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The Expedition of the Research Vessel "Polarstern" to the Arctic in 2012 (ARK-XXVII/1)

Edited by
Agnieszka Beszczynska-Möller
with contributions of the participants

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Bremerhaven - Longyearbyen

Chief scientist
Agnieszka Beszczynska-Möller

Coordinators
Rainer Knust/Eberhard Fahrbach

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1. ZUSAMMENFASSUNG UND FAHRTVERLAUF

Agnieszka Beszczynska-Möller AWI

Der erste Fahrtabschnitt der 27. Expedition der *Polarstern* in die Arktis war ozeanographischer und biogeochemischer Forschung in der nördlichen Framstraße gewidmet. Die Expedition dauerte vom 14. Juni bis zum 15. Juli und endete in Longyearbyen auf Spitzbergen. Während einer fünftägigen Überfahrtszeit zum Forschungsgebiet wurden 6 CTD-Stationen (Conductivity, Temperature, Depth) durchgeführt sowie 4 NEMO-Floats (Navigating European Marine Observer) und 5 SVP-B-Drifter (Surface Velocity Project-Barometer) ausgelegt. Die Messungen lieferten Daten für mehrere Projekte, darunter für das EU-Projekt der physikalischen Ozeanographie ACOBAR (Acoustic Technology for Observing the Interior of the Arctic Ocean), das HAFOS-Projekt (The Hybrid Arctic/Antarctic Float Observing System) sowie für die biogeochemischen Projekte der Forschungsgruppe PEBCAO (Phytoplankton Ecology and Biogeochemistry in the Changing Ocean) und der beiden Gruppen vom IFM-GEOMAR in Kiel.

Die ozeanographischen Arbeiten zwischen nördlichem Nordatlantik und Arktischem Ozean entlang der Framstraße hatten die Messung der ozeanischen Volumen- und Wärmeflüsse zum Ziel, womit deren jährliche und dekadische Variabilitäten erfasst werden sollen. Es wurden vertikale Profile von Temperatur, Salzgehalt und Sauerstoffgehalt an 81 CTD-Stationen entlang eines bei 78°50‘ Nord gelegenen Schnittes gemessen, der die ganze Breite der Framstraße zwischen dem ostgrönländischen Schelf und dem Schelf westlich Spitzbergens umfasste. Meeresströmungen in der oberflächennahen Schicht wurden bei fahrendem Schiff und auf den Stationen registriert. Zwei weitere CTD-Schnitte wurden zusätzlich abgearbeitet; einer entlang der Eiskante auf dem grönländischen Schelf (18 Stationen) und einer entlang der Laufbahn tomographischer Signale in der östlichen Framstraße (20 Stationen). Die Verankerungen, die 2010 und 2011 ausgelegt worden waren und das ganze Jahr hindurch Temperatur, Salzgehalt und Meeresströmungen kontinuierlich registrierten, wurden vollständig ausgetauscht. Insgesamt wurden 12 Verankerungen aufgenommen und 14 Verankerungen neu ausgelegt (einschließlich zweier profilierender Verankerungen). Damit wird die mittlerweile seit 15 Jahren andauernde Langzeitmessung fortgesetzt. Um die zeitlich kontinuierlichen, aber räumlich weniger hochauflösenden Messungen durch die verankerten Geräte zu ergänzen, wurde ein autonom operierendes Tauchgerät, der Seaglider, für eine zwei Monate dauernde Messperiode in der nördlichen Framstaße ausgelegt. Um die akustische Unterwassernavigation für die zukünftigen Glider-Missionen unter dem Meereis zu erproben, wurden 7 RAFOS Schallquellen im westlichen, eisbedeckten Teil der Framstraße neu ausgebracht; 5 wurden geborgen.

Auf insgesamt 11 multidisziplinären Stationen entlang von 78°5’N gab es zusätzlich zu den hydrographischen Messungen und den mit der CTD-Rosette genommenen Wasserproben auch noch Probenentnahmen mit Netzen für die biologischen Studien der PEBCAO Gruppe. 180 Proben wurden entnommen, um die Anzahl und die taxonomische Zusammensetzung von Algen zu bestimmen. An weiteren 84 Proben wurden die Konzentrationen von Kohlenstoff, Stickstoff, Silikat und Nährstoffen bestimmt. Die Abundanz und räumliche Verteilung von Mesozooplankton wurde mittels eines Multischleppnetzes in fünf verschiedenen Tiefen bis zur maximalen Tiefe von 1.500 m erfasst. Am Material aus 10 vertikalen Schleppfängen mit dem großen Multinetz wurden 10 Amphipodenarten identifiziert. Um die Zusammensetzung des Phytoplanktons zu bestimmen, wurden 69 Wasserproben für mikroskopische Analysen genommen und weitere 105 Proben von 35 Stationen wurden zur Durchführung von Genanalysen filtriert. Die Phytoplanktonproben zielten auch darauf ab, eine arktische Schlüsselart, die Mikroalge *P. pouchetii*, in den oberen 10 m zu untersuchen. In 60 Proben konnten 492 Kolonien isoliert werden, die meisten davon zwischen 2° West und 10° Ost. An Bord wurden zwei Experimente durchgeführt, um die Auswirkungen einer pCO_2-Änderung auf die dominanten Copepodenarten zu untersuchen. Insgesamt 350 Wasserproben von 6 Stationen während der Überfahrt und von 16 Stationen in der Framstraße wurden für DNA- und RNA-Analysen gewonnen, um die Auswirkung der Erwärmung der Ozeane auf die Zusammensetzung und den Stoffwechsel des Phytoplankton zu untersuchen.

Zur Untersuchung des Kohlenstoffhaushalts verschiedener Wassermassen, der Eigenschaften der verschiedenen Strömungen, und um Veränderungen in der Ventilation der Wassermassen zu quantifizieren, wurden Verteilungen in den Konzentrationen von DIC (gelöster anorganischer Kohlenstoff), Sauerstoff, Nährstoffen und den Spurenstoffen CFC-12 (Fluorchlorkohlenwasserstoff-12) und SF_6 (Schwefelhexafluorid) auf 42 Stationen entlang des Schnitts aufgenommen und mit Ausnahme von DIC und Nährstoffen an Bord gemessen. Wasserproben zur Bestimmung der Verteilung stabiler Sauerstoffisotope ($\delta^{18}O$) wurden auf 32 Stationen genommen und an weiteren 16 für die Bestimmung radiogener Neodymium-Isotope (Nd) und Seltener Erden (REE). Die Kenntnisse, die über die Spurenstoffe gewonnen werden, helfen, die Wassermassenverteilung in der Framstraße zu charakterisieren. Wasserproben zur Bestimmung von gelöstem schwarzen Kohlenstoff (DBC), gelöstem organischen Kohlenstoff (DOC) und farbigem gelöstem organischen Material (CDOM) wurden genommen (100 Proben für DBC und 250 Proben für DOC und CDOM), um zu bestimmen, wie viel DBC aus den Flüssen in den Arktischen Ozean und damit schließlich in den Atlantischen Ozean eingebracht wird. Um die Flussmengen von CO_2, CH_4, N_2O und CO im Austausch zwischen Ozean und Atmosphäre in der Framstraße zu quantifizieren, wurde ein Equilibrator an das en-Route-Pumpensystem der *Polarstern* angeschlossen. Ein Membran-Inlet-Massenspektrometer wurde genutzt, um kontinuierlich das Verhältnis von gelöstem Sauerstoff zu Argon (O_2/Ar) zu messen.

Die geodätischen Arbeiten in Nordost-Grönland mit Ausbringung der GPS-Sensoren an der grönländischen Küste, konnten wegen der ungünstigen Flugwetterbedingungen, nicht ausgeführt werden. Auf zwei Schnitten, einem entlang der Küste West-Spitzbergens und einem entlang des 78°50‘N-Schnitts wurde die *in situ* Verteilung von Seevögeln und Meeressäugern untersucht. Die Beobachtungen wurden von der Brücke aus und im Verlauf von Helikopter durchgeführt (insgesamt 470 Beobachtungsabschnitte, jeweils 30 Minuten lang). Insgesamt 28 Seevogelarten und 16 Meeressäugerarten wurden beobachtet. Die Hauptergebnisse im Verlauf der Beobachtungsreihe in der nördlichen Framstraße bestehen in der sehr hohen Zahl von gesichteten Elfenbeinmöwen (>400 Vögel) und in den ersten Sichtungen einer Plüschkopfente und einer Polarmöwe, sowie in den Sichtungen von Seiwalen und Narwalen (3 Gruppen mit insgesamt 17 Tieren). Es wurden zahlreiche Eisbären beobachtet (27 Tiere mit mindestens 4 Jungen).

Fahrtverlauf

14. Juni	Abfahrt von Bremerhaven 08:00LT. Test von Parasound und Hydrosweep, Posidonia USBL Box, GAPS und Gravimeter durch FIELAX nahe Helgoland. Rücktransport der FIELAX/Laeisz Gruppe via Helikopter und Auslaufen in Richtung Framstraße um 18:00LT.
15.-16. Juni	Transit zur ersten Station bei 70°N. Vorbereitung der Ausrüstung und Messgeräten.
17. Juni	Die ersten 2 CTD/Handnetz-Stationen auf dem Transekt in der Norwegischen See.
18. Juni	CTD-Stationen und Probenahme mit Hand- und Bongonetzen auf dem Transekt in der Norwegischen See. Auslegung der 4 NEMO-Floats und 2 SVP-B-Bojen unterwegs.
19. Juni	CTD-Stationen, Beprobung mit dem Handnetz und Test-Station für Multinetz auf dem Transekt in der Norwegischen See. Auslegung der 2 SVP-B-Bojen unterwegs.
20. Juni	Auslegung einer SVP-B-Boje. Beprobung mit dem Handnetz. Beginn der CTD-Stationen auf dem Hauptschnitt bei 78°50'N.
21. Juni	CTD-Stationen, dabei 2 Super-Stationen[1)] mit Multinetz bei 7°O und 8°O. Auslegung der Verankerung F1-14. Aufnahme der Verankerungen F2-15, F3-14, F4-14, F5-14.
22. Juni	CTD-Stationen in der Nacht. Auslegung der Verankerungen F2-16, F3-15, F4-15. Weitere CTD-Stationen, eine Super-Station bei 6°O.
23. Juni	CTD-Stationen in der Nacht. Auslegung der Verankerung F5-15. Aufnahme der Verankerungen F22-2 und F6-15. Auslegung des Seagliders MK557.
24. Juni	CTD-Stationen in der Nacht. Auslegung der Verankerung F20-4a. Aufnahme des Seagliders MK557. Auslegung der Verankerungen F6-16 und F20-4b. Weitere CTD-Stationen mit Super-Station bei 5°O.
25. Juni	CTD-Stationen in der Nacht. Aufnahme der Verankerung F7-11. Weitere CTD-Stationen mit eine Super-Station bei 4°O. Auslegung der Verankerung F7-12.
26. Juni	CTD-Stationen in der Nacht. Aufnahme der Verankerungen F8-12, F15-9 und F168. Weitere CTD-Stationen.

