measurements showed relatively deep euphotic zones down to 80 metres.

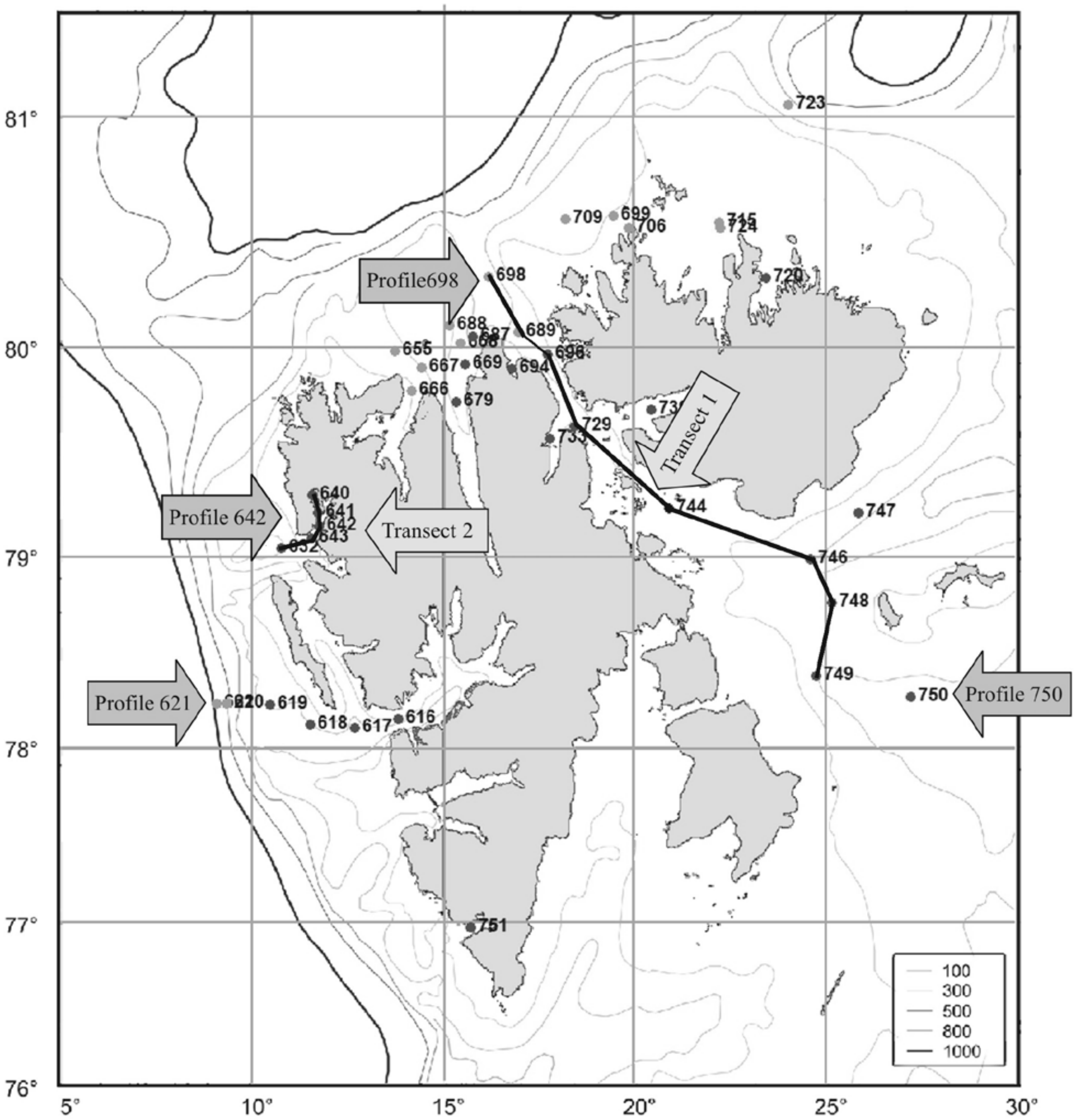

Fig. 3.3: CTD stations and locations of the profiles illustrated in Fig. 3.4 and of the two transects shown in Fig. 3.5 and 3.6

The strong influence of the warm waters of the WSC is shown exemplarily by the temperature transect through the Hinlopenstretet (Figs. 3.5 and 3.6): Despite the fact of beginning in the north of the archipelago, temperatures are still nearly as high as in the western waters of the islands. These warm waters enter far into the strait. The very cold Arctic waters of the Barents Sea are clearly detectable only from station 744 onward.

The effect of fresh water inflow to the fjords adjacent to melting glaciers is illustrated in Fig. 3.7 (for orientation see also Fig. 3.4, transect 2). Shallow lenses (≤ 10 metres) of low salinity water (≤ 32 psu) lie above a thick layer of higher salinities up to more than 34 psu.

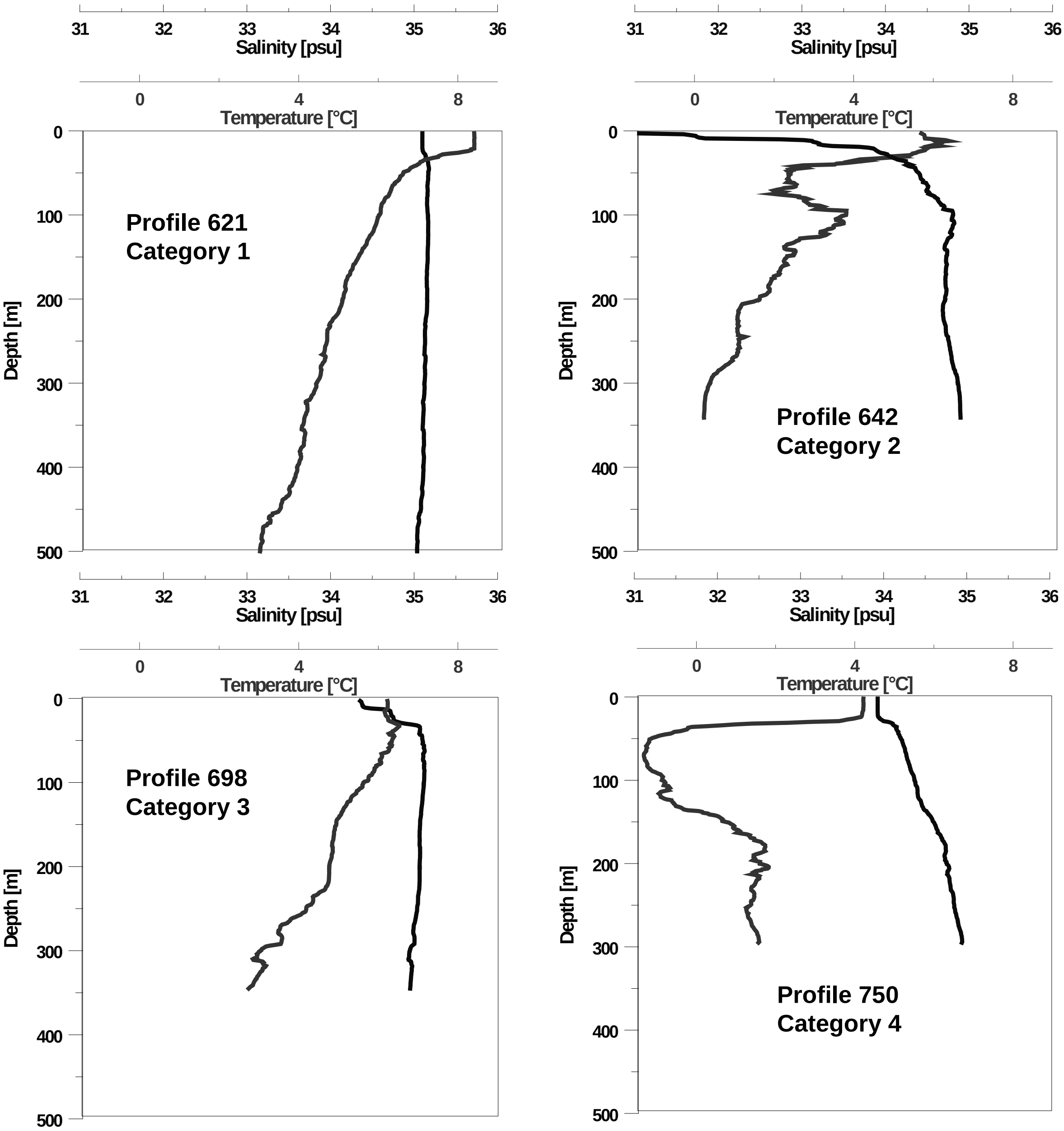

Fig. 3.4: Typical vertical profiles for the different categories mentioned above. For locations see Fig. 3.3

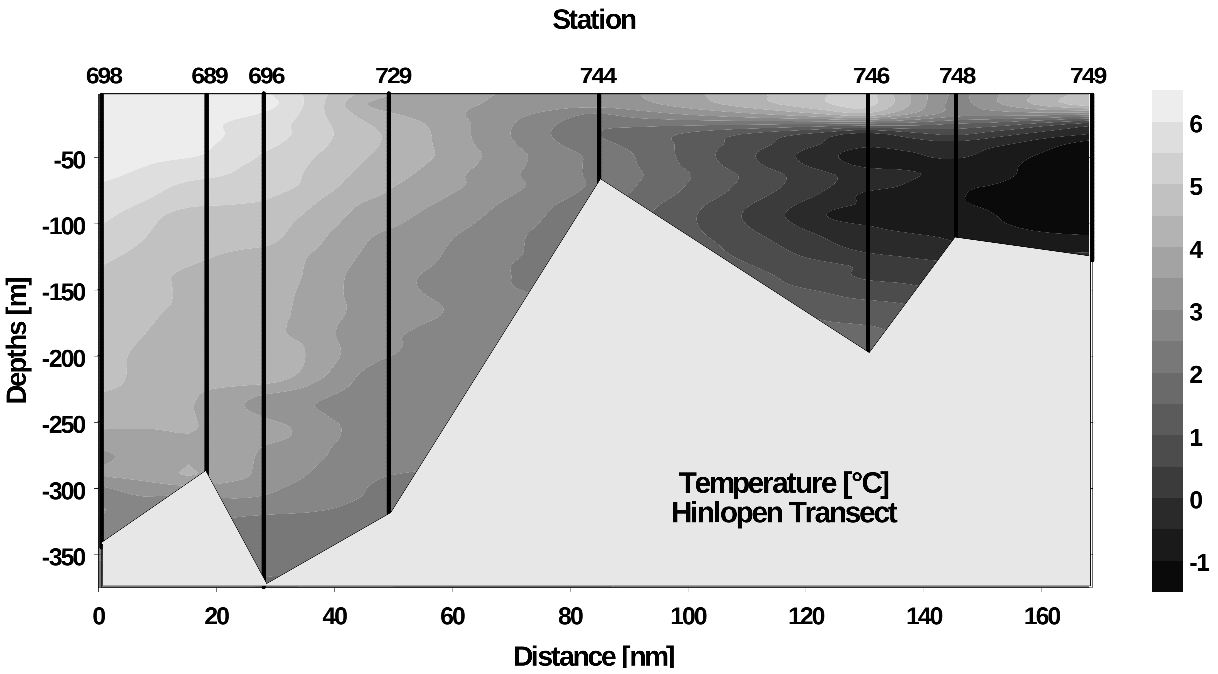

Fig. 3.5: Transect of temperature through the Hinlopenstretet (for location see „Transect 1” in Fig. 3.3)

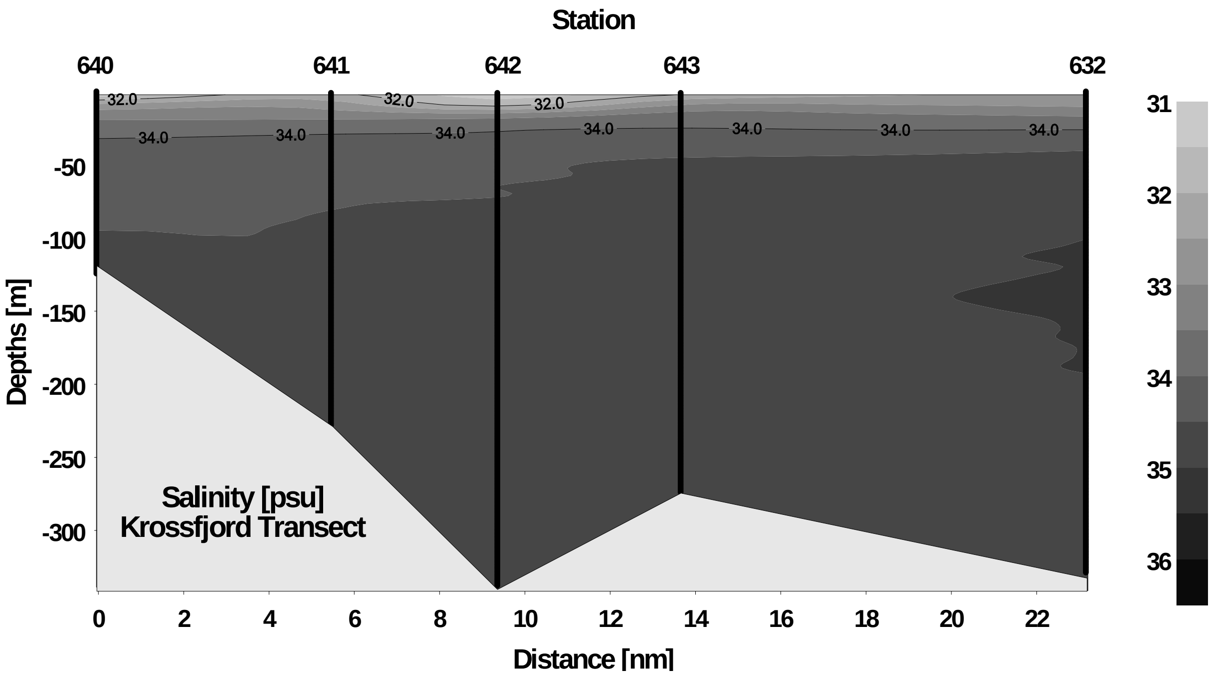

Fig. 3.6: Transect of salinity in the Krossfjord (for location see „Transect 2” in Fig. 3.3)

3.4.3 Light measurements

(M. Wisshak)

Eleven light measurements were carried out applying a LICOR Spherical Quantum Sensor (LI-193SA) in combination with a data logger (LI-1400) and a 100 m cable (Fig. 3.7 and Table 3.3). The relevant measured spectrum lay within a wavelength range of 400-700 nm, which corresponds to the photosynthetically active radiation (PAR; unit = µmol photons m^{-2} s^{-1}). The measurements were undertaken with the aid of the fast rescue boat in order to minimise potential bias due to shadows cast by the research vessel and to be able to take controlled shallow measurement just below the water surface. The recorded data were additionally translated to percentages with respect to surface illumination. Numerous measurements were taken under a wide range of daytimes and weather conditions from cloudless calm weather to overcast and windy conditions. In addition to the subaqueous measurements, the surface PAR intensity was determined as a reference for the various weather conditions.

Tab. 3.3: Light sensor stations obtained during MSM02/3.

Station	No.	Site	Date	Time (UTC)	Lat. °N	Long. °E	Depth [m]
630	1	Sentinelleflaket	01.08.2006	15:05	77° 53,06'	12° 47,56'	36
654	2	Mitragrunnen	04.08.2006	12:56	79° 05,45'	10° 48,20'	95
658	3	Moffen	05.08.2006	8:20	79° 59,37'	14° 11,78'	60
672	4	Mosselbukta	06.08.2006	11:40	79° 54,57'	15° 49,72'	44
685	5	Mosselbukta	07.08.2006	16:55	79° 53,73'	15° 44,62'	79
693	6	Sorgfjorden	08.08.2006	14:49	79° 55,04'	16° 42,83'	94
702	7	Kapp Rubin	09.08.2006	12:28	80° 32,04'	19° 50,74'	94
712	8	Kapp Rubin	10.08.2006	9:02	80° 31,81'	19° 40,63'	68
732	9	Lomfjorden	13.08.2006	7:10	79° 34,97'	17° 52,11'	87
742	10	Hinlopenstretet	15.08.2006	7:16	79° 36,03'	18° 52,05'	100
754	11	Hornsund	17.08.2006	15:18	76° 57,18'	15° 44,29'	98

An additional set of light measurements was obtained via the SBE CTD, which was also equipped with a spherical quantum sensor (see above). However, these measurements were predominantly undertaken during night hours and in addition bear the disadvantage of not avoiding the shadow cast by the research vessel. Also, this method did not allow a controlled first measurement only few centimetres below the water surface but some metres below.

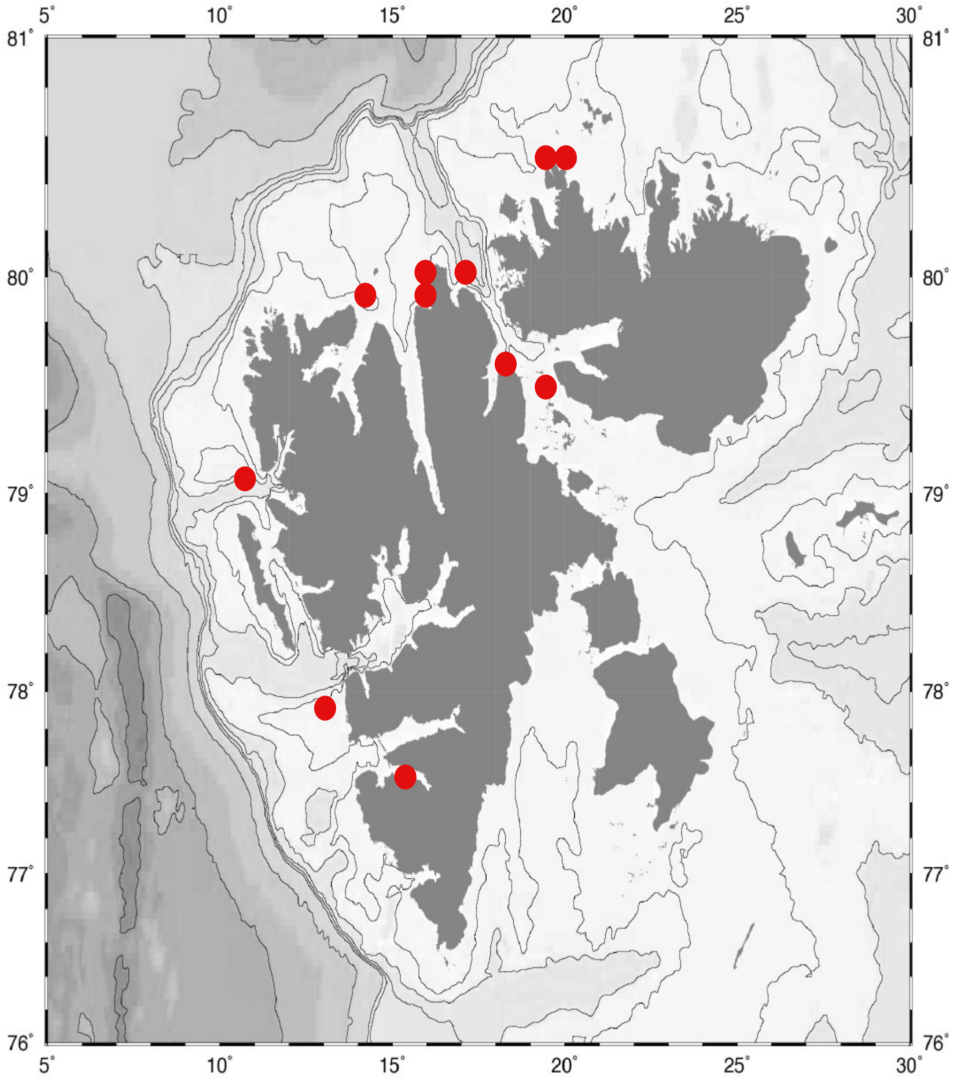

Fig. 3.7: Light sensor stations around Svalbard obtained during MSM02/3

Preliminary results

Defining the illumination status

The light availability in relation to bathymetry is one of the main factors influencing the distribution of light-dependant photoautotrophic biota. The scheme of the photic zonation distinguishes a euphotic zone, a dysphotic zone and an aphotic zone. The base of the euphotic zone is defined by the depth where the light intensity declines to 1% of the surface illumination. The base of the dysphotic zone corresponds to the photic limit, which is the depth at which photosynthesis balances respiration and below which photoautotrophic algae do not exist (~0.01% of the surface illumination).

The photosynthetically active radiation (PAR) was directly measured under various weather conditions in order to determine the depth of the boundaries of the photic zonation in the various study areas around Svalbard. The surface illumination of the 11 measurement sites ranged from 169 to 2,582 µmol photons m^{-2} s^{-1} above and 71 to 1,054 µmol photons m^{-2} s^{-1} just below the water surface, and light levels decreased exponentially toward deeper waters. For the determination of the boundaries between the various photic zones, the data were plotted in a semi-logarithmic graph where the intersection of the light logs with the 1% surface illumination mark indicates the lower boundary of the euphotic zone and with the 0.01% mark the base of the dysphotic zone, respectively. The base of the euphotic zone was directly measured in 20 to 50 m water depth (Hornsund and Hinlopenstretet, respectively) while the base of the dysphotic zone was found to be located in 60 to 115 m water depth (Mosselbukta and Hinlopenstretet, respectively). Hence, the maximum intensity of the rhodolith occurrences as recorded during the JAGO dives is located in the lower euphotic and upper dysphotic zone (~30 to 45 m water depth).

At some of the sites, specifically the fjord settings with considerable meltwater runoff overlying the water column as a brackish water layer with reduced transparency, the varying turbidity is clearly reflected in a downward increase in light penetration gradient, as for instance in the Lomfjorden (LS 9) or the Hornsund sites (LS 11). This observation is in accordance to the observations made while descending during the JAGO dives at these sites.

The result of this array of light measurements is generally confirmed with respect to the lower boundary of the euphotic zone by the CTD light measurements. There, the vast majority of the 39 measurements plot in a range of 15 to 50 m water depth for the euphotic/dysphotic boundary. Only few measurements plot outside this spectrum, probably as a result of insufficient general light level or other bias as an influence of the vessels shadow or a too deep upper start of the measurement.

3.4.4 Biological sampling

(D. Piepenburg, D. Fleischer)

Within an integrated multidisciplinary approach, involving oceanographic, geological and biological studies, the composition, abundance and distribution of seafloor communities of the Svalbard shelf were investigated by means of three gears: (1) dredge (DRG), (2) van Veen grab (BG), and (3) photographic probe (FTS). The basic idea behind the use of a combination of different gears was that each method has its specific pros and cons and is most adequate for the sampling of different community fractions and at different seafloor types. Together, especially if their results are combined with those gained with the video-based 'visual transect census' carried out using the submersible JAGO, they provide a more complete picture of the benthic assemblages present in the study area, as if they would in case of separate deployment.

FTS and DRG were employed, together with the submersible JAGO, in the study areas Mitragrunnen, Moffen Island, Mosselbukta and Kapp Rubin (Tab. 3.4). In the Duvefjord, we combined the FTS and BG. In the Lomfjord, it was possible to combine all four techniques JAGO, DRG, FTS and BG. The Hornsund was sampled by JAGO and FTS. The stations in the northwestern Barents Sea were sampled by BG only.

Dredge

The dredge was used to collect macro- and megabenthic epifauna. This gear does not provide quantitative samples but it can be employed on grounds made up by pebbles, cobbles and stones, i.e. at locations where the use of grabs and corers is not possible because these gears do not close and thus do not provide samples at all.

The dredge used during the cruise consists of a rectangular frame (100 cm wide and 40 cm high), to which a net of 150 cm length and 0.5 cm mesh size is fixed.

The main objective of the dredge hauls was a qualitative species inventory of the benthic fauna and flora. In addition, the results will help to identify the organisms visible in the video footage obtained during JAGO dives and in the seabed pictures provided by the photographic probe.

During the cruise the dredge was employed at a total of 6 stations (Table 3.4), all of which were in close proximity to the locations of JAGO dives and/or deployments of the photographic probe. All live specimens were sorted out of the catches and identified to lowest possible taxonomic level (putative species). Moreover, for each taxon identified the gross abundance was estimated (using a logarithmic abundance classification scheme), and voucher specimens were selected and fixed in a 4% formalin-seawater solution for later more precise identification in the lab.

Van Veen-type grab

A van Veen grab was employed to obtain quantitative samples of the macrobenthos. The grab used during the cruise measured 60 cm in width and 30 cm in height. It had an opening of 46.5 x 46.5 cm. It was deployed at a total of 9 stations (Table 3.4). Their positions were selected according to three criteria: (1) the seabed texture has to be appropriate (in case the seafloor primarily consists of sand, pebbles and stones the grab will not close (see above); (2) stations sampled last year by Norwegian colleagues are revisited; and (3) getting samples from areas that have not been investigated to date. For statistical reasons, at each station three replicate samples were taken in order to investigate the small-scale patchiness of the benthic fauna. Samples were gently washed through a sieve of 1 mm mesh size, and the sieve residue was fixed in 70% alcohol for later analysis of species composition, abundance and biomass in the lab after the cruise.

Photographic probe

The photographic probe was used to obtain high-resolution stills of the seabed, complementing the video footage obtained during the JAGO dives. The primary goal of its use was a quantitative inventory of the megabenthic epifauna.

The probe basically consisted of a vertically oriented still camera (PHOTOSEA™ 70 D) and an obliquely oriented strobe (PHOTOSEA™ 1500 D), both aligned 1 m apart from each other in a steel frame of 2.3 m length in total. It was vertically lowered to the sea floor from the ship, which by means of its high-precision GPS-based Dynamic Positioning System (DPS) moved slowly with a constant speed of 0.25 kn along a transect that was determined before the deployment in a multi-beam-derived map displaying the bathymetry of the study in high resolution. On bottom contact of a weight hanging about 1.4 m below the probe, both camera and strobe were triggered, and bottom contact was signalled to the ship via a single-conductor cable. The gear was then heaved a few metres and subsequently lowered again for the next bottom contact and seabed exposure. By control of the ship's DPS, the interval between the single shots was kept constant at approximately 10 m. In this manner, series of 30 non-overlapping photographs, distributed along the predefined 300m-transects, were obtained at each station [at some stations, less than 30 shots were taken due to technical problems]. The system did not comprise a video camera allowing for real-time monitoring; i.e. all sea floor photographs were taken blindly. As the distance between camera and seabed was kept constant for each exposure by means of the trigger mechanism, the bottom area imaged by each photograph was the same (1 m^2). Two laser light points with a distance of 22.5 cm to each other were projected on the depicted seabed area and provided a scale in each photo.

In total, 224 seabed photographs were taken at 8 stations at water depths ranging from 25 to 240 m (Table 3.4). The station plan was designed in order to complement the video surveys carried out by JAGO, i.e., whenever feasible, the photographic transects were embedded into the video transects covered by JAGO.

The exposed slides will be developed and analysed at home. The high resolution of the sea floor pictures, due to the relatively small camera-seabed distance and the high quality of the optical system and film material used (KODAK EKTACHROME™ 64 ASA 70 mm colour slide film), will allow to investigate epibenthic individuals as small as 1 mm. The "close-up" pictures of the sea floor will be evaluated according to the following aspects:

(a) "in situ" observations of epibenthic habitat structures

(b) quantitative determination of absolute population densities

(c) identification of spatial distribution patterns

and, if population densities are sufficiently high,

(d) assessment of size spectra of large epibenthic organisms

For species identification, megabenthic specimens were collected from dredge catches taken at the same or nearby locations. In the course of the quantitative analysis of the photographs, epibenthic organisms will be determined by comparison with these specimens (and, if necessary, with the help of taxonomic experts) and counted. For comparative analyses, these counts will be raised to absolute abundance values (ind m^{-2}).

Tab. 3.4: Benthic sampling (BG - van Veen grab; DRG - Dredge; FTS - Photographic probe).

Station	Gear	Lat. °N	Long. °E	Depth [m]	Site	Remarks
636	DRG-1	79°5,47’ -79°5,68’	10°48,17’ -10°49,38’	98 -99	Mitragrunnen	Course 129°; 15 min; 1 kn
637	DRG-2	79°5,91’ -79°5,84’	10°47,69’ -10°46,37’	48 -49	Mitragrunnen	Course 262°; 15 min; 1 kn
653	FTS-1	79°05,940' - 79°05,701'	10°45,63' - 10°46,84'	41 - 69	Mitragrunnen	25 pictures
660	FTS-2	79°59,534' - 79°59,469'	14°13,962' - 14°13,335'	39 - 48	Moffen	20 pictures
661	DRG-3	79°59,26’ -79°59,45’	14°15,28’ -14°14,08’	40 -40	Moffen	Course 309°; 15 min; 1 kn
674	FTS-3	79°54, 591' - 79°54,647'	15°48,906' - 15°48,069'	40 - 51	Mosselbukta	30 pictures
675	DRG-4	79°54,21’ -79°53,53’	15°46,94’ -15°44,89’	61 - 72	Mosselbukta	Course 206°; 15 min; 1 kn
696	BG-1	79°58,02’ -79°58,02’	17°44,54’ -17°44,55’	383	Northern Hinlopenstretet	Three proper replicates
704	DRG-5	80°31,22’ -80°31,44’	19°44,23’ -19°43,02’	45 - 43	Kapp Rubin	Course 26°; 15 min; 1 kn
705	FTS-4	80°32,039' - 80°31,988'	19°50,745' - 19°51,383'	88 - 24	Kapp Rubin	29 pictures
720	BG-2	80°18,94’ -80°18,73’	23°25,18’ -23°25,67’	312 -321	Duvefjorden	Three proper replicates
722	FTS-5	80°15,312' - 80°15,502'	23°33,435' - 23°33,919'	47 - 42	Duvefjorden	30 pictures
734	DRG-6	79°34,96’ -79°34,69’	17°50,78’ -17°50,94	43 -49	Lomfjorden	Course 171°; 15 min; 1 kn
735	FTS-6	79°34,800' - 79°34,789'	17°50,504' - 17°51,664'	54 - 66	Lomfjorden	30 pictures
737	BG-3	79°41,01’ -79°41,01’	18°18,07’ -18°18,07’	417 - 417	Lomfjorden	Three proper replicates
743	FTS-7	79°35,838' - 79°36,005'	18°52,195' -18°51,820'	25 - 239	Hinlopenstretet	30 pictures
744	BG-4	79°14,16’ -79°14,16’	20°53,38’ -20°53,38’	79 -79	Southern Hinlopenstretet	Three proper replicates
746	BG-5	78°59,20’ -78°59,20’	24°35,83’ -24°35,83’	208	Barents Sea	Three proper replicates
747	BG-6	79°13,10’ -79°13,10’	25°51,27’ -25°51,28’	192	Barents Sea	Three proper replicates
748	BG-7	78°46,03’ -78°46,03’	25°08,28’ -25°08,28’	122	Barents Sea	Three proper replicates
749	BG-8	78°23,14 -78°23,14	24°44,45 -24°44,45	138	Barents Sea	Three proper replicates
750	BG-9	78°16,19’ -78°16,19’	27°11,70 -27°11,70	312	Barents Sea	Three proper replicates
755	FTS-8	79°57,181' - 79°57,183'	15°45,014' - 15°44,320'	40 - 95	Hornsund	30 pictures

Preliminary results

Benthic ecology

The main objective of the biological sampling programme was to analyse spatial variations in the structure of benthic assemblages in the shelf waters around Svalbard. In the investigated coastal habitats, the distribution, composition and abundance of the benthos are assumed to be mainly controlled by light penetration (and, hence, the occurrence of coralline red algae) and the kinetic energy regime (waves, current, tides). As these factors depend very much on the water depth, a depth zonation is the most pronounced pattern in the distribution of benthic assemblages. In addition, the sedimentation setting (which in turn is largely determined by the presence or absence of glaciers) is of special significance off the Svalbard coasts.

Within the context of international and multidisciplinary cooperation, the analyses will contribute to the documentation of the present condition of the marine ecosystems off Svalbard. This is an important issue, as most models agree in the prediction that northern seas will experience particularly severe ecosystem shifts because of pronounced sea temperature rise and rapid sea-ice reduction. Due to the influence of the North Atlantic Current system, even now most benthic species inhabiting the coastal waters off Svalbard, particularly at the western and northern coasts, are actually of Atlantic origin, i.e. they are immigrants from the south that also occur at boreal latitudes. Endemic Arctic species, which are adapted to extremely low temperatures characterizing polar environments and do occur in Arctic waters only, are clearly less numerous that those Arctic-boreal species. Due to the expected climate-related ecosystem shifts, their numbers are likely to further decrease, especially in transition regions between sub-Arctic and high-Arctic climates, such as Svalbard. We will test whether this trend has already set off.

Shipboard results

Dredge catches

Overall, the number of macrobenthic (putative) species, sorted on board out of the dredge catches (Fig. 3.8), totals 111 (Tab. 3.5). Crustacea were most diverse (24; Tab. 3.5), followed by Mollusca (23), Polychaeta (15), and Echinodermata (14). Only two species – the brittle star *Ophiopholis aculeata* (Echinodermata: Ophiuroidea) and the prawn *Lebbeus polaris* (Crustacea: Decapoda) – were present in all catches (Tab. 3.5). The numbers of (putative) species per station ranged from 18 at station 636 (Mitragrunnen) to 46 at station 675 (Mosselbukta) (Tab. 3.5). Note that these numbers are conservative estimates of species richness, as it is certain that more species will be added in a more detailed analysis in the lab after the cruise.

Fig. 3.8: Dredge catch from station 637 (Mitragrunnen, 50 m)

Tab. 3.5: Preliminary list of putative species (live specimens only) in dredge samples.

Taxa \ Station	636	637	661	675	704-2	734
Rhodophyta						
Lithothamnion sp.		X	X	X		X
Ptilota sp.				X	X	
Phaeophyta						
Desmarestia aculeata				X		
Porifera						
Porifera indet.		X	X	X	X	
Calcaronea indet.					X	
Cnidaria						
Lafeiodae indet.						X
Hydrozoa indet.	X		X			X
Lucernaria quadricornis			X	X		
Ptychogastria polaris						X
Alcyoniidae indet.					X	X
Hormathia digitata						X
Hormathia nodosa					X	X

Taxa \ Station	636	637	661	675	704-2	734
Actiniidae indet.						X
Brachiopoda						
Hemithiris psittacea				X	X	
Bryozoa						
Cellepora sp.		X	X	X		
Flustridae indet.				X		
Myriapora coarctata	X	X				
Bryozoa indet.			X	X		X
Sipunculida						
Golfingiidae indet.			X		X	
Sipunculida indet.						X
Nemertea						
Nemertea indet.		X		X		X
Mollusca: Polyplacophora						
Tonicella rubra		X	X	X	X	X
Puncturella noachina		X				
Tectura sp.					X	
Polyplacophora indet.			X			
Mollusca: Gastropoda						
Margarites sp.				X	X	X
Margarites costalis				X		
Margarites striatus		X				
Lepeta caeca					X	X
Naticidae indet.					X	
Boreotrophon truncatus		X		X		
Trophon clathratus				X		
Trophon truncatus				X		
Buccinum hydrophanum						X
Buccinum sp.		X				
Dendronotus frondosus			X			
Cadlina laevis				X		
Mollusca: Bivalvia						
Musculus laevigatus					X	
Musculus sp.						X
Chlamys islandica	X	X	X	X		
Astarte crenata					X	
Tridonta montagui					X	
Macoma sp.						X
Hiatella arctica		X	X	X	X	X
Polychaeta						
Harmothoe nodosa				X		
Harmothoe imbricata	X	X	X			

Taxa \ Station	636	637	661	675	704-2	734
Nephtys sp.		X			X	X
Nereis sp.			X			
Nereis zonata				X	X	X
Onuphis conchylega	X	X				
Lysippe labiata						X
Brada sp.				X		
Flabelligera affinis				X	X	
Terebellides stroemi				X	X	
Thelepus cincinnatus		X		X	X	
Amphitrite cirrata			X			
Branchiomma infarctum						X
Chone sp.			X			
Sabellidae indet.					X	
Pantopoda						
Nymphon sp.				X	X	
Nymphonidae indet.			X			X
Phoxichilidium femuratum				X		
Pantopoda indet.			X			
Crustacea						
Balanus sp.	X	X	X	X	X	
Mysidae indet.						X
Mysis oculata	X					
Mysis sp.			X			
Ampelisca eschrichtii						X
Anonyx laticoxae		X			X	
Eusirus cuspidatus			X			
Lysianassidae indet.						X
Monoculodes borealis	X	X				
Paramphithoe hystrix						X
Pleustes panopla			X			
Rhachotropis sp.						X
Dulichia spinosissima			X			
Caprella sp.			X			
Lebbeus polaris	X	X	X	X	X	X
Spirontocaris phippsii		X				
Spirontocaris spinus	X	X	X	X	X	
Spirontocaris turgida				X	X	
Sabinea sarsii	X	X				
Sabinea septemcarinata		X				X
Sclerocrangon ferox		X	X	X	X	X
Hyas araneus			X	X	X	
Hyas coarctatus		X				
Pagurus pubescens	X	X	X	X	X	

Taxa \ Station	636	637	661	675	704-2	734
Echinodermata						
Heliometra glacialis						X
Pteraster militaris				X		
Henricia sanguinolenta				X	X	X
Crossaster papposus						X
Leptasterias sp.		X				
Ophiacantha bidentata	X			X	X	X
Amphiura sundevalli						X
Ophiopholis aculeata	X	X	X	X	X	X
Ophiocten sericeum					X	X
Ophiura robusta	X	X		X	X	X
Ophiura sarsi	X	X				X
Strongylocentrotus sp.		X	X	X	X	X
Strongylocentrotus pallidus	X					
Myriotrochus rinkii						X
Ascidiacea						
Boltenia echinata			X	X	X	
Styela rustica			X	X	X	
Pisces						
Eumicrotremus spinosus	X					
Liparis sp.		X		X		
Lumpenus lampretaeformis				X		
Entelurus aequoreus		X				
Zoarcidae indet.				X		X
Artediellus atlanticus				X	X	X
Myoxochephalus scorpius			X			
Cottidae indet.			X		X	X
Sum (111)	**18**	**34**	**35**	**46**	**41**	**45**

JAGO video footage

In a preliminary analysis undertaken on board, part of the video footage gained during JAGO dives (10 stations in total) was scanned for the composition of the epibenthic assemblages imaged along the dive transects.

In total, the number of megabenthic (putative) species, identified in the video footage, was 57 (Tab. 3.6). Echinoderms were most diverse (13), followed by Cnidaria (9), Mollusca (8), and Chordata (7). The numbers per station ranged from 2 at station 647 to 29 at station 684 (Tab. 3.6). It should again be noted that these numbers are conservative estimates of species richness, as it is certain that more species will be added in a more detailed 'visual transect census' carried out in the lab after the cruise.

Tab. 3.6: Preliminary list of (putative) species identified in video footage from JAGO dives.

Taxa \ Station	634	644	647	652	657	671	680	684	711	731
Rhodophyta										
Lithothamnion sp.		X			X	X	X	X	X	X
Ptilota sp.						X		X	X	
Porifera										
Porifera indet.	X	X		X		X	X	X		
Geodia sp.									X	
Cnidaria										
Lafeiodae indet.	X			X	X				X	X
Hydrozoa indet.						X			X	
Lucernaria quadricornis		X								
Pennatulacea indet.		X								
Alcyoniidae indet.		X							X	X
Gersemia rubiformes									X	
Gorgoniidae indet.									X	
Actinia indet.					X				X	
Actiniidae indet.	X									X
Hormathia nodosa	X			X		X			X	X
Ctenophora										
Ctenophora indet.		X				X				
Bryozoa										
Bryozoa indet.				X				X	X	
Cellepora sp.								X		
Flustra foliacea									X	
Flustridae indet.									X	
Myriapora coarctata								X		
Mollusca										
Tonicella rubra						X		X	X	
Puncturella noachina								X		
Velutina sp.								X		
Trophon truncatus									X	
Buccinidae indet.	X									
Chlamys islandica	X	X		X	X	X	X	X	X	
Hiatella arctica									X	
Octopodidae indet.	X									
Polychaeta										
Polydora sp.					X					
Sabellidae indet.	X			X	X					X
Serpulidae indet.						X	X			
Thelepus cincinnatus									X	
Crustacea										
Balanus sp.	X	X		X	X	X	X	X	X	

Taxa \ Station	634	644	647	652	657	671	680	684	711	731
Hyas sp.		X			X	X		X	X	
Hyas araneus				X						
Pagurus sp.		X		X	X	X		X	X	
Echinodermata										
Heliometra glacialis	X								X	X
Pteraster militaris						X				
Crossaster papposus	X			X	X	X		X		
Solaster endeca								X		
Solasteridae indet.		X							X	
Asteriidae indet.					X	X		X		X
Gorgonochephalus sp.	X								X	
Ophiopholis aculeate	X					X	X	X		X
Ophiocten sericeum			X							X
Ophiura sarsi		X								X
Ophiuridae indet.					X				X	
Strongylocentrotus sp.		X		X	X		X	X	X	X
Cucumariidae indet.									X	
Chordata: Ascidiacea										
Ascidiacea indet.						X	X	X	X	
Styela sp.					X	X				
Chordata: Pisces										
Gadus morhua	X									
Melanogrammus aeglefinus				X						
Uria lomvia			X							
Zoarcidae indet.					X					
Artediellus atlanticus									X	
Cottidae indet.	X	X			X	X				
Sum (57)	**14**	**14**	**2**	**12**	**16**	**18**	**8**	**20**	**29**	**13**

3.4.5 Geological sampling

(D. Hebbeln, B. Dorschel, M. Wisshak, S.-B. Löffler, M. Eisele, R. Schäfer, B. Meyer-Schack, J. Freiwald, T. Bergmann)

For combined biological and geological studies sediments from the Svalbard shelf were sampled with a Van Veen-type grab sampler, a boxcorer (GKG) and a gravity corer with tubes of 3 m (SL 3), 6 m (SL 6) and 9 m (SL 9) length. These gears have been used for retrieving surface sediments and longer sediment cores, respectively.

Van Veen-type grab sampler

For fast repetitive sampling to obtain replicates for statistical analyses of the benthic fauna a 60 cm wide and 30 cm high grab sampler has been used. On most stations at least 3 replicates have been retrieved.

Boxcorer

The main tool for the sampling of undisturbed surface sediments was the boxcorer (GKG) with a box size of 30 * 30 cm, 50 cm in height. During cruise MSM02/3 a total of 21 boxcorers has been taken. All of them were successful and most recovered an average of 30 cm of sediment. Problems occurred at some stations where the boxcorer grabbed larger pebbles that hampered the closure of the box resulting in the loss of most of the finer sediments.

Subsampling of the boxcorer

Upon recovery the living epi-benthic fauna has been collected from the sediment surface before the sediment has been sampled. The general sampling scheme comprised the following samples:

- 10 * 5 cm of the uppermost 1 cm of the sediment column for benthic foraminifera studies (stained with Bengal rose and stored at 4°C) (>MARUM group)
- 5 * 5 cm of the uppermost 1 cm of the sediment column for bulk sediment analyses (stored at 4°C) (>MARUM group)
- 5 * 5 cm of the uppermost 1 cm of the sediment column for grain size analyses (stored at 4°C) (>MARUM/Cork group)
- 5 * 5 cm of the uppermost 1 cm of the sediment column for bulk sediment analyses (stored at 4°C) (>IPAL group)
- sieving of clearly distinguishable layers through 5 mm and 0.5 mm sieves and drying of these fractions (>IPAL group)
- one archive core (stored at 4°C) (>IPAL group)

Gravity corer

In order to recover longer sediment cores, a gravity corer with tube lengths of alternatively 3 m (SL 3), 6 m (SL 6) or 9 m (SL 9) and a weight of 1.8 tons was used for 19 casts. Before using the coring tools, the plastic liners inside the steel tubes have been marked lengthwise with a straight line in order to retain the orientation of the core for subsequent palaeomagnetic analyses. Once on board, the sediment core was cut into 1 m sections, closed with caps on both ends and labelled according to a standard scheme.

From the 19 gravity corers only 3 brought no sediments to the surface and only 3 tubes were bent, so-called bananas. The recovery of the other cores varied between 60 cm and 793 cm (Tab. 3.7). At some stations, coring suffered from overpenetration of the gravity corer due to the extreme softness of the sediments at these sites. Putting all cores together a total length of ~78 m has been recovered during cruise MSM02/3.

Tab. 3.7: Gravity corer sampling during MSM02/03.

Station	Gear	Lat. °N	Long. °E	Depth [m]	Recovery [cm]	Site	Remarks
623-3	SL 3	77°58,36´N	12°59,47´E	146	-/-	Sentinelleflaket	empty core
635-2	SL 6	79°03.20´N	10°54.00´E	349	586	Mitragrunnen / Kongsfjorden Deep	overpenetration
645-1	SL 9	79°03.21´N	10°54.01´E	348	752	same site as 635-2	
646-2	SL 6	79°09.30´N	11°43.60´E	352	559	Krossfjorden	overpenetration
648-2	SL 6	79°17.48´N	11°37.62´E	217	562	Lilliehöökfjorden	overpenetration
649-2	SL 6	79°13.20´N	11°43.20´E	272	562	Lilliehöökfjorden	overpenetration
666-4	SL 9	79°48.00´N	14°12.00´E	171	275	Woodfjorden	
673-2	SL 6	79°46.82´N	15°21.48´E	152	304	Wijdefjorden	
687-2	SL 6	80°03.04´N	15°47.55´E	228	-/-	N of Mosselbukta	core bended
696-2	SL 6	79°58.02´N	17°44.56´E	384	551	Hinlopenstretet off Sorgfjorden	overpenetration
696-7	SL 9	79°58.02´N	17°44.54´E	384	696	same site as 696-2	
698-2	SL 9	80°19.13´N	16°11.02´E	352	793	outer Hinlopenstretet	
717-2	SL 6	80°31.32´N	22°13.04´E	212	224	Nordenskjöldbukta	
720-3	SL 9	80°18.91´N	23°26.03´E	326	437	inner Duvefjorden	
726-2	SL 9	80°34.57´N	23°25.96´E	284	263	outer Duvefjorden	
728-2	SL 6	80°47.97´N	19°15.26´E	157	-/-	Sjuøyane	core bended
737-2	SL 9	79°41.01´N	18°18.07´E	418	567	Hinlopenstretet off Lomfjorden	
739-3	SL 9	79°42.62´N	20°25.49´E	217	575	Wahlbergfjorden	
746-3	SL 9	78°59.20´N	24°35.83´E	208	60	Eriksenstretet	core bended

Subsampling of the gravity cores

All cores recovered around Svalbard were cut into one-meter sections, which were opened lengthwise in an archive and work half. The archive half was used for core description, core photography, and colour scanning (see below). The work half was sampled with two series of syringes (10 ml) for geochemical and faunal studies, both at 5 cm intervals. All sample material of the sediment cores retrieved during cruise MSM02/3 will be transported to Bremen and stored in the MARUM core repository at the University of Bremen.

Preliminary results

Geology

The objective of the geological sampling programme, especially of obtaining long sediment cores, was to analyse temporal variations in the sediment accumulation around northern Svalbard. In the investigated near coastal settings sediment accumulation is assumed to be directly controlled by onshore erosion, which in this region basically is due to glacier activity.

Glacier activity in Svalbard is closely tight to precipitation and air temperature and, thus, palaeorecords of sediment accumulation at strategically selected sites around northern Svalbard bear the potential to reconstruct glacier activity (as a palaeoclimate proxy) way beyond the time of human observations. Furthermore, by comparing sites from Svalbard's west coast all along the way to northern Nordaustlandet can provide information about regional variability in climate forcing across the archipelago. After a first inspection of the cores it is assumed that the cover up to several millennia.

Shipboard results

Cores were examined on four so-called transects around Svalbard. For each of these transects a short characterisation of the types of sediments found in the gravity cores is summarised below. More details are shown in the individual core descriptions.

The Lilliehöökfjord – Krossfjord – Kongsfjord Transect

Five gravity cores were retrieved from four sites along this transect: one very proximal to the large Lilliehööks glacier in the inner Lilliehöökfjord (648-2), one more distal to the glacier in the outer Lilliehöökfjord (649-2), one from the central Krossfjord (646-2) and two from the same site in the Kongsfjord Deep (635-2 and 645-1). Typical to all these sites was a very soft sediment that caused overpenetration of the gravity corer, even when it was lowered with extreme low speeds of 0.3 m/s. Only the long core from the Kongsfjord Deep (645-1) contains an undisturbed record including the sediment surface. In general, the sediments in all these cores consisted of olive-gray to gray sandy clayey silts to silty clays. In most cases the sediments showed varying amounts of black mottles and flames and sections with higher amounts of these were marked by H_2S smell when they were opened. Especially in the Lilliehöökfjord mud as well as sand turbidites were common. A comparison of the colour data from the two cores from the Kongsfjord Deep allowed a detailed correlation of the cores, indicating also the part lost in core 635-2 due to overpenetration (Fig. 3.9).

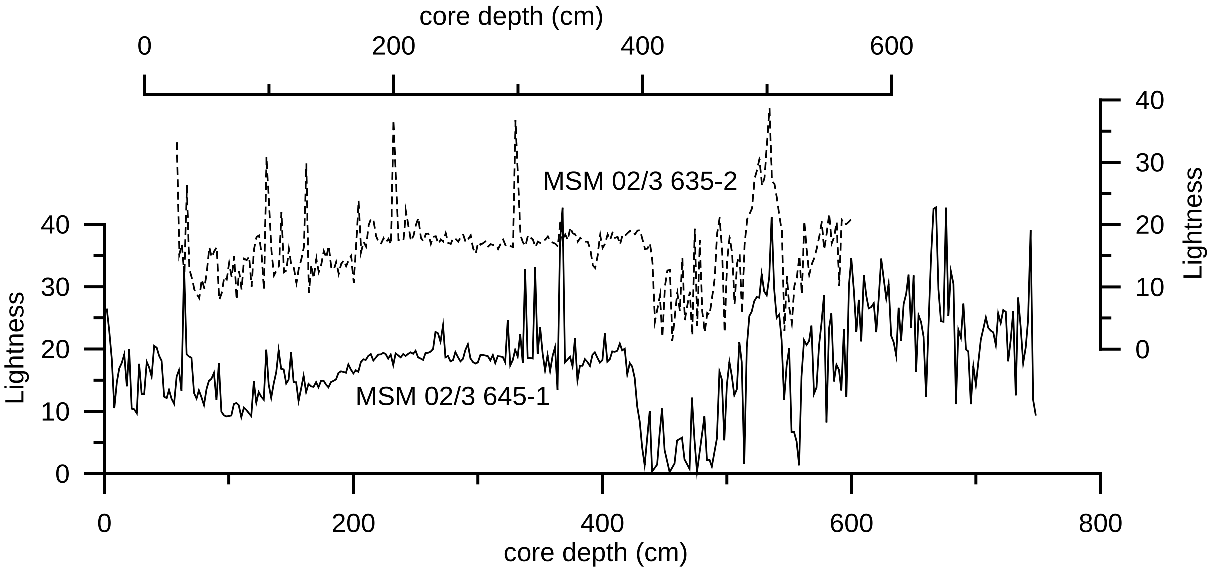

Fig. 3.9: Comparison of the lightness data of the two cores MSM02/3 635-2 and MSM02/3 645-1, taken from the same site in the Kongsfjord Deep, eastern Svalbard

The Woodfjord – Wijdefjord transect

The gravity corer was deployed at three sites along this transect. However, at site 687-2 in the outer Wijdefjord the core was bended due to too much ice-rafted gravel in the sediments. This core yielded no core recovery. The other two cores taken at from the mouth of the Woodfjord (666-4) and at the mouth of the inner Wijdefjord (673-2) resulted in ~3 m recovery each. In accordance with the outcropping Devonian “Old Red” rocks onshore, the mainly silty clays in these two cores revealed brownish to even reddish sediments. Interestingly, there were no larger dropstones found along the cut surface of the opened cores. The much lower water content compared to the cores from the Lilliehöökfjord point to slower sediment accumulation in these two fjords.

The Nordaustlandet transect

This transect was sampled at four stations, however, the northwestern most station close to the Seven islands (Sjuøyane) was not successful with a bended core without any recovery. The sites further to the east in the Nordenskjöldbukta (717-2) and in the inner (720-3) and outer (726-2) Duvefjord yielded core recoveries ranging between 224 cm and 437 cm. The two cores from the outer Duvefjord and from the Nordenskjöldbukta are very similar in having a top meter of olive gray silty clays underlain by gray silty clay. The 437 cm long inner Duvefjord core is marked by continuous silty clay deposition in its upper 2.5 m. However, below that level frequent thin fine sand layers point to turbidite activity in the inner shelf trough. Thus, at some point back in time there was a considerable change in the sedimentation processes at this site probably linked to changes in onshore glacier activity.

The Hinlopenstretet transect

From the northern Hinlopenstretet to the Wahlbergfjord, a tributary to the Hinlopenstretet, a total of four sites have been sampled, with one site (696) being sampled twice as the first six-meter gravity corer (696-2) suffered from full overpenetration. The second cast with a nine-meter tube (696-7) provided a full, very good record. In both of these two cores an approximately 50 cm section of distinctly laminated sediments of a reddish colour (Fig. 3.10) have been penetrated. The cause for the deposition of such laminated sediments at this site was discussed onboard with options ranging from a former ice-dammed lake in this region to a short-term depositional event. However, only detailed analyses in the home laboratory can provide an answer on this. Interestingly, the core from the Wahlbergfjord (739-2) has in its lowermost part pale brown to reddish sediments very similar to those just above the laminated sections in the other two cores. At all these sites the uppermost layers consist of olive gray to brownish gray silty clays as they are also found in the entire core taken off the Lomfjord in the central Hinlopenstretet. Thus, also at this site a similar laminated section may occur further down in the sediment column. The longest core (698-2) with 793 cm obtained during the entire cruise has been retrieved on this transect. Also at this quite northern position some of the sediments show the typical brownish-reddish colours found in most of the Hinlopenstretet cores and in the Woodfjord/Wijdefjord cores.

Fig. 3.10: Laminated sediments in core 696-7

In general, the sediment cores obtained during this cruise provide an excellent base for the envisaged study of the sediment accumulation around northern Svalbard. In addition to the main objective outlined above that can be worked on with these cores, one of the most thrilling observations are the laminated sediments from the Hinlopenstretet that will be investigated in detail in the MARUM laboratories in Bremen. The gravity-core logs and the box-corer-logs are available upon request from the senior author of this section.

3.4.6 Research Submersible “JAGO”

(J. Schauer, K. Hissmann, S. Fricke)

The major working tool during MSM02/3 for in situ documentation and sampling on the shelves around Spitsbergen was the manned submersible "JAGO". JAGO is certified to a maximum operating depth of 400 m and can accommodate two persons, the pilot and a scientist/observer, at atmospheric pressure (Table 3.8). The autonomous underwater craft is devoted primarily to research in the marine sciences and is used by scientists for a personal view on the sea floor.

JAGO has two large acrylic dome ports that allow excellent visibility on the seabed. The craft is electrically driven and able to move underwater autonomously within the reach of the navigation and communication systems stationed on the surface vessel. The vehicle is equipped with fluxgate compass, USBL navigation and tracking system, underwater telephone, sonar, video and still cameras, oceanographic sensors and 8 function manipulator arm for handling various sampling devices to accomplish almost any underwater work from within the sub. Typical applications are benthic and/or mid-water observations and surveys, video/photo documentation, underwater sampling, environmental studies, search and location of objects, salvage work and support in emergency cases. Because of its compact construction and small weight of 3 tons JAGO can be launched and recovered from nearly any larger boat and vessel with sufficient crane capacity. Over sea transportation is made with a shippers own 20’ standard sea freight container. The craft was built in 1989 in South Germany and is stationed since January 2006 at the Leibniz-Institute of Marine Sciences IFM-Geomar in Kiel. JAGO has made more than 900 dives throughout the World’s Oceans and in deep lakes. It carried some hundred different observers to the sea floor, mainly scientists of various disciplines in the field of marine biology, microbiology, geology, palaeontology, sedimentology, biogeochemistry, oceanography and environmental conservation, film teams, photographers and marine engineers.

Tab. 3.8: General specifications of research submersible JAGO.

Dimensions	Length... 3.2 m, Beam ... 2.0 m, Height ... 2.5 m
Weight in air	3000 kg
Operation depth	400 m
Cruising speed	1 knot
Crew	1 pilot, 1 observer
Life Support	96 man hours
Pressure hull	steel, 15 – 18 mm
Viewports	bow-window (ø 700 mm), top dome / hatch (ø 450 mm) providing 360-degree view, both acrylic
Power supply	lead acid batteries, total capacity 540 AH – 24 Volt DC
Propulsion	4 reversible horizontal thrusters at stern, 2 rotational thrusters on starboard and port side, 1 bow and 1 aft thruster
General systems	720 l floatation tanks for buoyancy at surface 40 l trim tank for buoyancy control underwater 2 oxygen high pressure cylinders 3 pressure air cylinders Filters for air regeneration (carbon dioxide absorbent)
Rescue systems	Emergency drop weight Dead Man Safety-System Generation of >500 kg positive buoyancy Emergency buoy with rescue device
Equipment	Underwater tracking system, fluxgate compass, depth gauges, vertical and horizontal scanning sonar, underwater acoustic telephone communication, digital video- and still cameras, hydraulic manipulator arm with 8 functions and exchangeable claws, CTD, sampling devices for organisms, gas, water, fluids, sediments, rocks
Certified by	Germanischer Lloyd Hamburg
Built	1989, Germany

The most important requirements for a suitable mothership for JAGO are a deck crane with a lifting capacity of min. 5 tons at an outreach of at least 3 metres from the ship’s side, and sufficient deck space for save handling during deployment and recovery. Deployment over the ship’s side is preferred. The crane does not need to be modified or specially adjusted for handling the craft. The submersible and support equipment is brought on board in a 6 m standard sea freight container that is then used at sea for storage of the support equipment.

JAGO is regularly operated from board of German research vessels. The recently commissioned MERIAN carried JAGO for the first time. She proved to be a very suitable mothership for the submersible operation. The main deck crane on the starboard aft deck (knuckle-boom crane #3, SWL 5 tons) was used for deployment and recovery of the sub, and, alternatively, when crane #3 was out of order for short periods, crane #1, the same type of crane at midships. Both cranes have a working radius of 12 metres. The outer boom can be lowered close to the water surface what reduces uncontrolled swinging movements of load that is attached to the crane hook. Both cranes are operated by remote control while standing on deck. The bosun during MSM02/3, Norbert Bosselmann, knew JAGO from previous research cruises, was familiar with the handling procedure and therefore assured safe launching and recovery. The swimmer, who is standing on top of JAGO during out- and inboarding and who disconnects and connects the crane hook and ropes on JAGO, was wearing a dry suit for protection against low water temperatures (4-6 degrees during MSM02/3). Two different boats were used for towing JAGO away from the ships side after deployment and back under crane position for recovery: a 3 m DSB inflatable equipped with a 40 HP outboard engine and the 7 m fast-rescue boat with jet propulsion.

Some components of the communication and underwater USBL tracking and positioning systems for the submersible were installed inside the ship's starboard moonpool. A transceiver and a hydrophone were mounted on a pole of 170 cm length. The pole was then attached underneath the lower platform of the cage inside the moonpool. Although both hydrophones were located about 1 m below the ship's hull when lowered completely inside the moonpool, acoustics and signal detection were strongly affected by the noises and water turbulences produced by the pods and in particular by the pump-jet when in action. The pump-jet of the ship is located only a few metres ahead of the moonpool. Some problems also occurred with adjusting the fluxgate compass - another component of the underwater positioning system for the sub. The compass was mounted on the upper cabin deck as far as possible away from any steel structure. It provided data with unusual distortions in certain directions, indicating that the electromagnetic field on board of the MERIAN must be generally very strong. Tracking of the submersible while submerged was also affected at some dive sites by a distinctive thermocline in around 50 m water depth.

Part of the ship's equipment is a USBL tracking and positioning system from IXSEA, the POSIDONIA 6000 with two different transponders that can be mounted on targets like a ROV, bottom lander or a submersible. The intension was to test the system on JAGO during MSM02/3. Unfortunately communication between the surface unit, the antenna (hydrophones) and the transponder could not be established. During the final trial the surface unit had a short circuit that caused serious damages on one of the circuit boards, the entire system was out of function and had to be replaced by a new unit after the cruise.

During MSM02/3 JAGO was used for ground truthing of the multibeam charts, which were produced during the cruise, for visual and video documentation of the shallow-water slopes, for water sampling close above the sea bed and for selective sampling of rhodoliths and their associated fauna with minimum impact on the surrounding. Nineteen dives were performed on 13 of the 18 cruise days in water depths between 10 and 250 metres (Table 3.9). In total, 37 hours were spent underwater. Ten different scientists and two crewmembers (Captain and Chief Mate) had the chance for a personal view on the sea floor. About 20 hours of underwater video images and dive tracks (Lat./Long. positions) are available. Table 3.10 provides an overview of all benthos and water samples collected with JAGO.

Tab. 3.9: JAGO dives on MSM02/3.

JAGO Dive #	Project Dive, Stat #	Location	Time subm.	Time surf.	Total dive time (min)	Touch down position	Lift off position	Min-Max Depth (m)	Video tapes #
930	1 / 634	Mitragrunnen	10:19	12:49	150	N 79.04.54 E 10.46.94	N 79.04.99 E 10.47.65	140-250	1
931	2 / 644	Mitragrunnen	8:43	11:29	147	N 79.05.76 E 10.46.29	N 79.05.95 E 10.45.611	41-60	2
932	3 / 647	Lilliehöökfjorden	21:09	22:06	57	- -	- -	30-39	3
933	4 / 652	Kapp Mitra	9:02	11:29	147	N 79.03.53 E 11.13.75	N 79.04.35 E 11.14.43	47-108	4
934	5 / 657	Moffen	8:49	12:31	222	N 79.59.09 E 14.10.96	N 79.53.69 E 14.13.40	43-75	5, 6, 7
935	6 / 671	Mosselbukta	13:40	16:09	149	N 79.54.62 E 15.48.67	N 79.54.51 E 15.50.23	27-43	8, 9
936	7 / 680	Mosselbukta	10:07	10:53	46	N 79.53.86 E 15.42.86	N 79.53.84 E 15.41.68	127	9
937	8 / 681	Mosselbukta	12:58	13:36	38	N 79.54.47 E 15.47.71	N 79.54.35 E 15.47.85	46	HD
938	9 / 682	Mosselbukta	14:36	15:05	29	N 79.54.54 E 15.54.73	N 79.54.43 E 15.54.90	10	HD
939	10 / 684	Mosselbukta	18:47	21:24	157	N 79.53.68 E 15.44.57	- -	44-78	10, 11
940	11 / 692	Sorgfjorden	13:52	16:24	152	N 79.55.09 E 16.42.79	N 79.55.07 E 16.42.54	77-98	-
941	12 / 701	Kapp Rubin	14:15	17:24	189	N 80.32.01 E 19.50.77	N 80.31.95 E 19.51.30	30-78	12
942	13 / 703	Kapp Rubin	17:59	18:43	44	N 80.31.77 E 19.48.70	- -	80-110	12
943	14 / 711	Kapp Rubin	10:57	13:54	177	N 80.31.76 E 19.40.04	N 80.31.86 E 19.41.47	30-70	13
944	15 / 714	Kapp Rubin	20:15	20:56	41	- -	- -	15-27	-
945	16 / 731	Lomfjorden	8:58	11:34	156	N 79.35.02 E 17.52.29	N 79.34.89 E 17.50.96	38-75	14+15
946	17 / 741	Hinlopenstretet	9:06	9:40	34	N 79.36.03 E 18.52.23	N 79.35.85 E 18.51.34	28-36	15
947	18 / 753	Hornsund	17:01	19:58	177	N 76.57.14 E 15.44.30	N 76.57.20 E 15.45.21	35-88	15+16
948	19 / 757	Isfjorden	12:34	14:34	120	N 78.18.68 E 14.31.97	N 78.18.74 E 14.31.22	40-60	16+17

Tab. 3.10: Overview of JAGO samples

Station #	Jago Dive #	Site	Date	Samples	Depth [m]
634	930	Mitragrunnen	02.08.2006	Egg cases	192
				Bivalves	192
				Barnacles	192
644	931	Mitragrunnen	03.08.2006	Hydrozoan	43
				Rhodoliths	42
				Actinians	42
				Rhodoliths	41
				Bottom Water	41
652	933	Kapp Mitra	04.08.2006	Rhodoliths	47
				Bottom Water	47
657	934	Moffen	05.08.2006	Bivalves	43
				Bottom Water	43
671	935	Mosselbukta	06.08.2006	Rhodoliths	42
				Rhodoliths	27
				Bottom Water	27
				Rhodoliths	25
680	936	Mosselbukta	07.08.2006	Ascidians	127
681	937	Mosselbukta	07.08.2006	Rhodoliths	46
				Bottom Water	46
682	938	Mosselbukta	07.08.2006	Algal crusts	11
684	939	Mosselbukta	07.08.2006	Rhodoliths	44
				Bottom Water	44
701	941	Kapp Rubin	09.08.2006	Algal crusts	42
				Algal crusts	35
				Rhodoliths	34
				Bottom Water	50
703	942	Kapp Rubin	09.08.2006	Bottom Water	50
				Rhodoliths	35
711	943	Kapp Rubin	10.08.2006	Rhodoliths	45
				Rhodoliths	44
731	945	Lomfjord	13.08.2006	Algal crusts	45
				Bottom Water	50
753	947	Hornsund	16.08.2006	Bryozoans	42
				Sponges	42
				Bivalves	42
				Sponges	43
				Bivalves	43
				Bottom Water	47
				Bryozoans	52
				Barnacles	52
757	948	Isfjorden	17.08.2006	Rhodoliths	45

3.4.7 Polar History – Landings at historical sites on Svalbard 2006

(C. Lüdecke)

Thursday, 3 August 2006

Landing at Ebeltofthamna (Mitrahalføya), where the German Geophysical Observatory investigated the upper air by aerological ascents in 1912 to 1914, Kurt Wegener (Alfred Wegener`s brother) had been station leader from 1912 to 1913. When he got notice by radio communication that the Schröder-Stranz expedition had an accident, he started the first rescue expedition, which was not very successful.

We have visited the place at Ebeltofthamna, where the German Geophysical Observatory had been close to the old graves, before the house had been transferred to Ny Ålesund during World War I. We found some remains of a wooden roof and three heaps of garbage with rusty tins and fragments of glass, among which, a brown bottle of Maggi seasoning sauce could be identified.

Sunday, 6 August 2006

Landing at Mosselbukta – Investigation of the remains of „Polhem“, the accommodation house of A.E. Nordenskiöld‘s overwintering (1872-1873). Two of the surviving members of the Schröder-Stranz Expedition, Rüdiger und Rave, stayed there during the winter 1912/1913. We measured the base area of the hut of 11.30 m x 15 m and the side walls around.

Tuesday, 8 August 2006

Multi-beam survey in Sorgfjorden (Teurenburg) in order to find a suitable target for the planned dive of JAGO. Landing at the NW entrance of Sorgfjorden (Eolusflaffhaugen), where we visited and video-documented the graveyard of 30 sealers and whalers of the 17th century at Eoluskrossen. In the 17th century, Sorgfjorden (Teurenburg) had been the scene of a sea battle between French war ships and whalers. The ship of the Schröder-Stranz expedition, „Herzog Ernst“, had anchored here during a storm at the end of 1912. The ship was captured by sea-ice and had to stay the winter in place. Later, the ship came free and sailed back to Tromsø.

A parallel dive with JAGO did not find any evidence of the sunken whaling fleet of the 17th century.

Wednesday / Thursday 9 / 10 August 2006

Multi-beam survey of the northern entrance of Beverly Sund searching for the sunken ship „Loevenskjöld“ of the private German rescue expedition of Theodor Lerner. He had been the first to help the lost Schröder-Stranz expedition. His ship „Loevenskjöld“ has been beset by pack ice and finally sunk. Unfortunately, no target worth a JAGO dive could be identified.

Friday 11 August 2006

Landing at Dokken / Dovefjorden for investigation of the last known camp of Schröder-Stranz. Before the excavation with the authorization of the Sysselman, a photo and video-documentation of the site was carried out. The locations of last year’s findings were marked. Then the site was systematically investigated with a metal-detector. Finally the excavation started. Unfortunately, we did not find any box or bottle with a note. We only found a piece of canvas, three little leather straps, a bullet (not fired), five little screws, a rusty piece of metal (from an opened fish tin?). We also had a look at the little cave above the camp site, but could not find anything.

The investigations had to be interrupted, when a polar bear became interested in our work and kept approaching us until four shots from a blank gun chased him away.