27. Juni	CTD-Stationen in der Nacht. Auslegung der Verankerungen F8-13 und F15-9. Weitere CTD-Stationen mit Super-Station bei 1°50'O.
28. Juni	CTD-Stationen in der Nacht. Auslegung der Verankerung F16-9 und Aufnahme der Verankerung F9-10. Weitere CTD-Stationen, dabei eine Super-Station bei 0°2'O (mit 3 Einsätzen des Multinetzes)
29. Juni	CTD-Stationen in der Nacht. Auslegung der Verankerung F9-11 und Aufnahme der Verankerung F10-11. Weitere CTD-Stationen.
30. Juni	CTD-Stationen in der Nacht, dabei eine Super-Station bei 2°30'W. Auslegung der Verankerung F10-12.
1. Juli	CTD-Stationen in der Nacht. Transit nach Süden und Aufnahme der RAFOS-Verankerung FSQ3-1. Aufnahme-versuch der RAFOS-Verankerung FSQ3-2 nicht gelungen. Auslegung der RAFOS-Verankerung FSQ3-3. Die akustische Lauschstation vom Schlauchboot. Transit zurück zum Hauptschnitt bei 78°50'N. Weitere CTD –Stationen.
2. Juli	Transit nach Norden und Aufnahme der RAFOS-Verankerung FSQ4-1. Auslegung der RAFOS-Verankerung FSQ4-2 abgebrochen wegen technischer Problemer mit der Schallquelle.
3. Juli	Beprobung mit Hand- und Bongonetzen. Transit Richtung Grönland durch dickes und kompaktes Meereis, mit dem Ziel GPS-Sensoren auf der Küste auszubringen. Der Helikopterflug nach Grönland musste wegen sehr schlechter Sichtbedingungen (dicker, eisiger Nebel) abgebrochen werden.
4. Juli	Abwarten auf Verbesserung des Flugwetters. Der Test-Flugversuch Richtung Grönland nicht gelungen auf Grund des dicken Nebels, Schneefalls und tiefer Wolkenuntergrenze. Mittlerweile CTD-Stationen entlang der Festeiskante.
5. Juli	Abwarten auf Verbesserung des Flugwetters. Fortdauerndes Nebel, Schneefall und tiefe Wolken. Weitere CTD-Stationen entlang der Festeiskante.
6. Juli	Abwarten auf Verbesserung des Flugwetters. Transit zurück zum Hauptschnitt bei 78°50'N. CTD-Stationen im Eis, dabei eine Super-Station bei 10°27'W.
7. Juli	CTD-Stationen auf dem Hauptschnitt mit einer Super-Station bei 7°30'W.
8. Juli	CTD-Stationen auf dem Hauptschnitt mit eine Super-Station bei 5°25'W. Auslegung der RAFOS-Verankerung FSQ7-1.
9. Juli	CTD-Stationen auf dem Hauptschnitt mit eine Super-Station bei 3°57'W. Auslegung der RAFOS-Verankerung FSQ6-1. Transit nach Norden.

10. Juli	Aufnahme der RAFOS-Verankerung FSQ2-3. Auslegung der RAFOS-Verankerungen FSQ2-4 und FSQ4-2. Aufnahme der RAFOS-Verankerung FSQ13.
11. Juli	Der zweiter Aufnahme-Versuch der RAFOS-Verankerung FSQ3-2 nicht gelungen. Auslegung der RAFOS-Verankerung FSQ5-1. Die akustische Lauschstation vom Schlauchboot. CTD-Stationen auf dem Abschnitt entlang des tomographischen Tracks D-A.
12. Juli	Weitere CTD-Stationen entlang des tomographischen Tracks D-A.
13. Juli	Weitere CTD-Stationen entlang des tomographischen Tracks D-A. Helikopter-Flug nach Longyearbyen, um den Seaglider SG127 abzuholen.
14. Juli	Test und Auslegung des Seagliders SG127. Transit nach Isfjorden.
15. Juli	Ankunft in Longyearbyen 08:00LT. Ausschiffung der wissenschaftlichen Fahrtteilnehmer 12:00LT. Ende des Fahrtabschnittes.

[1)]Eine Super-Station umfasst die Standard CTD-Station mit Entnahme der Wasserproben aus allen Tiefenbereichen sowie 2-3 vertikale Profile mit dem Multinetz.

SUMMARY AND ITINERARY

The first leg of the 27th *Polarstern* expedition to the Arctic was devoted to conduct oceanographic and biogeochemical research in the northern Fram Strait. The cruise started on June 14 from Bremerhaven and was finished on July 15 in Longyearbyen. During the 5-day long transit to the working area, 6 CTD stations (Conductivity, Temperature, Depth) were conducted and 4 NEMO (Navigating European Marine Observer) floats and 5 SVP-B drifters (Surface Velocity Project-Barometer) were deployed. The field research in the Fram Strait served different projects, among them the EU project ACOBAR (Acoustic Technology for Observing the Interior of the Arctic Ocean), the German project HAFOS (Hybrid Arctic/Antarctic Float Observing System), and a suite of biochemical studies carried by the research group PEBCAO (Phytoplankton Ecology and Biogeochemistry in the Changing Ocean) and by two groups from IFM-GEOMAR, Kiel.

The oceanographic measurements aimed at the estimation of oceanic volume and heat fluxes through Fram Strait between the northern North Atlantic and the Arctic Ocean with special emphasis on inter-annual and decadal variability. Hydrographic measurements (temperature, salinity and oxygen) were conducted on 81 CTD stations along the section, and ocean currents in the upper layer were measured both on stations and underway. Two additional CTD sections were alsoconducted, one along the ice edge on the Greenland shelf (18 stations) and one along the tomographic path in the eastern Fram Strait (20 stations). The moored array, deployed in 2010 and in 2011 for year-round measurements of temperature, salinity and currents was exchanged. Altogether 12 oceanographic moorings were recovered and 14 moorings were deployed (including two profiling moorings). Measurements at the moored array will provide an extension of the existing 15-year long time series of unbroken observations in Fram Strait. To complement the observations by moorings that are continuous in time yet though spatially relatively sparse, the high resolution hydrographic sections were measured by Seaglider, deployed for the 2-month long mission in Fram Strait. Five RAFOS sound sources were recovered and 7 acoustic sources were deployed in the western, ice-covered part of Fram Strait for under-ice acoustic navigation of the glider.

At 11 multidisciplinary stations along the 78°5’N section, the hydrographic measurements and collection of water samples were combined with net sampling for the biological studies by the PEBCAO group. 180 water samples were taken for gathering the information on algal abundance and taxonomic composition. Additional 84 samples were collected for analyzing the particulate carbon and nitrogen, silicate and nutrients. The abundance and distribution of mesozooplankton was investigated by vertical medium multinet hauls from 5 different depth strata down to 1,500 m. To study the distribution of amphipod species, 10 vertical casts with the large multinet were performed. For determining the phytoplankton compositions, 69 samples were collected for microscopic analysis and 105 water samples from 35 stations were filtrated for the analysis of ribosomal genes. On the individual phytoplankton species level, sampling was focused on the Arctic key micro algal species *P. pouchetii* collected from the upper 10 m layer. 492 isolates from 60 field samples were achieved, with most successful isolation of colonies between 2°W and 10°E. To investigate changes in pCO_2 on dominant copepod species, two experiments were conducted onboard. 350 samples were obtained from 6 stations during the transit and from 16 stations in Fram Strait for DNA and RNA analysis to study the effects of warming on phytoplankton community structure and metabolism.

To provide information about the carbon budget of the water masses, characteristics of ocean currents, and to quantify changes in ventilation, the profiles of water samples for DIC (dissolved inorganic carbon), oxygen, nutrients and the transient tracers CFC-12 (Chlorofluorocarbon-12) and SF_6 (Sulfur hexafluoride) were taken at 42 stations along the transect. The CFC-12, SF_6 and oxygen concentrations were measured onboard while DIC and nutrients samples will be analysed onshore. Water samples for the detection of stable oxygen isotope ($\delta^{18}O$) were collected at 32 stations and for radiogenic neodymium (Nd) isotopes and rare earth elements (REE) at 16 stations. These tracers will be used for the assessment of water mass signatures in Fram Strait. 100 water samples were collected for DBC (dissolved black carbon) and approx. 250 samples were taken for DOC (dissolved organic carbon) and CDOM (colored dissolved organic matter) analysis to determine how much of the riverine DBC entering the Arctic Ocean is subsequently exported to the Atlantic Ocean. To quantify air-sea exchange fluxes of CO_2, CH_4, N_2O and CO in Fram Strait, a glass-bed equilibrator was connected to the underway sampling system of *Polarstern* and a membrane-inlet mass spectrometer was used to continuously measure dissolved oxygen-to-argon (O_2/Ar) ratios.

The geodetic work with deployments of the GPS sensors on the Greenland coast could not be achieved due to the lack of flight permitting weather conditions. At sea distribution of seabirds and marine mammals was studied along two dedicated transects, the section along the West Spitsbergen coast and the main Fram strait section along 78°50'N by observations from the ship and during helicopter flights (470 periods of 30-min data recording). In total 28 bird species and 16 marine mammal species were observed. The main highlights were the very high number of Ivory Gulls (>400 individuals), the first in the record of sightings of the Spectacled Eider and the Iceland Gull as well as the sightings of Sei Whales and Narwhals (3 groups with 17 individuals). A high number of Polar Bear was also recorded (27 individuals with at least 4 cubs).

Cruise itinerary

14 June	Departure 08:00 LT according to the plan. Testing of Parasound and Hydrosweep, Posidonia USBL Box, GAPS and Gravimeter by FIELAX near Helgoland. Retransfer of the FIELAX/Laeisz group by helicopter and departure towards Fram Strait at 18:00LT.
15-16 June	Transit to the first station at 70°N. Preparations of equipment.

17 June	First 2 CTD stations and 2 hand net stations at the transect in the Norwegian Sea
18 June	CTD stations, sampling with hand and Bongo nets at the transect in the Norwegian Seas. Deployment of 4 NEMO floats and 2 SVP-B drifters on the way.
19 June	CTD stations, sampling with hand net and test station for Multinet at the transect in the Norwegian Seas. Deployment of 2 SVP-B drifters on the way.
20 June	Deployment of 1 SVP-B drifter. Sampling with hand net. Starting CTD stations at the 78°50’N section.
21 June	CTD stations including 2 SuperStations[1)] with Multinets at 7°E and 8°E. Deployment of mooring F1-14. Recovery of F2-15, F3-14, F4-14, F5-14.
22 June	CTD stations at night. Deployment of moorings F2-16, F3-15, F4-15. CTD stations with one SuperStation at 6°E.
23 June	CTD stations at night. Deployment of mooring F5-15. Recovery of moorings F22-2, F6-15. Deployment of Seaglider MK557.
24 June	CTD stations at night. Deployment of mooring F20-4a. Recovery of Seaglider MK557. Deployment of moorings F6-16 and F20-4b. CTD stations with one SuperStation at 5°E.
25 June	CTD stations at night. Recovery of mooring F7-11. CTD with SuperStation at 4°E. Deployment of F7-12.
26 June	CTD stations at night. Recovery of moorings F8-12, F15-9 and F168. CTD stations.
27 June	CTD stations at night. Deployment of moorings F8-13 and F15-9. CTD stations with one SuperStation at 1°50’E.
28 June	CTD stations at night. Deployment of mooring F16-9 and recovery of F9-10. CTD stations with one SuperStation at 0°2’E (with 3 Multinets)
29 June	CTD stations at night. Deployment of mooring F9-11 and recovery of F1011. CTD Stations.
30 June	CTD stations at night with SuperStation at 2°30’W. Deployment of mooring F10-12.
1 July	CTD stations at night. Transit to the south and recovery of RAFOS mooring FSQ3-1. Attempt to recover RAFOS mooring FSQ3-2 not successful. Deployment of RAFOS mooring FSQ3-3. Acoustic listening station from the rubber boat. Transit back to 78°50’N section. CTD stations.