3.5 Station list

Tab. 3.11: List of stations of R/V MARIA S. MERIAN Cruise MSM02/3

Station list Maria S. MERIAN No. 2 Leg 3

Station No.	Gear	No.	Location	Date	Start	Coordinates			at bottom	Coordinates			end stat.	Coordinates		
					Time (UTC)	Lat. °N	Long. °E	Depth (m)	Time (UTC)	Lat. °N	Long. °E	Depth (m)	Time (UTC)	Lat. °N	Long. °E	Depth (m)
616	CTD	1	Isfjorden	31.07.2006	10:18	78° 09,29'	13° 50,05'	424	10:48	78° 09,29'	13° 50,05'	417	10:55	78° 09,29'	13° 50,05'	424
617	CTD	2	Isfjorden	31.07.2006	12:58	78° 06,32'	12° 42,30'	253	13:19	78° 06,32'	12° 42,30'	245	13:30	78° 06,32'	12° 42,30'	253
618	CTD	3	Isfjorden	31.07.2006	16:24	78° 07,51'	11° 33,17'	261	16:40	78° 07,51'	11° 33,17'	249	16:57	78° 07,51'	11° 33,17'	261
619	CTD	4	Isfjorden	31.07.2006	20:03	78° 13,99'	10° 30,04'	288	20:20	78° 13,99'	10° 30,04'	282	20:31	78° 13,99'	10° 30,04'	288
620	CTD	5	Isfjorden	31.07.2006	22:05	78° 13,99'	09° 21,02'	476	22:25	78° 14,04'	09° 21,02'	465	22:39	78° 14,05'	09° 21,58'	461
621	CTD	6	Isfjorden	31.07.2006	23:21	78° 14,03'	09° 05,47'	968	0:02	78° 14,25'	09° 06,01'	944	0:30	78° 14,33'	09° 06,95'	928
622-1	MB	1	Sentinelleflaket	01.08.2006	4:43	77° 58,62'	12° 59,30'	150					5:47	77° 52,68'	12° 42,59'	40
622-2	MB	1	Sentinelleflaket	01.08.2006	5:57	77° 52,70'	12° 42,80'	40					6:55	77° 58,62'	13° 00,82'	149
623-1	GKG	1	Sentinelleflaket	01.08.2006	7:22	77° 58,36'	12° 59,48'	146	7:28	77° 58,36'	12° 59,48'	146	7:32	77° 58,36'	12° 59,48'	146
623-2	GKG	2	Sentinelleflaket	01.08.2006	7:33	77° 58,36'	12° 59,48'	146	7:36	77° 58,36'	12° 59,48'	146	7:54	77° 58,36'	12° 59,48'	146
623-3	SL	1	Sentinelleflaket	01.08.2006	8:17	77° 58,36'	12° 59,47'	146	8:20	77° 58,36'	12° 59,47'	146	8:36	77° 58,36'	12° 59,47'	146
624	BG	1	Sentinelleflaket	01.08.2006	9:12	77° 57,43'	12° 56,55'	131	9:21	77° 57,43'	12° 56,55'	130	9:27	77° 57,43'	12° 56,56'	131
625	BG	2	Sentinelleflaket	01.08.2006	10:01	77° 56,95'	12° 55,64'	124	10:07	77° 56,95'	12° 55,64'	124	10:13	77° 56,95'	12° 55,64'	124
626-1	BG	3	Sentinelleflaket	01.08.2006	10:36	77° 56,35'	12° 53,78'	37	10:40	77° 56,35'	12° 53,77'	37	10:44	77° 56,35'	12° 53,77'	37
626-2	BG	4	Sentinelleflaket	01.08.2006	10:45	77° 56,35'	12° 53,77'	37	10:47	77° 56,35'	12° 53,77'	37	10:51	77° 56,35'	12° 53,77'	37
627-1	BG	5	Sentinelleflaket	01.08.2006	11:13	77° 55,72'	12° 51,78'	33	11:16	77° 55,72'	12° 51,77'	33	11:19	77° 55,72'	12° 51,77'	33
627-2	BG	6	Sentinelleflaket	01.08.2006	11:22	77° 55,72'	12° 51,77'	33	11:26	77° 55,72'	12° 51,77'	33	11:28	77° 55,72'	12° 51,77'	33
627-3	BG	7	Sentinelleflaket	01.08.2006	11:29	77° 55,72'	12° 51,77'	33	11:31	77° 55,72'	12° 51,77'	33	11:34	77° 55,72'	12° 51,77'	33
627-4	BG	8	Sentinelleflaket	01.08.2006	11:35	77° 55,72'	12° 51,77'	33	11:37	77° 55,72'	12° 51,77'	33	11:40	77° 55,71'	12° 51,77'	33
628	BG	9	Sentinelleflaket	01.08.2006	12:05	77° 54,93'	12° 49,49'	31	12:07	77° 54,93'	12° 49,49'	31	12:09	77° 54,93'	12° 49,49'	31
629	BG	10	Sentinelleflaket	01.08.2006	12:39	77° 53,37'	12° 45,22'	38	12:42	77° 53,37'	12° 45,23'	38	12:45	77° 53,37'	12° 45,22'	38
630	LS	1	Sentinelleflaket	01.08.2006	15:05	77° 53,06'	12° 47,56'	36					15:32	77° 53,19'	12° 46,96'	34
631	ROV	1	Sentinelleflaket	01.08.2006	16:07	77° 53,37'	12° 45,22'	39					16:15	77° 53,37'	12° 45,22'	39
632	CTD	7	Mitragrunnen	01.08.2006	23:36	79° 02,37'	10° 46,99'	340	23:59	79° 02,37'	10° 46,99'	332	0:09	79° 02,37'	10° 46,99'	340
633-1	MB	2	Mitragrunnen / Outa Kongsfjorden	02.08.2006	0:45	79° 02,65'	10° 45,57'	341					1:11	79° 05,80'	10° 43,26'	42
633-2	MB	2	Mitragrunnen / Outa Kongsfjorden	02.08.2006	1:17	79° 05,77'	10° 44,31'	49					1:46	79° 02,70'	10° 50,48'	332
633-3	MB	2	Mitragrunnen	02.08.2006	2:01	79° 02,96'	10° 54,97'	350					2:30	79° 05,79'	10° 44,91'	46
633-4	MB	2	Mitragrunnen	02.08.2006	2:35	79° 05,79'	10° 45,88'	53					3:06	79° 03,42'	10° 59,14'	308
633-5	MB	2	Mitragrunnen	02.08.2006	3:18	79° 04,22'	11° 01,06'	184					3:46	79° 05,86'	10° 46,47'	46
633-6	MB	2	Mitragrunnen	02.08.2006	3:52	79° 05,91'	10° 47,86'	53					4:17	79° 04,81'	11° 03,29'	110
633-7	MB	2	Mitragrunnen	02.08.2006	4:26	79° 05,30'	11° 04,03'	94					4:54	79° 06,03'	10° 48,37'	43
633-8	MB	2	Mitragrunnen	02.08.2006	5:01	79° 06,16'	10° 50,65'	n.d.					5:21	79° 05,69'	11° 03,93'	93
633-9	MB	2	Mitragrunnen	02.08.2006	5:28	79° 06,08'	11° 03,37'	115					6:05	79° 06,42'	10° 42,34'	36
633-10	MB	2	Mitragrunnen	02.08.2006	6:05	79° 06,42'	10° 42,34'	36					6:38	79° 06,37'	11° 03,68'	130
634	JAGO	1	Mitragrunnen	02.08.2006	08:19	79° 04,50'	10° 47,20'	261	8:38	79° 04,54'	10° 46,94'	250	10:49	79° 04,99'	10° 47,65'	140
635-1	GKG	3	Mitragrunnen	02.08.2006	12:20	79° 03,20'	10° 54,00'	347	12:28	79° 03,20'	10° 54,00'	348	12:41	79° 03,21'	10° 54,00'	348
635-2	SL	2	Mitragrunnen	02.08.2006	13:06	79° 03,20'	10° 54,00'	349	13:12	79° 03,20'	10° 54,00'	349	13.30	79° 03,20'	10° 54,00'	350
636	DRG	1	Mitragrunnen	02.08.2006	14:17	79° 05,37'	10° 47,22'	99	14:22	79° 05,37'	10° 47,22'	99	15:05	79° 05,69'	10° 49,44'	100
637	DRG	2	Mitragrunnen	02.08.2006	15:34	79° 05,94'	10° 48,21'	51	15:40	79° 05,91'	10° 47,64'	49	16:11	79° 05,84'	10° 46,36'	49
638-1	MB	3	Mitragrunnen	02.08.2006	17:27	79° 04,66'	10° 43,61'	213					19:53	79° 05,92'	10° 52,50'	136
638-2	MB	3	Mitragrunnen	02.08.2006	20:28	79° 05,11'	10° 56,19'	127					21:35	79° 04,23'	11° 25,67'	
639	MB	4	Kongsfjorden / Krossfjorden	02.08.2006	21:35	79° 04,23'	11° 25,67'						8:00	79° 05,69'	10° 46,84'	70
640	CTD	8	Krossfjorden / Lilliehöökfjorden	02.08.2006	23:56	79° 18,32'	11° 36,69'	132	0:13	79° 18,32'	11° 36,69'	132	0:21	79° 18,32'	11° 36,69'	132
641	CTD	9	Krossfjorden / Lilliehöökfjorden	03.08.2006	1:32	79° 12,99'	11° 44,48'	243	1:37	79° 12,99'	11° 44,48'	232	1:46	79° 12,99'	11° 44,48'	243
642	CTD	10	Krossfjorden / Lilliehöökfjorden	03.08.2006	2:36	79° 09,10'	11° 46,73'	350	2:56	79° 09,10'	11° 46,73'	341	3:10	79° 09,10'	11° 46,73'	350
643	CTD	11	Krossfjorden / Lilliehöökfjorden	03.08.2006	4:05	79° 05,55'	11° 34,30'	283	4:23	79° 05,55'	11° 34,30'	279	4:33	79° 05,54'	11° 34,30'	284
644	JAGO	2	Mitragrunnen	03.08.2006	6:39	79° 05,70'	10° 46,74'	71	06:43	79° 05,76'	10° 46,29'	60	09:29	79° 05,95'	10° 45,61'	41
645-1	SL	3	Mitragrunnen	03.08.2006	10:53	79° 03,21'	10° 54,01'	348	11:00	79° 03,21'	10° 54,01'	348	11:14	79° 03,21'	10° 54,01'	348

Station list Maria S. MERIAN No. 2 Leg 3

Station No.	Gear	No.	Location	Date	Start	Coordinates			at bottom	Coordinates			end stat.	Coordinates		
					Time (UTC)	Lat. °N	Long. °E	Depth (m)	Time (UTC)	Lat. °N	Long. °E	Depth (m)	Time (UTC)	Lat. °N	Long. °E	Depth (m)
646-1	GKG	4	Krossfjorden	03.08.2006	14:24	79° 09,30'	11° 43,60'	352	14:32	79° 09,30'	11° 43,60'	352	14:44	79° 09,30'	11° 43,60'	352
646-2	SL	4	Krossfjorden	03.08.2006	15:09	79° 09,30'	11° 43,60'	352	15:16	79° 09,30'	11° 43,60'	352	15:28	79° 09,30'	11° 43,60'	352
647	JAGO	3	Lilliehöökfjorden - glacier slope	03.08.2006	18:14	79° 19,37'	11° 37,49'		19:09	79° 19,37'	11° 37,49'	39	20:06	79° 19,36'	11° 37,03'	
648-1	GKG	5	Lilliehöökfjorden	03.08.2006	22:10	79° 17,48'	11° 37,62'	217	22:16	79° 17,48'	11° 37,62'	217	22:25	79° 17,48'	11° 37,61'	217
648-2	SL	5	Lilliehöökfjorden	03.08.2006	22:42	79° 17,48'	11° 37,62'	217	22:52	79° 17,48'	11° 37,62'	217	23:10	79° 17,48'	11° 37,62'	217
649-1	GKG	6	Lilliehöökfjorden	04.08.2006	0:06	79° 13,20'	11° 43,20'	272	0:12	79° 13,20'	11° 43,20'	272	0:22	79° 13,20'	11° 43,20'	272
649-2	SL	6	Lilliehöökfjorden	04.08.2006	0:35	79° 13,20'	11° 43,20'	272	0:44	79° 13,20'	11° 43,20'	272	0:58	79° 13,20'	11° 43,20'	272
650	ROV	2	Lilliehöökfjorden	04.08.2006	1:14	79° 13,20'	11° 43,20'	272					1:32	79° 13,20'	11° 43,20'	272
651	MB	5	Mitragrunnen	04.08.2006	1:46	79° 12,87'	11° 44.37'	234					5:40	79° 03,64'	11° 14,86'	106
652	JAGO	4	Krossfjorden - entrance, Kapp Mitr	04.08.2006	6:56	79° 03,52'	11° 14,05'	99	07:02	79° 03,71'	11° 13,75'	92	09:29	79° 04,35'	11° 14,43'	47
653	FS	1	Mitragrunnen	04.08.2006	11:35	79° 05,94'	10° 45,63'	40	11:40	79° 05,94'	10° 45,63'	41	12:30	79° 05,70'	10° 46,85'	72
654	LS	2	Mitragrunnen	04.08.2006	12:56	79° 05,45'	10° 48,20'	95								
655	CTD	12	Moffen	04.08.2006	20:21	79° 59,01'	13° 44,91'	156	20:34	79° 59,01'	13° 44,91'	147	20:52	79° 59,01'	13° 44,91'	156
656	MB	6	Moffen	04.08.2006	22:11	79° 58,10'	13° 51,57'	128					6:10	79° 59,11'	14° 10,50'	78
657	JAGO	5	Moffen	05.08.2006	06:49	79° 59,12'	14° 10,73'	77	6:56	79° 59,09'	14° 10,56'	75	10:31	79° 53,69'	14° 13,40'	43
658	LS	3	Moffen	05.08.2006	8:20	79° 59,37'	14° 11,78'	60					9:00	79° 59,46'	14° 13,05'	48
659-1	GKG	7	Moffen	05.08.2006	11:30	79° 58,80'	14° 03,00'	112	11:33	79° 58,80'	14° 03,00'	112	11:39	79° 58,80'	14° 03,00'	112
660	FS	2	Moffen	05.08.2006	12:48	79° 59,52'	14° 13,97'	39	12:53	79° 59,52'	14° 13,96'	40	13:29	79° 59,46'	14° 13,33'	48
661	DRG	3	Moffen	05.08.2006	13:50	79° 59,08'	14° 16,37'	41	14:00	79° 59,10'	14° 16,32'	40	14:33	79° 59,45'	14° 14,07'	40
662-1	BG	7	Moffen	05.08.2006	14:49	79° 59,49'	14° 13,92'	40	14:52	79° 59,49'	14° 13,92'	40	14:54	79° 59,49'	14° 13,92'	40
662-2	BG	8	Moffen	05.08.2006	14:57	79° 59,49'	14° 13,93'	40	15:00	79° 59,49'	14° 13,92'	40	15:04	79° 59,49'	14° 13,92'	40
663-1	BG	9	Moffen	05.08.2006	15:32	79° 59,17'	14° 10,97'	69	15:37	79° 59,17'	14° 10,97'	69	15:42	79° 59,17'	14° 10,97'	70
663-2	BG	10	Moffen	05.08.2006	15:42	79° 59,17'	14° 10,97'	69	15:46	79° 59,17'	14° 10,97'	69	15:49	79° 59, 17'	14° 10,97'	69
664	MB	7	Moffen	05.08.2006	16:16	79° 58,12'	14° 19,40'	42					19:30	79° 57,77'	14° 19,40'	58
665	MB	8	Moffen - Woodfjorden	05.08.2006	20:16	79° 49,50'	14° 13,54'	131					20:47	79° 45,99'	14° 07, 13'	190
666-1	GKG	8	Woodfjorden	05.08.2006	21:19	79° 48,00'	14° 12,00'	171	21:23	79° 48,00'	14° 12,00'	171	21:35	79° 48,00'	14° 12,00'	171
666-2	SL	6	Woodfjorden	05.08.2006	21:50	79° 48,00'	14° 12,00'	171	21:54	79° 48,00'	14° 12,00'	171	22:07	79° 48,00'	14° 12,00'	171
666-3	CTD	14	Woodfjorden	05.08.2006	22:22	79° 48,00'	14° 11,98'	171	22:36	79° 48,00'	14° 11,98'	164	22:50	79° 48,00'	14° 11,98'	171
666-4	SL	7	Woodfjorden	05.08.2006	22:53	79° 48,00'	14° 12,00'	171	22:57	79° 48,00'	14° 12,00'	171	23:15	79° 48,00'	14° 12,00'	171
667	CTD	15	Woodfjorden	06.08.2006	0:09	79° 54,59'	14° 27,58'	143	0:22	79° 54,58'	14° 27,57'	132	0:30	79° 54,58'	14° 27,57'	143
668	CTD	16	Woodfjorden	06.08.2006	1:47	80° 01,19'	15° 26,50'	160	2:00	80° 01,24'	15° 27,23'	147	2:15	80° 01,24'	15° 27,34'	162
669	CTD	17	Woodfjorden	06.08.2006	3:51	79° 55,55'	15° 35,29'	156	4:03	79° 55,55'	15° 35,28'	156	4:08	79° 55,55'	15° 35,28'	156
670	MB	9	Mosselbukta	06.08.2006	6:28	79° 54,20'	15° 44,91'	81					10:33	79° 53,40'	15° 45,88'	42
671	JAGO	6	Mosselbukta	06.08.2006	11:40	79° 54,64'	15° 48,62'	44	13:53	79° 54,62'	15° 48,67'	42	14:09	79° 54,51'	15° 50,23'	27
672	LS	4	Mosselbukta	06.08.2006	11:40	79° 54,57'	15° 49,72'	44					13:00	79° 54,57'	15° 49,72'	44
673-1	GKG	9	Wijdefjorden	06.08.2006	17:11	79° 46,82'	15° 21,47'	152	17:15	79° 46,82'	15° 21,47'	152	17:23	79° 46,82'	15° 21,48'	152
673-2	SL	7	Wijdefjorden	06.08.2006	17:38	79° 46,82'	15° 21,48'	152	17:43	79° 46,82'	15° 21,48'	152	17:51	79° 46,82'	15° 21,48'	152
674	FS	3	Mosselbukta	06.08.2006	19:34	79° 54,59'	15° 48,90'	40	19:45	79° 54,59'	15° 48,91'	40	20:25	79° 54,64'	15° 48,05'	51
675	DRG	4	Mosselbukta	06.08.2006	20:57	79° 54,21'	15° 46,94'	61	21:10	79° 54,21'	15° 46,94'	62	21:59	79° 53,52'	15° 44,89'	72
676	BG	11	Mosselbukta	06.08.2006	22:29	79° 53,67'	15° 43,00'	102	22:32	79° 53,67'	15° 42,99'	102	22:36	79° 53,67'	15° 42,99'	102
677	BG	12	Mosselbukta	06.08.2006	22:55	79° 53,50'	15° 40,02'	149	23:01	79° 53,50'	15° 40,02'	149	23:06	79° 53,50'	15° 40,02'	149
678	MB	10	Moffen	07.08.2006	0:53	79° 58,23'	14° 19,42'						4:15	79° 58,34'	14° 20,27'	
679	CTD	18	Wijdefjorden	07.08.2006	5:47	79° 45,02'	15° 20,07'	135	5:59	79° 45,02'	15° 20,07'	127	6:06	79° 45,02'	15° 20,07'	135
680	JAGO	7	Mosselbukta	07.08.2006	7:53	79° 53,85'	15° 42,18'	101	08:07	79° 53,86'	15° 42,86'	127	08:53	79° 53,84'	15° 41,68'	20
681	JAGO	8	Mosselbukta	07.08.2006	10:42	79° 54,38'	15° 47,92'	41	10:58	79°54,47'	15° 47,71'	46	11:36	79° 54,35'	15° 47,85'	41
682	JAGO	9	Mosselbukta	07.08.2006	12:36	79° 54,51'	15° 49,12'	32	12:58	79° 54,54'	15° 54,73'	10	13:05	79° 54,43'	15° 54,90'	10
683	MB	11	Outer Wijdefjorden	07.08.2006	14:10	79° 48,50'	15° 20,04'	140					14:36	79° 45,00'	15° 20,01'	135
684	JAGO	10	Mosselbukta	07.08.2006	16:43	79° 53,72'	15° 44,75'	80	16:47	79°53,68'	15° 44,57'	78	19:24	79° 53,54'	15° 46,58'	44

Station list Maria S. MERIAN No. 2 Leg 3

Station No.	Gear	No.	Location	Date	Start	Coordinates			at bottom	Coordinates			end stat.	Coordinates		
					Time (UTC)	Lat. °N	Long. °E	Depth (m)	Time (UTC)	Lat. °N	Long. °E	Depth (m)	Time (UTC)	Lat. °N	Long. °E	Depth (m)
685	LS	5	Mosselbukta	07.08.2006	16:55	79° 53,73'	15° 44,62'	79					17:34	79° 53,61'	15° 45,65'	61
686	MB	12	Outer Wijdefjorden	07.08.2006	20:38	80° 01,35'	15° 43,90'	155					21:00	80° 03,80'	15° 50,27'	216
687-1	GKG	10	Outer Wijdefjorden	07.08.2006	21:30	80° 03,05'	15° 48,09'	223	21:36	80° 03,05'	15° 48.01'	222	21:45	80° 03,06'	15° 47.94'	221
687-2	SL	8	Outer Wijdefjorden	07.08.2006	22:00	80° 03,04'	15° 47,69'	225	22:06	80° 03,04'	15° 47,55'	228	22:17	80° 03,06'	15° 47,23'	229
687-3	CTD	19	Outer Wijdefjorden	07.08.2006	22:45	80° 03,05'	15° 47,61'	228	23:01	80° 03,13'	15° 47,17'	219	23:15	80° 03,17'	15° 47,21'	226
688	CTD	20	Outer Wijdefjorden	08.08.2006	0:01	80° 06,15'	15° 10,79'	150	0:14	80° 06,04'	15° 10,23'	142	0:21	80° 06,02'	15° 10,22'	148
689	CTD	21	Outer Wijdefjorden	08.08.2006	2:19	80° 04,16'	16° 57,69'	299	2:36	80° 04,11'	16° 57,72'	291	2:51	80° 04,07'	16° 57,59'	295
690	MB	13	Sorgfjorden	08.08.2006	3:34	79° 58,65'	16° 47,90'	75					6:50	79° 57,13'	16° 48,54'	94
691	MB	14	Sorgfjorden	08.08.2006	6:51	79° 57,13'	16° 48,54'	90					10:55	79° 54,89'	16° 42,31'	100
692	JAGO	11	Sorgfjorden	08.08.2006	11:48	79° 55,05'	16° 42,81'	94	11:52	79° 55,09'	16° 42,79'	88	14:24	79° 55,07'	16° 42,54'	94
693	LS	6	Sorgfjorden	08.08.2006	14:49	79° 55,04'	16° 42,83'	94					15:04	79° 55,04'	16° 42,83'	94
694	CTD	22	Sorgfjorden	08.08.2006	15:59	79° 54,28'	16° 48,95'	53	16:03	79° 54,12'	16° 48,95'	45	16:08	79° 54,28'	16° 48,95'	53
695	MB	15	Hinlopenstretet	08.08.2006	17:54	79° 56,01'	17° 50,74'	410					18:20	79° 58,50'	17° 42,84'	384
696-1	GKG	11	Inner Hinlopenstretet	08.08.2006	18:41	79° 58,02'	17° 44,56'	384	18:50	79° 58,02'	17° 44,56'	384	19:02	79° 58,02'	17° 44,56'	384
696-2	SL	9	Inner Hinlopenstretet	08.08.2006	19:16	79° 58,02'	17° 44,56'	384	19:22	79° 58,02'	17° 44,56'	384	19:57	79° 58,02'	17° 44,56'	384
696-3	CTD	23	Inner Hinlopenstretet	08.08.2006	20:07	79° 58,07'	17° 44,57'	384	20:29	79° 58,08'	17° 44,57'	376	20:40	79° 58,07'	17° 44,57'	384
696-4	BG	13	Inner Hinlopenstretet	08.08.2006	20:58	79° 58,02'	17° 44,55'	384	21:08	79° 58,02'	17° 44,55'	384	21:16	79° 58,02'	17° 44,55'	384
696-5	BG	14	Inner Hinlopenstretet	08.08.2006	21:21	79° 58,02'	17° 44,55'	384	21:31	79° 58,02'	17° 44,55'	384	21:39	79° 58,02'	17° 44,55'	384
696-6	BG	15	Inner Hinlopenstretet	08.08.2006	21:43	79° 58,02'	17° 44,55'	384	21:52	79° 58,02'	17° 44,55'	384	22:01	79° 58,02'	17° 44,54'	384
696-7	SL	10	Inner Hinlopenstretet	08.08.2006	22:17	79° 58,02'	17° 44,54'	384	22:25	79° 58,02'	17° 44,54'	384	22:41	79° 58,02'	17° 44,54'	384
697	MB	16	Outer Hinlopenstretet	09.08.2006	1:03	80° 18,12'	16° 11,86'	345					1:24	80° 20,24'	16° 14,00'	374
698-1	GKG	12	Outer Hinlopenstretet	09.08.2006	1:46	80° 19,20'	16° 11,88'	353	1:54	80° 19,19'	16° 11,68'	353	2:05	80° 19,19'	16° 11,44'	353
698-2	SL	11	Outer Hinlopenstretet	09.08.2006	2:22	80° 19,13'	16° 11,02'	352	2:30	80° 19,15'	16° 11,09'	352	2:50	80° 19,13'	16° 10,91'	353
698-3	CTD	24	Outer Hinlopenstretet	09.08.2006	2:59	80° 19,14'	16° 10,91'	352	3:19	80° 19,19'	16° 10,90'	345	3:30	80° 19,21'	16° 10,85'	353
699	CTD	25	Kapp Rubin	09.08.2006	6:59	80° 35,00'	19° 27,84'	144	7:09	80° 35,01'	19° 27,62'	142	7:15	80° 35,03'	19° 27,48'	144
700	MB	17	Kapp Rubin	09.08.2006	7:59	80° 31,62'	19° 39,45'						11:34	80° 31,00'	19° 44,09'	41
701	JAGO	12	Kapp Rubin	09.08.2006	12:08	80° 31,99	19° 50,62'	73	12:15	80° 32,01'	19° 50,77'	78	15:24	80° 31,95'	19° 51,30'	30
702	LS	7	Kapp Rubin	09.08.2006	12:28	80° 32,04'	19° 50,74'	94					12:46	80° 32,00'	19° 50,74'	75
703	JAGO	13	Kapp Rubin	09.08.2006	15:57	80° 31,93'	19° 50,68'	57	15:59	80° 31,77'	19° 48,70'	99	16:43	80° 31,77'	19° 48,42'	95
704-1	DRG	5	Kapp Rubin	09.08.2006	17:32	80° 31,24'	19° 44,32'	47	17:34	80° 31,23'	19° 44,15'	46	17:40	80° 31,27'	19° 43,84'	46
704-2	DRG	6	Kapp Rubin	09.08.2006	18:07	80° 31,22'	19° 44,27'	45	18:12	80° 31,22'	19° 44,23'	45	18:29	80° 31,44'	19° 43,02'	44
705	FS	4	Kapp Rubin	09.08.2006	19:08	80° 32,03'	19° 50,76'	81	19:17	80° 32,05'	19° 50,75'	87	19:47	80° 31,99'	19° 51,40'	27
706	CTD	26	Kapp Rubin	09.08.2006	20:05	80° 32,01'	19° 50,77'	71	20:17	80° 32,02'	19° 50,78'	62	20:22	80° 32,02'	19° 50,77'	81
707	MB	18	Kapp Rubin	09.08.2006	20:39	80° 31,76'	19° 49,34'	87					21:16	80° 32,23'	19° 36,74'	84
708	MB	19	offshore Kapp Rubin	09.08.2006	22:14	80° 33,89'	18° 27,07'	121					22:48	80° 34,36'	18° 06,29'	134
709-1	CTD	27	North off Lågøya	09.08.2006	23:16	80° 34,32'	18° 12,49'	149	23:29	80° 34,26'	18° 12,35'	144	23:34	80° 34,25'	18° 12.31'	149
709-2	GKG	13	North off Lågøya	09.08.2006	23:45	80° 34,28'	18° 12,59'	150	23:49	80° 34,28'	18° 12,57'	150	23:56	80° 34,26'	18° 12,44'	149
710	MB	20	Kapp Rubin	10.08.2006	1:54	80° 31,72'	19° 39,79'	69					7:55	80° 31,83'	19° 39,40'	41
711	JAGO	14	Kapp Rubin	10.08.2006	8:56	80° 31,80'	19° 40,67'	72	09:03	80° 31,76'	19° 40,04'	70	11:54	80° 31,86'	19° 41,47'	30
712	LS	8	Kapp Rubin	10.08.2006	9:02	80° 31,81'	19° 40,63'	68					9:22	80° 31,77'	19° 40,32'	69
713	MB	21	Kapp Rubin	10.08.2006	12:36	80° 32,09'	19° 43,49'	112					16:16	80° 31,76'	19° 44,06'	60
714	JAGO	15	Kapp Rubin	10.08.2006	17:02	80° 32,19'	19° 50,40'		18:15	80° 31,51'	19° 52,15	27	18:56	80° 31,51	19° 52,28°	
715	CTD	28	Kapp Wrede	10.08.2006	22:10	80° 33,27'	22° 12,99'	228	22:25	80° 33,25'	22° 13,29'	218	22:35	80° 33,24'	22° 13,47'	226
716	MB	22	Kapp Wrede	10.08.2006	22:52	80° 33,19'	22° 13,79'	225					23:43	80° 31,34'	22° 10,89'	265
717-1	GKG	14	Kapp Wrede	11.08.2006	0:00	80° 31,28'	22° 13,23'	218	0:06	80° 31,29'	22° 13,21'	217	0:15	80° 31,30'	22° 13,17'	214
717-2	SL	12	Kapp Wrede	11.08.2006	0:39	80° 31,33'	22° 13,05'	215	0:43	80° 31,32'	22° 13,04'	212	0:53	80° 31,31'	22° 13,00'	211
718	Excavation *	1	Duvefjorden	11.08.2006	7:24	80° 14,83'	23° 31,58'						14:28	80° 15,44'	23° 33,72'	
719	MB	23	Duvefjorden	11.08.2006	7:38	80° 16,06'	23° 24,65'	321					8:14	80° 19,10'	23° 25,68'	334

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Station No.	Gear	No.	Location	Date	Start	Coordinates			at bottom	Coordinates			end stat.	Coordinates		
					Time (UTC)	Lat. °N	Long. °E	Depth (m)	Time (UTC)	Lat. °N	Long. °E	Depth (m)	Time (UTC)	Lat. °N	Long. °E	Depth (m)
720-1	CTD	29	Duvefjorden	11.08.2006	8:20	80° 18,82'	23° 25,31'	321	8:39	80° 18,82'	23° 25,30'	312	8:50	80° 18,83'	23° 25,37'	323
720-2	GKG	15	Duvefjorden	11.08.2006	8:55	80° 18,77'	23° 25,26'	320	9:07	80° 18,66'	23° 25,06'	312	9:15	80° 18,70'	23° 25,21'	318
720-3	SL	13	Duvefjorden	11.08.2006	9:52	80° 18,89'	23° 25,91'	322	9:59	80° 18,91'	23° 26,03'	326	10:10	80° 18,89'	23° 25,91'	323
720-4	BG	16	Duvefjorden	11.08.2006	10:20	80° 18,93'	23° 25,14'	312	10:29	80° 18,94'	23° 25,19'	312	10:38	80° 18,90'	23° 25,25'	317
720-5	BG	17	Duvefjorden	11.08.2006	10:40	80° 18,82'	23° 25,25'	317	10:48	80° 18,84'	23° 25,27'	319	10:58	80° 18,80'	23° 25,46'	322
720-6	BG	18	Duvefjorden	11.08.2006	10:59	80° 18,79'	23° 25,50'	322	11:08	80° 18,73'	23° 25,68'	321	11:19	80° 18,67'	23° 25,96'	316
721	MB	24	Dokken	11.08.2006	11:52	80° 15,80'	23° 33,20'	41					13:33	80° 15,60'	23° 34,50'	56
722	FS	5	Duvefjorden	11.08.2006	14:02	80° 15,34'	23° 33,37'	55	14:05	80° 15,31'	23° 33,44'	48	14:57	80° 15,79'	23° 33,52'	51
723	CTD	30	Open shelf north off Nordkapp	11.08.2006	23:59	81° 02,98'	24° 00,10'	253	0:17	81° 02,91'	24° 00,25'	243	0:32	81° 02,87'	24° 00,45'	254
724	CTD	31	Nordenskiöldbukta	12.08.2006	6:01	80° 32,02'	22° 13,54'	233	6:15	80° 32,05'	22° 13,76'	223	6:24	80° 32,06'	22° 14,07'	234
725	MB	25	Outer Duvefjorden	12.08.2006	7:51	80° 36,40'	23° 21,40'	278					8:18	80° 33,62'	23° 25,71'	309
726-1	GKG	16	Outer Duvefjorden	12.08.2006	8:33	80° 34,52'	23° 25,92'	284	8:42	80° 34,52'	23° 26,01'	284	8:52	80° 34,53'	23° 26,17'	284
726-2	SL	14	Outer Duvefjorden	12.08.2006	9:04	80° 34,56'	23° 25,94'	284	9:10	80° 34,57'	23° 25,96'	284	9:26	80° 34,57'	23° 26,12'	283
727	MB	26	Sjuøyane (seven islands)	12.08.2006	14:01	80° 45,97'	19° 15,36'	134					14:32	80° 48,89'	19° 16,88'	145
728-1	GKG	17	Sjuøyane (seven islands)	12.08.2006	15:05	80° 47,98'	19° 15,15'	158	15:09	80° 47,98'	19° 15,22'	157	15:16	80° 47,98'	19° 15,28'	156
728-2	SL	15	Sjuøyane (seven islands)	12.08.2006	15:23	80° 47,97'	19° 15,06'	159	15:31	80° 47,97'	19° 15,26'	157	15:39	80° 47,96'	19° 15,61'	150
729	CTD	32	Lomfjorden	13.08.2006	0:28	79° 38,00'	18° 25,01'	339	0:44	79° 38,00'	18° 25,01'	339	1:03	79° 38,00'	18° 25,01'	339
730	MB	27	Lomfjorden	13.08.2006	2:05	79° 33,92'	17° 47,85'	122					6:02	79° 34,97'	17° 52,12'	86
731	JAGO	16	Lomfjorden	13.08.2006	6:55	79° 34,97'	17° 52,11'	87	06:58	79° 35,02'	17° 52,29'	75	09:34	79° 34,89'	17° 50,96'	38
732	LS	9	Lomfjorden	13.08.2006	7:10	79° 34,97'	17° 52,11'	87					7:32	79° 34,97'	17° 52,11'	86
733	CTD	33	Lomfjorden	13.08.2006	9:56	79° 35,51'	17° 48,01'	133	10:12	79° 34,51'	17° 48,01'	133	10:17	79° 34,51'	17° 48,01'	133
734	DRG	7	Lomfjorden	13.08.2006	10:45	79° 34,98'	17° 50,79'	42	10:59	79° 34,92'	17° 50,81'	48	11:14	79° 34,69'	17° 50,94'	50
735	FS	6	Lomfjorden	13.08.2006	11:53	79° 34,80'	17° 50,51'	54	11:56	79° 34,80'	17° 50,50'	54	12:40	79° 34,80'	17° 51,70'	65
736	MB	28	Lomfjorden	13.08.2006	12:52	79° 35,02'	17° 52,39'	85					14:30	79° 41,50'	18° 19,29'	426
737-1	GKG	18	Lomfjorden	13.08.2006	14:53	79° 41,02'	18° 18,06'	417	15:02	79° 41,01'	18° 18,07'	417	15:13	79° 41,01'	18° 18,07'	418
737-2	SL	16	Lomfjorden	13.08.2006	15:30	79° 41,01'	18° 18,07'	418	15:36	79° 41,01'	18° 18,07'	418	15:51	79° 41,01'	18° 18,07'	418
737-3	BG	19	Lomfjorden	13.08.2006	15:56	79° 41,01'	18° 18,07'	418	16:06	79° 41,01'	18° 18,07'	418	16:18	79° 41,02'	18° 18,07'	418
737-4	BG	20	Lomfjorden	13.08.2006	16:19	79° 41,02'	18° 18,07'	418	16:27	79° 41,02'	18° 18,07'	418	16:37	79° 41,02'	18° 18,07'	418
737-5	BG	21	Lomfjorden	13.08.2006	16:40	79° 41,02'	18° 18,07'	418	16:49	79° 41,02'	18° 18,07'	418	16:59	79° 41,02'	18° 18,07'	418
738	MB	29	Wahlbergfjorden	13.08.2006	18:56	79° 42,30'	20° 00,90'	154					19:43	79° 42,92'	20° 29,68'	220
739-1	CTD	34	Wahlbergfjorden	13.08.2006	20:10	79° 42,62'	20° 25,50'	216	20:23	79° 42,62'	20° 25,49'	208	20:30	79° 42,62'	20° 25,50'	217
739-2	GKG	19	Wahlbergfjorden	13.08.2006	20:33	79° 42,62'	20° 25,50'	216	20:42	79° 42,62'	20° 25,50'	216	20:50	79° 42,62'	20° 25,50'	217
739-3	SL	17	Wahlbergfjorden	13.08.2006	20:58	79° 42,62'	20° 25,49'	217	21:03	79° 42,62'	20° 25,50'	217	21:16	79° 42,62'	20° 25,50'	217
740	MB	30	Hinlopenstretet	13.08.2006	22:56	79° 36,17'	18° 51,71'	336					4:32	79° 34,78'	18° 55,24'	81
741	JAGO	17	Hinlopenstretet	14.08.2006	7:01	79° 36,03'	18° 52,04'	275	07:06	79° 36,03'	18° 52,23'	35	07:40	79° 35,85'	18° 51,34'	30
742	LS	10	Hinlopenstretet	14.08.2006	7:16	79° 36,03'	18° 52,05'	275					7:31	79° 35,90'	18° 52,17'	27
743	FS	7	Hinlopenstretet	14.08.2006	8:40	79° 35,80'	18° 52,20'	40	8:45	79° 35,80'	18° 52,20'	39	9:38	79° 36,00'	18° 51,80'	240
744-1	BG	22	Southern Hinlopenstretet	14.08.2006	12:59	79° 14,16'	20° 53,38'	79	13:07	79° 14,16'	20° 53,38'	79	13:13	79° 14,16'	20° 53,38'	79
744-2	BG	23	Southern Hinlopenstretet	14.08.2006	13:15	79° 14,16'	20° 53,37'	79	13:18	79° 14,16'	20° 53,37'	79	13:24	79° 14,16'	20° 53,33'	79
744-3	BG	24	Southern Hinlopenstretet	14.08.2006	13:25	79° 14,16'	20° 53,33'	79	13:29	79° 14,16'	20° 53,29'	79	13:34	79° 14,15'	20° 53,19'	79
744-4	CTD	35	Southern Hinlopenstretet	14.08.2006	14:05	79° 14,16'	20° 53,37'	79	14:13	79° 14,15'	20° 53,38'	71	14:17	79° 14,16'	20° 53,37'	79
745	MB	31	Eriksenstretet	14.08.2006	19:07	79° 01,80'	24° 31,67'	183					19:39	78° 57,90'	24° 37,60'	210
746-1	CTD	36	Eriksenstretet	14.08.2006	20:05	78° 59,21'	24° 35,86'	209	20:18	78° 59,21'	24° 35,84'	196	20:29	78° 59,21'	24° 35,83'	208
746-2	GKG	20	Eriksenstretet	14.08.2006	20:33	78° 59,21'	24° 35,83'	208	20:40	78° 59,21'	24° 35,83'	208	20:49	78° 59,21'	24° 35,83'	208
746-3	SL	18	Eriksenstretet	14.08.2006	20:58	78° 59,21'	24° 35,83'	208	21:03	78° 59,21'	24° 35,83'	208	21:23	78° 59,21'	24° 35,83'	208
746-4	BG	25	Eriksenstretet	14.08.2006	21:28	78° 59,21'	24° 35,83'	208	21:33	78° 59,21'	24° 35,83'	208	21:40	78° 59,21'	24° 35,83'	208
746-5	BG	26	Eriksenstretet	14.08.2006	21:41	78° 59,21'	24° 35,83'	208	21:46	78° 59,21'	24° 35,83'	208	21:51	78° 59,21'	24° 35,83'	208
746-6	BG	27	Eriksenstretet	14.08.2006	21:54	78° 59,21'	24° 35,83'	208	22:00	78° 59,21'	24° 35,83'	208	22:06	78° 59,21'	24° 35,83'	208