2 July	Transit northward and recovery of RAFOS mooring FSQ4-1. Deployment of FSQ4-2 cancelled due to the failure of sound source.
3 July	Hand and Bongo net stations. Transit through the compact sea ice towards Greenland for deployment of GPS sensors on the coast. No weather condition for flights due to dense fog.
4 July	Waiting for flight permitting weather conditions. Trial flight towards Greenland not successful due to the fog, snow fall and low cloud ceiling. In the meantime CTD stations along the fast ice edge.
5 July	Waiting for flight permitting weather conditions. Persistent fog, snow falls and low cloud ceiling. CTD stations along the fast ice edge.
6 July	Waiting for flight permitting weather conditions. Transit back to the 78°50'N section. CTD stations in ice with one SuperStation at 10°27'W.
7 July	CTD stations at the main section with one SuperStation at 7°30'W.
8 July	CTD stations at the main section with one SuperStation at 5°25'W. Deployment of RAFOS mooring FSQ7-1.
9 July	CTD stations with one SuperStation at 3°57'W. Deployment of RAFOS mooring FSQ6-1. Transit northward.
10 July	Recovery of RAFOS mooring FSQ2-3. Deployment of RAFOS moorings FSQ2-4 and FSQ4-2. Recovery of RAFOS mooring FSQ13.
11 July	Second attempt to recover RAFOS mooring FSQ3-2 not successful. Deployment of RAFOS mooring FSQ5-1. Acoustic listening station from the rubber boat. CTD stations at the section along tomographic track DA.
12 July	CTD stations at the section along tomographic track DA.
13 July	CTD stations at the section along tomographic track DA. Helicopter flight to Longyearbyen to pick up the Seaglider SG127
14 July	Tests and deployment of Seaglider SG127. Transit to Isfjorden.
15 July	Arrival Longyearbyen 08:00LT. Disembarking of the scientific crew 12:00LT. End of the cruise.

[1)]A superStation include a standard CTD cast with full collection of water samples and 2-3 vertical hauls by multinet.

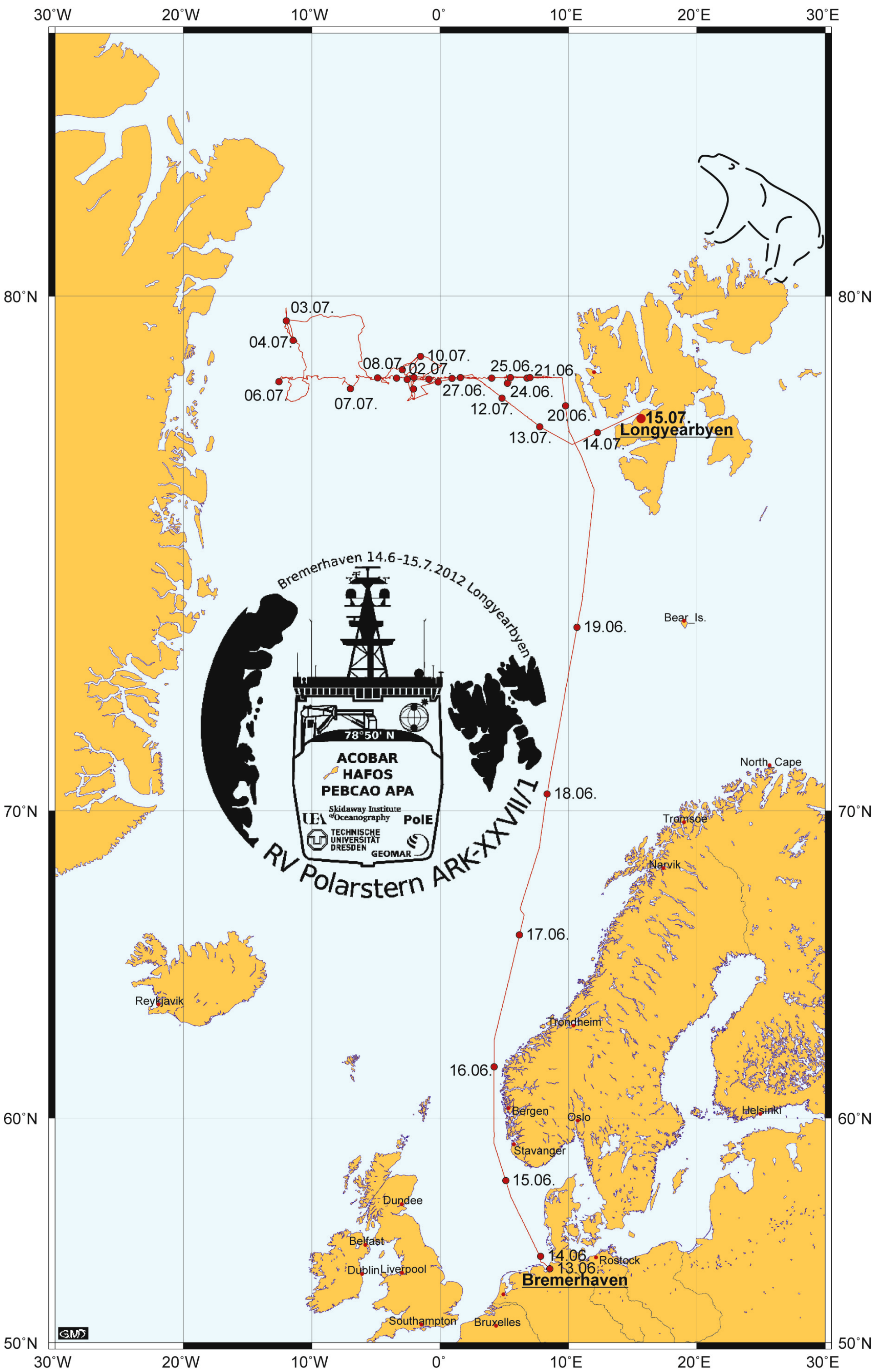

Abb.1.1: Die Fahrtroute der Polarstern während ARK-XXVII/1

Fig. 1.1: Cruise track of RV Polarstern during the expedition ARK-XXVII/1

2. WEATHER CONDITIONS

Harald Rentsch, Klaus Buldt, Julianne Hempelt DWD

At the beginning of the cruise ARK-XXVII/1 on June 14th at 8:00 MESZ in Bremerhaven a low pressure system over Ireland was strengthening when our ship moved northward. On the front side of the high pressure ridge over western North Sea the sea and wind were relatively calm with wind force up to 4 Bft, mostly from northerly to easterly directions. Starting on June 18th we got wind of nearly 7 Bft from north-westerly direction for one day, while the wave height did not reach more than 2.5 m. This coincided with covered skies, rain and partly foggy conditions. These bad weather conditions had continued for next two days on our track to Fram Strait while the wind speed decreased to below 20 knots.

After the middle of the week the pressure gradient raised considerably resulting in south-westerly winds up to wind force 7 Bft. Despite wave heights between 2.5 and 3 m all moorings could be perfectly recovered. Due to warmer air, the ceiling of broken clouds were fixed above 500 ft and helicopters could perform flights for watching whales, partly at sunshine. This cyclonal-influenced weather situation continued on 22nd and 23rd of June in Fram Strait (Fig. 2.1). Up to this time we had been getting the polar-origin air from the north, which was cooled by ice, producing often fog or low clouds.

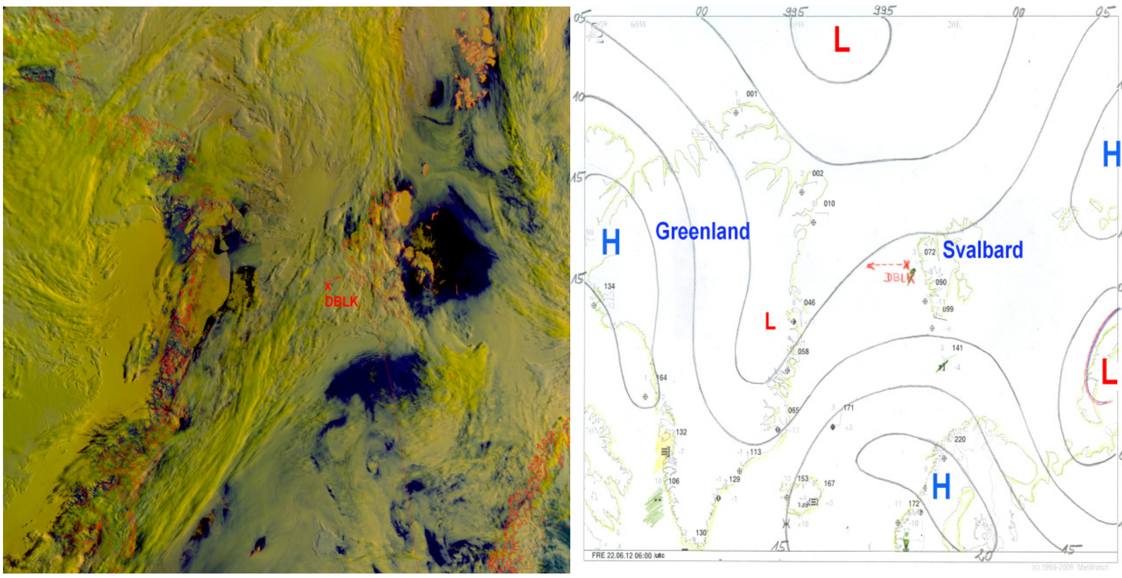

Fig. 2.1: Analysis of surface-pressure chart for 22.06.2012, 06 utc (left), and VIS/IR-satellite picture 22.06.2012, 06:23 utc (right). The position of Polarstern is marked by the sign x, labelled by the ship's call sign DBLK, its track is shown by dashed red lines.

On June 25th the moist, unstable, layered air came from the Arctic Ocean and was dominant for the weather for the next 2 days. This situation in connection with a upper low, which crossed the Frame Strait and moved further on towards Barents Sea and often caused snow- and rain showers, resulted in insufficient flight conditions with respect to meteorological terms. Therefore the scheduled helicopter flights over the ice covered area for sea mammals watching could not be performed. Under the north-westerly wind of Bft 4-5 the sea remained nearly calm, with only some restrictions during recovery of moorings due to bad visibility and precipitation.

For the next three days during our course along 78.8°N the cold air and often snow or snow-showers were observed at upper levels and the wind blew from north-westerly directions with Bft 4. On June 28th some lows on the surface and aloft passed our ships track and the wind force of Bft 7 from northerly directions caused some problems with mooring recovery at the position 78.8°N 1°W since ice-sheets were spreading into the recovery area.

On June 29th we were mostly under the influence of a steering low and snowfall, the wind blew with Bft 5 from the northeast direction. On the low's back side after the end of snowfall the weather conditions improved, allowing the helicopter flights one day later. On July 1st July the pressure increased slowly in Fram Strait and breaking clouds were observed in the working area together with the weak easterly winds. These conditions allowed another helicopter campaign to watch animals in the ice-covered areas. The extended ice sheets (one-year and multi-year ice) along the ship's track hampered the recovery of moorings and made it difficult to find the optimal way through the ice.

Starting on July 2nd the low clouds were dominant in the northern part of an upper, steering low over Greenland Sea. The low was moving towards the coast of eastern Greenland, towards the position of the helicopter flights scheduled for the deployment of GPS sensorsobs. On July 3rd and 4th the ship was in the region influenced by fronts and within a stable stratification of air nearby the surface, causing snowfall and low clouds in the wide range around the working area. All flights towards the cost of Greenland had to be cancelled due to insufficient flight meteorological conditions, in spite of entering the open water polynya far away from the Greenland's fast ice edge.

One day later the influence of high pressure on the surface strengthened strongly. The weak wind could not transport away the whole moisture in low-altitude air below an inversion layer in lower atmosphere. Due to this and additional cyclonal processes in the upper atmosphere, some polar lows built up (Fig. 2.2) and circulated anticlockwise around the upper low producing snow and fog. All flight actions were stopped due to insufficient flight weather conditions described above.