Station list Maria S. MERIAN No. 2 Leg 3

Station No.	Gear	No.	Location	Date	Start	Coordinates			at bottom	Coordinates			end stat.	Coordinates		
					Time (UTC)	Lat. °N	Long. °E	Depth (m)	Time (UTC)	Lat. °N	Long. °E	Depth (m)	Time (UTC)	Lat. °N	Long. °E	Depth (m)
746-7	BG	28	Eriksenstretet	14.08.2006	22:09	78° 59,21'	24° 35,83'	208	22:13	78° 59,21'	24° 35,83'	208	22:20	78° 59,21'	24° 35,83'	208
747-1	BG	29	Barents Sea	15.08.2006	0:23	79° 13,10'	25° 51,28'	193	0:27	79° 13,10'	25° 51,27'	193	0:33	79° 13,10'	25° 51,28'	193
747-2	BG	30	Barents Sea	15.08.2006	0:36	79° 13,10'	25° 51,27'	193	0:41	79° 13,10'	25° 51,27'	193	0:46	79° 13,10'	25° 51,27'	193
747-3	BG	31	Barents Sea	15.08.2006	0:50	79° 13,10'	25° 51,27'	193	0:54	79° 13,10'	25° 51,28'	193	1:00	79° 13,10'	25° 51,28'	193
747-4	CTD	37	Barents Sea	15.08.2006	1:23	79° 13,10'	25° 51,28'	193	1:35	79° 13,10'	25° 51,27'	187	1:47	79° 13,10'	25° 51,27'	193
748-1	CTD	38	Barents Sea	15.08.2006	4:24	78° 46,03'	25° 08,28'	123	4:35	78° 46,03'	25° 08,29'	112	4:40	78° 46,03'	25° 08,28'	123
748-2	BG	32	Barents Sea	15.08.2006	4:54	78° 46,03'	25° 08,28'	123	4:58	78° 46,03'	25° 08,29'	123	5:02	78° 46,03'	25° 08,28'	123
748-3	BG	33	Barents Sea	15.08.2006	5:04	78° 46,03'	25° 08,28'	123	5:07	78° 46,03'	25° 08,29'	123	5:11	78° 46,03'	25° 08,29'	123
748-4	BG	34	Barents Sea	15.08.2006	5:13	78° 46,03'	25° 08,29'	123	5:15	78° 46,03'	25° 08,29'	123	5:20	78° 46,03'	25° 08,28'	123
748-5	BG	35	Barents Sea	15.08.2006	5:21	78° 46,03'	25° 08,28'	123	5:24	78° 46,03'	25° 08,29'	123	5:28	78° 46,03'	25° 08,28'	123
749-1	BG	36	Barents Sea	15.08.2006	7:44	78° 23,14'	24° 44,45'	138	7:50	78° 23,14'	24° 44,45'	138	7:54	78° 23,14'	24° 44,45'	138
749-2	BG	37	Barents Sea	15.08.2006	7:55	78° 23,14'	24° 44,45'	138	7:59	78° 23,14'	24° 44,45'	138	8:02	78° 23,14'	24° 44,45'	138
749-3	BG	38	Barents Sea	15.08.2006	8:04	78° 23,14'	24° 44,45'	138	8:07	78° 23,14'	24° 44,45'	138	8:11	78° 23,14'	24° 44,45'	138
749-4	BG	39	Barents Sea	15.08.2006	8:13	78° 23,14'	24° 44,49'	138	8:16	78° 23,14'	24° 44,45'	138	8:19	78° 23,14'	24° 44,45'	138
749-5	CTD	39	Barents Sea	15.08.2006	8:33	78° 23,14'	24° 44,45'	138	8:44	78° 23,14'	24° 44,45'	127	8:48	78° 23,14'	24° 44,45'	138
750-1	CTD	40	Barents Sea	15.08.2006	12:10	78° 16,19'	27° 11,71'	312	12:28	78° 16,19'	27° 11,71'	298	12:36	78° 16,19'	27° 11,71'	312
750-2	GKG	21	Olgastretet	15.08.2006	12:50	78° 16,19'	27° 11,70'	312	12:57	78° 16,19'	27° 11,70'	312	13:07	78° 16,19'	27° 11,70'	312
750-3	BG	40	Olgastretet	15.08.2006	13:17	78° 16,19'	27° 11,71'	312	13:25	78° 16,19'	27° 11,70'	313	13:34	78° 16,19'	27° 11,70'	312
750-4	BG	41	Olgastretet	15.08.2006	13:55	78° 16,19'	27° 11,71'	312	13:42	78° 16,19'	27° 11,70'	312	13:51	78° 16,19'	27° 11,70'	312
750-5	BG	42	Olgastretet	15.08.2006	13:52	78° 16,19'	27° 11,70'	312	14:00	78° 16,19'	27° 11,70'	312	14:09	78° 16,19'	27° 11,70'	312
750-6	BG	43	Olgastretet	15.08.2006	14:11	78° 16,19'	27° 11,70'	312	14:18	78° 16,19'	27° 11,70'	312	14:27	78° 16,19'	27° 11,70'	312
751	CTD	41	Hornsund	16.08.2006	11:52	76° 58,53'	15° 44,07'	234	12:05	76° 58,53'	15° 44,07'	230	12:16	76° 58,53'	15° 44,07'	234
752	MB	32	Hornsund	16.08.2006	13:08	76° 57,69'	15° 47,16'	210					13:57	76° 57,24'	15° 46,51'	
753	JAGO	18	Hornsund	16.08.2006	14:58	76° 57,18'	15° 44,29'	97	15:01	76° 57,14'	15° 44,30'	88	17:58	76° 57,20'	15° 45,21'	51
754	LS	11	Hornsund	16.08.2006	15:18	76° 57,18'	15° 44,29'	98					15:34	76° 57,16'	15° 44,49'	79
755	FS	8	Hornsund	16.08.2006	18:25	76° 57,18'	15° 45,01'	39	18:28	76° 57,18'	15° 45,01'	40	19:12	76° 57,18'	15° 44,32'	96
756	MB	33	Isfjorden	17.08.2006	8:17	78° 18,30'	14° 34,32'	127					8:58	78° 18,86'	14° 31,94'	54
757	JAGO	19	Isfjorden	17.08.2006	10:30	78° 18,64'	14° 32,00'	63	10:34	78° 18,68'	14° 31,97'	60	12:34	78° 18,74'	14° 31,22'	40

3.6 Acknowledgements

The scientists of MSM 2/03 expressed their sincere thanks to Captain Holtschmidt and his crew for excellent and skilful partnership during the entire cruise. The chief scientist was greatly supported by Captain Berkenheger (Leitstelle) and Klaus Bohn in sorting out administrative and logistical duties. Special thanks also to the Sysselman of Svalbard for the permission to operate in inshore waters. This cruise was funded by the Deutsche Forschungsgemeinschaft.

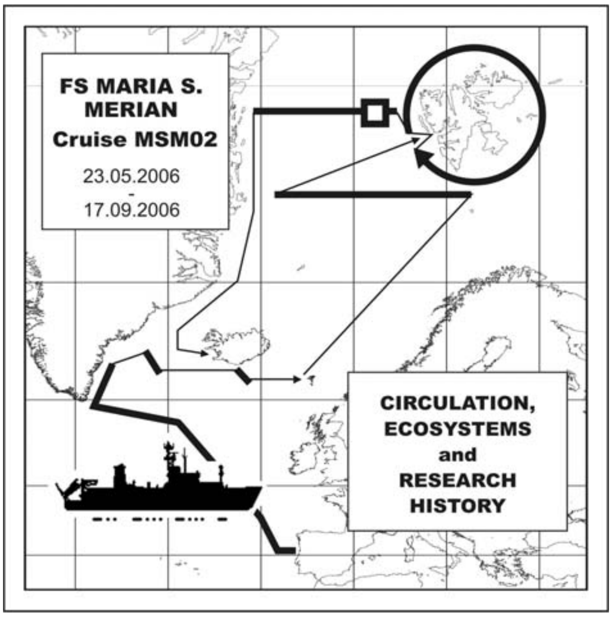
MARIA S. MERIAN-Berichte 09-1

Circulation and Ecosystems in the Subpolar and Polar North Atlantic

Part 4

Cruise No. 2, Leg 4

August 20 to September 16, 2006
Longyearbyen (Svalbard) – Reykjavik (Island)



U. Schauer, H. Auel, E. Bauerfeind, A. Beszczynska-Möller, L. Bittermann, S. Bury, G. Fonseca, F. Gallucci, R. Graupner, S. Himme, R. Leiterer, S. Laakmann, N. Lochthofen, M. Monsees, A. Nauels, K. Rabe, T. Soltwedel, M. Volkenandt, W. Walczowski, J. Wegner, A. Wisotzki

Table of Contents

4.1 Participants

Tab. 4.1: List of Participants on Leg MSM02/4 and Abbreviations

Name	Discipline	Institute
Auel, Holger	Scientist	UB
Bauerfeind, Eduard	Scientist	AWI
Beszczynska-Möller, Agnieszka	Scientist	AWI
Bittermann, Lennart	Student	AWI
Bury, Sandra	Student	AWI
Dirk Kalmbach	Technician	AWI
Graupner, Rainer	Technician	Optimare
Gustavo Fonseca	Scientist	AWI
Himme, Stefan	Student	AWI
Kochzius, Marc	Scientist	UB
Laakmann, Silke	Scientist	UB
Leiterer, Reik	Student	AWI
Monsees, Matthias	Technician	Optimare
Nauels, Alexander	Student	AWI
Normen Lochthofen	Technician	AWI
Rabe, Katrin	Student	AWI
Schauer, Ursula	Chief Scientist	AWI
Soltwedel, Thomas	Scientist	AWI
Strothman, Olaf	Technician	AWI
Volkenandt, Mareike	Student	AWI
Walczowski, Waldemar	Scientist	IOPAS
Wegner, Jan	Technician	AWI
Wisotzki, Andreas	Technician	AWI

Participating Institutions

AWI	Alfred-Wegener-Institut für Polar- und Meeresforschung, Am Handelshafen 12, 27570 Bremerhaven, Germany
IOPAS	Institute of Oceanology of the Polish Academy of Sciences, U1. Powstancow Warszawy 55, Sopot, Poland
UB	University of Bremen, P.O. Box 330440, 28334 Bremen, Germany
Optimare	Optimare Sensorsysteme, Am Luneort 15a, 27572 Bremerhaven, Germany

4.2 Research Programme

The leg MSM02/4 comprised studies of the variability of the oceanic fluxes through the Fram Strait and of marine polar ecosystems. This work contributes to long-term studies addressing the relation and the response of the various Arctic subsystems to the rigorous climatic changes of the last decades.

The northernmost extension of the North Atlantic Current system consists of the circulation of Atlantic Water through the Arctic Ocean. A large part flows through the Fram Strait which is the only deep connection between the Arctic and the World Ocean. From the North Atlantic warm and saline water flows to the Arctic Ocean where it is modified by cooling, freezing and melting and where a large amount of fresh water is added through river runoff and Pacific water inflow. Shallow fresh waters, ice and saline deep waters return to the North Atlantic. The outflow from the Arctic Ocean to the Nordic Seas and further to the Atlantic Ocean forms a contribution of the thermohaline circulation cell. Knowledge of these fluxes is a basic requirement for the quantification of the circulation cells of the Arctic and Atlantic Oceans and for understanding their role in climate variability on inter-annual to decadal scales.

To quantify the variation of volume, heat and salt fluxes through Fram Strait, an array of moorings is maintained since 1997 to measure currents, temperature and salinity. The year-round measurements are combined with hydrographic sections taken during the cruises. Until 2005 the observations were done in the framework of the European Union projects “VEINS” (Variability of Exchanges in Northern Seas, 1997-2000) and “ASOF-N” (Arctic-Subarctic Ocean Fluxes, 2002-2005). At present the work is part of the EU Integrated Project “DAMOCLES” (Developing Arctic Modeling and Observing Capabilities for Long-term Environmental Studies). It is associated to the international Arctic-wide study “ASOF”.

While Arctic organisms are highly adapted to extreme environmental conditions with strong seasonal variation, the recent climate change (sea ice extent and thickness, ocean temperature, salinity and nutrients content) challenges the resilience of Arctic life. The stability of Arctic ecosystems is probably not strong enough to withstand the sum of these factors which might lead to a collapse of subsystems. To assess the impact of large-scale environmental changes on an ecosystem in the transition zone between the northern North Atlantic and the central Arctic Ocean, in 1999 the Alfred Wegener Institute for Polar and Marine Research (AWI) established the deep-sea long-term observatory HAUSGARTEN, representing by now the only open-ocean long-term station in a polar region.

In the HAUSGARTEN observatory, 15 sampling sites along a depth transect (1000 - 5500 m) and along a latitudinal transect following the 2500 m isobath are sampled each year. Moorings and different free-falling systems (Bottom-Lander) act as local observation platforms. Multidisciplinary research at HAUSGARTEN covers almost all compartments of the pelagic and the benthic marine ecosystem, with focus on benthic processes.

The DFG funded project “Biodiversity and ecology of deep-sea copepods in polar seas – speciation processes and ecological niches in the homogeneous environment of the pelagic realm” addresses biodiversity and feeding ecology of dominant deep-sea copepods in polar regions. The two copepod families Euchaetidae and Aetideidae are important components of zooplankton communities in the deep ocean and in high latitudes. Species of both families can be responsible for one to two thirds of the total energy flow through the carnivorous trophic level, and may consume nearly half of the vertical carbon flux. A characteristic, but still enigmatic feature of Euchaetidae and Aetideidae is the co-occurrence of several closely related species in deep-sea habitats of the Arctic and Antarctic. Since the pelagic deep sea is an almost homogeneous environment without physical barriers, the sympatric co-occurrences of such closely related species raise the questions how the biodiversity of these deep-sea species evolved and what mechanisms minimize inter-specific competition, which would otherwise lead to the extinction of less fit competitors.

The project focuses on differences in vertical distribution, life-cycle strategies, diet spectra and feeding behaviour of different co-occurring deep-sea copepods in order to characterise their distinct ecological niches in the deep-sea pelagic realm. With these objectives, the project covers central issues of international marine biodiversity initiatives, such as Census of Marine Zooplankton (CMarZ) and Census of Marine Life (CoML).

4.3 Narrative of the cruise

The cruise started in Longyearbyen at August 20th, 2006 afternoon. Several parts of the deck gear did not work then but the continuation of repairs was postponed to the next port call in Reykjavik.

We reached the working area in Fram Strait in the following night and the first CTD-casts along a strait-wide hydrographical section at 78°50'N were taken. At all casts a lowered ADCP was attached to the CTD/rosette for velocity measurements. In the morning of August 21st we returned eastwards and tried to recover the first mooring F3-8 (Fig.4.1). Acoustic interrogation failed to evoke a response from either the transponder at the top of the mooring or the bottom releasers and also after a “blind” release the mooring did not surface. After this disappointing start we continued eastwards and successfully recovered moorings F2-9, F1-8 and a PIES (Pressure Inverted Echo Sounder). Due to the malfunction of the 20-t-beam all mooring work during the cruise (altogether 48 mooring movements) was carried out with the A-frame at the afterdeck. The following night was filled again with CTD/lADCP-work and a first Multinet for the biodiversity programme. Due to dense station spacing we kept this day/night working scheme although it lead to some back and forth pattern of the cruise track for much of the cruise.

At the next day we gave F3-8 one more try and with slightly changed parameters of the deck unit we were able to hear the mooring. This told us that it was still in place at 1000 m water depth although released and this meant that we had to dredge it. We used 3000 m of lines and all available dredge anchors and recovered what was left from F3-8: the lowest instruments and the two releasers. At August 23rd the first moorings, F3-9, PIES-F2-10, F2-10, F1-9, were deployed and F4-8 was recovered. During one of the deployments, the mooring capstan broke. Fortunately we could by-pass the mooring rope and use a belayer capstan instead. Thanks to the calm weather we could go on with the heavy mooring programme despite of various other failures of the decks gear that continued during the rest of the cruise: several times sudden stoppings of the A-frame winch, malfunction of the A-frame itself, failure finally also of the belayer capstan (which could be repaired), etc. During the mooring procedures the POSIDONIA system was successfully used. However, for the entire cruise, we were not able to enable the transponders in the water directly with POSIDONIA. We had to use a hydrophone instead. Once enabled, POSIDONIA worked fine to locate the transponders in all depths.

In the evening of August 26th, the next threat to our expedition was the failure of the second of 4 Diesels - any further Diesel failure would have required immediate port call.

Fortunately we could continue and start our biological programme in the HAUSGARTEN between the West Spitsbergen slope and the Molloy Deep, where Multicorer stations were taken and a Lander was deployed for the first out of three times for 24 hours for respiration experiments. That was followed by the recovery of a lander and a mooring that had been deployed for one year and further mooring recovery and deployments and CTD work along 78°50'N. At all HAUSGARTEN positions also Multicorer casts were taken.

Until 31st August we had no contact with sea ice and the weather was very calm. Ice information was not accessible through internet since due to the northern position Inmarsat communication was not possible. Instead we were provided with low resolution sea ice images sent by email from the University of Hamburg (Lars Kaleschke). The ice maps showed open water up to 81°N north of Svalbard so that we decided that we could carry out a planned CTD section across the slope of the Yermak Plateau to study the western branch of the West Spitsbergen Current.

At 1st September we headed northward along the prime meridian. At 79°22'N we met the ice edge and headed eastward to get back to open water. Only at 3°E we could move northward again. We proceeded with the CTD stations north-eastward in a loose field of thin (< 1m thick) ice which was covered with a several decimeters thick layer of snow - obviously marked by the heavy storm that had splintered large parts of the central Arctic ice cover this summer. At the 3rd September we reached the northernmost position at 81°22'N, 7°58'E at the eastern flank of the Yermack Plateau and took in addition to the CTD cast a Multicorer and a multiple net cast. The sea ice field became denser and drifted northward with 1 kn so that we decided to return south-eastward. During the entire excursion CTD stations were taken in about 8 nm distance and every third station an Apstein net was taken for phytoplankton samples. At 4th September we finished the last CTD cast at the southern slope of the Litke Trough and returned southeast-wards to the HAUSGARTEN area in time to recover a 24-h respiration experiment bottom lander.

During the 5th September we sampled 4 Multicorer/CTD stations and recovered a long-term biological mooring FEVI-11. A swivel near the sediment trap showed strong corrosion so that we were lucky to have recovered the mooring in due time. In the meantime, westerly winds had spread the sea ice field eastwards into the HAUSGARTEN area. Because of the ice we had to remove Posidiona from the moon pool and to close the moon pool with a lid. At the eastern rim of the Molloy Deep a thin (ca. 1 km) strip of thick ice with ridges moved southward with up to 1.8 kn indicating a strong anticyclonic motion around the Deep. In the night of the 7th September we finished operating in the HAUSGARTEN with deployment of a lander for continuation of long-term visual sediment observations and sampling and returned to 78°50'N to complete the oceanographic mooring and CTD section.

Steaming westward, we came quickly in denser ice coverage. At the position of mooring F9-8 the ice cover was more than 8/10 and the flows were several 100 m wide. After reinstalling POSIDONIA we verified exactly the position of F9-8. Fortunately the local ice field and the excellent manoeuvrability of the ship allowed us to establish temporarily a small ice-free area so that the mooring could be released in open water. Soon the ice cover closed again but the mooring could be recovered in dense ice without problem. Since steaming back and forth through the ice would have been too time-consuming we deployed the new mooring during the same night. We were rewarded with a bright full moon which at times was surrounded by a halo. During the night we continued with CTD stations and - every 20 nm - with Multiple Net stations.

West of 1°W the ice flows became larger but also the leads became wider. The westernmost mooring, F10-8 at 78°50’N 2°W, was critical since the top element had surfaced in June and it was unclear how much of the mooring was still on the ground. At the mooring position, it turned out that the releaser was still at the bottom. A wide ice-free area seemed to allow us to release the mooring and to have enough time even for potential salvage operations. The mooring started to rise but the rising slowed down until the mooring remained 100 m below the surface. In the meantime the ice field had accelerated and the mooring got under the ice. We remained at the site until the following morning tracking the mooring with POSIDONIA and hoping that the ice situation would change again to our favour but it remained below a kilometre-wide ice flow so that it was finally lost.

The dense ice field forced us to leave our CTD/LADCP/Multinet line along 78°50’N and make a detour to the south. A low pressure system centred at 74°N and wind up to 7 Beaufort drove the ice at 78°30’N westward with speeds up to 2 kn. According to available ice maps an ice-free tongue extended north-westwards towards Greenland so that at 11th September we made a last try to get northward. After three last northern CTD, multinet and Multicorer stations we headed southwards towards Iceland. On our way south, we moved along an ice stream which was aligned with the shelf edge where we conducted 3 Multicorer stations at about 2000 m for a study of meridional nematode distribution. At the lovely and sunny morning of 13th September we reached 74°N 18°W close to the Greenland coast and, being observed by one of the rare gyrfalcons, successfully recovered a last mooring from the IfM Hamburg which had been inaccessible under heavy ice during MSM02/2 when the recovery was planned originally.

Because of the many failures of crucial ship’s equipment the *Leitstelle* had asked us to skip one of the research days in favour of additional repair time for the *Krögerwerft* in Reykjavik. Due to the excellent work of crew and scientists as well as to optimal weather conditions this was possible with only little loss in the scientific programme so that we reached Reykjavik on September 16.

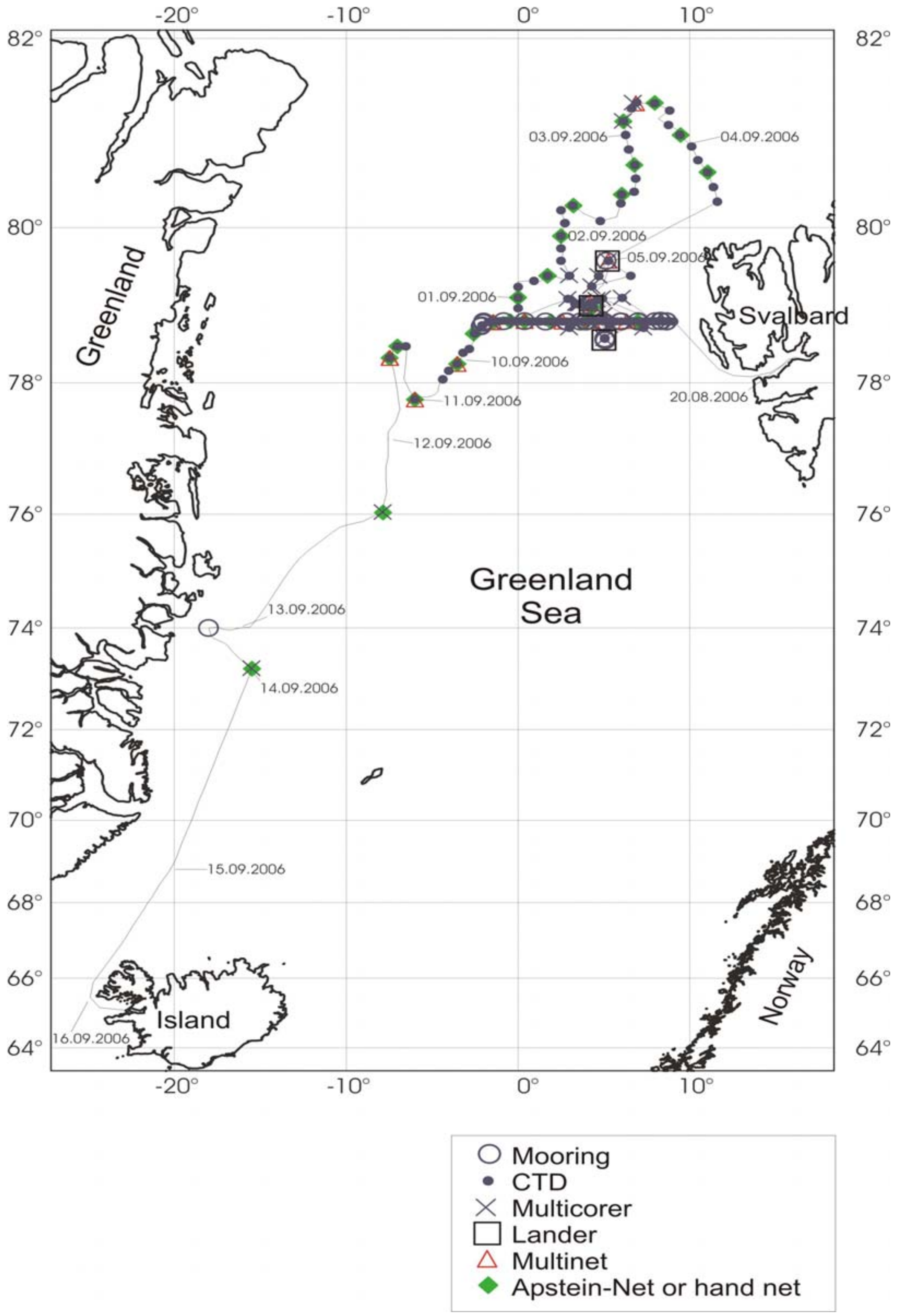


Fig. 4.1: Cruise track of MSM02/4, August 20 to September 16, 2006

4.4 Preliminary results

4.4.1 Hydrography and circulation in the Fram Strait

(U. Schauer, A. Beszczynska-Möller, L. Bittermann, R. Graupner, R. Leiterer, M. Monsees, A. Nauels, W. Walczowski, A. Wisotzki)

Scientific background

The northernmost extension of the North Atlantic Current system consists of the circulation of Atlantic Water through the Arctic Ocean. From the North Atlantic warm and saline water flows to the Arctic Ocean where it is modified by cooling, freezing and melting and where huge amounts of river runoff are added. Shallow fresh waters, ice and saline deep waters return to the North Atlantic. The northward flow of Atlantic water has consequences for the internal Arctic Ocean circulation and influences ice and atmosphere. The outflow from the Arctic Ocean to the Nordic Seas and further to the Atlantic Ocean forms a contribution of the thermohaline circulation cell. Atlantic water enters the Arctic Ocean through the shallow Barents Sea and through Fram Strait, the only deep connection between the Arctic Ocean and Nordic Seas. Knowledge of these fluxes and their variation is a requirement for the quantification of the circulation cells of the Arctic and Atlantic Oceans and for understanding their role in climate variability on inter-annual to decadal scales.

The complicated topographic structure of the Fram Strait leads to a splitting of the West Spitsbergen Current carrying Atlantic Water northward in 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, flowing above the western continental slope, carries water from the recirculation of the various branches southwards but also much of the freshwater input and part of the Barents Sea inflow leaves the Arctic Ocean through Fram Strait so that the volume flow is not balanced to be zero.

To quantify the variation of volume, heat and salt fluxes through Fram Strait, an array of moorings is maintained since 1997 to measure currents, temperature and salinity. The year-round measurements are combined with hydrographic sections taken during the cruises. Until 2005 the observations were done in the framework of the European Union projects “VEINS“ (Variability of Exchanges in Northern Seas, 1997-2000) and “ASOF-N“ (Arctic-Subarctic Ocean Fluxes, 2002-2005). At present the work is part of the EU Integrated Project “DAMOCLES“ (Developing Arctic Modeling and Observing Capabilities for Long-term Environmental Studies). It is associated to the international Arctic-wide study “ASOF”.

The mooring array covers the deep part of the Fram Strait from the eastern to the western shelf edge. This long-term effort is conducted in close co-operation with the Norwegian Polar Institute (NPI). The eastern and central moorings are maintained by AWI and the moorings west of 3°W are run by the NPI. The number of moorings varied over the years and was increased from initially 12 to now 16 after low spatial resolution turned out to be problematic with respect to the circulation in the central Fram Strait. In 2003 it was extended again to cover the eastern part of the East Greenland shelf. In 2005 three pressure inverted echo sounders (PIES Model

6.1E) from the University of Rhode Island were added. Combining pressure gradients and the acoustic travel time measurements of the PIES with historical hydrography data from the site gives the opportunity to obtain time series of full depth profiles of temperature and specific volume anomaly. This combination can be used to estimate the baroclinic flow and the heat transport.

Work at Sea

The two main activities of the oceanographic programme during MSM02/04 were the recovery and redeployment of all AWI moorings and measurements of CTD (Conductivity, Temperature, Depth) profiles. The hydrographic section in Fram Strait at 78°50'N, which has been occupied regularly since 1997, was measured with 51 CTD stations. The section west of 2°30'W was covered by ice that was inaccessible for R/V MARIA S. MERIAN. We evaded the ice sailing south-westward and had to take the westernmost 9 stations off the standard line. Being restricted by the ice from going further west, we had time to extend our work instead to the north-east. 31 CTD stations were performed crossing the Yermak Plateau and running a section to the Svalbard slope along 10°E, thereby repeating a section that was taken in 1999. 23 CTD profiles were taken within the HAUSGARTEN programme. Due to problems with CTD and rosette (see below), we took all stations with oceanographic relevance with the AWI CTD system without rosette and the casts with biological relevance with the ship's system. During all oceanographic casts a lowered Acoustic Doppler Current Profiler (LADCP) was attached to the CTD frame to obtain the velocity field.

11 of 12 moorings and all 3 PIES, which had been deployed in summer 2005 during ARKXXI/1b along 78°50'N east of 3°W, were recovered (Fig. 4.2). Each mooring carried 3 to 7 instruments including rotor and acoustic current meters from Aanderaa Instruments, acoustic current profilers from RD Instruments, temperature and salinity probes from Sea-Bird Electronics Inc. (Sea-Bird) and bottom pressure recorders from Sea-Bird. The western part of the array (4 tall rigs and 2 tube moorings) was served by R/V LANCE in autumn 2006.

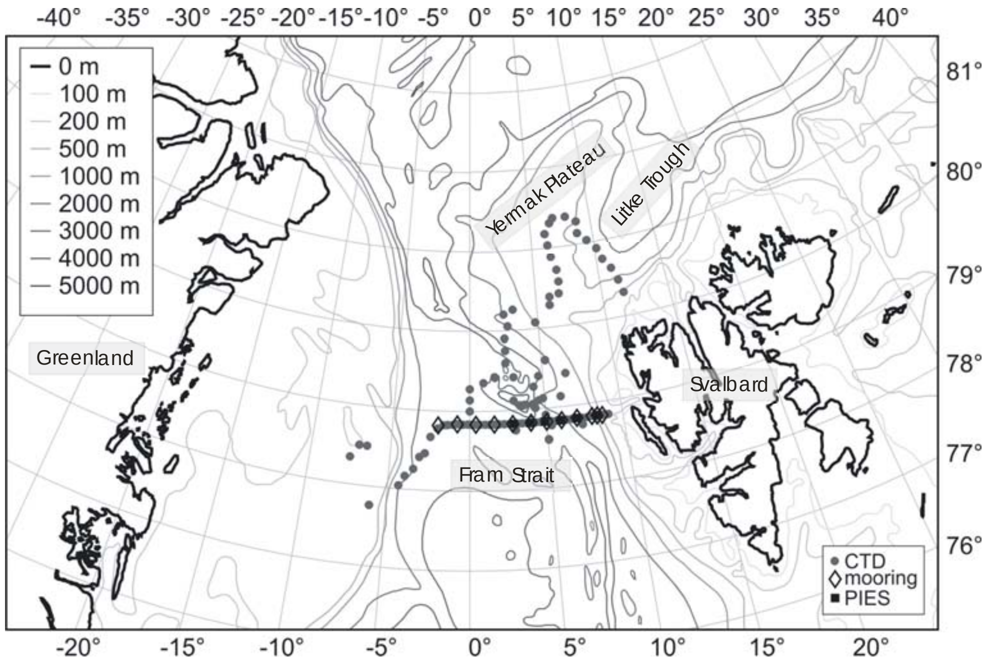
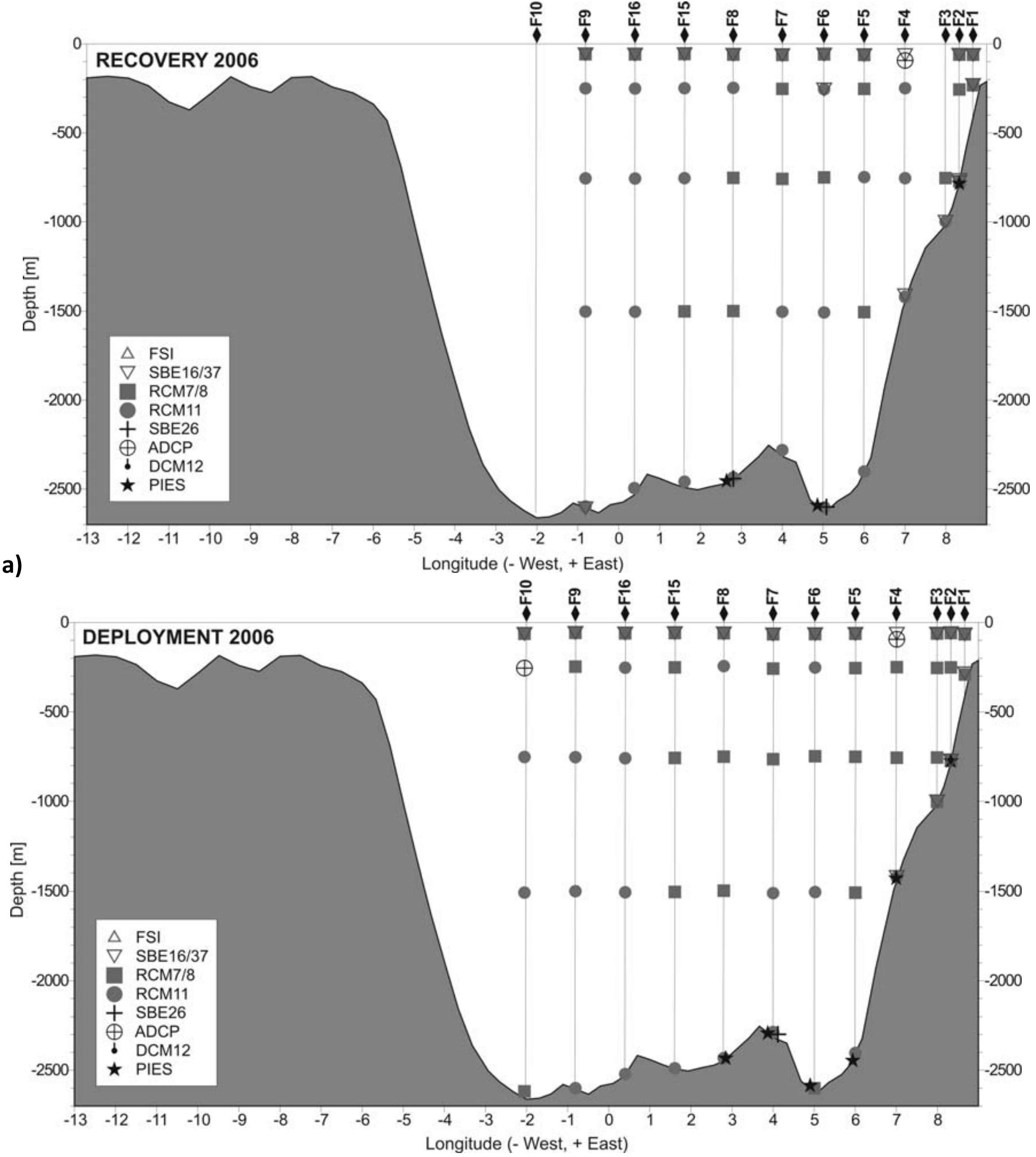


Fig. 4.2: Map with the position of CTD stations, moorings and PIES

The mooring recovery rate was 86% (Fig. 4.3, upper panel). The top of mooring F3 was already gone before the recovery (this was noticed by an alert of the ARGOS sender located on the mooring top). Since we operated in open water at 1000 m water depth we tried to dredge the remaining part. We were successful and 3 out of 6 deployed instruments were retrieved. Also mooring F10 had lost its top already in spring 2006. The site was however covered by loose drifting ice. The remaining parts of the mooring could be located by POSIDONIA and when the ice floes had left the position and a fairly large open water area had established the mooring was released. Unfortunately it turned out that the left-over buoyancy was not enough to raise the remaining elements.



a)

b)

Fig. 4.3: Transect across Fram Strait with the moored instruments recovered (a) and deployed (b) during MSM02/04

66 of the 68 recovered instruments, including PIES, delivered data which is a data return of 97%. One Aanderaa RCM8 was flooded and the WH-ADCP at the mooring F4 stopped a few

weeks after deployment. The recovered and deployed instruments and the data return are summarized in Tab. 4.2 and 4.3.