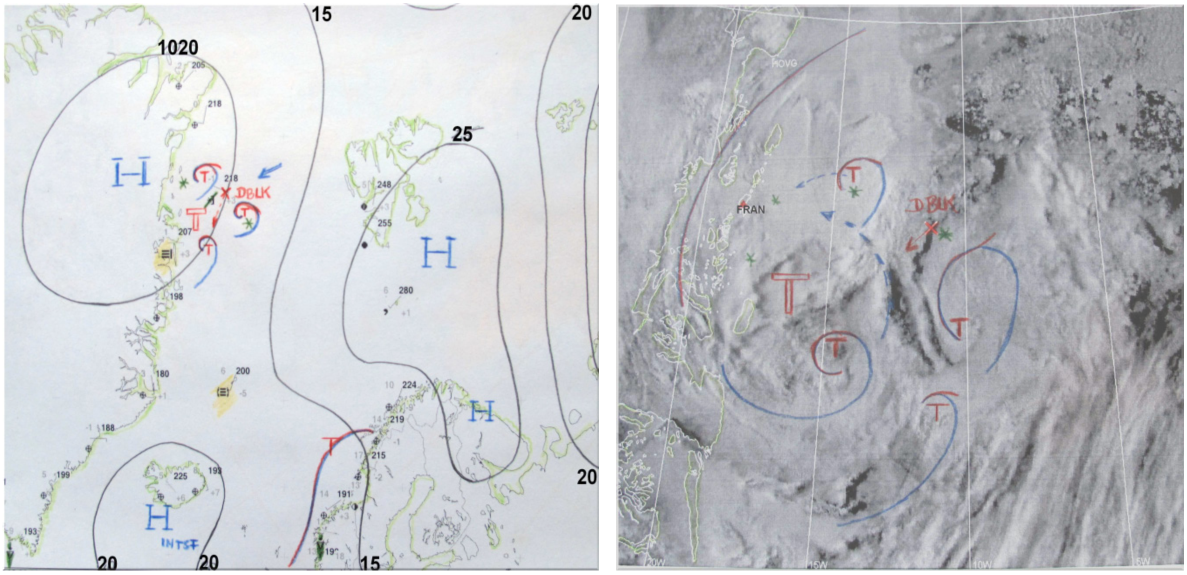

Fig. 2.2: Analysis of surface-pressure chart for 05.07.2012, 06 utc (left), and IR-satellite picture 05.07.2012, 07:04 utc (right). The position of POLARSTERN is marked by "x" sign and labelled with the ship's call sign DBLK; T-sign (not filled, red): upper low; T-sign (filled, red with fronts): Polar Low; H: high pressure; dashed blue lines: movement of Polar Lows anticlockwise.

Starting from July 6th we had a break of weather; a cold airflow from the north let to dry weather with northerly winds up to Bft 5. At the edge of the low nearby Svalbard the flight weather was slightly improving day by day, so during the next 3 days all flights dedicated to marine mammals watching were successful. The ice conditions along our track eastward remained difficult but rather good ice information based on the satellite pictures help to find the optimal way through the ice. One day later, on July 9th some polar lows moved towards our cruise track, bringing fog and low clouds, all driven by the northerly winds up to Bft 6. Therefore the helicopter flights were possible only in the morning. The difficult ice situation caused some delays for station work. Finally, one day later, when ship was moving out of the ice towards Svalbard, the low clouds and fog disappeared more often and helicopter flight could be carried out. Wind velocity was very low and increasing pressure dominated the weather situation until the end of our cruise. We reached our destination, Longyearbyen, under the fair weather on July 15th in the morning with the air temperature around 7°C.

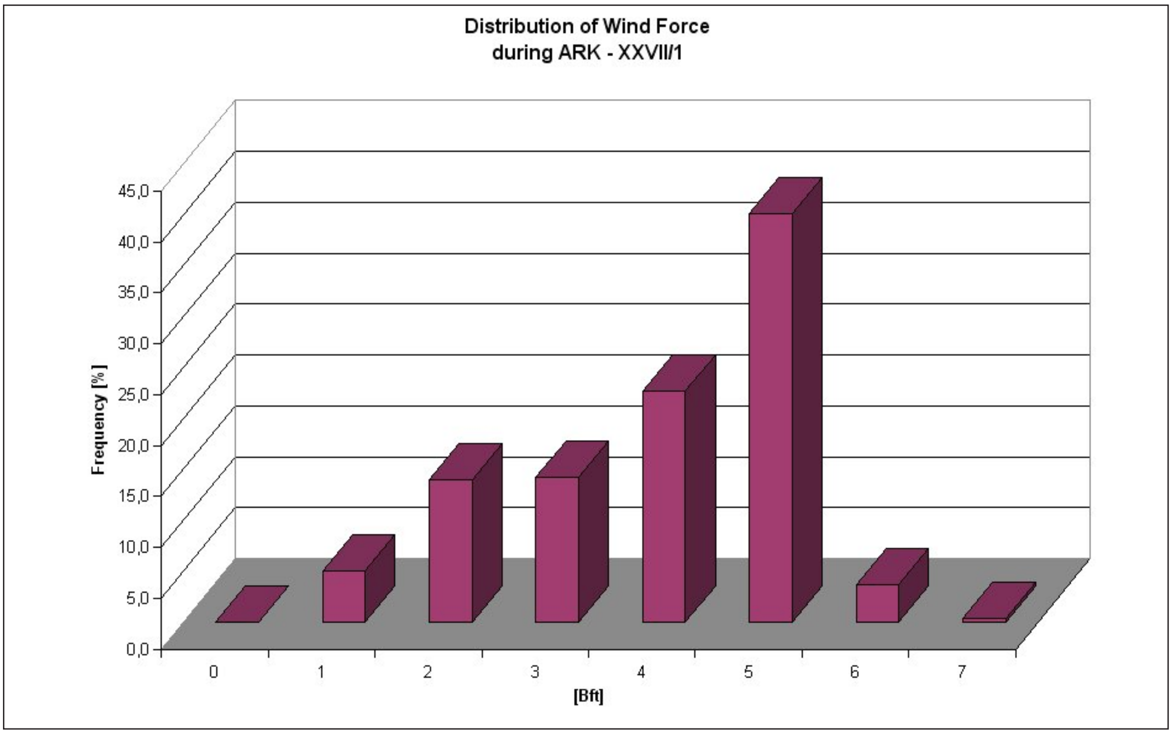

Fig. 2.3: Distribution of wind force during ARK-XXVII/1

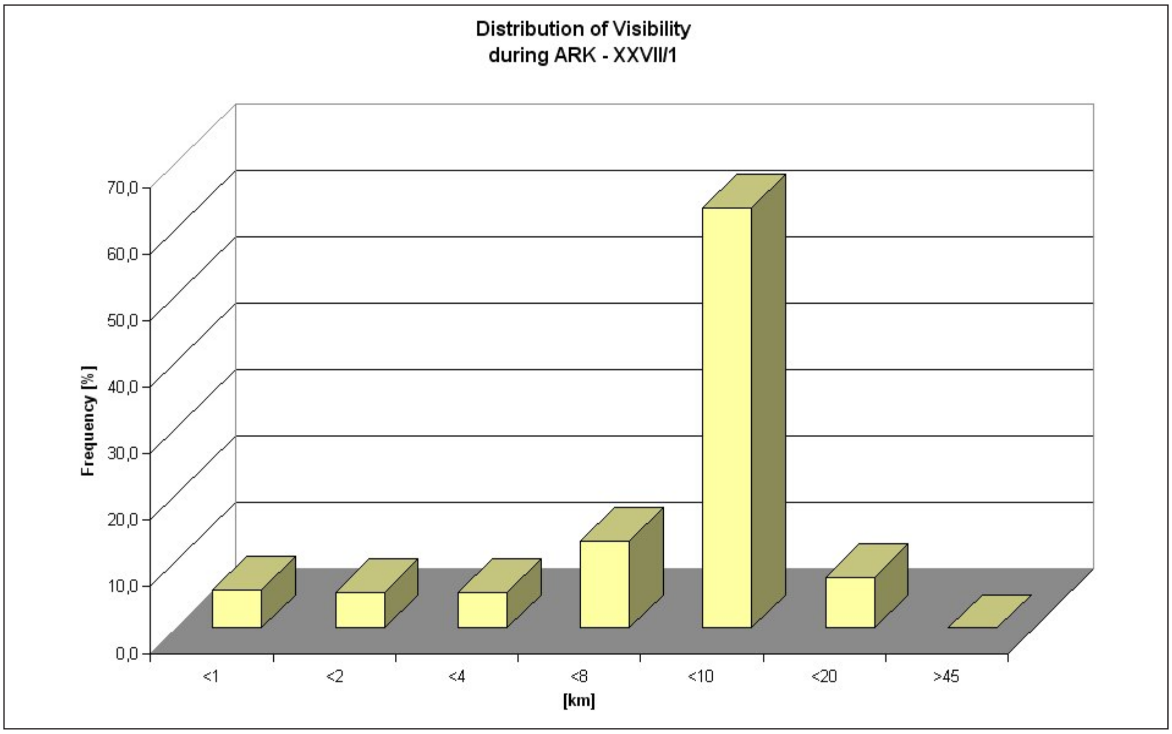

Fig. 2.4: Distribution of visibility during ARK-XXVII/1

3. OCEANIC FLUXES THROUGH FRAM STRAIT AND AT THE ENTRANCE TO THE ARCTIC OCEAN

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AWI

Objectives

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

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

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

It is our aim to measure the oceanic fluxes through Fram Strait and to determine their variability on seasonal to decadal time scales. Since 1997, year-round velocity, temperature and salinity measurements are carried out in Fram Strait with moored instruments. Hydrographic sections exist since 1980. The estimates of mass and heat fluxes through the strait are provided through a combination of both data sets. From 1997 to 2000 intensive fieldwork occurred in the framework of the EU project VEINS (Variability of Exchanges in Northern Seas). After the end of VEINS it was maintained under national programmes. From 2003 to 2005, the work was carried out as part of the international Programme ASOF (Arctic-Subarctic Ocean Flux Study) and was partly funded in the EU ASOF-N project. In 2006-2009 measurements in Fram Strait were performed under the EU DAMOCLES (Developing Arctic Modelling and Observing Capabilities for Long-term Environment Studies) Integrated Project and since 2009 the observational programme has been continued in the context of the EU ACOBAR project. The mooring line is maintained in close co-operation with the Norwegian Polar Institute (NPI). The results of the measurements will be used in combination with regional models, to investigate the nature and origin of the transport fluctuations on seasonal to decadal time scales.

Work at sea

The oceanographic work at sea during ARK-XXVII/1 included two main activities: the recovery and redeployment of the array of moorings and measurements of CTD (Conductivity, Temperature, Depth) profiles (Fig. 3.1). The standard section in Fram Strait at 78°50’N, which has been occupied regularly since 1997, was measured with the high resolution coverage by 80 CTD stations, extending westward to 12°47’W. Two additional hydrographic section were also occupied, one along the ice edge in the western Fram Strait with 18 CTD stations and second along the tomographic track in the eastern part of the strait with 20 stations.