The deployment positions were kept as close as possible to the old positions (Fig. 4.3). The instrumentation agrees in general with that of the recovered moorings (Tab. 4.2). Some instruments were added in order to obtain better vertical resolution and additional information by new sensor types. Four moorings are equipped with bottom pressure recorders from Sea-Bird Electronics to obtain changes of the sea level inclination indicative of barotropic velocity changes, one of them with the sea level gauge SBE26 and three with SBE16 with the pressure sensors. Two moorings are equipped with upward looking ADCPs. All FSI current meters, which had been used in previous years and turned out to be extremely unreliable, were replaced by the Aanderaa acoustic current meters RCM11.

All three PIES provided full data sets but the bottom temperature records seem to be wrong. Data from PIES SN141 were excessively noisy but still information can be partly extracted. All recovered PIES were equipped with the POSIDONIA transponders ET861G what made recovery much easier as compared to the standard procedure. Using the POSIDONIA transponders allowed also obtaining the accurate positions and depths of deployed instruments. Using the PIES Acoustic Command System (ACS) in the standard mode from board of R/V MARIA S. MERIAN was highly inefficient due to the high level of the ship noise. Six PIES were deployed during MSM02/4, three at the positions of recovered instruments and three in between.

Altogether 106 CTD profiles were taken at 104 stations and water samples were collected during 14 casts. Two CTD systems from Sea-Bird Electronics Inc SBE911+ were used. For most stations the AWI CTD system SN 321/287 was in service. It was equipped with duplicate temperature and conductivity sensors (temperature sensors SBE3, SN 4550 and 4574, conductivity sensors SBE4, SN 3147 and 3173, and pressure sensor Digiquartz 410K-105 SN 53962/51197). The CTD was connected to a SBE32 Carousel Water Sampler, SN 55, with 24 12-liter bottles. Additionally a Benthos Altimeter Model PSA-916, SN 1228/1229, and a Wetlabs C-Star Transmissometer, SN 946, was mounted on the carousels. Salinity of 25 water samples was measured using the Guidline salinometer with Standard Water Batch P145 for calibration of the salinity sensor. Because of a failure of the carousel of the AWI system, at 3 stations the IOW CTD Seabird System SBE911+ was used with the following sensors: temperature SBE3, SN 4459 and 4450, conductivity: SBE4, SN 2935 and 2941, and pressure sensor Digiquartz 410K-105 SN 95797.

Together with each CTD cast, measurements of velocity were conducted using a Lowered Acoustic Doppler Current Profiler (LADCP). A self-recording 307.2 kHz RDI, SN 3313, was attached to the rosette frame in downward-looking manner. The LADCP measured currents in 20 depth cells, each cell 10 m thick. In the vicinity of the bottom, bottom track was used. The vertical speed of the rosette was about 1 ms^{-1}. The LADCP data were read directly after profiling. The water depth was calculated by integration of the vertical velocity obtained from the LADCP and checked against the 1-second averages of the CTD records. The position was obtained from the navigation files of the ship with the resolution of 1 second. The LADCP data were processed using the software LDEO6 to obtain vertical profiles of currents from the surface to bottom. The results were stored as ASCI *.lad files (eastward and northward velocity components in m/s) and plots (Fig 4.9). In the next step the profiles were corrected for tidal motions by subtracting the vertically homogenous tide components K1, O1, M2, and S2 using amplitudes and phases reported by Kowalik and Proshutinsky (1995). The data were vertically averaged over 20 meters. All together 103 LADCP casts were obtained.

Tab. 4.2: Moorings recovered during MSM 02/04

Moor -ing	Latitude Longitude	Water depth (m)	Date and time of first useful record	Instrument type	Serial number	Instr. depth (m)	Time series length (days)
F1-8	78°49.95’N 08°39.85’E	244	17.08.05 08:00	RCM7 VTP1000,tlow	8367	61	369.3
				SBE 37 CTP	2610	63	369.2
				SBE 37 CT	2086	232	369.2
				RCM8 VTP1000,tlow	10004	233	369.3
F2-9	78°50.14’N 08°19.64’E	778	18.08.05 10:00	RCM7 VTP1000,tlow	8400	60	367.9
				SBE 37 CTP	250	62	367.9
				RCM11VTP3500,tlow	455	256	367.9
				SBE 37 CT	2088	766	367.9
				RCM8 VT	10498	772	367.8
				SBE 16	630	798	358.5
PIES E	78°50.36’N 08°19.63’E	785	18.08.05 11:00	PIES	067	784	
F3-8	78°50.32’N 07°59.52’E	1011	18.08.05 14:00	RCM7 VTP1000,tlow	8401	62	lost
				SBE 37 CTP	2236	64	lost
				RCM11VTP3500,tlow	457	253	lost
				RCM8 VT	10499	754	369.0
				RCM11 VTP3500	458	999	367.7
				SBE 16	1167	1001	367.6
F4-8	78°50.18’N 07°00.14’E	1432	18.08.05 16:00	SBE 37 CTP	2237	64	370.1
				ADCP	951	93	0
				RCM11VTP3500,tlow	461	249	370.1
				RCM11 VTP3500	462	755	370.1
				SBE 37	2090	1415	370.1
				RCM11 VT	145	1421	370.1
F5-8	78°49.97’N 06°00.21’E	2412	23.08.05 14:00	RCM7 VTP1000,tlow	8402	62	369.7
				SBE 16 P1000	1975	64	369.7
				RCM8 VT,tlow	9768	253	369.7
				RCM11 VTP3500	501	749	369.7
				RCM8 VTP3000	9783	1505	369.7
				RCM11 VT	486	2401	369.7
F6-9	78°49.82’N 05°01.34’E	2644	26.08.05 16:00	RCM7 VTP1000,tlow	8405	59	363.9
				SBE 16 P1000	1973	61	363.9
				RCM11VTCP3500,tlow	452	255	363.9
				SBE37	2089	257	363.9
				RCM8 VTP3000	9215	751	363.9
				RCM11 VTP3500	513	1507	363.9
				RCM11 VT	102	2633	363.9
				SBE26	258	2644	364.0
PIES C	78°49.97’N 04°54.60’E	2598	26.08.05 16:00	PIES	062	2597	
F7-7	78°50.00’N 04°00.00’E	2292	26.08.05 12:00	RCM8 VTP1000,tlow	9201	62	363.2
				SBE 16 P3000	2420	64	363.1
				RCM8 VT,tlow	10503	253	363.2
				RCM7 VTP20MPa	8395	759	363.2
				RCM11 VTP3500	469	1503	363.2
				RCM11 VT	127	2281	348.5

Moor -ing	Latitude Longitude	Water depth (m)	Date and time of first useful record	Instrument type	Serial number	Instr. depth (m)	Time series length (days)
F8-8	78°50.05’N	2441	31.08.05	RCM8 VT,tlow	9390	60	362.8
	02°48.10’E		16:00	SBE 37P	2392	62	362.7
				RCM11 VTP3500,tlow	472	247	362.8
				RCM7 VTP20MPa,	10925	753	362.8
				RCM8 VTP20MPa	9995	1499	362.8
				RCM11 VT	134	2435	362.8
				SBE26	276	2491	357.9
PIES W	78°49.88’N	2488	31.08.05	PIES	141	2487	
	02°50.63’E		17:00				
F15-4	78°49.98’N	2498	30.08.05	RCM8 VTP1000,tlow	11887	57	364.5
	01°36.60’E		20:00	SBE 37P	2393	59	364.5
				RCM11VTP3500,tlow	474	249	364.5
				RCM11 VTP3500	504	755	364.5
				RCM8 VTP(blind)	10005	1501	flooded
				RCM11 VT	133	2487	364.5
F16-4	78°50.10’N	2530	30.08.05	RCM8 VTP1000,tlow	11892	59	364.5
	00°24.07’E		14:00	SBE 37P	2395	61	365.2
				RCM11VTP3500,tlow	475	251	365.2
				RCM11 VTP3500	506	757	365.2
				RCM11 VTP3500	500	1503	365.2
				RCM11 VT	135	2519	365.2
F9-7	78°50.30’N	2609	30.08.05	RCM7 VTP2000,tlow	10491	58	373.3
	00°48.66’W		10:00	SBE 37P	2396	60	373.2
				RCM11VTP3500,tlow	491	250	373.3
				RCM11 VTP3500	512	756	373.3
				RCM11 VTP3500	509	1502	373.3
				RCM11 VT	144	2598	373.3
				SBE 16 P10000	631	2609	373.3
F10-8	78°49.90’N	2663	06.09.05	RCM8 VTP1000,tlow	8396	61	mooring lost
	01°59.99’W		10:00	SBE 37P	2609	63	
				ADCP	1563	253	
				RCM11 VTP3500	489	750	
				RCM11 VTP3500	465	1506	
				RCM8 VT	9389	2652	

Abbreviations:

ADCP	RDI Inc. Self-Contained Acoustic Doppler Current Profiler
ACM	Falmouth Scientific Inc. 3-dimensional acoustic current meter
VTCP	Aanderaa current meter with temperature, conductivity and pressure sensor
VTP	Aanderaa current meter with temperature and pressure sensor
VT	Aanderaa current meter with temperature sensor
tlow	Aanderaa current meter with Low Range temperature sensor setup
P1000/2000/3500/20MPa	Maximum range of pressure sensor (Aanderaa current meter or SBE)
RCM7	Aanderaa current meter type RCM7
RCM8	Aanderaa current meter type RCM8
RCM 11	Aanderaa Doppler current meter with temperature sensor
SBE 16	Seabird Electronics SBE16 recording temperature, conductivity, and pressure
SBE 26	Seabird Electronics SBE26 bottom pressure recorder
SBE 37	Seabird Electronics SBE37 recording temperature and conductivity (optionally pressure SBE 37 P)
PIES	Pressure Inverted Echo Sounder

Tab. 4.3: Moorings deployed during MSM 02/04

Mooring	Latitude Longitude	Water depth (m)	Date and time of first useful record	Instrument type	Serial-number	Instr. Depth (m)
F1-9	78°49.96’N 08°39.79’E	245	23.08.06 18:00	RCM8 VTP1000	9192	66
				SBE 37	446	68
				SBE 37	445	232
				RCM8 VTP1000	9402	238
F2-10	78°50.14’N 08°19.60’E	782	23.08.06 16:00	RCM7 VTP1000	10530	59
				SBE16	2415	61
				RCM8 VTP	10872	251
				SBE 16 Transm.	2418/446	772
				RCM7 VT	9403	773
PIES-F2-10	78°50.50' N 08°19.52' E	775	23.08.06 14:00	C-PIES	181	775
F3-9	78°50.32’N 07°59.50’E	1012	23.08.06 12:00	RCM7 VTP1000,	3517	62
				SBE 16	2416	64
				RCM8 VTP	10002	254
				RCM8 VT	9186	755
				SBE16/Transm.	2419/445	1001
				RCM11 VT	20	1003
F4-9	78°50.36’N 07°00.60’E	1432	27.08.06 12:00	SBE 37P	1229	65
				ADCP-UP	1368	94
				RCM8 VTP	11613	250
				RCM8 VTP	9212	756
				RCM11 VT	217	1422
				SBE16/Transm.	2421/435	1424
PIES-F4-9	78°50.184'N 06°59.706'E	1427	27.08.06 08:00	C-PIES	182	1427
F5-9	78°50.02’N 06°00.20’E	2412	28.08.06 16:00	RCM7 VTP	11888	63
				SBE 16 P1000	2413	65
				RCM8 VTP	9206	255
				RCM8 VTP	9213	751
				RCM8 VTP	9786	1507
				RCM11 VT	295	2403
PIES-F5-9	78°49.86' N 05°56.26' E	2446	28.08.06 14:00	PIES	058	2446
F6-10	78°49.83’N 05°01.34’E	2644	28.08.06 20:00	RCM8 VTP	11889	65
				SBE 16 P1000	2414	67
				RCM11VTCP	296	252
				RCM8 VT	9188	748
				RCM11 VTP	311	1504
				RCM8	9180	2635
PIES-F6-10	78°50.142'N 04°54.107'E	2586	28.08.06 18:00	C-PIES	183	2586
F7-8	78°50.02’N 04°00.02’E	2298	29.08.06 12:00	RCM7 VTP	8403	66
				SBE 16 P2000	1253	68
				RCM8 VT	9769	258
				RCM8 VT	9770	764
				RCM11 VTP	312	1510
				RCM11 VT	297	2286
				SBE26	259	2298

Mooring	Latitude Longitude	Water depth (m)	Date and time of first useful record	Instrument type	Serial-number	Instr. Depth (m)
PIES-F7-8	78°49.887'N 03°56,756'E	2287	29.08.06 09:00	PIES	071	2287
F8-9	78°49.98'N 02°48.04'E	2445	29.08.05 20:00	RCM7 VTP	8048	60
				SBE 16	1976	62
				RCM11 VT	314	244
				RCM7 VTP	10927	750
				RCM8 VT	6854	1496
				RCM11 VT	315	2432
PIES-F8-9	78°49.998'N 02°50.766'E	2433	29.08.06 18:00	C-PIES	074	2433
F15-5	78°49.96'N 01°36.53'E	2496	30.08.06 16:00	RCM8 VTP1000	10531	59
				SBE 16	1977	61
				RCM7 VTP1000	8417	251
				RCM7 VTP20MPa	10928	757
				RCM8 VT	9391	1503
				RCM11 VT	313	2489
F16-5	78°50.10'N 00°24.08'E	2533	31.08.06 18:00	RCM8 VT	9782	61
				SBE 16	2422	63
				RCM11VTP	508	253
				RCM11 VTP	568	759
				RCM11 VTP	569	1505
				RCM11 VT	298	2521
F9-8	78°50.34'N 00°48.64'W	2614	08.09.06 00:00	RCM7 VTP1000	8050	58
				SBE 37P	2087	60
				RCM8 VTP	9207	247
				RCM11 VTP	570	753
				RCM11 VTP	513	1499
				RCM11 VT	294	2600
F10-9	78°49.26'N 02°02.99'W	2669	09.09.06 00:00	RCM8 VTP1000	9195	63
				SBE 37	448	65
				ADCP-UP	1561	255
				RCM11 VTCP	452	752
				RCM11 VTP	501	1507
				RCM11 VT	212	2654

Abbreviations:

ADCP-UP	RDI Inc. Self-Contained Acoustic Doppler Current Profiler Upper-Looking
VTCP	Aanderaa current meter with temperature, conductivity and pressure sensor
VTP	Aanderaa current meter with temperature and pressure sensor
VT	Aanderaa current meter with temperature sensor
P1000/2000/3500/20MPa	Maximum range of pressure sensor (Aanderaa current meter or SBE)
RCM7	Aanderaa current meter type RCM7
RCM8	Aanderaa current meter type RCM8
RCM 11	Aanderaa Doppler current meter with temperature sensor
SBE 16	Seabird Electronics SBE16 recording temperature, conductivity, and pressure
SBE 26	Seabird Electronics SBE26 bottom pressure recorder
SBE 37	Seabird Electronics SBE37 recording temperature and conductivity (optionally pressure SBE 37P)
PIES	Pressure Inverted Echo Sounder
C-PIES	Pressure Inverted Echo Sounder with DCS (Doppler Current Sensor)

Tab. 4.4: CTD stations carried out during MSM02/04

Station	Cast	Latitude	Longitude	Depth	P max	Day	Month	Year	Hour	Minute
758	1	78.833	9.083	228	222	20	8	2006	21	41
759	1	78.834	8.824	230	224	20	8	2006	22	31
760	1	78.833	8.500	579	578	20	8	2006	23	26
761	1	78.833	8.155	926	930	21	8	2006	0	27
762	1	78.833	7.672	1084	1090	21	8	2006	1	46
763	1	78.833	7.339	1207	1215	21	8	2006	3	3
764	1	78.834	6.671	1738	1756	21	8	2006	4	56
767	2	78.840	8.324	779	781	21	8	2006	12	56
768	1	78.835	8.662	244	239	21	8	2006	15	0
769	1	78.834	6.333	2146	2172	21	8	2006	18	12
770	1	78.833	5.668	2529	2563	21	8	2006	23	58
771	1	78.832	5.335	2586	2622	22	8	2006	2	12
772	2	78.839	7.992	1017	1023	22	8	2006	19	48
773	1	79.133	6.092	1250	1259	23	8	2006	1	54
774	1	79.130	4.904	1512	1533	23	8	2006	4	11
778	2	78.836	7.000	1424	1438	23	8	2006	20	17
779	1	79.108	4.601	1872	1891	24	8	2006	0	28
780	1	79.066	4.181	2414	2448	24	8	2006	3	44
783	2	78.833	3.999	2290	2322	24	8	2006	18	51
784	1	78.834	4.623	2506	2543	24	8	2006	21	10
785	1	78.834	4.311	2365	2399	24	8	2006	23	18
786	1	79.060	4.159	2460	2496	25	8	2006	5	47
788	1	79.015	4.350	1100	1014	25	8	2006	11	27
791	2	78.918	5.002	2584	2623	25	8	2006	22	3
792	1	78.781	5.333	2424	2463	26	8	2006	1	0
793	1	78.606	5.068	2289	2319	26	8	2006	6	7
797	2	78.610	5.068	902	813	26	8	2006	15	45
798	2	78.835	4.903	2587	2625	26	8	2006	20	4
799	1	78.750	7.330	1219	1228	27	8	2006	1	9
800	1	78.836	6.998	1424	1436	27	8	2006	5	9
803	1	78.606	5.069	2288	2320	27	8	2006	19	25
803	3	78.607	5.069	2288	2319	27	8	2006	22	49
804	1	78.833	3.751	2225	2256	28	8	2006	2	24
805	1	78.833	3.414	2320	2350	28	8	2006	4	21
806	2	78.833	6.003	2417	2452	28	8	2006	10	33
811	2	79.064	3.657	3102	3152	28	8	2006	23	58
812	2	79.060	3.581	3487	3554	29	8	2006	4	4
815	2	78.831	2.843	2434	2467	29	8	2006	15	15
818	1	78.833	3.117	2395	2428	29	8	2006	20	36
819	2	78.750	2.999	2495	2532	30	8	2006	0	15
820	1	78.833	2.584	2471	2506	30	8	2006	2	57
821	2	78.833	1.615	2495	2530	30	8	2006	11	9
823	2	78.835	0.402	2530	2567	30	8	2006	20	8
824	1	78.833	0.666	2447	2482	31	8	2006	2	0
825	1	78.833	0.998	2436	2466	31	8	2006	4	1
826	1	78.833	1.300	2472	2504	31	8	2006	6	10
827	1	78.833	1.914	2505	2541	31	8	2006	8	44
828	1	78.833	2.253	2489	2525	31	8	2006	10	54
830	1	78.834	0.095	2575	2610	31	8	2006	16	50
831	1	79.003	0.001	2548	2585	31	8	2006	19	34
832	1	79.140	0.000	2661	2700	31	8	2006	22	10
833	1	79.280	-0.001	2760	2803	1	9	2006	1	4
834	1	79.355	0.937	3129	3177	1	9	2006	5	1

Station	Cast	Latitude	Longitude	Depth	P max	Day	Month	Year	Hour	Minute
835	1	79.419	1.731	1804	1825	1	9	2006	8	18
836	1	79.417	3.000	2764	2806	1	9	2006	12	4
837	1	79.600	2.501	2853	2898	1	9	2006	17	4
838	1	79.750	2.500	3851	3921	1	9	2006	20	5
839	1	79.900	2.498	2832	2876	1	9	2006	23	25
840	1	80.054	2.758	2494	2530	2	9	2006	2	32
841	1	80.201	2.499	1632	1656	2	9	2006	5	9
842	1	80.257	3.206	1311	1323	2	9	2006	8	3
843	1	80.079	4.812	1082	1091	2	9	2006	11	45
844	1	80.280	5.999	572	573	2	9	2006	14	25
845	1	80.382	6.038	569	570	2	9	2006	15	41
846	1	80.413	6.769	624	627	2	9	2006	17	23
847	1	80.563	6.852	701	705	2	9	2006	18	59
848	1	80.710	6.798	824	826	2	9	2006	20	26
849	1	80.880	6.467	873	876	2	9	2006	22	22
850	1	81.035	6.290	805	809	3	9	2006	0	3
851	1	81.179	6.146	683	686	3	9	2006	1	57
852	1	81.308	6.626	746	751	3	9	2006	4	58
853	1	81.369	6.930	922	929	3	9	2006	6	47
854	1	81.365	7.978	495	494	3	9	2006	11	49
855	1	81.288	8.831	1184	1195	3	9	2006	15	25
856	1	81.139	8.784	1098	1107	3	9	2006	18	41
857	1	81.035	9.439	1005	1010	3	9	2006	21	29
858	1	80.913	10.115	1102	1111	4	9	2006	0	32
859	1	80.762	10.498	1416	1434	4	9	2006	2	35
860	1	80.630	11.036	1097	1107	4	9	2006	4	42
861	1	80.464	11.399	672	672	4	9	2006	6	54
862	1	80.299	11.627	183	178	4	9	2006	8	45
866	1	79.604	5.272	2657	2697	4	9	2006	21	10
867	2	79.416	6.582	1379	1394	5	9	2006	4	44
868	2	79.283	4.326	2354	2385	5	9	2006	9	36
869	1	79.411	4.709	2498	2535	5	9	2006	12	17
872	1	79.604	5.268	1101	1015	5	9	2006	20	45
873	1	79.057	3.523	3810	3880	6	9	2006	3	3
875	1	79.060	3.324	5019	5127	6	9	2006	10	43
878	1	79.124	2.927	5534	5660	6	9	2006	23	39
879	1	78.838	-0.142	2582	2620	7	9	2006	11	47
880	1	78.834	-0.455	2636	2676	7	9	2006	14	46
881	3	78.842	-0.815	2615	2654	7	9	2006	23	57
882	1	78.834	-1.094	2498	2534	8	9	2006	2	48
883	1	78.830	-1.428	2632	2672	8	9	2006	5	35
884	1	78.825	-1.702	2659	2699	8	9	2006	11	47
887	1	78.782	-2.091	2674	2714	9	9	2006	7	54
888	1	78.673	-2.519	2613	2652	9	9	2006	12	12
889	1	78.464	-2.842	2599	2638	9	9	2006	18	23
890	1	78.413	-3.172	2481	2517	9	9	2006	21	8
891	1	78.260	-3.515	2487	2523	10	9	2006	0	35
892	1	78.166	-4.006	2407	2442	10	9	2006	7	32
893	1	78.044	-4.351	2249	2281	10	9	2006	10	21
894	1	77.763	-6.000	374	373	11	9	2006	0	12
894	2	77.763	-6.000	374	191	11	9	2006	0	58
895	1	78.500	-6.500	298	296	11	9	2006	8	3
896	1	78.500	-7.000	287	285	11	9	2006	9	55
897	1	78.341	-7.490	215	211	11	9	2006	14	14

Preliminary Results

Warming and salinification, which has been observed already in the last years, continued in 2006 in the entire Fram Strait and especially in the West Spitsbergen Current (WSC) carrying Atlantic Water (AW) northward at the eastern side of the transect (Fig. 4.4). The Atlantic layer in the WSC extended deeper than the years before and the 0°C-isotherm was shifted down to ca. 1000 m. The AW occupied an exceptionally big area of the section what resulted in the largest heat content since the beginning of time series.

The Polar Front between cold Polar Water (PW) and the Atlantic Water in the western part of the section retreated westward as compared to the last 3 years. The surface layer of low salinity water was confined to the western part of the section with only small patches present above the AW in the middle part. This was different than in 2004 and 2005 when the low salinity surface water was spread nearly continuously across the whole section.

The CTD stations performed in the northern part of Fram Strait are combined into three sections (Fig. 4.5). Section Nord1 was located along the ice edge towards the north-east and crossed the western slope of the Yermak Plateau. Patches with temperature, T, higher than 4°C and salinity, S, exceeding 35 are found in the southern part, most likely recirculating AW. Even warmer ($T > 5$°C) and more saline waters constitute the Yermak Plateau branch of the WSC (Fig. 4.5a, b). The section Nord2 repeats this core above the slope and covers the Yermak Plateau. There is a distinct front between the AW core and the colder, less saline AW over the plateau (Fig. 4.5c, d). Section Nord3 cuts across the Litke Trough towards the shelf edge north of Svalbard where again very warm ($T >6.5$°C) and saline ($S >35.1$) was found above the upper slope at 700 m (Fig. 4.5.e, f). This core, being the continuation of the Svalbard branch of the WSC, had almost the same properties as at 78°50’N. Again a sharp front separates the warm core to the north from the water in the central Litke Trough which is also colder than the water on the Yermak Plateau. It could be earlier inflow water e.g. from the last winter. In the northern part the upper 100 m were occupied by cold ($T < 0$°C) and fresh ($S < 34.5$) water.

A time series of spatial averages of CTD temperature and salinity in Fram Strait was updated (Fig. 4.6), confirming that the temperatures and salinities in the layer 50 to 500 m were at record maximum in the WSC area but slightly decreased in the central part. In the EGC both mean temperature and salinity were comparable to values observed in 2005.

A time-space diagram of temperature and cross-section velocity obtained from the array of moorings at the nominal depth of 250 m, representative for the AW layer, confirms the tendencies found from summer hydrographic sections (Fig. 4.7). In late autumn and winter 2005/2006 significantly higher temperatures were observed not only in the WSC but especially in the middle part of Fram Strait, in the recirculation area. A seasonal signal of typically lower temperatures in late winter and spring was strongly dumped and seasonal differences in temperature were much smaller than in previous years. In the WSC the cross-section current velocity was lower in 2005-2006 than in 2004-2005 and the winter maximum of the northward flow was also much weaker. In the recirculation area the cross-section flow was variable, similar as in previous years while in the EGC a stronger southward flow was observed during the last deployment period. The weaker flow in the WSC resulted in a decreased volume transport with the much lower winter maximum in 2006 than in 2005 (Fig. 4.8).

The LADCP data show a strong shear between about 200 m and 1000 m over the Spitsbergen slope the core of the WSC (Fig. 4.9). In the same time this flow was strongly affected by mesoscale activity. Only one station the flow was to the north at 500 m and at 1000 m (Fig. 4.11 and 4.12). Along 78°50’N the flow changes frequently between northward and southward direction suggesting eddies or meanders but there is also westward motion. East of the prime meridian, the flow is southward in the upper part but the flow at the bottom is partly northward, most likely steered by the topography. North of the 78°50’N section the flow direction is very irregular. However, there seems to be an eastward flow north of the Molloy Deep transporting AW towards the Yermak Plateau. That would mean that in the western central Fram Strait, the recirculating AW splits again and part of it continues to recirculate to the south while another part diverts to the north and then northeast.

There is a strong coherent current crossing the central Yermak Plateau towards northeast in 100 and 500 m but the core of warm water that is clearly seen in the hydrographic data northeast of Svalbard shows no clear along-slope velocity signal.

The general conclusion for 2006 is that temperature and salinity in the WSC in Fram Strait were highest in the 10-year observation record. An increase of the AW spatial coverage was also observed. The current pattern in the northern Fram Strait is very irregular.

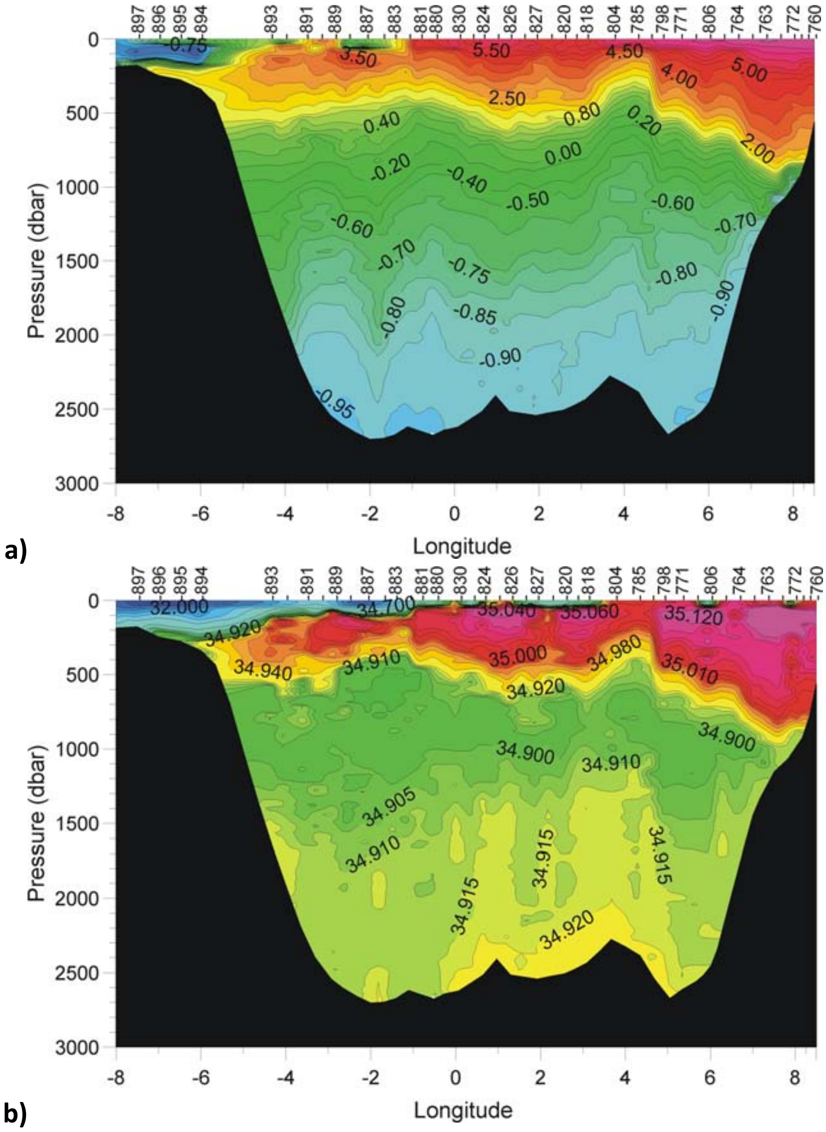


Fig. 4.4: Vertical distribution of potential temperature (a) and salinity (b) across Fram Strait measured during MSM02/04

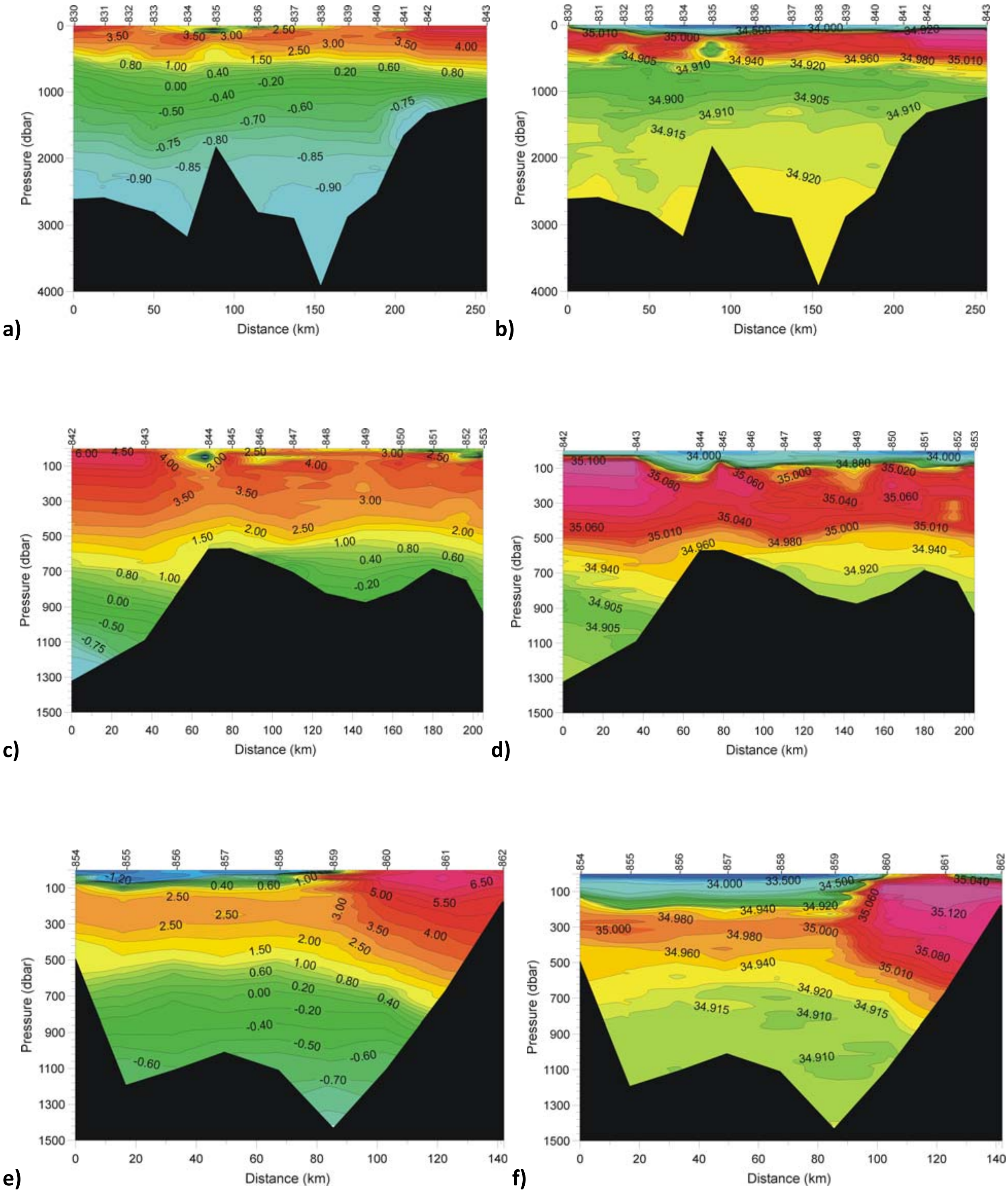


Fig. 4.5: Vertical distributions of temperature and salinity at sections (a, b) Nord1, (c, d) Nord2 and (e, f) Nord3

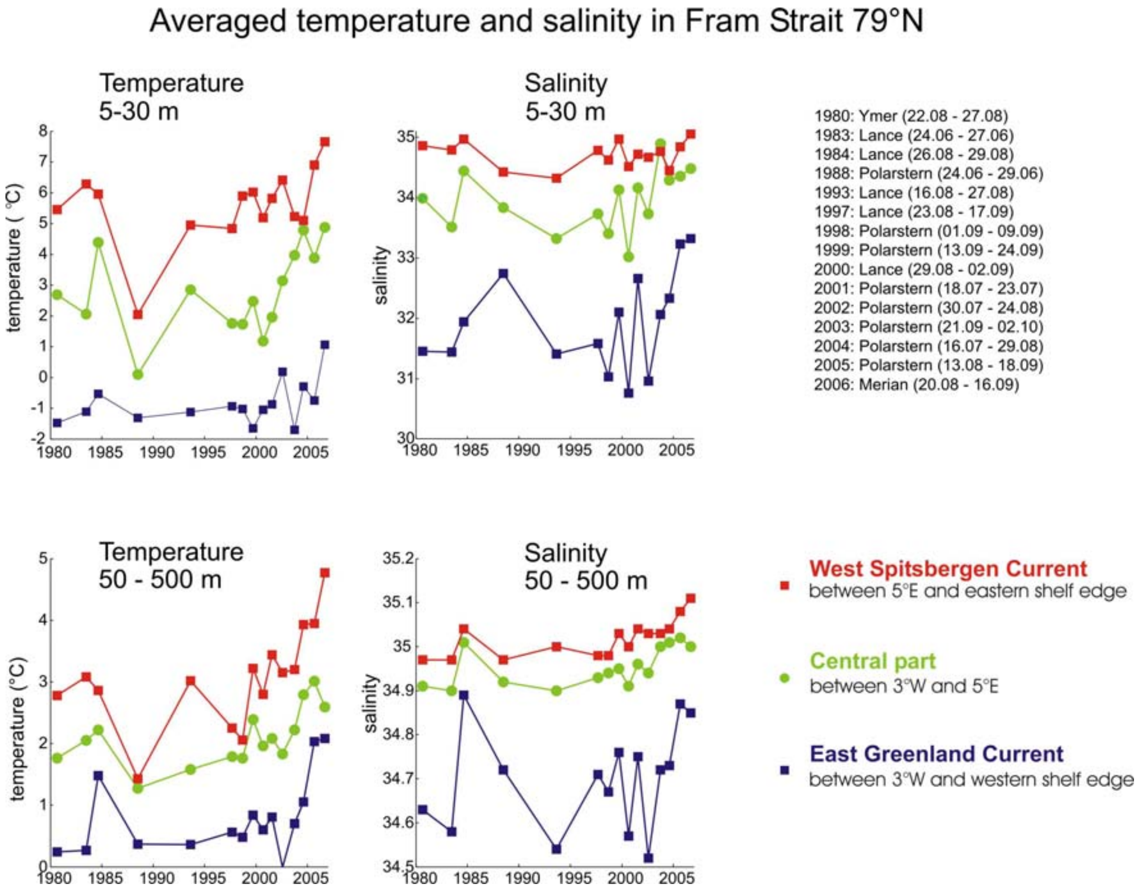


Fig. 4.6: Spatially averaged temperatures and salinities from CTD measurements in the Fram Strait in the West Spitsbergen Current (WSC), in the Central part (C) and in the East Greenland Current (EGC)