The mooring array covers the entire deep part of Fram Strait between the continental slope west of Spitsbergen to the shelf edge east of Greenland. In 2003 it was extended by NPI onto the East Greenland shelf. In June-July 2012 *Polarstern* recovered all moorings in the central and eastern part of the strait, including 8 moorings which were deployed in 2011 during the ARK-XXVI/1 cruise (between 8°20’E and 2°47’E) and 4 moorings between 2°48’E and 2°W deployed two years earlier during ARK-XXV/1 and not exchanged in 2011. The easternmost mooring F1, located over the upper Spitsbergen continental slope at 8°40’ at the depth of 270 m, was not deployed in 2011 due to a high risk of damage by fishery vessels. This mooring had been lost during two subsequent deployment periods (2009-2010 and 2010-2011). In 2012 mooring F1 was deployed with a redesigned construction as the bottom mooring equipped with a trawl-resistant frame.

Each recovered tall subsurface mooring carried 3 to 8 instruments including rotor and acoustic current meters from Aanderaa Instruments (RCM7, RCM8 and RCM11), acoustic current profilers from RD Instruments (WH and QM ADCP), temperature and salinity sensors from Sea-Bird Electronics Inc. (SBE37 and SBE16) and bottom pressure recorders from Sea-Bird (SBE26). The whale recorder (AURAL M2) and two calibrated hydrophones for passive acoustic recording (H38 and H41) were also included in the recovered moorings as well as 5 develogic hydroacoustic modems Hydro-Node. The western moorings (west of 3°W), operated by NPI were recovered in September 2012 by RV *Lance*.

The recovered moorings F2 to F10 (including F15 and F16) were redeployed in a similar configuration as during the previous deployment except the additional upward-looking ADCPs (Acoustic Doppler Current Profilers) to test the new configuration of the moored array to be adopted under the HAFOS project. In future the HAFOS moored array will consist of gliders covering the upper 300 m layer and shorter moorings with ADCPs at the top. In the current configuration, for a sufficient vertical resolution each subsurface mooring carries 3 to 8 instruments (RCM 8 and RCM11 current meters from Aanderaa, acoustic Doppler current profilers (ADCP) from RDI and SBE16 and SBE37 temperature and salinity sensors from Seabird). Instruments were distributed at the nominal levels: 50m (subsurface layer), 250 m (Atlantic water layer), 750 m (lower boundary of the Atlantic water), 1,500 m (deep water) and 5 m above bottom (near-bottom layer). The easternmost mooring F1 was deployed as the bottom mooring with ADCP installed in the trawl-resistant bottom frame and one MicroCat mounted on the frame. Horizontal distances between moorings are smaller at the upper slope (moorings F1 to F3) and increase towards the deep part of the strait (ca. 20 km).

All instruments were configured for the two-year long deployment period since there is no *Polarstern* Arctic expedition planned in 2013. However, short before deployment it was discovered that a bigger part of battery packs for ADCPs, delivered just before the cruise as new by manufacturer, was already overdue regarding the recommendation for deployment (date given on the battery as 'not deploy after') and the most likely the devices will stop before the planned recovery date. To assure data delivery for this 2-year period, all ADCPs were back-up with additional Aanderaa current meters, located at each mooring next to ADCP at the nominal depth of 250m.

To test the near-real time (NRT) data transfer between moorings, three low-frequency long-range acoustic modems, the HAM.nodes manufactured by develogic GmbH, were interfaced to the current meters at selected moorings and deployed in 2009 for one-year long field test in the eastern Fram Strait (Fig. 3.2). Since acoustic data transmission over a typical range between moorings of the order (30 km) proved to be unreliable, the distance between long-range modems was reduced by adding a relay-link mooring with additional modem in a half-way between instrumented moorings. The results of the 2009-2010 test revealed significant problems related to the high level of ambient noise and low signal-to-noise ratio, resulting in a large number of failed transmissions. The next deployment of moorings with acoustic modems took place in 2011 when a tuning inductivity to increase the output amplitude (therefore the range of the modems) was implemented and transmission settings were adjusted (more often transmissions, smaller data packages). Of four long-range acoustic modems deployed in 2011 one was recovered in September 2011 and the remaining three were recovered during the ARK-XXVII/1 cruise in 2012. For the deployment in 2012 three moorings in the eastern Fram Strait were equipped with the low-frequency modems.

In addition to the long-term array, two additional moorings were also deployed in 2012, aimed in testing the profiling winches with CTD profiler equipped with Iridium modem for data transfer. Both moorings carried the underwater winch from the NGK Japan but the profiler systems were different. One mooring carried the original CTD profiler from NGK Japan equipped with acoustic modem for communication with the winch and Iridium modem for data transfer. The second mooring was equipped with the profiling top from Optimare GmbH (built on the basis of an adapted NEMO float) The profilers were programmed to cover the upper water column up to the surface. These moorings were located south of the moorings F5-F6 at the offshore boundary of the West Spitsbergen Current. The additional moorings with profiling winches and modems were recovered during the autumn cruise of KV *Svalbard* in September 2012.

For the testing purposes of the under ice acoustic navigation of gliders in Fram Strait, the array of the 260 Hz RAFOS sound sources was deployed in the central and western Fram Strait. Four RAFOS sound sources deployed in 2011 were recovered in 2012. One source located farther north at 79°39'N could not be recovered due to the compact ice cover at the mooring location (this source was recovered later in September 2012 from KV *Svalbard*). Seven acoustic moorings were deployed during ARK-XXVII/1 in 2012, six equipped with develogic RAFOS sound sources and one with the Webb RAFOS source. One develogic sound source failed immediately during deployment and deployment was cancelled.

The mooring recovery rate was 88 % (from 12 recovered moorings). Two Aandera RCM8 current meters lost the rotors and in one case, the instrument was blocked in a fixed position. Additionally, two RCM8 current meters was flooded and one recorded no data (memory failure). Two RCM11 (SN 452 and 458) recorded data in wrong channels, and data could not be converted into engineering units. One ADCP at mooring F7 was flooded; however there were no indications of leakage through the instrument cover. Most likely the water got into the pressure case through one (or more) of the ADCP mirrors. Two CTD sensors SBE37 stopped prematurely (one after 100 and one after 150 days). The distribution of instruments is shown on Fig. 3.2.

During ARK-XXVII/1 the 7th operational mission of Seaglider in Fram Strait was launched. The underwater glider is a buoyancy-driven device, which can alternately reduce and expand displaced volume to dive and climb through the ocean, just as do profiling floats. Unlike floats, a glider additionally carries wings and controls its pitch attitude to effectuate a horizontal speed component through the ocean. Originally the new Seaglider MK557 manufactured by iRobot Inc. was planned for summer deployment in 2012. However, after deployment of the glider on June 23 it occurred that MK557 behaved unstable and could not be navigated in the programmed direction. Therefore the glider was recovered one day later. To execute the summer glider mission in Fram Strait, the express freight of Seaglider SN127 to Longyearbyen was arranged. SG127 was picked up from the Svalbard airport with the *Polarstern* helicopter just before the end of the cruise (on July 13) and successfully deployed near the Isfjord entrance on the same day. The Seagliders are capable to profile between surface and 1,000 m with the horizontal speed 0.1-0.45 m/s and minimum vertical speed of 0.06 m/s. Seaglider SN127, deployed for the summer mission, was equipped with SBE Temperature/Conductivity Sensors, SBE43 dissolved oxygen sensor, Wetlabs BB2SF chlorophyll *a*, fluorescence and optical backscatter sensors. In addition, RAFOS hardware was installed to test the underwater acoustic navigation of the glider in sea ice covered areas. During its mission the Seaglider was operated from the Glider Operation Center in Bremerhaven. SG 127 was recovered from KV *Svalbard* on September 9 after completing 303 dives over the distance of 572 Nm.

The CTD measurements in the eastern and central part of Fram Strait occurred mostly during the nights between mooring work. Therefore the sequence of stations is rather irregular. Altogether 125 CTD casts were taken at 123 stations and water samples were collected during all casts (Fig. 3.1). One CTD system from Sea-Bird Electronics Inc SBE911+ was used. Mainly CTD probe SN 937 with duplicate T and C sensors (temperature sensors SBE3, SN 1373 (primary) and 1338 (secondary), conductivity sensors SBE4, SN 1198 (primary) and 1199 (secondary) and pressure sensor Digiquartz 410K-105 SN 0937) was in service. The CTD was connected to a SBE32 Carousel Water Sampler, SN 718 (24 12-liter bottles). Additionally the

Benthos Altimeter Model PSA-916 SN 46611, the Fluorometer Wetlabs FLRTD SN 1365 and the transmissiometer WetlabsCStar SN 1120DR were mounted on the carousel. Two dissolved oxygen sensors SBE43 were in use: SN1605 until June 29 and SN743 afterwards. The algorithm to compute oxygen concentration requires also measurements of temperature, salinity and pressure. Salinity of 54 water samples was measured using the Optimare Precision Salinometer SN 003 with Standard Water IAPSO Batch P154 for calibration of the salinity sensor.

Underway measurements with a vessel-mounted narrow band 150 kHz ADCP from RD Instruments and a Sea-Bird SBE45 thermosalinograph measurements were conducted along the transect to supply temperature, salinity and current data at a much higher spatial resolution than given through the moorings. Two thermosalinographs were in use, one at the 6 m depth in the bow thruster tunnel and one at the 11 m depth in the keel. Both instruments were controlled by taking water samples, which were measured on board.

Preliminary results

The data from the moored instruments were read out from the memory cards and preliminary processed onboard but the final processing including the pressure correction in on-going. The analysis of the hydrographic data occurred on the basis of preliminary data available on board. The post-cruise calibration might result in minor changes.

The temperature and salinity sections across Fram Strait are shown in Fig. 3.3. The main core of northward flowing warm and saline Atlantic Water (AW) is found at the eastern side of the transect in the shallow to intermediate layers. The West Spitsbergen Current (WSC) is visible at the eastern slope by downward sloping isolines. The AW layer in the West Spitsbergen Current was much shallower compared to the previous year, over the upper shelf slope the isotherm 0°C was shifted up to approx. 600 m (observed at ~1,000 m in 2011). AW temperature in the WSC was much lower in summer 2012 than in 2011 with no water warmer than 5°C observed (except a small surface patch around 7°E). In contrast to summer 2011 when very warm water was found in the WSC but AW directly recirculating westward was much colder than average, in 2012 temperature of recirculating AW in the central Fram Strait was similar to the temperature of AW in the WSC. The AW mean temperature in the WSC (defined after Rudels et al., 2005 with T>2°C and $27.7<\sigma_Q< 27.97$) was 3.41°C in 2012 as compared to 3.85°C in 2011 and maximum of 4.88°C observed in 2006. In the western deep part of the strait, in vicinity of the Polar Front, patches of recirculating AW were found with maximum temperature about 3-3.5°C as opposite to the previous three years were much warmer water (with temperature above 5°C and in 2009 even above 6°C) was carried by the Atlantic Return Current to the west and ultimately south. The position of the Polar Front between the Arctic-derived Polar Water and Atlantic Water at the surface was shifted eastward and located about the Greenwich meridian (as compared to 3°W in 2010 and around 2°W in 2011). The Polar water surface layer observed in 2011 was thicker in 2011 than in the year before. The Polar water spread further eastward in the East Greenland Current but on the upper continental slope east of Greenland higher temperatures were observed in 2012 (maximum ~2°C) than in 2011 (maximum ~1°C).

Salinity of the AW water in 2012 was similar as in 2011, but its vertical distribution confirms that the AW layer in 2012 was much shallower as the year before. In 2011 water more saline than 35 was observed in the entire upper 800 m layer in the WSC while in 2012 it occupied only the 400 m thick upper layer (on average). Opposite to the dipole structure found in 2011 with very saline water in the WSC and low salinity in the central part of the strait, in 2012 the AW layer with salinity higher then 35 had similar thickness in the entire eastern Fram Strait between the upper slope west of Svalbard and the Polar Front. The thickness of low salinity (fresh) water in the western Fram Strait, above the continental slope east of Greenland, was similar in 2012 and 2011.