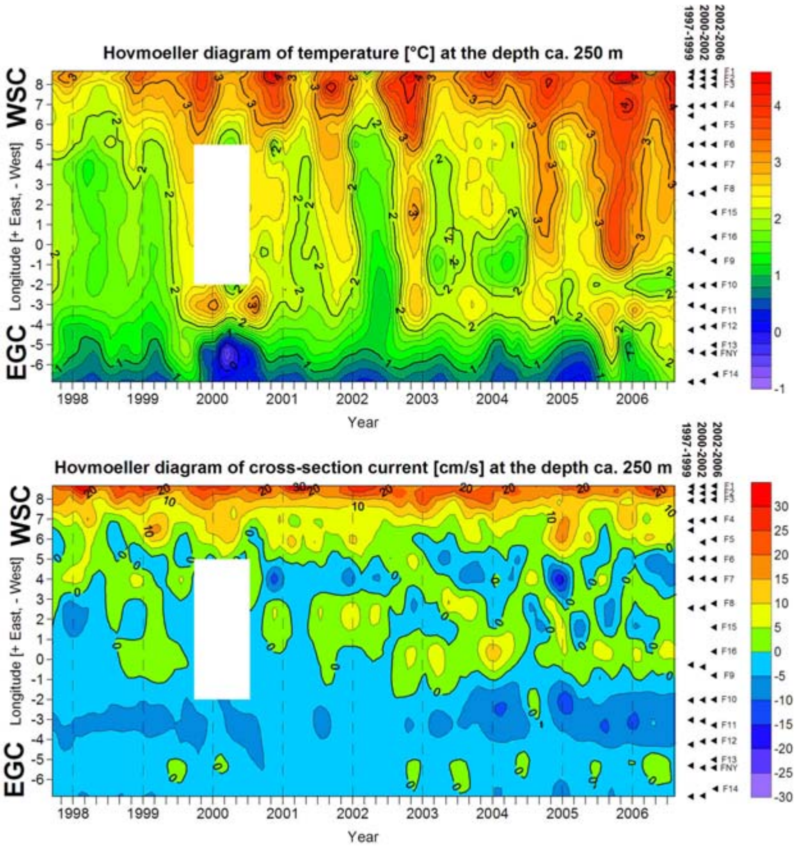


Fig. 4.7:
Hovmöller diagrams of temperature (upper fig.) and cross-section current (lower fig.) in the AW layer at the nominal depth 250m in 1997-2006. Monthly means of the measured values used

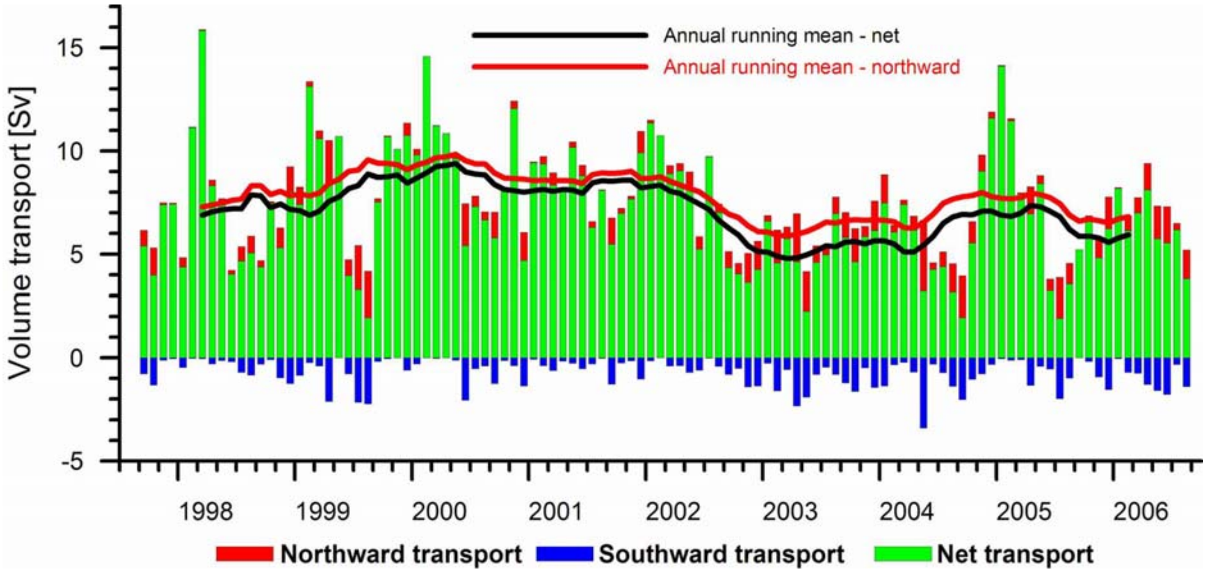
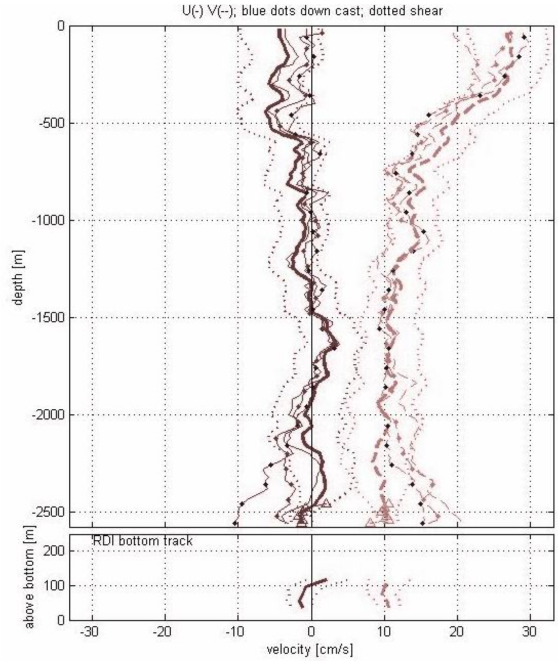


Fig. 4.8: Monthly means of the northward, southward and net volume transport in the West Spitsbergen Current based on results from the moorings between 1997 and 2006



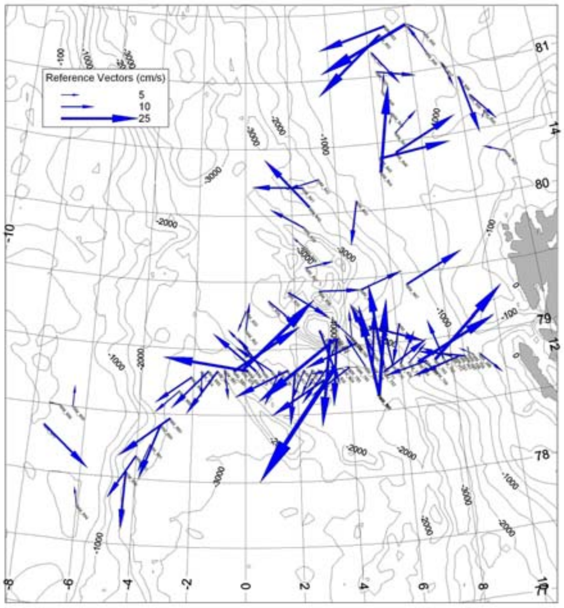
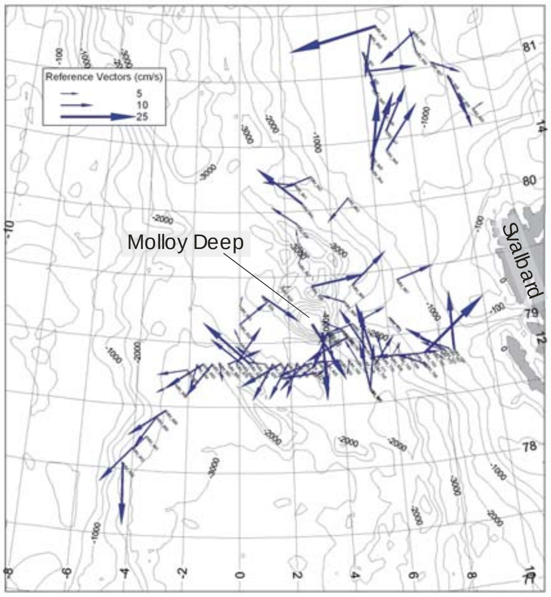


Fig. 4.9 (left panel)**:** LADCP-measured vertical profiles

Fig. 4.10 (right panel)**:** Detided LADCP-measured currents at 100 m



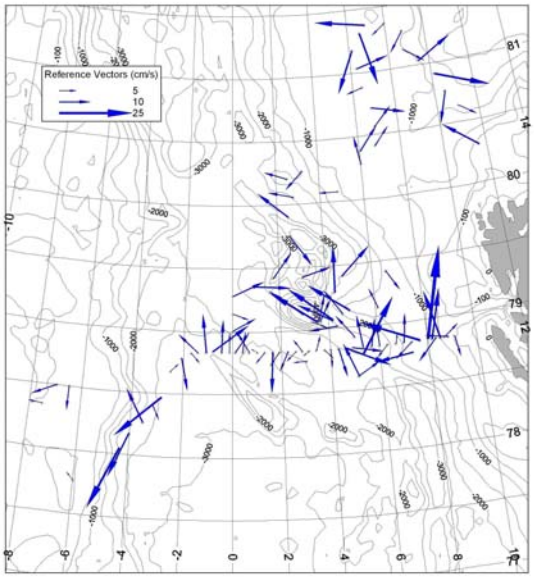


Fig. 4.11 (left panel): Detided LADCP-measured currents at 500 m

Fig. 4.12 (right panel): Detided LADCP-measured currents 20 m above the bottom

4.4.2 Ecosystems time series studies and experimental work in the deep Arctic Ocean

(T. Soltwedel, E. Bauerfeind, S. Bury, G. Fonseca, S. Himme, N. Lochthofen, K. Rabe, M. Volkenandt, J. Wegner)

Due to its enormous dimensions and inaccessibility, the deep-sea realm remains the world's least known habitat. Until a few years ago, deep-sea research simply meant the assessment of the present status in a distinct, unexplored region of the world’s oceans. Single sampling campaigns or measurements, however, generate only snap shots, not allowing extrapolation on temporal variabilities. Consequently, ecological assessments are largely confined. Only long-term investigations at selected sites offer the opportunity to identify environmental settings determining the structure, complexity and the development of deep-sea communities. There is strong evidence that ongoing industrialisation also affects the marine environment, including the deep sea. Hence, basic data are urgently needed to assess anthropogenic impacts on the deep-sea ecosystem. Long-term investigations at selected sites provide the information necessary to assess the present status, and to describe changes due to anthropogenic impacts. The opportunity to measure processes on sufficiently long time scales will finally help to differentiate spatial and temporal variability from (natural) long-term trends.

High latitudes are amongst the most sensitive environments in respect to climate change, a fact urgently demanding the assessment of time series especially in Polar Regions. HAUSGARTEN observatory, established in 1999 by the Deep-Sea Research Group of the Alfred-Wegener-Institute for Polar and Marine Research, represents the first and only deep-sea long-term station at high latitudes (Fig. 4.13). Beside a central experimental area at 2500 m water depth, we defined 9 stations along a depth transect between 1000-5500 m from the Vestnesa Ridge to the

Molloy Hole, and additional 6 stations along a latitudinal transect crossing the central HAUSGARTEN station, which will be revisited yearly to analyse seasonal and interannual variations in biological, geochemical and sedimentological parameters.

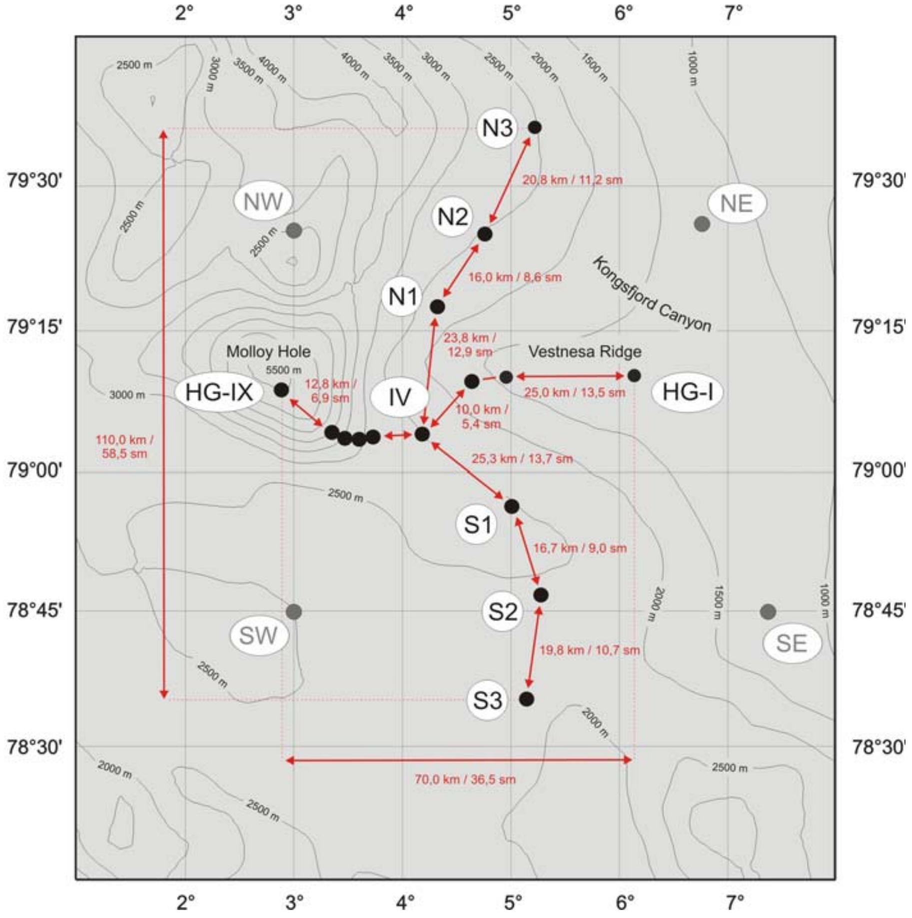


Fig. 4.13: Standard sampling site (black dots) and additional stations in 2006 (grey dots) of the seep-sea long-term observatory HAUSGARTEN in eastern Fram Strait

4.4.3 Interdisciplinary investigations at the deep-sea long-term observatory HAUSGARTEN

(T. Soltwedel, E. Bauerfeind, K. Rabe)

Long-term investigations at HAUSGARTEN comprise various compartments of the deep-sea ecosystem, including the water column and the deep seafloor. To characterise and quantify organic matter fluxes to the seafloor, we use moorings carrying sediment traps. The exchange of solutes between the sediments and the overlaying waters as well as the bottom currents is studied to investigate major processes at the sediment-water-interface. Virtually undisturbed sediment samples are taken using a multiple corer. Various biogenic compounds from the sediments are analysed to estimate activities (e.g. bacterial exoenzymatic activity) and total biomass of the smallest sediment-inhabiting organisms. Results help to describe the eco-status of the benthic system. The quantification of benthic organisms from bacteria to megafauna is a major goal in biological investigations.

The scientific sampling during R/V MARIA S. MERIAN cruise MSM02-4 to HAUSGARTEN observatory was a real success. CTD casts were performed at all permanent HAUSGARTEN sampling sites. Except for the station at 5000 m on the depth transect, all HAUSGARTEN stations were sampled for surface sediments by means of a multiple corer. This year, another four sampling site were set up at the north- and south-western, and the north- and south-eastern edges of the HAUSGARTEN region to get a better idea about two-dimensional patterns in the area of investigations. Moorings equipped with current meters and sediment traps were exchanged at the central HAUSGARTEN station as well as at the northernmost and southernmost HAUSGARTEN site. A free-falling grab respirometer was deployed 3-times to study the carbon remineralisation by the benthic community (see 4.4.5). A long-term bottom-lander carrying various instruments (current meter, time-lapse camera, sediment trap) was recovered and re-deployed at the central HAUSGARTEN station.

Preliminary results

Organic material, which is produced in the upper water column of the ocean, is the major food source for heterotrophic organisms inhabiting the deeper water layers and the sediment. The transfer and modification of this organic material to the deep waters and finally the sediments of the deep sea is studied by means of annually moored sediment traps at 3 positions in the HAUSGARTEN area (Fig. 4.13). Altogether seasonally resolved samples from 6 sediment traps were obtained, covering the period September 2005 - July 2006. The amount of material collected in the bottles of the long-term mooring show a distinct seasonal pattern. Fig. 4.14 shows an example of material obtained with a trap moored 200 m below the sea surface. Larger fluxes can be deduced during September/October 2005 (samples 1-4). Very little material was intercepted by the sediment traps after this period until April/May 2006 (samples 10-13), when the amount of material started to increase again. Only a rough impression can be obtained from this visual inspection of the sampling jars, more detailed information will be obtained after chemical, biochemical and microscopic analysis of the samples later on.

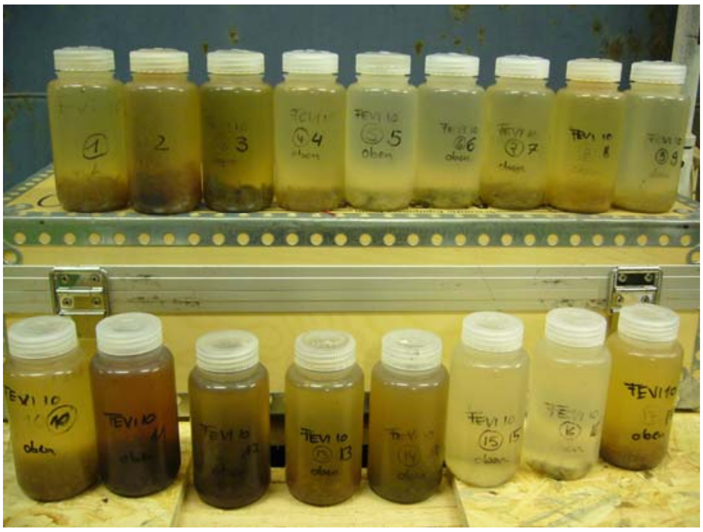


Fig. 4.14: Sampling jars from the trap of mooring FEVI 10

At the positions of the sediment trap moorings, CTD-Rosette hauls from the surface to the seafloor were carried out and water samples were taken at 12 depths for the analysis of Chlorophyll *a*, seston, particulate organic carbon and nitrogen, and the determination of biogenic Si as well as species composition of the phytoplankton. Along the oceanographic transects to the North, across the Fram Strait and parallel to the Greenland continental slope, samples were taken with an Apstein net (25 µm) for the analysis of phytoplankton composition in the upper 50 m of the water column (Fig. 4.15). A first analysis of the material revealed that diatoms were the most abundant forms in the samples in the region of the HAUSGARTEN. Here, several species belonging to the centric diatom genus *Rhizosolenia*, *Thalassiosira*, and *Chaetoceros* as well as pennate diatoms of the genus *Fragillariopsis, Nitzschia, and Pseudonitzschia* occurred in higher abundances. Along the oceanographic transect to the North also cells of the autotrophic dinoflagellate *Ceratium* (namely *Ceratium arcticum)* were present in large quantities. Occasionally, we observed heterotrophic Dinoflagellates and Tintinnids in large numbers in the samples. Besides, the diatoms the silicoflagellate *Dictyocha speculum* and the Chrysophycea*e* *Dinobryon sp.* were observed regularly in the samples. Colonies and single cells of the prymnesiophyceae Phaeocystis *sp*. appeared only occasionally.

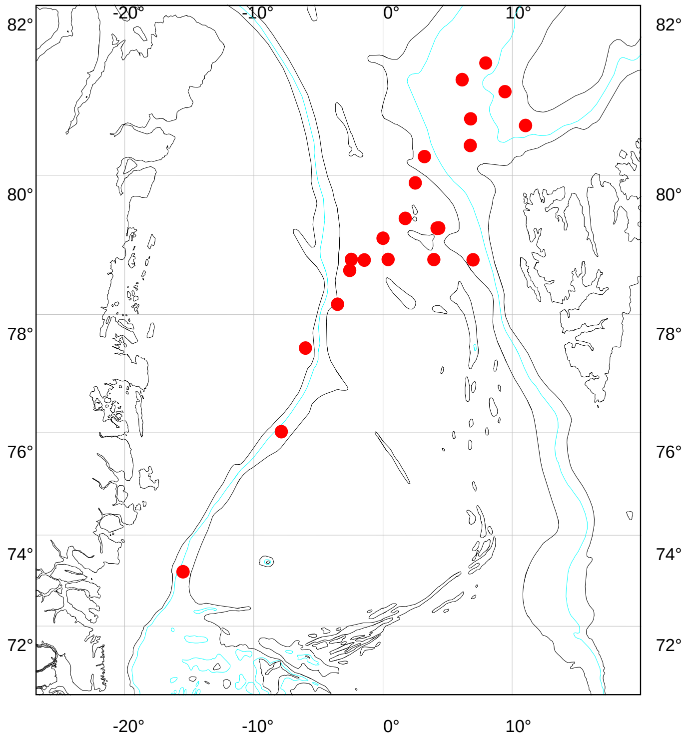


Fig. 4.15: Map showing stations were net samples for the determination of phytoplankton composition were taken

First results from sediment analyses carried out on board directly after sampling showed an ongoing trend in sediment-bound organic matter and benthic activity indicating that the general decrease in organic matter flux to the deep seafloor of the last 5 years is persistent. An ongoing trend in decreasing organic matter input will certainly affect the entire deep-sea ecosystem.

4.4.4 Latitudinal shifts in deep sea nematode assemblages

(G. Fonseca, T. Soltwedel)

Latitudinal species diversity gradients are among the most conspicuous biogeographic patterns on Earth. Research in the subject has a long history, particularly for terrestrial organisms. Investigation of the diversity and species richness of deep-sea metazoa over latitudinal scales is relatively new and, so far, restricted to molluscs, isopods, and most recently to nematodes. It is believed that the diversity of deep-sea organism may respond positively to the productivity of the overlaying-waters. However, most deep-sea metazoan data have been collected for purposes other than large-scale studies. Interpretation of these data may be problematical as samples were taken at different water depths and under other uncontrolled environmental variables that might obscure any large-scale pattern.

The northern part of the Greenland continental margin is characterized by lower solar radiation and higher ice concentrations than the southern latitudes. These atmospheric and oceanographic changes can considerably affect the primary production in the overlaying waters and consequently the input of organic material to the benthic system. Meiobenthic species richness and abundances are expected to respond immediately to such input. In an attempt to characterize the latitudinal shifts in the meiobenthic communities along the Eastern Greenland margin, we sampled 3 stations between the latitudes 73°N and 79°N at similar water depths (1850-2015 m). At each station one multiple core (MUC) carrying eight cores of 10 cm in diameter was taken. Three sub-samples from different MUC tubes were collected for each abiotic (water content and grain size) and biotic (meiofauna, chloroplastic pigments and microbial biomass) sediment parameters. In order to investigate gradients within the sediment column, samples were sliced horizontally in 1 cm layers.

4.4.5 Carbon remineralisation by the benthic community

(T. Soltwedel, S. Himme)

The seafloor plays an important role in the regulation of the chemical composition of water masses in the oceans. The conventional approach to study geochemical and biological processes at the seafloor is to collect a sediment sample from the seabed, bring it up to the surface and there make observations and carry out experiments on it either on-board ship or in the laboratory. It is difficult, if not impossible, to obtain accurate data from the deep-sea, because artefacts are induced when the samples are subjected to large changes in hydrostatic pressure and temperature as they are brought up to the surface. Therefore, it's preferable to carry out experiments and measurements with the use of bottom landers directly at the sea floor (*in situ*).

To assess and quantify the role of the benthos in the recycling of carbon and to calculate the fluxes of solutes across the sediment water interface, we performed measurements of *in situ* oxygen consumption at the seabed. Sediment community oxygen consumption was measured using a free-falling grab respirometer. The lander consists of a flotation tripod and four integrated incubation chambers (Fig. 4.16). Each chamber encloses approx. 6000 cm^3 of sediment and about 6 l of water. A new-designed subsystem of the respirometer draws off (and stores) 8-times 60 ml of the overlying water for ship-board Winkler titrations, to measure the decrease of dissolved oxygen due to the respiration of sediment-inhabiting organisms within the chambers. The free-falling grab respirometer was deployed 3-times at the central HAUSGARTEN station as well as at the northernmost and southernmost HAUSGARTEN site. Station depths were approx. 2500 m water depth; incubation times were 12 hours, each.

Fig. 4.16:
Deployment of the free-falling grab respirometer

4.4.6 Responses of deep-sea nematode assemblages to increase food availability

(G. Fonseca, F. Gallucci)

The periodic sedimentation of phytodetritus, sinking from the euphotic waters to the deep seafloor, is now well documented for many oceanic areas. Despite its initial more or less even deposition, the combination of currents and topography results in a patchy distribution on a scale of centimetre to tens of centimetre. This spatio-temporal patchiness of organic matter input against a background of low productivity is likely to be one of the most important structuring factors determining benthic deep-sea communities. Nevertheless, how small scale species distributions are affected by the patchy input of organic matter remains largely unknown. This is particularly true for the nematodes, the most abundant metazoan taxa in deep-sea sediments.

In order to get insight into how the patchiness deposition of phytodetritus affects nematodes species small-scale distribution, a short-term experiment was conducted on board of the R/V MARIA S. MERIAN during cruise MSM02/4. Twelve undisturbed multiple core sediment samples (9.5 cm inner diameter) taken at the HAUSGARTEN area from 1500 m water depth were incubated shipboard in a temperature-controlled room at 2ºC in the dark during a period of 17 days. Patchy carbon deposition was mimicked by adding a fixed amount (equivalent to 1 g C.m^{-2}) of the freeze-dried diatom *Thalassiossira weissflogii* to a delimited area of the core. At each time interval (T_0 - before adding the patch of algae; T_1 - 8 days after adding the patch of algae and T_2 - 15 days after adding the patch of algae), four cores were detailed sampled for nematodes, chloroplastic pigments and bacterial biomass analysis.

In parallel, another experiment was carried out to investigate the capability of deep-sea nematode species to colonize patches of defaunated sediment. A 500 µm mesh-covered cylinder (1.6 cm diameter, 10 cm height) was placed in a plastic container (5.5 cm in diameter, 11 cm in height) filled up to 3 cm height with deep-sea sediment samples containing indigenous meiofauna. The mesh cylinder was filled up to 3 cm depth with defaunated sediment that was either enriched with the diatom *T. weissflogii* or unenriched. Four replicates of each treatment were sampled after 9 and 17 days. As controls, 4 plastic containers containing deep-sea sediment with meiofauna but no internal cylinder were also sampled at each time interval.

4.4.7 Biofouling experiments at the deep seafloor

(N. Lochthofen)

Biofouling on submerged surfaces like ships hulls, and underwater structures is a well known problem. It occurs also on scientific installations and devices for underwater research. Instruments which remain for longer periods of time in the water may show failures due to biofouling. The dimension of fouling in the deep Arctic Ocean is comparatively low, but prior experiences show that fouling even appears under these conditions.

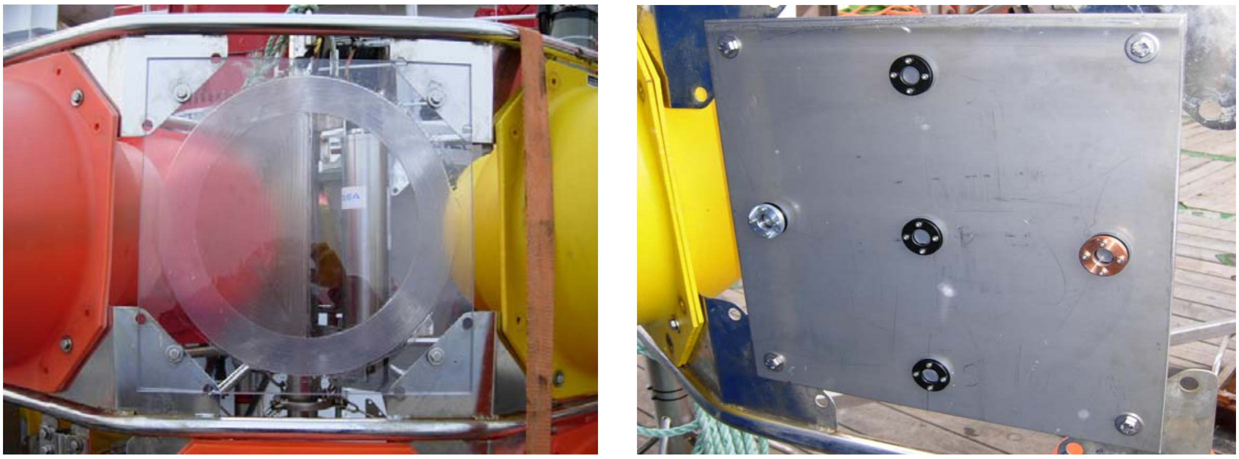
To characterise the kind and degree of biofouling and to test some methods of fouling prevention, we developed three experiments. These experiments have been mounted on a long-term bottom-lander installed for one year at the central HAUSGARTEN site:

(i) Fouling characterisation: Arrays of 60 microscope slides (one upon the other) were assembled on each of the three bottom-lander legs (Fig. 4.17). With this alignment we not only want to retrieve samples to analyse the type of fouling but also to detect impacts of different current directions and the distance to the ground on it. A current meter was mounted on top of the bottom-lander to measure current direction and velocity.

(ii) Fouling prevention (A): Plastic panels with silicon coatings (Fig. 4.18) were exposed to determine the efficiency of silicon under deep-sea conditions. Silicone fouling-release coatings may be a good alternative to toxic fouling paints. An uncoated area of the panel serves as control. The panel positions are similar to the array positions of the fouling characterisation experiment (i) because the current direction and velocity may have an impact as well.

(iii) Fouling prevention (B): There are many different applications for optical glasses in marine research, ranging from camera lenses to measuring fields in optical sensors. To compare diverse fouling prevention methods, five pieces of glass were mounted on a metal panel (Fig. 4.18). Two of them with a direct coating (silicon, silicon oil with nano-particles), two others bordered with a metal ring (zinc, copper). The fifth glass without treatment serves as control.

Fig. 4.17: Arrays of microscope slides (see close-up) assembled along the bottom-lander legs



a)

b)

Fig. 4.18: Plastic panel with silicon coating (a) and five pieces of glass partly with coatings and different metal ring mounted on a metal panel (b)

4.4.8 Biodiversity and ecology of deep-sea copepods

(H. Auel, S. Laakmann)

Background & Objectives

The DFG funded project "Biodiversity and ecology of deep-sea copepods in polar seas – speciation processes and ecological niches in the homogeneous environment of the pelagic realm" focuses on the biodiversity and feeding ecology of dominant deep-sea copepods in the Arctic and Antarctic Oceans.

The two copepod families Euchaetidae and Aetideidae are important components of zooplankton communities throughout the World Ocean, especially in deep oceanic waters and Polar Regions. Most of these species inhabit meso- and bathypelagic depths, while some are epi- or benthopelagic. Euchaetidae contribute significantly to the zooplankton biomass in both Polar Regions, while Aetideidae are characteristic inhabitants of the Arctic and Antarctic deep-sea. The genus *Paraeuchaeta* is carnivorous and includes major predators on other mesozooplankton. Aetideid copepods are generally referred to as omnivorous. Species of both families can be responsible for one to two thirds of the total energy flow through the carnivorous trophic level, and may consume nearly half of the vertical carbon flux. Thus, these meso- and bathypelagic copepods substantially affect pelago-benthic coupling processes and, hence, may have a significant impact on carbon and energy fluxes in polar systems.

A characteristic, but still enigmatic feature of Euchaetidae and Aetideidae is the co-occurrence of several to many closely related species in pelagic deep-sea habitats of the Arctic and Antarctic. For instance, 14 species of the genus *Paraeuchaeta* coexist in waters around the South Georgia archipelago in the Southern Ocean. Since the pelagic deep-sea is an almost homogeneous environment without physical barriers, the sympatric co-occurrences of such closely related species raises the questions how the biodiversity of these deep-sea species evolved and what mechanisms effectively minimize inter-specific competition, which would otherwise lead to the extinction of less fit competitors.

Most deep-sea ecosystems depend on primary production in the thin euphotic surface layer of the ocean and on the sedimentation of organic matter to deeper strata. Therefore, resource limitation presumably represents an important factor in the evolution of meso- and bathypelagic species. Our project focuses on differences in vertical distribution, life-cycle strategies, diet spectra and feeding behaviour of different co-occurring deep-sea copepods in order to characterise their distinct ecological niches in the deep-sea pelagic realm. Thus, our project contributes to an improved understanding of deep-sea biodiversity and evolutionary patterns in general and in particular of the reasons and mechanisms sustaining a relatively rich meso- and bathypelagic fauna with a comparatively high biodiversity in polar seas despite the limited food supply and the absence of physical barriers. With these objectives, our project actively contributes to international marine biodiversity initiatives, such as Census of Marine Zooplankton (CMarZ).

Concentrating on important families of deep-sea copepods and applying state-of-the-art molecular genetic and biochemical methods, the project addresses the following questions:

1) How do closely related species (or even congeners) find individual niches in the almost homogeneous environment of the deep-sea pelagial?

2) Are there any differences in the vertical distribution of sympatric species?

3) How do feeding behaviour and diet composition differ between co-occurring species in order to minimise or avoid inter-specific competition?

4) When, how and why did the radiation of aetideid and euchaetid copepods occur leading to the high biodiversity of these groups of deep-sea inhabitants?

5) What are the speciation mechanisms in the almost homogeneous environment of the deep-sea pelagial?

6) What are the reasons and mechanisms sustaining a relatively rich meso- and bathypelagic fauna with a comparatively high biodiversity in polar seas despite the limited food supply and in the absence of physical barriers?

Work at Sea

During the expedition MSM02/4, deep-sea copepods were collected at a total of 11 stations by stratified multiple opening/closing net hauls (Hydro-Bios MultiNet, 300 µm mesh size). Sampling concentrated on a transect from East to West (6°52'E to 7°29'W). Seven stations were sampled at approximately 78°N, the others at latitudes of 77°45', 79°04', 79°36' and 81°22'N depending on the prevailing sea-ice conditions. Standard depth intervals (2000-1500-1000-500-200-100-50-0 m) were sampled in order to study differences in the vertical and regional distribution of copepod species in relation to hydrographic regimes. Since only five discrete depth strata could be sampled in one haul of the MultiNet, two successive hauls (one to 2000 m depth and another one to 200 m) were conducted at each station in order to combine deep sampling with a higher vertical resolution of the upper water layers.

Zooplankton samples were analysed in a temperature-controlled laboratory on board at 2°C immediately after the catch. Deep-sea copepods of the families Euchaetidae and Aetideidae (and other dominant species) were sorted, recorded and either used for experiments on board or deep-frozen at -80°C for molecular genetic and biochemical analyses (diet composition via fatty acid trophic biomarkers and stable isotopes) at the home laboratory in Bremen. The rest of the net samples was preserved either in formalin or in ethanol for genetic studies. In addition, zooplankton material (krill, amphipods, ostracods and chaetognaths) was collected for other projects conducted by co-operating partners at the Alfred Wegener Institute for Polar and Marine Research and at Bremen University.

Since food availability, feeding behaviour and diet composition are crucial factors determining the ecological niches of deep-sea animals, feeding experiments were carried out onboard. During quantitative feeding experiments, we determined ingestion rates at ambient conditions (darkness and *in situ* temperature of 2°C) with *Paraeuchaeta* species. Predators and prey were incubated for three or more days. After the termination of the experiments, the remaining prey organisms were counted and both, predators and prey, were deep-frozen for body-mass determination in the home laboratory. Furthermore, qualitative feeding experiments were carried out with aetideid species. Species were incubated with different food organisms in small dishes. Every two hours the remaining amount of the different food items was controlled and faecal pellet production recorded. More than 70 samples of faecal pellets were collected for subsequent biochemical and electron-microscopic analyses.

More than 50 measurements of oxygen consumption were conducted to establish metabolic rates and energy requirements of deep-sea copepods. The experiments included females, males and copepodids C5 of the most dominant euchaetid and aetideid species, i.e. *Paraeuchaeta norvegica*, *P. glacialis*, *P. barbata* and *P. polaris* as well as *Gaetanus brevispinus*, *G. tenuispinus* and *Aetideopsis rostrata*. One to four individuals were incubated for three to five days at *in situ* conditions in gas-tight glass bottles filled with oxygen-saturated seawater. Oxygen concentrations were determined by Winkler titration and corrected for microbial respiration in comparison to animal-free controls. In order to calculate mass-specific respiration rates, individuals for body-mass determination were frozen for later analysis in the home laboratory.