The anomalies of temperature and salinity from their long-term means (1997-2012) are shown on Fig. 3.4. In summer 2012 temperature in the entire WSC (in its core and off-shore branch) was lower than its long term mean with strongest negative anomalies up to 2-2.5°C found in the upper 700 m layer. Salinity values were close to the long-term average except the near-surface layer of ~50 m and the western Fram Strait where the strongest (both positive and negative) anomalies were observed. Above the lower continental slope east of Greenland, the Arctic Atlantic Water subducting below the Polar Water was also slightly warmer and more saline than the long-term average, while over the upper continental slope weakly negative temperature and strongly negative salinity anomalies were found in the whole water column. Temperature in the deep layer below 1,000 m was close to average at the entire section.

To identify the longer-term variability, time series of spatially averaged mean temperatures and salinities for typical water masses were derived for the depth interval from 50 to 500 m (Fig. 3.5). Three characteristic areas were distinguished in relation to the main flows: the West Spitsbergen Current (WSC) between the shelf edge and 5°E, the Return Atlantic Current (RAC) between 3°W and 5°E, and Polar Water in the East Greenland Current (EGC) between 3°W and the Greenland Shelf. The spatially averaged mean temperature of the upper 500 m layer in the WSC was the second lowest in 2012 and very close to the mean temperature in the RAC area. Mean temperature in the EGC domain increased slightly as compared to 2011. Salinity in the upper 500 m in the WSC was slightly lower than in 2011 and in the RAC it remained similar as the year before. A slight increase in salinity of the upper 500 m was also observed in the EGC domain.

The preliminary results obtained from the moored array confirm findings from the hydrographic snapshot. The long-term time series of deseasoned temperature of the Atlantic Water (at the nominal depth of 250 m) at three selected moorings in the core of the WSC (F2), at the western WSC edge (F6) and in the AW recirculation area (F7) are presented on Fig. 3.6. The continuous measurements at moorings show that the temperature in the WSC core and in the offshore was extremely high in winter 2011/2012, reaching the values of the 2006 maximum. However in the following summer AW temperature decreased significantly, being in the very core only slightly higher and in the off-shore branch much lower than in summer 2011. This warm winter peak was not observed in the recirculating water where temperatures in 2011-2012 were similar to the previous deployment period (2010-2011). More detailed analysis including estimation of oceanic fluxes will follow when the processing of the data from the full two-year period 2010-2012 is completed.

The new data sets were delivered by six upward-looking ADCPs (Acoustic Current Doppler Profilers), covering the upper 250m layer with the 8m cells. Example of variability of currents at all measured levels at the mooring F3 is shown on Fig. 3.7. Currents sticks represent hourly data low-pass filtered with a cut-off period of

40h. This vertically high resolution data (27 measured depths measured with ADCP versus 2 depths measured before with RCMs) confirm barotropic character of the flow but also reveal evolution of the vertical shear in time which will allow to better resolve the vertical structure of the current and in particular the structure of eddies passing through the array.

The hydrographic properties of water on the Greenland shelf are shown on Fig. 3.8 with temperature and salinity distributions at the meridional section along the fast ice edge (approx. between 10°30′ and 12°W). The warm water with higher salinity is visible in the near-bottom layer of ~80-100m thickness (below the depth of 280m). This warmer layer is covered by the cold and fresher Polar Water in the upper 150m.

A trajectory of the summer mission of the glider SG127 in 2012 is shown on Fig. 3.9 together with vertically averaged current vectors for the upper 1000 m, which are calculated from the glider hydrodynamic model and displacement during a single dive. Five long zonal sections between 2°W and 9°E (one of them between 0° and 6°E) were accomplished in this period together with several shorter sections in the eastern Fram Strait. Averaged current vectors reveal a coherent, strong northward flow in the West Spitsbergen Current and strong variability in the central part of Fram Strait. During the summer 2011 mission the glider covered a distance of 1060 km and completed 303 dives (mostly deep dives down to 1000 m), measuring pressure, temperature, salinity, dissolved oxygen and light transmission. The temperature and salinity distributions measured in the upper 1000 m during the whole length of the glider mission are shown on Fig. 3.10.

During the whole mission SG127 collected RAFOS receptions from RAFOS sources located in the central and western Fram Strait (Fig. 3.1) which where deployed during the ARK-XXVII/1 cruise. The glider calculated navigational solutions based on RAFOS signal using the built-in RAFOS hardware and the dedicated firmware from APL-UW. Altogether the glider collected 483 RAFOS receptions with correlation over the threshold (> 60) shown on Fig. 3.11. The highest number of valid receptions were for the RAFOS sources FSQ7-1 (develogic source), FSQ4-2 (Rossby source), FSQ1-4 (develogic source) and from the tomographic source A during the first half of the mission (until the source was recovered in September). There were no valid receptions from the RAFOS sources FSQ3-3 (develogic source), and tomographic sources B and C during the summer mission.

Data management

CTD data collected during ARK-XXVII/1 will be delivered after the post-cruise calibration to the PANGAEA data base and to the appropriate national data banks. The data recorded by the moored instrumentation will be post processed after the cruise at AWI and submitted to the PANGAEA data base within one year. The glider data collected during the summer mission are recorded at AWI in near-real time. The preliminary processing is done during the mission while the final post processing of the glider data takes place within one year after the completion of the mission. The processed glider data will be delivered to the PANGAEA data base within one year after the mission, provided that the necessary data formats and upload procedures will be worked out in the data base. The processed glider data will be also delivered to DAC (Data Assembly Center), which for AWI glider data is represented by the CORIOLIS Data Center.

References

Rudels, B., Björk, G., Nilsson, J., Winsor, P., Lake, I., Nohr, C. 2005. The interactions between waters from the Arctic Ocean and the Nordic Seas north of Fram Strait and along the East Greenland Current: results from the Arctic Ocean-02 Oden expedition. Journal of Marine Systems 55, 1–30. doi:10.1016/j.jmarsys.2004.06.00.

Tab. 3.1a: Moorings deployed in 2010 and recovered during ARK-XXVII/1

Mooring	Latitude Longitude	Water depth (m)	Date and time of first useful record	Instrument type	Serial number	Instr. depth (m)
F15-8	78°49.96′N	2502	18.07.10 08:00 UTC	RCM8 VT	6854	65
	01°35.90′E	(HSW)		SBE 37P	7727	80
	78.8327	2507		RCM8 VTP	11890	245
	1.5983	(corr. CTD)		RCM11 VT	135	750
				RCM11 VT	25	1497
				RCM11 VT	26	2463
F16-8	78°49.99′N	2533	17.07.10 14:00 UTC	RCM11 VTP	469	68
	00°24.05′E	(HSW)		SBE 37P	7729	81
	78.8332	2544		RCM7 VTP	10929	246
	0.4008	(corr. CTD)		RCM11 VT	100	752
				RCM11 VT	214	1498
				RCM11 VT	215	2515
F9-10	78°50.00′N	2617	19.07.10 16:00 UTC	Aural M2	MML13	57
	00°49.00′W	(HSW)		RCM11 VTP	512	58
	78.8333	2620		SBE 37P	7731	70
	-0.8167	(corr. CTD)		RCM8 VT	9763	247
				RCM8 VT	9187	753
				RCM8 VT	9391	1499
				RCM8 VT	9767	2586
F10-11	78°50.01′N	2663	20.07.10 11:00 UTC	RCM11 VTP	474	79
	01°59.97′W	(HSW)		SBE 37P	7726	80
	78.8335	2655		RCM8 VTP	11889	256
	-1.9995	(corr. CTD)		RCM8 VT	10496	753
				RCM7 VTP	8395	1499
				RCM11 VT	20	2636
FSQ3-1	78°30.00′N	2780	21.07.10	RAFOS source	22	ca. 700
	01°59.91′W	(HSW)	12:00	(Webb sound source)		
	78.5000	2817	UTC			
	-1.9985	(DWS)				

Tab. 3.1b: Moorings deployed in 2011 and recovered during ARK-XXVII/1

Mooring	Latitude Longitude	Water depth (m)	Date and time of first useful record	Instrument type	Serial number	Instr. depth (m)
F2-15	78°50.07'N	779	10.07.11 07:00 UTC	SBE 16	1973	76
(top@58m)	08°20.21'E	(DWS)		ADCP	14951	528
	78.8345	780		RCM	11887	529
	8.3368	(corr. CTD)		SBE 16	2420	230
				SBE 37	3813	771
				RCM8	10532	772
F3-14	78°49.99'N	1029	10.07.11 09:00 UTC	SBE 16	1975	93
(top@60m)	08°00.00'E	(DWS)		ADCP QM	14968	264
	78.8332			RCM		265
	8.0000			SBE 16	1977	266
				Holgiphone	H41	517
				RCM8 VTP	9194	774
				RCM8 VT	10531	1020
				SBE 37	246	1021
F4-14	78°50.01'N	1460	08.07.11 14:00 UTC	SBE 16	2413	113
(top@74m)	06°59.93'E	(DWS)		ADCP QM	14969	274
	78.8335		redeployed 12.07.11 14:00 UTC	RCM11	452	275
	6.9988			RCM11 VTP	472	732
				Develogic Modem	516	733
				RCM8 VTP	9783	1451
F5-14	78°50.01'N	2482	08.07.11 08:00 UTC	SBE 16	2419	77
(top@65m)	05°59.98'E	(HSW)		ADCP QM	14970	248
	78.8335	2414		RCM 11 VTP	461	249
	5.9997	(corr. CTD)		SBE 37	7728	250
				RCM11 VTP	458	696
				Develogic Modem	515	697
				RCM8 VTP	9995	1499
				RCM8 VT	9770	2406
F6-15	78°49.96'N	2707	07.07.11 08:00 UTC	SBE16	1976	65
(top@60m)	05°00.09'E	(DWS)		ADCP QM	14971	226
	78.8327	2644		RCM11 VTP	491	227
	5.0015	(corr. CTD)		SBE 37	7733	228
				Holgiphone	H38	478
				RCM 11 VTP	127	686
				Develogic Modem	514	687
				RCM 8 VT	9768	1489
				RCM 11 VT	315	2636

Mooring	Latitude Longitude	Water depth (m)	Date and time of first useful record	Instrument type	Serial number	Instr. depth (m)
F7-11	78°49.98'N	2335	06.07.11 12:00 UTC	SBE 16	319	92
(top@70m)	04°00.08'E	(DWS)		ADCP QM	15081	253
	78.8330	2292		RCM 8 VTP	11613	254
	4.0876	(corr. CTD)		SBE 37 P	7730	255
				RCM 8 VTP	9204	761
				RCM 8 VTP	9997	1508
				RCM 8 VT	9785	2284
F8-12	78°50.04'N	2495	06.07.11 06:00 UTC	SBE 16	1167	83
(top@65m)	02°46.63'E	(HSW)		ADCP QM	15082	255
		2446		RCM 8	9213	256
		(corr. CTD)		SBE SM 37 P	7732	256
				RCM 8	11892	763
				RCM 8	10004	1510
				RCM 11 VT	475	2438
F22-2	78°50.00'N	2619	07.07.11 13:00 UTC	Develogic Modem	517	702
(top@93m)	05°30.09'E	(DWS)				
F23-1	78°49.00'N	2698	07.07.11 11:00 UTC	Develogic Modem	3915	701
(top@89m)	04°59.98'E	(DWS)				
FSQ1-3	78°59.09'N	2486	02.07.11 11:00 UTC	RAFOS source	16	722
(top@713m)	02°56.02'W	(DWS)		(Rossby SQ	0008	722
				Develogic Electronic)		
FSQ2-3	78°59.65'N	2590	30.06.11 08:00 UTC	RAFOS source	36	782
(top@722m)	00°01.01'E	(DWS)		(Rossby SQ	19	
				Develogic Electronic)		
FSQ3-2	78°29.98'N	2819	01.07.11 08:00 UTC	RAFOS source	Not recovered	
(top@705m)	02°05.02'W	(DWS)		(Develogic SQ		
				Develogic Electronic)		
FSQ4-1	79°10.00'N	2644	30.06.11	RAFOS source	17	830
(top@694m)	01°30.08'W	(DWS)	12:00 UTC	(Rossby SQ	004	830
				Develogic Electronic)		

Abbreviations:

ADCP WH	RDI Inc. Self-Contained Acoustic Doppler Current Profiler Work Horse 300 Hz
ADCP QM	RDI Inc. Self-Contained Acoustic Doppler Current Profiler Quarter Master 150 Hz
VTP	Aanderaa current meter with temperature and pressure sensor
VT	Aanderaa current meter with temperature sensor
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 37	Seabird Electronics SBE37 recording temperature and conductivity (optionally pressure 37P)
RAFOS	RAFOS (Sound Fixing and Ranging) sound source

Tab. 3.2: Moorings deployed during ARK-XXVII/1

Mooring	Latitude Longitude	Water depth (m)	Date and time of first useful record	Instrument type	Serial number	Instr. depth (m)
F1-14	78° 50.01'N	240 (CTD)	21.06.2012	ADCP QM	14090	240
(top@238m)	08° 39.99'E	246 (DWS)	05:00 UTC	SBE 37	2384	240
	78.8335					
	8.6665					
F2-16	78° 50.05'N	787 (CTD)	22.06.2012	RCM8 VT	10531	86
(top@55m)	08° 20.17'E	809 (DWS)	07:00	SBE 37	1229	87
	78.83416			ADCP QM	14016	262
	8.33617			RCM8 VT	10532	263
				SBE 37	250	264
				SBE 37	220	774
				RCM11 VT	101	779
F3-15	78° 49.91'N	1005 (CTD)	22.06.2012	RCM11 VTP	461	59
(top@45m)	08° 00.29'E	1028 (DWS)	10:00 UTC	SBE 37	1237	60
	78.83183			ADCP QM	14086	240
	8.00483			RCM8 VT	9770	241
				SBE 37	9487	242
				Holgiphone	H33	493
				RCM11 VTP	506	750
				SBE 37	230	991

Mooring	Latitude Longitude	Water depth (m)	Date and time of first useful record	Instrument type	Serial number	Instr. depth (m)
				RMC11 VT	504	997
F4-15	78° 50.01′N	1420 (CTD)	22.06.2012	RCM8 VTP	11887	74
(top@60m)	06° 59.99′E	1465 (DWS)	13:00 UTC	SBE 37	2392	75
	78.83350			ADCP QM	14087	235
	6.99983			RCM8 VTP	9183	236
				SBE 37	2393	237
				RCM7 VTP	8048	692
				SonoVault	1026	743
				SonoVault	1024	1410
				RCM8 VT	10497	1412
F5-15	78° 50.01′N	2418 (CTD)	23.06.2012	RCM8 VTP	9194	74
(top@55m)	06° 00.04′E	2474 (DWS)	07:00 UTC	SBE 37	2396	75
	78.83350			ADCP QM	14088	225
	6.00067			RCM8 VTP	10002	226
				SBE 37	2610	227
				RCM11 VTP	462	673
				RCM11 VTP	486	1424
				RCM8 VT	9390	2410
F6-16	78° 49.99′N	2712 (DWS)	24.06.2012	RCM11 VT	315	61
(top@40m)	05° 00.00′E		12:00 UTC	SBE 37	2237	62
	78.83316			ADCP QM	14089	252
	5.00000			RCM11 VTP	491	253
				SBE 37	244	254
				Holgiphone	H34	504
				RCM11 VTP	455	751
				RCM8 VT	9186	1553
				RCM8 VT	9188	2636
F7-12	78° 49.72′N	2292 (CTD)	25.06.2012	SBE 37	8130	79
(top@55m)	04° 00.51′E	2345 (DWS)	13:00 UTC	ADCP QM	14951	239
	78.82867			RCM8 VTP	9997	240
	4.00850			SBE 37	8131	241
				RCM7 VT	8402	742
				RCM8 VT	3517	1498
				RCM8 VT	9782	2284
F8-13	78°49.37′N	2466 (CTD)	27.06.2012	SBE 16	2415	71
(top@55m)	02°45.33′E	2457 (DWS)	09:00 UTC	ADCP QM	14950	272
	78.82283			RCM8 VTP	9785	273
	2.75550			SBE 16	1979	274
				RCM8 VT	10872	781

Mooring	Latitude Longitude	Water depth (m)	Date and time of first useful record	Instrument type	Serial number	Instr. depth (m)
				RCM8 VT	9182	1522
				RCM8 VT	9185	2458
F15-9	78°50.12’N	2495 (CTD)	27.06.2012	SBE 16	2416	64
(top@50m)	01°35.08’E	2499 (DWS)	13:00 UTC	ADCP QM	14971	246
	78.83533			RCM8 VTP	11613	247
	1.58467			SBE 16	2421	248
				RCM7 VTP	8403	755
				RCM11 VTP	619	1531
				RCM8 VT	10503	2487
F16-9	78°49.76’N	2525 (CTD)	28.06.2012	SBE 16	2414	59
(top@50m)	00°25.77’E	2579 (DWS)	06:00 UTC	SonoVault	C1023	60
	78.82933			ADCP QM	14968	243
	0.42950			RCM8 VT	9768	244
				SBE 37	9488	245
				RCM8 VTP	9206	751
				SonoVault	C21	802
				RCM8 VTP	9998	1499
				SonoVault	C22	2515
				RCM11 VT	314	2517
F9-11	78°49.90’N	2593 (CTD)	29.06.2012	SBE 37	9486	55
(top@50m)	00°48.80’W	2603 (HS)	08:00 UTC	ADCP QM	14969	225
	78.83167			RCM8 VTP	9995	226
	-0.81333			SBE 37	9489	227
				RCM8 VTP	9207	733
				RCM7 VTP	10928	1479
				RCM11 VT	298	2585
F10-12	78°49.87’N	2666 (HS)	30.06.2012	SBE 37	9490	57
(top@50m)	02°03.46’W		19:00 UTC	ADCP QM	14970	248
	78.83117			RCM8 VTP	10004	249
	-2.05767			SBE 37	9491	250
				Holgiphone	H21	550
				RCM8 VTP	9201	755
				RCM8 VT	9786	1512
				RCM11 VT	296	2708
F20-4a	78°45.00’N	2410 (CTD)	24.06.2012	CTD Profiler	03	0-83
(top@75m)	05°29.96’E	2469 (DWS)	07:00 UTC	Profiling winch		
	78.75000					
	5.49933					

Mooring	Latitude Longitude	Water depth (m)	Date and time of first useful record	Instrument type	Serial number	Instr. depth (m)
F20-4b	78°45.00'N	2375 (DWS)	24.06.2012	CTD Profiler	11	0-115
(top@115m)	05°15.03'E		14:00 UTC	Profiling winch		
	78.75000					
	5.25050					
FSQ1-4	78°57.12'N	2500 (DWS)	02.07.2012	RAFOS source	0019	741
(top@90m)	02°57.53'W	2455 (HS)	13:00 UTC	(Develogic SQ		
	78.95200			Develogic		
	-2.95883			Electronic)		
FSQ2-4	79° 00.20'N	2556 (HS)	10.07.2012	RAFOS source	0020	795
(top@143m)	00° 00.63'E		08:00 UTC	(Develogic SQ		
	79.00333			Develogic		
	0.01050			Electronic)		
FSQ3-3	78°29.16'N	2711 (HS)	01.07.2012	RAFOS source	0016	799
(top@149m)	02°28.52'W		11:00 UTC	(Develogic SQ		
	78.48600			Develogic		
	-2.47533			Electronic)		
FSQ4-2	79°09.12'N	2595 (HS)	10.07.2012	RAFOS source		734
(top@82m)	01°28.77'W		12:00 UTC	(Rossby SQ	17	
	79.15200			Develogic	0005	
	-1.47950			Electronic)		
FSQ5-1	78°34.97'N	2801 (HS)	11.07.2012	RAFOS source	22	789
(top@87m)	01°00.00'W		08:00 UTC	(Webb SQ		
	78.58283			Webb Electronics)		
	-1.00000					
FSQ6-1	78°49.51'N	2645 (HS)	09.07.2012	RAFOS source	0015	734
(top@92m)	01°29.05'W		22:00 UTC	(Develogic SQ		
	78.825167			Develogic		
	-1.484166			Electronic)		
FSQ7-1	78°44.23'N	1758 (HS)	08.07.2012	RAFOS source	0014	747
(top@90m)	04°02.79'W		17:00 UTC	(Develogic SQ		
	78.737167			Develogic		
	-4.04650			Electronic)		

Abbreviations:

ADCP WH	RDI Inc. Self-Contained Acoustic Doppler Current Profiler Work Horse 300 Hz
ADCP QM	RDI Inc. Self-Contained Acoustic Doppler Current Profiler Quarter Master 150 Hz
VTP	Aanderaa current meter with temperature and pressure sensor
VT	Aanderaa current meter with temperature sensor
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 37	Seabird Electronics SBE37 recording temperature and conductivity (optionally with pressure sensor 37P)
RAFOS	RAFOS (Sound Fixing and Ranging) sound source