Preliminary Results

A total of more than 1000 deep-frozen samples was collected including different developmental stages of four euchaetid and eight aetideid species. For several more species, final confirmation is still pending. *Paraeuchaeta norvegica* was the most abundant euchaetid copepod in the eastern part of the investigation area dominated by Atlantic water masses. At the westernmost stations on the East Greenland Shelf influenced by polar waters of the East Greenland Current, *P. glacialis* replaced the boreal-Atlantic congener *P. norvegica*. In comparison to previous studies conducted in the mid of the 1990ies, boreal-Atlantic species were more abundant and widespread in the Fram Strait region during MSM02/4, supporting the oceanographers' observation of an increased Atlantic inflow via the West Spitsbergen Current with higher core temperatures and a more westward extension.

With regard to meso- and bathypelagic copepods, closely related or congeneric species were usually confined to discrete depth ranges resulting in a multi-layered vertical distribution pattern and partitioning of the water column. However, certain congeners shared the same depth layers or had overlapping depth ranges. Thus, vertical partitioning contributes to an avoidance of inter-specific competition, but additional mechanisms are required to explain cases of co-existence.

The successful combination of fieldwork and experimental approaches during MSM02/4 as well as molecular genetic and biochemical analyses to be conducted in the home laboratory will expand our knowledge about life-cycle strategies and biodiversity of meso- and bathypelagic zooplankton and help to elucidate speciation processes in the deep-sea environment.

4.5 Station List

Tab. 4.5: List of stations of R/V MARIA S. MERIAN Cruise MSM02/4

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abbreviation	Action
MSM2/758-1	20.08.2006	21:49	78° 49.99' N	9° 4.99' E	225.5	CTD/RO	at depth
MSM2/759-1	20.08.2006	22:40	78° 50.11' N	8° 49.32' E	221.8	CTD/RO	at depth
MSM2/760-1	20.08.2006	23:40	78° 50.01' N	8° 29.91' E	574.5	CTD/RO	at depth
MSM2/761-1	21.08.2006	00:48	78° 50.00' N	8° 9.27' E	923.6	CTD/RO	at depth
MSM2/762-1	21.08.2006	02:09	78° 50.00' N	7° 40.32' E	1081.9	CTD/RO	at depth
MSM2/763-1	21.08.2006	03:31	78° 50.00' N	7° 20.33' E	1207.7	CTD/RO	at depth
MSM2/764-1	21.08.2006	05:28	78° 50.01' N	6° 40.27' E	1744.3	CTD/RO	at depth
MSM2/765-1	21.08.2006	07:34	78° 50.20' N	8° 0.16' E	1010.7	MOR	Hydrophone into the water
MSM2/765-1	21.08.2006	07:47	78° 50.31' N	8° 0.03' E	0	MOR	released
MSM2/765-1	21.08.2006	08:36	78° 50.35' N	7° 59.63' E	0	MOR	action
MSM2/766-1	21.08.2006	09:09	78° 50.12' N	8° 19.96' E	0	MOR	Hydrophone into the water
MSM2/766-1	21.08.2006	09:09	78° 50.12' N	8° 19.96' E	0	MOR	released
MSM2/766-1	21.08.2006	09:10	78° 50.12' N	8° 19.94' E	0	MOR	on the surface
MSM2/766-1	21.08.2006	09:12	78° 50.12' N	8° 19.89' E	0	MOR	Hydrophone on Deck
MSM2/766-1	21.08.2006	10:13	78° 50.62' N	8° 19.02' E	0	MOR	releaser on deck
MSM2/766-1	21.08.2006	10:15	78° 50.64' N	8° 18.98' E	0	MOR	mooring on deck
MSM2/767-1	21.08.2006	11:53	78° 50.42' N	8° 18.62' E	0	MOR	released
MSM2/767-1	21.08.2006	12:34	78° 50.42' N	8° 18.62' E	0	MOR	on the surface
MSM2/767-1	21.08.2006	12:47	78° 50.39' N	8° 19.41' E	0	MOR	mooring on deck
MSM2/767-2	21.08.2006	13:18	78° 50.39' N	8° 19.45' E	776.1	CTD/RO	at depth

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abbreviation	Action
MSM2/768-1	21.08.2006	14:04	78° 50.17' N	8° 40.44' E	227.7	MOR	Hydrophone into the water
MSM2/768-1	21.08.2006	14:05	78° 50.15' N	8° 40.41' E	229.3	MOR	released
MSM2/768-1	21.08.2006	14:06	78° 50.15' N	8° 40.41' E	0	MOR	on the surface
MSM2/768-1	21.08.2006	14:35	78° 50.12' N	8° 19.89' E	0	MOR	Hydrophone on Deck
MSM2/768-1	21.08.2006	14:45	78° 50.64' N	8° 18.98' E	0	MOR	releaser on deck
MSM2/768-1	21.08.2006	14:46	78° 50.64' N	8° 18.98' E	0	MOR	mooring on deck
MSM2/768-2	21.08.2006	15:10	78° 50.08' N	8° 39.69' E	242.1	CTD/RO	at depth
MSM2/769-1	21.08.2006	18:55	78° 50.03' N	6° 19.97' E	2146.7	CTD/RO	at depth
MSM2/769-2	21.08.2006	19:49	78° 50.03' N	6° 19.98' E	2146.7	MN	surface
MSM2/769-2	21.08.2006	20:00	78° 50.03' N	6° 19.98' E	2146.8	MN	at depth
MSM2/769-2	21.08.2006	20:12	78° 50.03' N	6° 19.98' E	2146.8	MN	on deck
MSM2/769-3	21.08.2006	20:20	78° 50.03' N	6° 19.97' E	2146.9	MN	surface
MSM2/769-3	21.08.2006	21:34	78° 50.03' N	6° 19.98' E	2154.2	MN	at depth
MSM2/769-3	21.08.2006	22:47	78° 50.03' N	6° 19.96' E	2148.1	MN	on deck
MSM2/770-1	22.08.2006	00:47	78° 49.98' N	5° 40.11' E	2524.6	CTD/RO	at depth
MSM2/771-1	22.08.2006	03:02	78° 49.96' N	5° 20.05' E	2580.4	CTD/RO	at depth
MSM2/772-1	22.08.2006	07:45	78° 50.33' N	7° 59.44' E	0	MOR	Hydrophone into the water
MSM2/772-1	22.08.2006	07:58	78° 50.28' N	7° 59.04' E	0	MOR	released
MSM2/772-1	22.08.2006	08:26	78° 49.96' N	7° 57.64' E	0	MOR	Hydrophone on Deck
MSM2/772-1	22.08.2006	08:49	78° 50.35' N	7° 59.41' E	0	MOR	Hydrophone into the water
MSM2/772-1	22.08.2006	09:08	78° 50.32' N	7° 59.38' E	0	MOR	Hydrophone on Deck
MSM2/772-1	22.08.2006	10:50	78° 49.74' N	7° 59.12' E	1012.1	MOR	action
MSM2/772-1	22.08.2006	15:48	78° 50.41' N	7° 58.04' E	0	MOR	action
MSM2/772-1	22.08.2006	16:42	78° 50.59' N	7° 58.01' E	0	MOR	action
MSM2/772-1	22.08.2006	16:48	78° 50.61' N	7° 58.01' E	0	MOR	action
MSM2/772-1	22.08.2006	18:19	78° 50.64' N	7° 58.01' E	1023.5	MOR	action
MSM2/772-1	22.08.2006	18:38	78° 50.64' N	7° 58.01' E	1024	MOR	action
MSM2/772-1	22.08.2006	19:23	78° 50.64' N	7° 58.01' E	1023.8	MOR	action
MSM2/772-1	22.08.2006	19:25	78° 50.63' N	7° 58.04' E	1024.4	MOR	mooring on deck
MSM2/772-2	22.08.2006	20:08	78° 50.34' N	7° 59.54' E	1014.6	CTD/RO	at depth
MSM2/773-1	22.08.2006	23:58	79° 7.99' N	6° 5.49' E	1266.2	MUC	at sea bottom
MSM2/773-2	23.08.2006	01:21	79° 8.02' N	6° 5.42' E	1257	MUC	at sea bottom
MSM2/773-3	23.08.2006	02:20	79° 8.00' N	6° 5.52' E	1257.1	CTD/RO	at depth
MSM2/774-1	23.08.2006	04:45	79° 7.82' N	4° 54.21' E	1520.7	CTD	at depth
MSM2/774-2	23.08.2006	05:48	79° 7.82' N	4° 54.21' E	1519	MUC	at sea bottom
MSM2/775-1	23.08.2006	10:12	78° 50.32' N	7° 59.50' E	1012.3	MOR	surface
MSM2/775-1	23.08.2006	11:21	78° 50.32' N	7° 59.50' E	1012.7	MOR	slipped
MSM2/776-1	23.08.2006	12:39	78° 50.47' N	8° 19.62' E	773	MOR	action
MSM2/776-1	23.08.2006	12:56	78° 50.50' N	8° 19.52' E	774.9	MOR	released
MSM2/776-1	23.08.2006	13:00	78° 50.51' N	8° 19.52' E	772.4	MOR	action
MSM2/776-2	23.08.2006	13:40	78° 50.15' N	8° 19.61' E	780.4	MOR	surface
MSM2/776-2	23.08.2006	14:31	78° 50.14' N	8° 19.60' E	780.5	MOR	on the ground
MSM2/776-2	23.08.2006	14:35	78° 50.14' N	8° 19.59' E	780	MOR	on deck
MSM2/777-1	23.08.2006	15:30	78° 49.96' N	8° 39.79' E	245.7	MOR	surface
MSM2/777-1	23.08.2006	16:05	78° 49.96' N	8° 39.79' E	244.9	MOR	slipped
MSM2/778-1	23.08.2006	18:19	78° 50.17' N	7° 0.16' E	1421.7	MOR	Hydrophone into the water
MSM2/778-1	23.08.2006	18:27	78° 50.18' N	7° 0.26' E	0	MOR	Hydrophone on Deck
MSM2/778-1	23.08.2006	18:32	78° 50.21' N	7° 0.69' E	0	MOR	Hydrophone into the water
MSM2/778-1	23.08.2006	18:33	78° 50.22' N	7° 0.74' E	0	MOR	released
MSM2/778-1	23.08.2006	18:34	78° 50.23' N	7° 0.78' E	0	MOR	on the surface
MSM2/778-1	23.08.2006	18:34	78° 50.23' N	7° 0.78' E	0	MOR	Hydrophone on Deck
MSM2/778-1	23.08.2006	18:42	78° 50.28' N	7° 0.53' E	0	MOR	on the surface
MSM2/778-1	23.08.2006	18:57	78° 50.34' N	7° 0.21' E	0	MOR	action
MSM2/778-1	23.08.2006	19:04	78° 50.47' N	7° 0.72' E	0	MOR	action
MSM2/778-1	23.08.2006	19:08	78° 50.50' N	7° 0.87' E	0	MOR	action
MSM2/778-1	23.08.2006	19:28	78° 50.52' N	7° 0.87' E	0	MOR	action
MSM2/778-1	23.08.2006	19:52	78° 50.58' N	7° 1.08' E	0	MOR	releaser on deck
MSM2/778-2	23.08.2006	20:43	78° 50.16' N	7° 0.01' E	1419.1	CTD/RO	at depth
MSM2/779-1	24.08.2006	01:07	79° 6.48' N	4° 36.04' E	1886.3	CTD/RO	at depth
MSM2/779-2	24.08.2006	02:26	79° 6.50' N	4° 35.95' E	1878.9	MUC	at sea bottom
MSM2/780-1	24.08.2006	04:30	79° 3.93' N	4° 10.84' E	2413.3	CTD/RO	at depth
MSM2/780-2	24.08.2006	05:41	79° 3.93' N	4° 10.84' E	2413.7	MN	surface
MSM2/780-2	24.08.2006	05:50	79° 3.93' N	4° 10.84' E	2413.5	MN	at depth
MSM2/780-2	24.08.2006	06:01	79° 3.93' N	4° 10.84' E	2415.1	MN	on deck
MSM2/780-3	24.08.2006	06:09	79° 3.93' N	4° 10.84' E	2415.9	MN	surface
MSM2/780-3	24.08.2006	07:16	79° 3.93' N	4° 10.84' E	2413.5	MN	at depth
MSM2/780-3	24.08.2006	08:32	79° 3.93' N	4° 10.84' E	2413.3	MN	on deck
MSM2/780-4	24.08.2006	09:20	79° 3.93' N	4° 10.84' E	2410.8	MUC	at sea bottom
MSM2/781-1	24.08.2006	10:39	79° 0.80' N	4° 20.47' E	2542.8	HN	surface
MSM2/781-1	24.08.2006	10:49	79° 0.80' N	4° 20.47' E	2543.1	HN	on deck
MSM2/781-2	24.08.2006	11:07	79° 0.80' N	4° 20.45' E	2543	LANDER	surface
MSM2/781-2	24.08.2006	11:14	79° 0.80' N	4° 20.33' E	2544.4	LANDER	on Deck
MSM2/781-2	24.08.2006	11:23	79° 0.80' N	4° 20.47' E	2543.9	LANDER	surface
MSM2/781-2	24.08.2006	11:26	79° 0.80' N	4° 20.44' E	2543	LANDER	released
MSM2/781-2	24.08.2006	12:36	79° 0.76' N	4° 19.54' E	2543	LANDER	Information
MSM2/782-1	24.08.2006	13:36	79° 4.68' N	4° 6.79' E	0	LANDER	surface
MSM2/782-1	24.08.2006	13:53	79° 4.68' N	4° 6.79' E	0	LANDER	released
MSM2/782-1	24.08.2006	15:01	79° 4.84' N	4° 6.66' E	0	LANDER	Information
MSM2/782-1	24.08.2006	15:13	79° 4.87' N	4° 7.12' E	0	LANDER	on Deck
MSM2/783-1	24.08.2006	16:46	78° 49.98' N	3° 59.84' E	2297.9	MOR	Hydrophone into the water
MSM2/783-1	24.08.2006	16:56	78° 49.93' N	3° 59.86' E	0	MOR	Hydrophone on Deck

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abbreviation	Action
MSM2/783-1	24.08.2006	17:02	78° 49.87' N	3° 59.87' E	0	MOR	Hydrophone into the water
MSM2/783-1	24.08.2006	17:04	78° 49.85' N	3° 59.88' E	0	MOR	released
MSM2/783-1	24.08.2006	17:06	78° 49.83' N	3° 59.89' E	0	MOR	action
MSM2/783-1	24.08.2006	17:32	78° 49.74' N	3° 59.07' E	0	MOR	on the surface
MSM2/783-1	24.08.2006	17:36	78° 49.70' N	3° 58.82' E	0	MOR	action
MSM2/783-1	24.08.2006	17:45	78° 49.62' N	3° 58.82' E	0	MOR	action
MSM2/783-1	24.08.2006	17:58	78° 49.58' N	3° 58.80' E	0	MOR	action
MSM2/783-1	24.08.2006	18:10	78° 49.59' N	3° 58.88' E	0	MOR	action
MSM2/783-1	24.08.2006	18:24	78° 49.45' N	3° 58.63' E	0	MOR	mooring on deck
MSM2/783-2	24.08.2006	19:33	78° 49.97' N	3° 59.82' E	2296.6	CTD/RO	at depth
MSM2/784-1	24.08.2006	21:59	78° 49.98' N	4° 36.94' E	2493.6	CTD/RO	at depth
MSM2/785-1	25.08.2006	00:02	78° 50.03' N	4° 17.31' E	2377.9	CTD/RO	at depth
MSM2/785-2	25.08.2006	00:56	78° 50.09' N	4° 17.00' E	2379.1	MN	surface
MSM2/785-2	25.08.2006	01:06	78° 50.14' N	4° 17.10' E	2378.8	MN	at depth
MSM2/785-2	25.08.2006	01:18	78° 50.15' N	4° 17.15' E	2378.2	MN	on deck
MSM2/785-3	25.08.2006	01:24	78° 50.11' N	4° 17.29' E	2374.9	MN	surface
MSM2/785-3	25.08.2006	02:40	78° 50.10' N	4° 17.12' E	2377.1	MN	at depth
MSM2/785-3	25.08.2006	03:56	78° 49.96' N	4° 17.11' E	2375.7	MN	on deck
MSM2/786-1	25.08.2006	06:35	79° 3.78' N	4° 7.87' E	2469	CTD/RO	at depth
MSM2/787-1	25.08.2006	08:24	79° 0.72' N	4° 19.49' E	2553.4	MOR	surface
MSM2/787-1	25.08.2006	10:52	79° 0.82' N	4° 20.59' E	2541.5	MOR	slipped
MSM2/787-1	25.08.2006	10:59	79° 0.82' N	4° 20.59' E	2541.7	MOR	releaser on deck
MSM2/788-1	25.08.2006	11:46	79° 0.90' N	4° 20.98' E	2539.2	CTD/RO	at depth
MSM2/789-1	25.08.2006	13:02	79° 0.76' N	4° 17.91' E	0	LANDER	Information
MSM2/789-1	25.08.2006	13:09	79° 0.69' N	4° 17.25' E	0	LANDER	released
MSM2/789-1	25.08.2006	13:51	79° 0.80' N	4° 17.71' E	0	LANDER	Information
MSM2/789-1	25.08.2006	14:00	79° 0.90' N	4° 17.76' E	0	LANDER	on Deck
MSM2/790-1	25.08.2006	15:38	78° 49.76' N	5° 1.01' E	2649.9	MOR	Hydrophone into the water
MSM2/790-1	25.08.2006	15:43	78° 49.76' N	5° 1.01' E	2648.4	MOR	released
MSM2/790-1	25.08.2006	15:45	78° 49.76' N	5° 1.00' E	2647.2	MOR	on the surface
MSM2/790-1	25.08.2006	16:44	78° 50.44' N	5° 2.34' E	0	MOR	action
MSM2/790-1	25.08.2006	16:54	78° 50.45' N	5° 2.27' E	0	MOR	action
MSM2/790-1	25.08.2006	17:21	78° 51.13' N	5° 1.74' E	0	MOR	action
MSM2/790-1	25.08.2006	17:48	78° 51.31' N	5° 1.02' E	0	MOR	action
MSM2/790-1	25.08.2006	18:27	78° 51.60' N	4° 59.14' E	0	MOR	mooring on deck
MSM2/791-1	25.08.2006	21:08	78° 55.05' N	5° 0.10' E	2589.2	MUC	at sea bottom
MSM2/791-2	25.08.2006	22:01	78° 55.05' N	5° 0.10' E	2589.8	CTD/RO	at depth
MSM2/792-1	26.08.2006	01:47	78° 46.84' N	5° 19.95' E	2420.2	CTD/RO	at depth
MSM2/792-2	26.08.2006	03:49	78° 46.84' N	5° 20.09' E	2417.3	MUC	at sea bottom
MSM2/793-1	26.08.2006	06:51	78° 36.71' N	5° 3.78' E	2295.2	CTD/RO	at depth
MSM2/794-1	26.08.2006	07:55	78° 36.36' N	5° 3.96' E	2297.5	MOR	Hydrophone into the water
MSM2/794-1	26.08.2006	08:01	78° 36.36' N	5° 3.96' E	2292.6	MOR	released
MSM2/794-1	26.08.2006	08:44	78° 36.45' N	5° 2.74' E	0	MOR	Hydrophone on Deck
MSM2/794-1	26.08.2006	08:45	78° 36.45' N	5° 2.74' E	0	MOR	on the surface
MSM2/794-1	26.08.2006	09:18	78° 36.84' N	5° 3.74' E	0	MOR	mooring on deck
MSM2/795-1	26.08.2006	10:04	78° 35.18' N	5° 4.31' E	0	MOR	Hydrophone into the water
MSM2/795-1	26.08.2006	10:30	78° 35.18' N	5° 4.31' E	0	MOR	released
MSM2/795-1	26.08.2006	10:31	78° 35.18' N	5° 4.31' E	0	MOR	on the surface
MSM2/795-1	26.08.2006	10:32	78° 35.18' N	5° 4.31' E	0	MOR	Hydrophone on Deck
MSM2/795-1	26.08.2006	12:17	78° 36.41' N	5° 5.63' E	0	MOR	mooring on deck
MSM2/796-1	26.08.2006	13:16	78° 36.37' N	5° 4.17' E	0	MOR	surface
MSM2/796-1	26.08.2006	13:25	78° 36.37' N	5° 4.16' E	0	MOR	released
MSM2/796-1	26.08.2006	13:55	78° 36.40' N	5° 3.98' E	0	MOR	on the ground
MSM2/797-1	26.08.2006	14:35	78° 36.59' N	5° 4.06' E	0	LANDER	surface
MSM2/797-1	26.08.2006	15:40	78° 36.59' N	5° 4.09' E	0	LANDER	Information
MSM2/797-2	26.08.2006	16:03	78° 36.67' N	5° 4.07' E	0	CTD/RO	at depth
MSM2/797-2	26.08.2006	16:09	78° 36.67' N	5° 4.07' E	2295.3	CTD/RO	at depth
MSM2/797-2	26.08.2006	16:16	78° 36.68' N	5° 4.08' E	2293.6	CTD/RO	at depth
MSM2/797-2	26.08.2006	16:20	78° 36.69' N	5° 4.08' E	2293.8	CTD/RO	at depth
MSM2/797-2	26.08.2006	16:26	78° 36.70' N	5° 4.08' E	2293.9	CTD/RO	at depth
MSM2/797-2	26.08.2006	16:27	78° 36.70' N	5° 4.08' E	2293.7	CTD/RO	at depth
MSM2/797-2	26.08.2006	16:29	78° 36.70' N	5° 4.08' E	2292.1	CTD/RO	at depth
MSM2/797-2	26.08.2006	16:31	78° 36.70' N	5° 4.08' E	2292.8	CTD/RO	on deck
MSM2/798-1	26.08.2006	18:17	78° 49.95' N	4° 54.37' E	2537	MOR	Hydrophone into the water
MSM2/798-1	26.08.2006	18:38	78° 49.96' N	4° 54.35' E	0	MOR	released
MSM2/798-1	26.08.2006	18:58	78° 49.95' N	4° 54.36' E	0	MOR	Hydrophone on Deck
MSM2/798-1	26.08.2006	19:37	78° 49.95' N	4° 54.36' E	0	MOR	on the surface
MSM2/798-1	26.08.2006	19:47	78° 50.14' N	4° 54.37' E	0	MOR	mooring on deck
MSM2/798-2	26.08.2006	20:52	78° 50.10' N	4° 54.16' E	2633.3	CTD/RO	at depth
MSM2/799-1	27.08.2006	01:50	78° 44.93' N	7° 19.25' E	1219	CTD/RO	at depth
MSM2/799-2	27.08.2006	03:42	78° 44.93' N	7° 19.25' E	1220.4	MUC	at sea bottom
MSM2/800-1	27.08.2006	05:39	78° 50.15' N	6° 59.91' E	1421.7	CTD/RO	at depth
MSM2/800-2	27.08.2006	07:04	78° 50.31' N	7° 0.31' E	1423.4	MOR	surface
MSM2/800-2	27.08.2006	07:07	78° 50.31' N	7° 0.24' E	1421.5	MOR	Hydrophone into the water
MSM2/800-2	27.08.2006	07:07	78° 50.31' N	7° 0.24' E	1421.5	MOR	slipped
MSM2/800-2	27.08.2006	07:10	78° 50.28' N	7° 0.07' E	1420.2	MOR	Hydrophone on Deck
MSM2/800-2	27.08.2006	07:25	78° 50.18' N	6° 59.70' E	1427.1	MOR	on the ground
MSM2/800-3	27.08.2006	09:21	78° 49.67' N	6° 59.29' E	1440.6	HN	surface
MSM2/800-3	27.08.2006	09:24	78° 49.67' N	6° 59.29' E	1448.1	HN	on deck
MSM2/800-4	27.08.2006	09:25	78° 49.67' N	6° 59.29' E	1449.7	HN	surface
MSM2/800-4	27.08.2006	09:31	78° 49.67' N	6° 59.29' E	1454.7	HN	on deck

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abbreviation	Action
MSM2/800-5	27.08.2006	09:53	78° 49.70' N	6° 59.33' E	1444.9	MOR	surface
MSM2/800-5	27.08.2006	10:48	78° 50.40' N	7° 0.93' E	1410.7	MOR	slipped
MSM2/800-5	27.08.2006	11:02	78° 50.42' N	7° 1.08' E	0	MOR	on the ground
MSM2/801-1	27.08.2006	14:34	78° 34.88' N	5° 5.02' E	2286.8	MOR	surface
MSM2/801-1	27.08.2006	16:49	78° 34.88' N	5° 5.02' E	2287.2	MOR	Hydrophone into the water
MSM2/801-1	27.08.2006	16:50	78° 34.88' N	5° 5.02' E	2288.7	MOR	Hydrophone on Deck
MSM2/801-1	27.08.2006	16:50	78° 34.88' N	5° 5.02' E	2288.7	MOR	slipped
MSM2/801-1	27.08.2006	16:51	78° 34.88' N	5° 5.02' E	2288.1	MOR	on the ground
MSM2/802-1	27.08.2006	17:31	78° 36.60' N	5° 4.15' E	2295.2	LANDER	Hydrophone into the water
MSM2/802-1	27.08.2006	17:36	78° 36.60' N	5° 4.15' E	0	LANDER	released
MSM2/802-1	27.08.2006	17:38	78° 36.60' N	5° 4.15' E	2295.3	LANDER	Hydrophone back to deck
MSM2/802-1	27.08.2006	17:57	78° 36.52' N	5° 3.75' E	2295	LANDER	Hydrophone into the water
MSM2/802-1	27.08.2006	17:59	78° 36.52' N	5° 3.75' E	2294.8	LANDER	Hydrophone back to deck
MSM2/802-1	27.08.2006	18:12	78° 36.52' N	5° 3.75' E	2295.1	LANDER	spotted
MSM2/802-1	27.08.2006	18:30	78° 37.28' N	5° 5.64' E	2292.8	LANDER	on Deck
MSM2/803-1	27.08.2006	20:10	78° 36.40' N	5° 4.12' E	2293.2	CTD/RO	at depth
MSM2/803-2	27.08.2006	21:55	78° 36.40' N	5° 4.12' E	2292.8	MUC	at sea bottom
MSM2/803-3	27.08.2006	23:30	78° 36.46' N	5° 4.23' E	2293.9	CTD/RO	at depth
MSM2/804-1	28.08.2006	03:06	78° 49.98' N	3° 45.05' E	2228.1	CTD/RO	at depth
MSM2/805-1	28.08.2006	04:20	78° 49.96' N	3° 24.83' E	2327.5	CTD/RO	surface
MSM2/805-1	28.08.2006	05:06	78° 49.89' N	3° 24.60' E	2325.9	CTD/RO	at depth
MSM2/806-1	28.08.2006	08:43	78° 49.88' N	5° 59.56' E	2421	MOR	Hydrophone into the water
MSM2/806-1	28.08.2006	08:45	78° 49.88' N	5° 59.56' E	2421.3	MOR	released
MSM2/806-1	28.08.2006	08:55	78° 49.88' N	5° 59.56' E	0	MOR	on the surface
MSM2/806-1	28.08.2006	08:56	78° 49.88' N	5° 59.56' E	0	MOR	Hydrophone on Deck
MSM2/806-1	28.08.2006	10:12	78° 50.22' N	5° 59.04' E	0	MOR	mooring on deck
MSM2/806-2	28.08.2006	11:15	78° 49.97' N	6° 0.21' E	2418.2	CTD/RO	at depth
MSM2/807-1	28.08.2006	12:29	78° 49.99' N	5° 56.81' E	2443.6	MOR	surface
MSM2/807-1	28.08.2006	12:31	78° 50.02' N	5° 56.85' E	2448.5	MOR	slipped
MSM2/807-1	28.08.2006	12:32	78° 50.03' N	5° 56.84' E	2444.1	MOR	Hydrophone into the water
MSM2/807-1	28.08.2006	12:36	78° 50.04' N	5° 56.86' E	2445.6	MOR	Hydrophone on Deck
MSM2/807-1	28.08.2006	13:05	78° 49.86' N	5° 56.26' E	2446.4	MOR	on the ground
MSM2/808-1	28.08.2006	13:19	78° 49.99' N	6° 0.37' E	2419.2	MOR	surface
MSM2/808-1	28.08.2006	13:22	78° 49.98' N	6° 0.36' E	2418.3	MOR	action
MSM2/808-1	28.08.2006	13:54	78° 50.02' N	6° 0.20' E	2422.1	MOR	action
MSM2/808-1	28.08.2006	14:20	78° 50.02' N	6° 0.20' E	2420.5	MOR	action
MSM2/808-1	28.08.2006	14:41	78° 50.02' N	6° 0.20' E	2420.8	MOR	action
MSM2/808-1	28.08.2006	14:55	78° 50.02' N	6° 0.20' E	2420.8	MOR	action
MSM2/808-1	28.08.2006	14:57	78° 50.02' N	6° 0.20' E	2419.9	MOR	action
MSM2/808-1	28.08.2006	15:00	78° 50.02' N	6° 0.20' E	2419.1	MOR	action
MSM2/808-1	28.08.2006	15:04	78° 50.02' N	6° 0.20' E	2419.3	MOR	Hydrophone into the water
MSM2/808-1	28.08.2006	15:05	78° 50.02' N	6° 0.20' E	2419.1	MOR	slipped
MSM2/809-1	28.08.2006	16:34	78° 49.99' N	4° 54.60' E	2557.7	MOR	action
MSM2/809-1	28.08.2006	16:38	78° 49.98' N	4° 54.30' E	2538.3	MOR	surface
MSM2/809-1	28.08.2006	16:39	78° 49.98' N	4° 54.20' E	2530.5	MOR	Hydrophone into the water
MSM2/809-1	28.08.2006	16:44	78° 49.99' N	4° 54.17' E	2533.2	MOR	Hydrophone on Deck
MSM2/809-1	28.08.2006	17:13	78° 49.99' N	4° 54.16' E	0	MOR	on the ground
MSM2/810-1	28.08.2006	18:12	78° 49.83' N	5° 1.35' E	2653	MOR	surface
MSM2/810-1	28.08.2006	18:15	78° 49.83' N	5° 1.35' E	0	MOR	action
MSM2/810-1	28.08.2006	18:49	78° 49.83' N	5° 1.34' E	0	MOR	action
MSM2/810-1	28.08.2006	19:10	78° 49.83' N	5° 1.34' E	2652.6	MOR	action
MSM2/810-1	28.08.2006	19:27	78° 49.83' N	5° 1.34' E	2648.7	MOR	action
MSM2/810-1	28.08.2006	19:42	78° 49.83' N	5° 1.34' E	2646.6	MOR	action
MSM2/810-1	28.08.2006	19:46	78° 49.83' N	5° 1.34' E	2649.6	MOR	action
MSM2/810-1	28.08.2006	19:49	78° 49.83' N	5° 1.34' E	2648.5	MOR	Hydrophone into the water
MSM2/810-1	28.08.2006	19:51	78° 49.83' N	5° 1.34' E	2649.2	MOR	slipped
MSM2/810-1	28.08.2006	19:52	78° 49.83' N	5° 1.34' E	2648.8	MOR	Hydrophone on Deck
MSM2/811-1	28.08.2006	22:54	79° 3.82' N	3° 39.49' E	3112.4	MUC	at sea bottom
MSM2/811-2	29.08.2006	00:51	79° 3.82' N	3° 39.42' E	3114.9	CTD/RO	at depth
MSM2/812-1	29.08.2006	03:09	79° 3.61' N	3° 34.86' E	3512.7	MUC	at sea bottom
MSM2/812-2	29.08.2006	05:08	79° 3.61' N	3° 34.86' E	3509	CTD/RO	at depth
MSM2/813-1	29.08.2006	08:06	78° 49.99' N	3° 56.87' E	2282.9	MOR	surface
MSM2/813-1	29.08.2006	08:08	78° 49.99' N	3° 56.77' E	2290.3	MOR	slipped
MSM2/813-2	29.08.2006	08:17	78° 49.98' N	3° 56.72' E	2287.3	HN	surface
MSM2/813-2	29.08.2006	08:27	78° 49.98' N	3° 56.72' E	2286.7	HN	on deck
MSM2/813-1	29.08.2006	08:40	78° 49.98' N	3° 56.72' E	2286.7	MOR	on the ground
MSM2/813-3	29.08.2006	09:02	78° 50.02' N	4° 0.02' E	2300.3	MOR	surface
MSM2/813-3	29.08.2006	10:26	78° 50.02' N	4° 0.02' E	2296.4	MOR	at depth
MSM2/813-3	29.08.2006	10:29	78° 50.02' N	4° 0.02' E	2299.5	MOR	releaser on deck
MSM2/814-1	29.08.2006	10:57	78° 49.98' N	3° 38.57' E	2260.4	MOR	Hydrophone into the water
MSM2/814-1	29.08.2006	12:06	78° 50.12' N	2° 47.35' E	2448.1	MOR	released
MSM2/814-1	29.08.2006	12:07	78° 50.12' N	2° 47.35' E	2452	MOR	on the surface
MSM2/814-1	29.08.2006	13:24	78° 49.63' N	2° 45.93' E	2453.9	MOR	mooring on deck
MSM2/815-1	29.08.2006	13:46	78° 49.96' N	2° 50.99' E	2436.9	MOR	Hydrophone into the water
MSM2/815-1	29.08.2006	13:49	78° 49.96' N	2° 50.90' E	0	MOR	released
MSM2/815-1	29.08.2006	13:51	78° 49.96' N	2° 50.81' E	0	MOR	Hydrophone on Deck
MSM2/815-1	29.08.2006	14:48	78° 49.92' N	2° 49.57' E	0	MOR	on the surface
MSM2/815-1	29.08.2006	15:00	78° 49.74' N	2° 49.95' E	0	MOR	mooring on deck
MSM2/815-2	29.08.2006	16:05	78° 49.87' N	2° 50.58' E	2440.5	CTD/RO	at depth
MSM2/816-1	29.08.2006	17:04	78° 50.00' N	2° 51.00' E	2437.4	MOR	action
MSM2/816-1	29.08.2006	17:06	78° 50.00' N	2° 50.99' E	2439.4	MOR	surface

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abbreviation	Action
MSM2/816-1	29.08.2006	17:07	78° 50.00' N	2° 50.97' E	2436.5	MOR	Hydrophone into the water
MSM2/816-1	29.08.2006	17:13	78° 49.98' N	2° 50.87' E	0	MOR	Hydrophone on Deck
MSM2/816-1	29.08.2006	17:42	78° 49.98' N	2° 50.87' E	0	MOR	on the ground
MSM2/817-1	29.08.2006	18:14	78° 49.90' N	2° 47.91' E	2447.2	MOR	surface
MSM2/817-1	29.08.2006	18:15	78° 49.91' N	2° 47.91' E	2446.7	MOR	action
MSM2/817-1	29.08.2006	18:46	78° 49.98' N	2° 48.04' E	2443.9	MOR	action
MSM2/817-1	29.08.2006	19:08	78° 49.98' N	2° 48.04' E	2445.8	MOR	action
MSM2/817-1	29.08.2006	19:27	78° 49.98' N	2° 48.04' E	2443	MOR	action
MSM2/817-1	29.08.2006	19:37	78° 49.98' N	2° 48.03' E	2443.9	MOR	action
MSM2/817-1	29.08.2006	19:40	78° 49.98' N	2° 48.04' E	2443	MOR	action
MSM2/817-1	29.08.2006	19:44	78° 49.98' N	2° 48.04' E	2443.3	MOR	Hydrophone into the water
MSM2/817-1	29.08.2006	19:45	78° 49.98' N	2° 48.04' E	2443	MOR	released
MSM2/817-1	29.08.2006	19:46	78° 49.98' N	2° 48.04' E	2443.3	MOR	Hydrophone on Deck
MSM2/817-1	29.08.2006	19:49	78° 49.98' N	2° 48.04' E	2443	MOR	releaser on deck
MSM2/818-1	29.08.2006	21:18	78° 50.00' N	3° 7.04' E	2399	CTD/RO	at depth
MSM2/819-1	29.08.2006	23:32	78° 44.98' N	2° 59.95' E	2497.6	MUC	at sea bottom
MSM2/819-2	30.08.2006	01:02	78° 44.98' N	2° 59.95' E	2497.6	CTD/RO	at depth
MSM2/820-1	30.08.2006	03:45	78° 49.99' N	2° 35.03' E	2474.8	CTD/RO	at depth
MSM2/820-2	30.08.2006	04:45	78° 49.99' N	2° 35.03' E	2475.1	MN	surface
MSM2/820-2	30.08.2006	04:56	78° 50.00' N	2° 35.03' E	2476.1	MN	at depth
MSM2/820-2	30.08.2006	05:09	78° 50.00' N	2° 35.02' E	2474.5	MN	on deck
MSM2/820-2	30.08.2006	05:20	78° 49.99' N	2° 35.03' E	2476.7	MN	surface
MSM2/820-2	30.08.2006	06:32	78° 49.99' N	2° 35.03' E	2475.4	MN	at depth
MSM2/820-2	30.08.2006	07:45	78° 50.00' N	2° 35.03' E	2475.6	MN	on deck
MSM2/821-1	30.08.2006	09:08	78° 49.94' N	1° 37.24' E	2499.8	MOR	Hydrophone into the water
MSM2/821-1	30.08.2006	09:11	78° 49.94' N	1° 37.25' E	2498.5	MOR	released
MSM2/821-1	30.08.2006	09:18	78° 49.94' N	1° 37.24' E	0	MOR	on the surface
MSM2/821-1	30.08.2006	09:19	78° 49.94' N	1° 37.24' E	0	MOR	Hydrophone on Deck
MSM2/821-1	30.08.2006	10:48	78° 50.03' N	1° 35.34' E	2494.8	MOR	mooring on deck
MSM2/821-2	30.08.2006	11:53	78° 49.96' N	1° 36.88' E	2508.2	CTD/RO	at depth
MSM2/822-1	30.08.2006	14:13	78° 49.96' N	1° 36.53' E	2495.6	MOR	surface
MSM2/822-1	30.08.2006	14:14	78° 49.96' N	1° 36.54' E	2496	MOR	action
MSM2/822-1	30.08.2006	14:50	78° 49.96' N	1° 36.54' E	2495.3	MOR	action
MSM2/822-1	30.08.2006	15:17	78° 49.96' N	1° 36.54' E	2496.4	MOR	action
MSM2/822-1	30.08.2006	15:34	78° 49.96' N	1° 36.53' E	2496.1	MOR	action
MSM2/822-1	30.08.2006	15:48	78° 49.96' N	1° 36.54' E	2494.5	MOR	action
MSM2/822-1	30.08.2006	15:54	78° 49.96' N	1° 36.54' E	2494.3	MOR	released
MSM2/822-1	30.08.2006	15:55	78° 49.96' N	1° 36.54' E	2496	MOR	releaser on deck
MSM2/823-1	30.08.2006	17:58	78° 50.10' N	0° 24.06' E	2532.5	MOR	Hydrophone into the water
MSM2/823-1	30.08.2006	18:07	78° 50.10' N	0° 24.08' E	0	MOR	Hydrophone on Deck
MSM2/823-1	30.08.2006	18:17	78° 50.03' N	0° 24.52' E	0	MOR	Hydrophone into the water
MSM2/823-1	30.08.2006	18:20	78° 50.03' N	0° 24.52' E	0	MOR	released
MSM2/823-1	30.08.2006	18:23	78° 50.03' N	0° 24.52' E	0	MOR	on the surface
MSM2/823-1	30.08.2006	18:51	78° 50.47' N	0° 23.24' E	0	MOR	action
MSM2/823-1	30.08.2006	18:57	78° 50.56' N	0° 23.52' E	0	MOR	action
MSM2/823-1	30.08.2006	19:08	78° 50.71' N	0° 23.70' E	0	MOR	action
MSM2/823-1	30.08.2006	19:22	78° 50.75' N	0° 23.30' E	0	MOR	action
MSM2/823-1	30.08.2006	19:40	78° 50.75' N	0° 22.80' E	0	MOR	action
MSM2/823-2	30.08.2006	20:53	78° 50.10' N	0° 24.10' E	2532.1	CTD/RO	at depth
MSM2/823-3	30.08.2006	21:54	78° 50.10' N	0° 24.09' E	2530.1	APSN	surface
MSM2/823-3	30.08.2006	22:12	78° 50.10' N	0° 24.10' E	2530.9	APSN	on deck
MSM2/823-4	30.08.2006	22:29	78° 50.10' N	0° 24.09' E	2530.8	MN	surface
MSM2/823-4	30.08.2006	22:37	78° 50.10' N	0° 24.09' E	2529.9	MN	at depth
MSM2/823-4	30.08.2006	22:49	78° 50.10' N	0° 24.10' E	2531.2	MN	on deck
MSM2/823-5	30.08.2006	23:04	78° 50.10' N	0° 24.09' E	2529.3	MN	surface
MSM2/823-5	31.08.2006	00:09	78° 50.10' N	0° 24.09' E	2529.4	MN	at depth
MSM2/823-5	31.08.2006	01:23	78° 50.10' N	0° 24.09' E	2529.9	MN	on deck
MSM2/824-1	31.08.2006	02:44	78° 49.95' N	0° 39.97' E	2444.7	CTD/RO	at depth
MSM2/825-1	31.08.2006	04:46	78° 49.99' N	0° 59.90' E	2436.7	CTD/RO	at depth
MSM2/826-1	31.08.2006	06:59	78° 49.96' N	1° 17.98' E	2472.2	CTD/RO	at depth
MSM2/827-2	31.08.2006	09:16	78° 50.00' N	1° 54.86' E	2508.2	HN	surface
MSM2/827-2	31.08.2006	09:22	78° 50.00' N	1° 54.86' E	2506.7	HN	on deck
MSM2/827-3	31.08.2006	09:25	78° 50.00' N	1° 54.86' E	2507.5	HN	surface
MSM2/827-1	31.08.2006	09:30	78° 50.00' N	1° 54.86' E	2507.6	CTD/RO	at depth
MSM2/827-3	31.08.2006	09:34	78° 50.00' N	1° 54.86' E	2507.9	HN	on deck
MSM2/828-1	31.08.2006	11:39	78° 49.99' N	2° 15.18' E	2490.3	CTD/RO	at depth
MSM2/829-1	31.08.2006	14:39	78° 50.10' N	0° 24.08' E	2537.7	MOR	surface
MSM2/829-1	31.08.2006	14:48	78° 50.10' N	0° 24.08' E	2533.8	MOR	action
MSM2/829-1	31.08.2006	15:17	78° 50.10' N	0° 24.08' E	2538.5	MOR	action
MSM2/829-1	31.08.2006	15:37	78° 50.10' N	0° 24.08' E	2532.9	MOR	action
MSM2/829-1	31.08.2006	15:57	78° 50.10' N	0° 24.08' E	2530.7	MOR	action
MSM2/829-1	31.08.2006	16:07	78° 50.10' N	0° 24.08' E	2530.4	MOR	action
MSM2/829-1	31.08.2006	16:14	78° 50.10' N	0° 24.08' E	2533.5	MOR	Hydrophone into the water
MSM2/829-1	31.08.2006	16:15	78° 50.10' N	0° 24.08' E	2532.9	MOR	slipped
MSM2/829-1	31.08.2006	16:16	78° 50.10' N	0° 24.08' E	2530.2	MOR	Hydrophone on Deck
MSM2/830-1	31.08.2006	17:39	78° 50.01' N	0° 5.68' E	2579	CTD/RO	at depth
MSM2/831-1	31.08.2006	20:24	79° 0.16' N	0° 0.05' E	2551.9	CTD/RO	at depth
MSM2/832-1	31.08.2006	22:58	79° 8.40' N	0° 0.01' W	2664.1	CTD/RO	at depth
MSM2/832-2	31.08.2006	23:57	79° 8.40' N	0° 0.01' W	2663.7	APSN	surface
MSM2/832-2	01.09.2006	00:03	79° 8.40' N	0° 0.01' W	2663	APSN	on deck
MSM2/833-1	01.09.2006	01:56	79° 16.79' N	0° 0.07' W	2764.3	CTD/RO	at depth

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abbreviation	Action
MSM2/834-1	01.09.2006	06:01	79° 21.29' N	0° 56.20' E	3132.6	CTD/RO	at depth
MSM2/835-1	01.09.2006	08:50	79° 25.15' N	1° 43.83' E	1937.3	CTD/RO	at depth
MSM2/835-2	01.09.2006	09:37	79° 25.15' N	1° 43.83' E	1939	APSN	surface
MSM2/835-2	01.09.2006	09:44	79° 25.15' N	1° 43.83' E	1936.2	APSN	on deck
MSM2/835-3	01.09.2006	09:46	79° 25.15' N	1° 43.83' E	1938.5	APSN	surface
MSM2/835-3	01.09.2006	09:51	79° 25.15' N	1° 43.83' E	1936.3	APSN	on deck
MSM2/836-1	01.09.2006	12:55	79° 25.02' N	3° 0.02' E	2787.1	CTD/RO	at depth
MSM2/836-2	01.09.2006	14:52	79° 24.76' N	3° 0.01' E	2618.8	MUC	at sea bottom
MSM2/837-1	01.09.2006	17:59	79° 35.99' N	2° 29.96' E	2860	CTD/RO	at depth
MSM2/838-1	01.09.2006	21:12	79° 44.99' N	2° 30.00' E	3877.8	CTD/RO	at depth
MSM2/839-1	02.09.2006	00:15	79° 53.99' N	2° 29.86' E	2845.8	CTD/RO	at depth
MSM2/839-2	02.09.2006	01:19	79° 53.99' N	2° 29.86' E	2840.2	APSN	surface
MSM2/839-2	02.09.2006	01:23	79° 53.99' N	2° 29.86' E	2835.9	APSN	on deck
MSM2/840-1	02.09.2006	03:21	80° 3.60' N	2° 45.02' E	2497.6	CTD/RO	at depth
MSM2/841-1	02.09.2006	05:56	80° 12.17' N	2° 29.30' E	3303.3	CTD/RO	at depth
MSM2/841-1	02.09.2006	05:57	80° 12.18' N	2° 29.29' E	3296	CTD/RO	at depth
MSM2/841-1	02.09.2006	06:05	80° 12.20' N	2° 29.19' E	3287.7	CTD/RO	at depth
MSM2/842-1	02.09.2006	08:28	80° 15.47' N	3° 12.63' E	1310.5	CTD/RO	at depth
MSM2/842-2	02.09.2006	09:02	80° 15.53' N	3° 13.50' E	1305.1	APSN	surface
MSM2/842-2	02.09.2006	09:10	80° 15.59' N	3° 13.67' E	1307.1	APSN	on deck
MSM2/843-1	02.09.2006	12:04	80° 4.67' N	4° 48.77' E	1082	CTD/RO	at depth
MSM2/844-1	02.09.2006	14:39	80° 16.84' N	6° 0.17' E	571.6	CTD/RO	at depth
MSM2/845-1	02.09.2006	15:53	80° 22.87' N	6° 2.65' E	567.1	CTD/RO	at depth
MSM2/845-2	02.09.2006	16:19	80° 22.88' N	6° 3.70' E	568.1	APSN	surface
MSM2/845-2	02.09.2006	16:29	80° 22.90' N	6° 4.18' E	565.4	APSN	on deck
MSM2/846-1	02.09.2006	17:35	80° 24.78' N	6° 46.28' E	628.7	CTD/RO	at depth
MSM2/847-1	02.09.2006	19:12	80° 33.74' N	6° 51.47' E	698.9	CTD/RO	at depth
MSM2/848-1	02.09.2006	20:46	80° 42.65' N	6° 47.72' E	831.7	CTD/RO	at depth
MSM2/848-2	02.09.2006	21:10	80° 42.68' N	6° 47.36' E	825.3	APSN	surface
MSM2/848-2	02.09.2006	21:18	80° 42.71' N	6° 47.22' E	827.4	APSN	on deck
MSM2/849-1	02.09.2006	22:43	80° 52.82' N	6° 27.69' E	880.1	CTD/RO	at depth
MSM2/850-1	03.09.2006	00:21	81° 2.14' N	6° 17.67' E	803.8	CTD/RO	at depth
MSM2/851-1	03.09.2006	02:14	81° 10.72' N	6° 8.64' E	681.8	CTD/RO	at depth
MSM2/851-2	03.09.2006	02:31	81° 10.69' N	6° 8.55' E	682	APSN	surface
MSM2/851-2	03.09.2006	02:39	81° 10.66' N	6° 8.52' E	682	APSN	on deck
MSM2/851-3	03.09.2006	03:04	81° 10.59' N	6° 8.49' E	679.3	MUC	at sea bottom
MSM2/852-1	03.09.2006	05:11	81° 18.41' N	6° 37.46' E	748.7	CTD/RO	at depth
MSM2/853-1	03.09.2006	07:07	81° 22.03' N	6° 55.29' E	919.7	CTD/RO	at depth
MSM2/853-2	03.09.2006	07:39	81° 21.90' N	6° 52.23' E	927.4	MN	surface
MSM2/853-2	03.09.2006	08:14	81° 21.91' N	6° 49.19' E	923.9	MN	at depth
MSM2/853-2	03.09.2006	08:51	81° 21.90' N	6° 45.71' E	851.6	MN	on deck
MSM2/853-3	03.09.2006	09:31	81° 21.98' N	6° 41.67' E	802.9	MUC	at sea bottom
MSM2/854-1	03.09.2006	12:01	81° 21.96' N	7° 58.17' E	505.5	CTD/RO	at depth
MSM2/854-2	03.09.2006	12:28	81° 22.09' N	7° 57.00' E	463	APSN	surface
MSM2/854-2	03.09.2006	12:34	81° 22.15' N	7° 57.14' E	469.2	APSN	on deck
MSM2/855-1	03.09.2006	15:49	81° 17.34' N	8° 49.14' E	1187.6	CTD/RO	at depth
MSM2/856-1	03.09.2006	19:02	81° 8.41' N	8° 46.76' E	1115.9	CTD/RO	at depth
MSM2/857-1	03.09.2006	21:48	81° 2.10' N	9° 27.12' E	1012.2	CTD/RO	at depth
MSM2/857-2	03.09.2006	22:18	81° 2.20' N	9° 27.97' E	1020.9	APSN	surface
MSM2/857-2	03.09.2006	22:29	81° 2.23' N	9° 28.39' E	1025.7	APSN	on deck
MSM2/858-1	04.09.2006	01:03	80° 54.66' N	10° 8.22' E	1112.7	CTD/RO	at depth
MSM2/859-1	04.09.2006	03:01	80° 45.78' N	10° 29.35' E	1410.7	CTD/RO	at depth
MSM2/860-1	04.09.2006	05:02	80° 37.84' N	11° 2.41' E	1096.3	CTD/RO	at depth
MSM2/860-2	04.09.2006	05:30	80° 37.77' N	11° 1.95' E	1092.8	APSN	surface
MSM2/860-2	04.09.2006	05:41	80° 37.70' N	11° 1.58' E	1096.8	APSN	on deck
MSM2/861-1	04.09.2006	07:10	80° 27.98' N	11° 24.55' E	664.2	CTD/RO	at depth
MSM2/862-1	04.09.2006	08:54	80° 17.98' N	11° 37.74' E	180.1	CTD/RO	at depth
MSM2/863-1	04.09.2006	16:19	79° 36.22' N	5° 10.30' E	2733.7	LANDER	surface
MSM2/863-1	04.09.2006	16:19	79° 36.22' N	5° 10.30' E	2733.7	LANDER	released
MSM2/864-1	04.09.2006	17:30	79° 36.24' N	5° 16.31' E	2649.6	MUC	at sea bottom
MSM2/865-1	04.09.2006	18:41	79° 35.98' N	5° 9.87' E	2739.6	MOR	Hydrophone into the water
MSM2/865-1	04.09.2006	18:47	79° 35.97' N	5° 9.87' E	0	MOR	Hydrophone on Deck
MSM2/865-1	04.09.2006	18:54	79° 35.86' N	5° 9.85' E	0	MOR	Hydrophone into the water
MSM2/865-1	04.09.2006	18:56	79° 35.86' N	5° 9.85' E	0	MOR	released
MSM2/865-1	04.09.2006	18:58	79° 35.86' N	5° 9.85' E	0	MOR	Hydrophone on Deck
MSM2/865-1	04.09.2006	18:59	79° 35.86' N	5° 9.85' E	0	MOR	on the surface
MSM2/865-1	04.09.2006	19:27	79° 35.85' N	5° 10.50' E	0	MOR	action
MSM2/865-1	04.09.2006	19:33	79° 35.78' N	5° 10.64' E	0	MOR	action
MSM2/865-1	04.09.2006	19:47	79° 35.73' N	5° 10.89' E	0	MOR	action
MSM2/865-1	04.09.2006	20:06	79° 35.80' N	5° 11.07' E	0	MOR	action
MSM2/865-1	04.09.2006	20:24	79° 35.76' N	5° 11.37' E	0	MOR	action
MSM2/865-1	04.09.2006	20:32	79° 35.72' N	5° 11.63' E	0	MOR	action
MSM2/865-1	04.09.2006	20:33	79° 35.71' N	5° 11.67' E	0	MOR	mooring on deck
MSM2/866-1	04.09.2006	21:58	79° 36.22' N	5° 16.30' E	2657.7	CTD/RO	at depth
MSM2/866-2	04.09.2006	23:05	79° 36.22' N	5° 16.30' E	2653	MN	surface
MSM2/866-2	04.09.2006	23:14	79° 36.21' N	5° 16.29' E	2648.2	MN	at depth
MSM2/866-2	04.09.2006	23:23	79° 36.18' N	5° 16.39' E	2652.1	MN	on deck
MSM2/866-3	04.09.2006	23:31	79° 36.17' N	5° 16.41' E	2649.4	MN	surface
MSM2/866-3	05.09.2006	00:46	79° 36.01' N	5° 16.58' E	2651.7	MN	at depth
MSM2/866-3	05.09.2006	02:00	79° 35.94' N	5° 16.87' E	2645.2	MN	on deck
MSM2/867-1	05.09.2006	04:09	79° 24.99' N	6° 34.90' E	1380.3	MUC	at sea bottom

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abbreviation	Action
MSM2/867-2	05.09.2006	05:09	79° 24.99' N	6° 34.90' E	1379.2	CTD/RO	at depth
MSM2/868-1	05.09.2006	08:48	79° 16.96' N	4° 19.58' E	2348.1	MUC	at sea bottom
MSM2/868-3	05.09.2006	09:48	79° 16.96' N	4° 19.58' E	2356.6	HN	surface
MSM2/868-3	05.09.2006	09:54	79° 16.96' N	4° 19.58' E	2348.9	HN	on deck
MSM2/868-2	05.09.2006	10:18	79° 16.96' N	4° 19.58' E	2354.5	CTD/RO	at depth
MSM2/869-1	05.09.2006	13:05	79° 24.66' N	4° 42.93' E	2494.8	CTD/RO	at depth
MSM2/869-2	05.09.2006	14:37	79° 24.61' N	4° 42.85' E	2501.7	MUC	at sea bottom
MSM2/870-1	05.09.2006	17:05	79° 36.07' N	5° 9.86' E	2739.7	MOR	surface
MSM2/870-1	05.09.2006	17:10	79° 36.07' N	5° 9.86' E	2739.3	MOR	action
MSM2/870-1	05.09.2006	17:24	79° 36.07' N	5° 9.86' E	2739.7	MOR	action
MSM2/870-1	05.09.2006	17:28	79° 36.07' N	5° 9.86' E	2739.7	MOR	action
MSM2/870-1	05.09.2006	17:59	79° 36.07' N	5° 9.87' E	2739.3	MOR	action
MSM2/870-1	05.09.2006	18:32	79° 36.07' N	5° 9.87' E	2739.2	MOR	action
MSM2/870-1	05.09.2006	18:41	79° 36.07' N	5° 9.87' E	2739.3	MOR	action
MSM2/870-1	05.09.2006	18:47	79° 36.07' N	5° 9.87' E	2739.3	MOR	Hydrophone into the water
MSM2/870-1	05.09.2006	18:52	79° 36.07' N	5° 9.87' E	0	MOR	slipped
MSM2/870-1	05.09.2006	18:53	79° 36.07' N	5° 9.87' E	0	MOR	Hydrophone on Deck
MSM2/871-1	05.09.2006	18:55	79° 36.07' N	5° 9.87' E	2739	LANDER	Hydrophone into the water
MSM2/871-1	05.09.2006	18:59	79° 36.07' N	5° 9.87' E	0	LANDER	released
MSM2/871-1	05.09.2006	19:48	79° 36.07' N	5° 9.87' E	0	LANDER	Hydrophone back to deck
MSM2/871-1	05.09.2006	19:52	79° 36.27' N	5° 10.71' E	0	LANDER	spotted
MSM2/871-1	05.09.2006	20:05	79° 36.36' N	5° 11.56' E	0	LANDER	on Deck
MSM2/872-1	05.09.2006	21:05	79° 36.20' N	5° 16.64' E	2641.7	CTD/RO	at depth
MSM2/873-1	06.09.2006	04:16	79° 3.21' N	3° 32.71' E	3689	CTD/RO	at depth
MSM2/874-1	06.09.2006	06:04	79° 3.72' N	3° 24.24' E	4495.9	MUC	surface
MSM2/874-1	06.09.2006	07:19	79° 3.75' N	3° 23.33' E	4615.6	MUC	at sea bottom
MSM2/874-1	06.09.2006	07:52	79° 3.75' N	3° 23.33' E	4682.8	MUC	information
MSM2/874-1	06.09.2006	08:11	79° 3.75' N	3° 23.33' E	4628.7	MUC	information
MSM2/874-1	06.09.2006	09:39	79° 3.76' N	3° 23.33' E	4593	MUC	on deck
MSM2/875-1	06.09.2006	10:34	79° 3.82' N	3° 20.01' E	5049.4	CTD/RO	at depth
MSM2/875-2	06.09.2006	12:12	79° 3.42' N	3° 19.04' E	4992.9	CTD/RO	at depth
MSM2/875-2	06.09.2006	15:24	79° 4.21' N	3° 17.52' E	5129.7	MUC	at sea bottom
MSM2/876-1	06.09.2006	18:15	79° 4.69' N	4° 6.78' E	2442.1	LANDER	surface
MSM2/876-1	06.09.2006	18:15	79° 4.69' N	4° 6.78' E	2442.1	LANDER	released
MSM2/876-1	06.09.2006	18:17	79° 4.69' N	4° 6.78' E	2441.4	LANDER	Hydrophone into the water
MSM2/876-1	06.09.2006	18:30	79° 4.69' N	4° 6.78' E	0	LANDER	Hydrophone back to deck
MSM2/876-1	06.09.2006	19:16	79° 4.69' N	4° 6.78' E	0	LANDER	at sea floor
MSM2/877-1	06.09.2006	21:31	79° 3.91' N	3° 29.56' E	3923.2	MUC	at sea bottom
MSM2/878-1	07.09.2006	01:24	79° 7.40' N	2° 55.76' E	5533.5	CTD/RO	at depth
MSM2/878-2	07.09.2006	05:46	79° 7.28' N	2° 55.44' E	5531	MUC	at sea bottom
MSM2/879-1	07.09.2006	12:37	78° 50.27' N	0° 8.49' W	2585	CTD/RO	at depth
MSM2/880-1	07.09.2006	15:39	78° 50.04' N	0° 27.34' W	2640.2	CTD/RO	at depth
MSM2/880-2	07.09.2006	16:34	78° 50.06' N	0° 27.37' W	2638.9	APSN	surface
MSM2/880-2	07.09.2006	16:42	78° 50.06' N	0° 27.37' W	2638.6	APSN	on deck
MSM2/881-1	07.09.2006	18:18	78° 50.26' N	0° 48.71' W	2611.5	MOR	Hydrophone into the water
MSM2/881-1	07.09.2006	18:25	78° 50.26' N	0° 48.72' W	0	MOR	Hydrophone on Deck
MSM2/881-1	07.09.2006	18:51	78° 50.26' N	0° 48.73' W	0	MOR	action
MSM2/881-1	07.09.2006	19:40	78° 50.25' N	0° 48.71' W	0	MOR	Hydrophone into the water
MSM2/881-1	07.09.2006	19:42	78° 50.25' N	0° 48.80' W	0	MOR	released
MSM2/881-1	07.09.2006	19:43	78° 50.24' N	0° 48.90' W	0	MOR	on the surface
MSM2/881-1	07.09.2006	19:44	78° 50.24' N	0° 48.91' W	0	MOR	Hydrophone on Deck
MSM2/881-1	07.09.2006	19:53	78° 50.17' N	0° 48.72' W	0	MOR	action
MSM2/881-1	07.09.2006	20:01	78° 50.12' N	0° 48.97' W	0	MOR	action
MSM2/881-1	07.09.2006	20:16	78° 50.04' N	0° 49.14' W	0	MOR	action
MSM2/881-1	07.09.2006	20:41	78° 49.96' N	0° 49.18' W	0	MOR	action
MSM2/881-1	07.09.2006	21:10	78° 49.84' N	0° 49.15' W	0	MOR	action
MSM2/881-1	07.09.2006	21:11	78° 49.84' N	0° 49.15' W	0	MOR	mooring on deck
MSM2/881-2	07.09.2006	21:57	78° 50.34' N	0° 48.64' W	2612	MOR	action
MSM2/881-2	07.09.2006	22:29	78° 50.34' N	0° 48.64' W	2612.6	MOR	action
MSM2/881-2	07.09.2006	22:50	78° 50.34' N	0° 48.64' W	2614	MOR	action
MSM2/881-2	07.09.2006	23:04	78° 50.34' N	0° 48.64' W	2613.1	MOR	action
MSM2/881-2	07.09.2006	23:18	78° 50.34' N	0° 48.64' W	2614.2	MOR	action
MSM2/881-2	07.09.2006	23:19	78° 50.34' N	0° 48.64' W	2614	MOR	action
MSM2/881-2	07.09.2006	23:23	78° 50.34' N	0° 48.64' W	2612.9	MOR	released
MSM2/881-2	07.09.2006	23:26	78° 50.34' N	0° 48.65' W	2614.3	MOR	on the ground
MSM2/881-2	08.09.2006	00:49	78° 50.50' N	0° 48.91' W	2619.9	CTD/RO	at depth
MSM2/882-1	08.09.2006	03:35	78° 50.02' N	1° 5.63' W	2511.9	CTD/RO	at depth
MSM2/883-1	08.09.2006	06:23	78° 49.71' N	1° 25.85' W	2632.1	CTD/RO	at depth
MSM2/883-2	08.09.2006	06:53	78° 49.57' N	1° 26.06' W	2636.7	HN	surface
MSM2/883-2	08.09.2006	07:03	78° 49.52' N	1° 26.23' W	2636.9	HN	on deck
MSM2/883-3	08.09.2006	07:20	78° 49.45' N	1° 26.38' W	2636.9	APSN	surface
MSM2/883-3	08.09.2006	07:26	78° 49.42' N	1° 26.48' W	2636.6	APSN	on deck
MSM2/883-4	08.09.2006	07:34	78° 49.41' N	1° 26.49' W	2636.6	MN	surface
MSM2/883-4	08.09.2006	07:48	78° 49.36' N	1° 26.57' W	2637.4	MN	at depth
MSM2/883-4	08.09.2006	07:59	78° 49.28' N	1° 26.72' W	2638.9	MN	on deck
MSM2/883-5	08.09.2006	08:07	78° 49.21' N	1° 26.92' W	2638.8	MN	surface
MSM2/883-5	08.09.2006	09:21	78° 48.66' N	1° 29.59' W	2647.4	MN	at depth
MSM2/883-5	08.09.2006	10:35	78° 48.18' N	1° 32.01' W	2655.1	MN	on deck
MSM2/884-1	08.09.2006	12:35	78° 49.51' N	1° 42.09' W	2659.2	CTD/RO	at depth
MSM2/885-1	08.09.2006	14:45	78° 49.90' N	1° 59.95' W	0	MOR	Hydrophone into the water
MSM2/885-1	08.09.2006	15:06	78° 49.88' N	1° 59.99' W	0	MOR	released

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abbreviation	Action
MSM2/885-1	08.09.2006	15:07	78° 49.88' N	1° 59.98' E	0	MOR	Hydrophone on Deck
MSM2/885-1	08.09.2006	19:12	78° 48.92' N	2° 3.28' W	0	MOR	action
MSM2/885-1	08.09.2006	20:08	78° 48.63' N	2° 2.70' W	0	MOR	action
MSM2/886-1	08.09.2006	20:30	78° 48.90' N	2° 0.74' W	0	MOR	surface
MSM2/886-1	08.09.2006	20:31	78° 48.90' N	2° 0.74' W	2683.3	MOR	action
MSM2/886-1	08.09.2006	21:12	78° 49.03' N	2° 1.95' W	0	MOR	action
MSM2/886-1	08.09.2006	21:31	78° 49.21' N	2° 2.27' W	0	MOR	action
MSM2/886-1	08.09.2006	21:48	78° 49.25' N	2° 2.46' W	2665.9	MOR	action
MSM2/886-1	08.09.2006	21:52	78° 49.25' N	2° 2.47' W	0	MOR	action
MSM2/886-1	08.09.2006	22:08	78° 49.26' N	2° 2.50' W	0	MOR	action
MSM2/886-1	08.09.2006	22:11	78° 49.26' N	2° 2.50' W	0	MOR	released
MSM2/886-1	08.09.2006	22:13	78° 49.26' N	2° 2.50' W	2669	MOR	action
MSM2/885-1	09.09.2006	08:23	78° 46.70' N	2° 6.28' W	0	MOR	Hydrophone into the water
MSM2/885-1	09.09.2006	08:32	78° 46.63' N	2° 6.55' W	0	MOR	Hydrophone on Deck
MSM2/887-1	09.09.2006	08:44	78° 46.54' N	2° 6.94' W	0	CTD/RO	at depth
MSM2/885-1	09.09.2006	09:32	78° 46.20' N	2° 8.57' W	0	MOR	action
MSM2/888-1	09.09.2006	13:04	78° 40.33' N	2° 33.20' W	2612.3	CTD/RO	at depth
MSM2/888-2	09.09.2006	13:52	78° 40.41' N	2° 34.55' W	2607.6	APSN	surface
MSM2/888-2	09.09.2006	14:00	78° 40.42' N	2° 34.75' W	2606.6	APSN	on deck
MSM2/889-1	09.09.2006	19:11	78° 27.87' N	2° 50.52' W	2600.5	CTD/RO	at depth
MSM2/890-1	09.09.2006	21:56	78° 24.76' N	3° 10.30' W	2482.9	CTD/RO	at depth
MSM2/891-1	10.09.2006	01:24	78° 15.58' N	3° 30.91' W	2488.9	CTD/RO	at depth
MSM2/891-2	10.09.2006	02:13	78° 15.58' N	3° 30.92' W	2489.7	APSN	surface
MSM2/891-2	10.09.2006	02:19	78° 15.58' N	3° 30.92' W	2489.8	APSN	on deck
MSM2/891-3	10.09.2006	02:31	78° 15.58' N	3° 30.92' W	2489.3	MN	surface
MSM2/891-3	10.09.2006	02:34	78° 15.58' N	3° 30.92' W	2489.6	MN	Error - Restart
MSM2/891-3	10.09.2006	02:37	78° 15.58' N	3° 30.91' W	2490.5	MN	on deck
MSM2/891-3	10.09.2006	03:36	78° 15.58' N	3° 30.91' W	2489.1	MN	surface
MSM2/891-3	10.09.2006	03:46	78° 15.58' N	3° 30.91' W	2489.3	MN	Hoisting
MSM2/891-3	10.09.2006	03:55	78° 15.58' N	3° 30.91' W	2487.2	MN	on deck
MSM2/891-3	10.09.2006	04:05	78° 15.58' N	3° 30.91' W	2488.5	MN	surface
MSM2/891-3	10.09.2006	05:17	78° 15.58' N	3° 30.91' W	2487.5	MN	at depth
MSM2/891-3	10.09.2006	06:30	78° 15.58' N	3° 30.91' W	2487.6	MN	on deck
MSM2/892-1	10.09.2006	08:14	78° 9.94' N	4° 0.27' W	2409.9	CTD/RO	at depth
MSM2/893-1	10.09.2006	11:02	78° 2.65' N	4° 21.06' W	2246.9	CTD/RO	at depth
MSM2/893-1	10.09.2006	13:11	78° 3.07' N	4° 30.13' W	2079.7	MUC	at sea bottom
MSM2/894-1	11.09.2006	01:10	77° 45.78' N	6° 0.05' W	378.5	CTD/RO	at depth
MSM2/894-2	11.09.2006	01:36	77° 45.78' N	6° 0.00' W	379.4	APSN	surface
MSM2/894-2	11.09.2006	01:43	77° 45.79' N	5° 59.96' W	378.8	APSN	on deck
MSM2/894-3	11.09.2006	01:55	77° 45.80' N	5° 59.90' W	379.1	MN	surface
MSM2/894-3	11.09.2006	02:11	77° 45.87' N	5° 59.75' W	380.3	MN	at depth
MSM2/894-3	11.09.2006	02:29	77° 46.01' N	5° 59.74' W	380.3	MN	on deck
MSM2/895-1	11.09.2006	08:11	78° 30.01' N	6° 30.01' W	301.1	CTD/RO	at depth
MSM2/896-1	11.09.2006	10:03	78° 30.01' N	6° 59.97' W	290.5	CTD/RO	at depth
MSM2/896-2	11.09.2006	10:35	78° 30.01' N	6° 59.97' W	289.6	APSN	surface
MSM2/896-2	11.09.2006	10:42	78° 30.01' N	6° 59.97' W	289.7	APSN	on deck
MSM2/897-1	11.09.2006	14:26	78° 20.47' N	7° 29.02' W	220.1	CTD/RO	at depth
MSM2/897-2	11.09.2006	14:29	78° 20.48' N	7° 28.95' W	217.3	APSN	surface
MSM2/897-2	11.09.2006	14:42	78° 20.55' N	7° 28.71' W	217.1	APSN	on deck
MSM2/897-3	11.09.2006	14:50	78° 20.61' N	7° 28.54' W	215.9	MN	surface
MSM2/897-3	11.09.2006	14:58	78° 20.62' N	7° 28.18' W	218.9	MN	at depth
MSM2/897-3	11.09.2006	15:08	78° 20.65' N	7° 27.81' W	218.3	MN	on deck
MSM2/897-4	11.09.2006	15:16	78° 20.70' N	7° 27.63' W	221.1	MN	surface
MSM2/897-4	11.09.2006	15:23	78° 20.72' N	7° 27.32' W	218.9	MN	at depth
MSM2/897-4	11.09.2006	15:29	78° 20.70' N	7° 26.94' W	215.8	MN	on deck
MSM2/898-1	12.09.2006	06:32	76° 1.60' N	7° 50.53' W	1844.2	APSN	surface
MSM2/898-1	12.09.2006	06:39	76° 1.53' N	7° 50.72' W	1844.7	APSN	on deck
MSM2/898-2	12.09.2006	07:20	76° 1.29' N	7° 51.27' W	1844.3	MUC	at sea bottom
MSM2/899-1	13.09.2006	09:00	74° 0.04' N	17° 59.67' W	206.7	MOR	Hydrophone into the water
MSM2/899-1	13.09.2006	09:03	74° 0.05' N	17° 59.79' W	205	MOR	Hydrophone on Deck
MSM2/899-1	13.09.2006	09:14	74° 0.03' N	17° 59.45' W	205.7	MOR	Hydrophone into the water
MSM2/899-1	13.09.2006	09:17	74° 0.01' N	17° 59.52' W	204.3	MOR	Hydrophone on Deck
MSM2/899-1	13.09.2006	09:30	74° 0.01' N	17° 59.29' W	204.2	MOR	Hydrophone into the water
MSM2/899-1	13.09.2006	09:31	74° 0.00' N	17° 59.31' W	207	MOR	released
MSM2/899-1	13.09.2006	09:34	73° 59.99' N	17° 59.38' W	207.1	MOR	on the surface
MSM2/899-1	13.09.2006	09:34	73° 59.99' N	17° 59.38' W	207.1	MOR	Hydrophone on Deck
MSM2/899-1	13.09.2006	09:55	74° 0.04' N	18° 0.43' W	208.4	MOR	releaser on deck
MSM2/899-1	13.09.2006	10:01	74° 0.03' N	18° 0.59' W	207.8	MOR	mooring on deck
MSM2/900-1	13.09.2006	22:19	73° 13.42' N	15° 29.54' W	2014.5	APSN	surface
MSM2/900-1	13.09.2006	22:24	73° 13.42' N	15° 29.54' W	2014.7	APSN	on deck
MSM2/900-2	13.09.2006	23:04	73° 13.42' N	15° 29.54' W	2014.4	MUC	at sea bottom

4.6 Acknowledgements

We are grateful to captain Holtschmidt and his crew for continous help, inventiveness and friendlyness, to the Leitstelle for their support and to Lars Kaleschke for small JPG-files with great ice information.