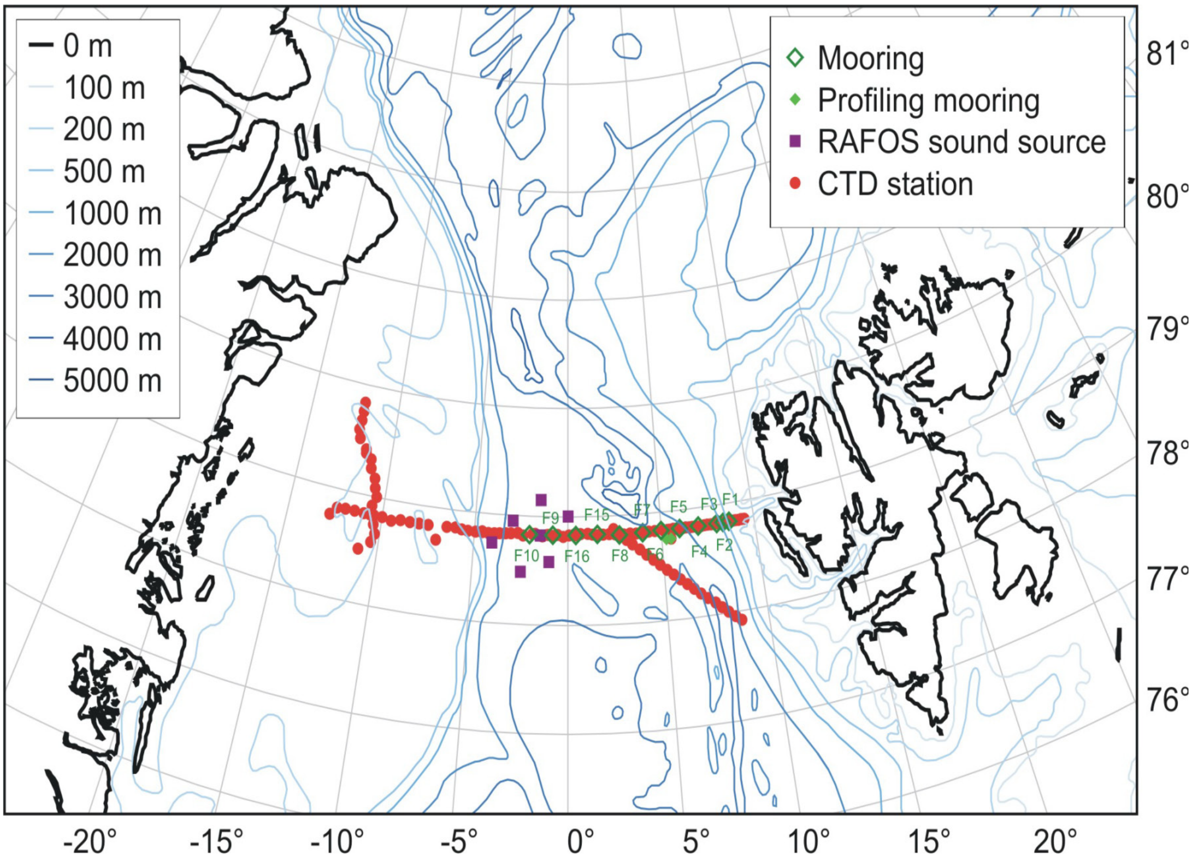


Fig. 3.1: Map with the position of CTD stations and moorings during ARK-XXVII/1

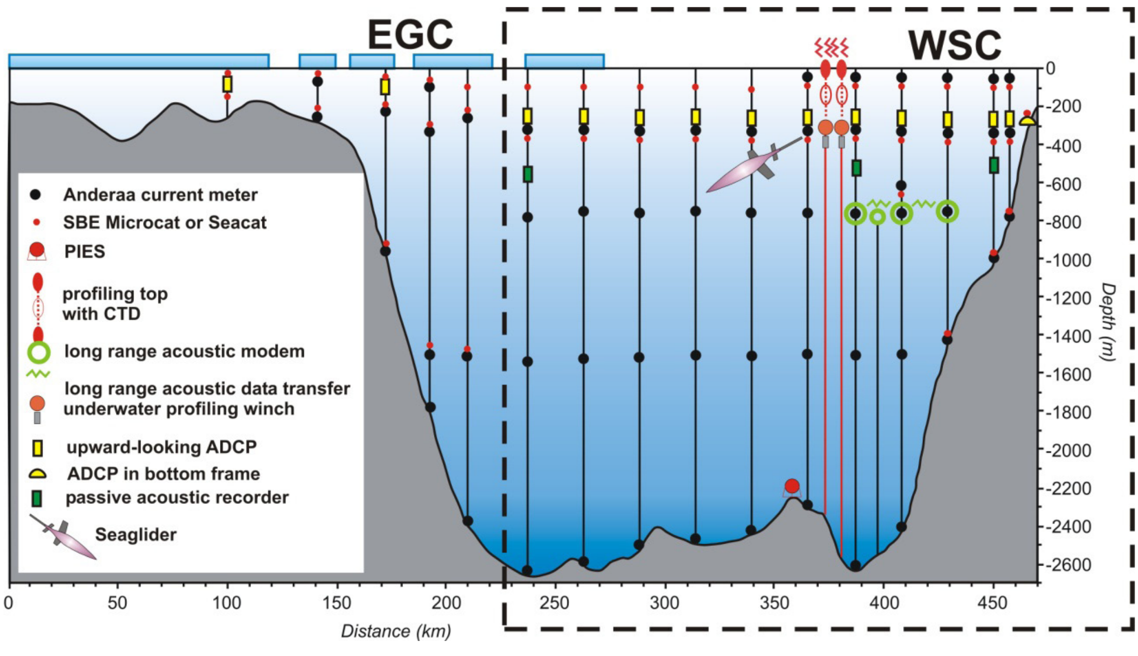


Fig. 3.2: The moored array in Fram Strait redeployed in 2012 during ARK-XXVII/1 for the deployment period 2012-2014 (dashed box indicated moorings operated by AWI)

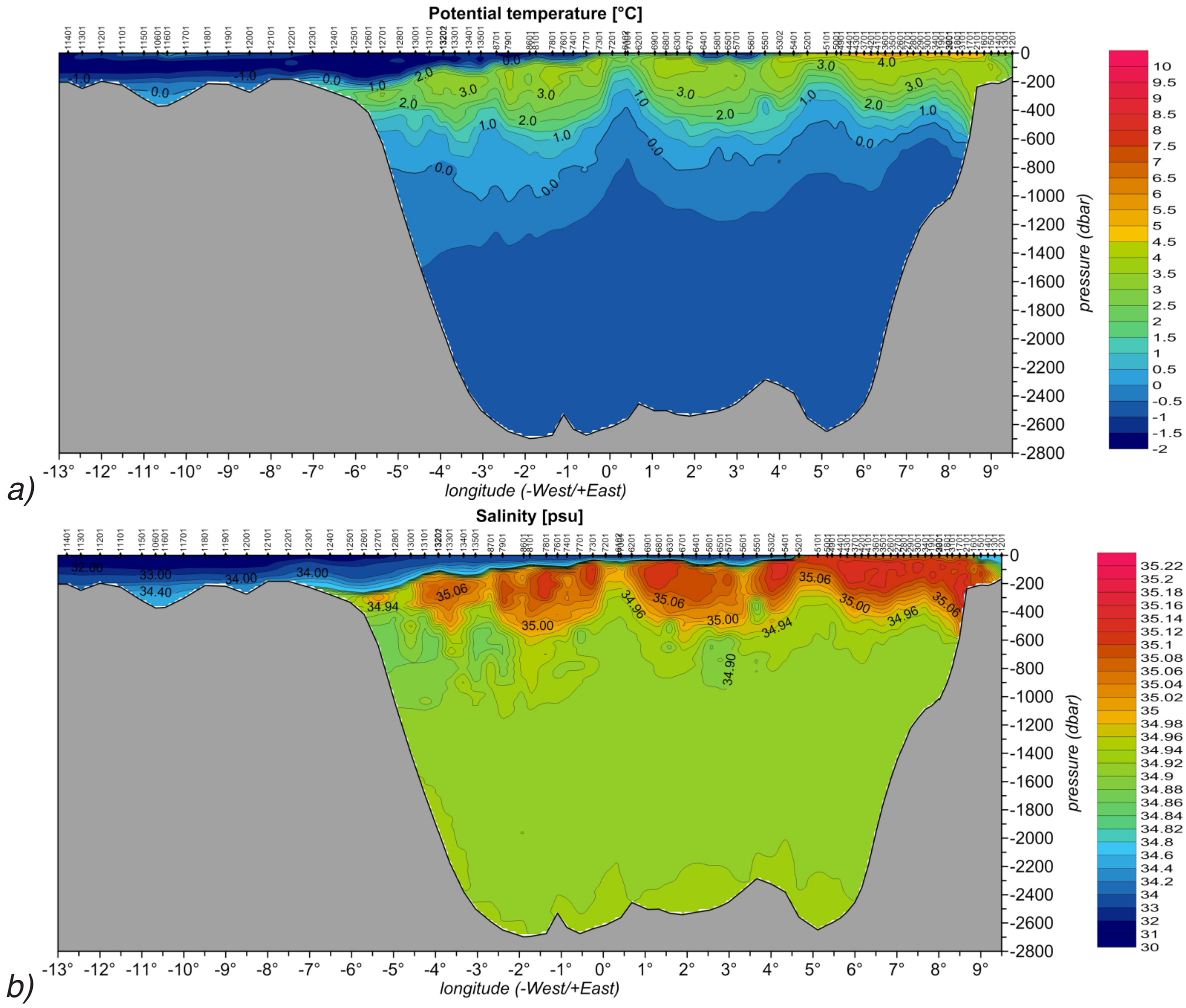
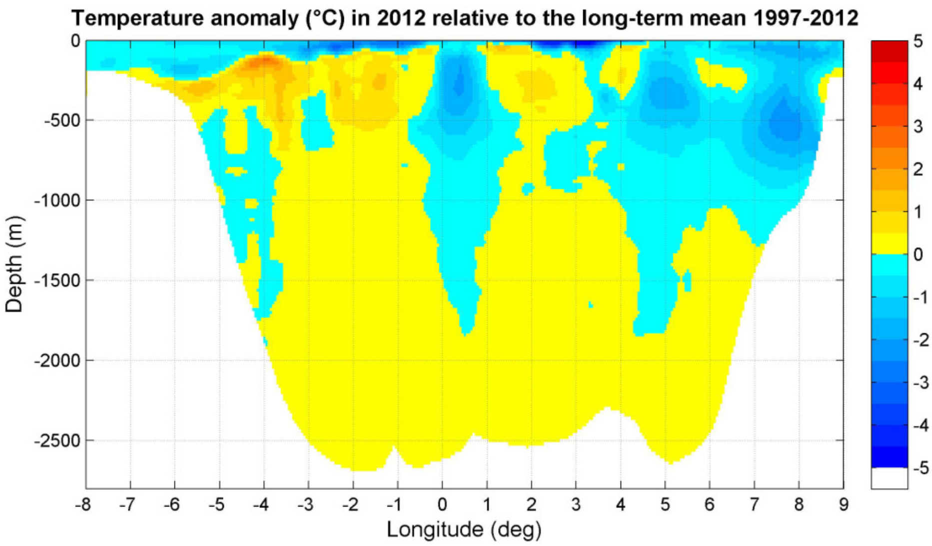
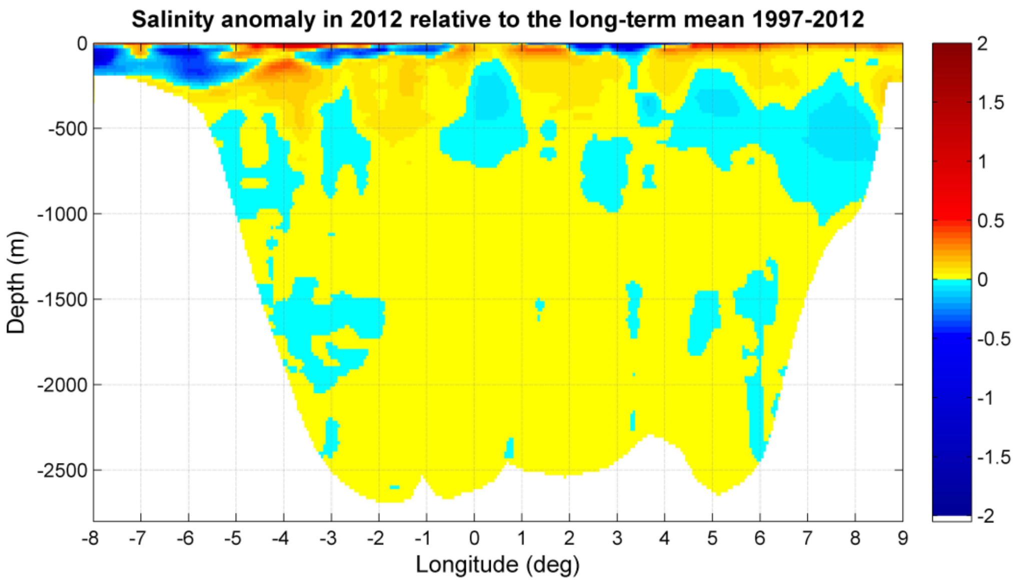


Fig. 3.3: Vertical distribution of potential temperature (a) and salinity (b) at the standard section across Fram Strait at 78°50'N measured during ARK-XXVII/1



a)



b)

Fig. 3.4: (a)Temperature and (b) salinity anomalies measured in 2012 during ARK-XXVII/1 relative to their long-term means (1997-2012)

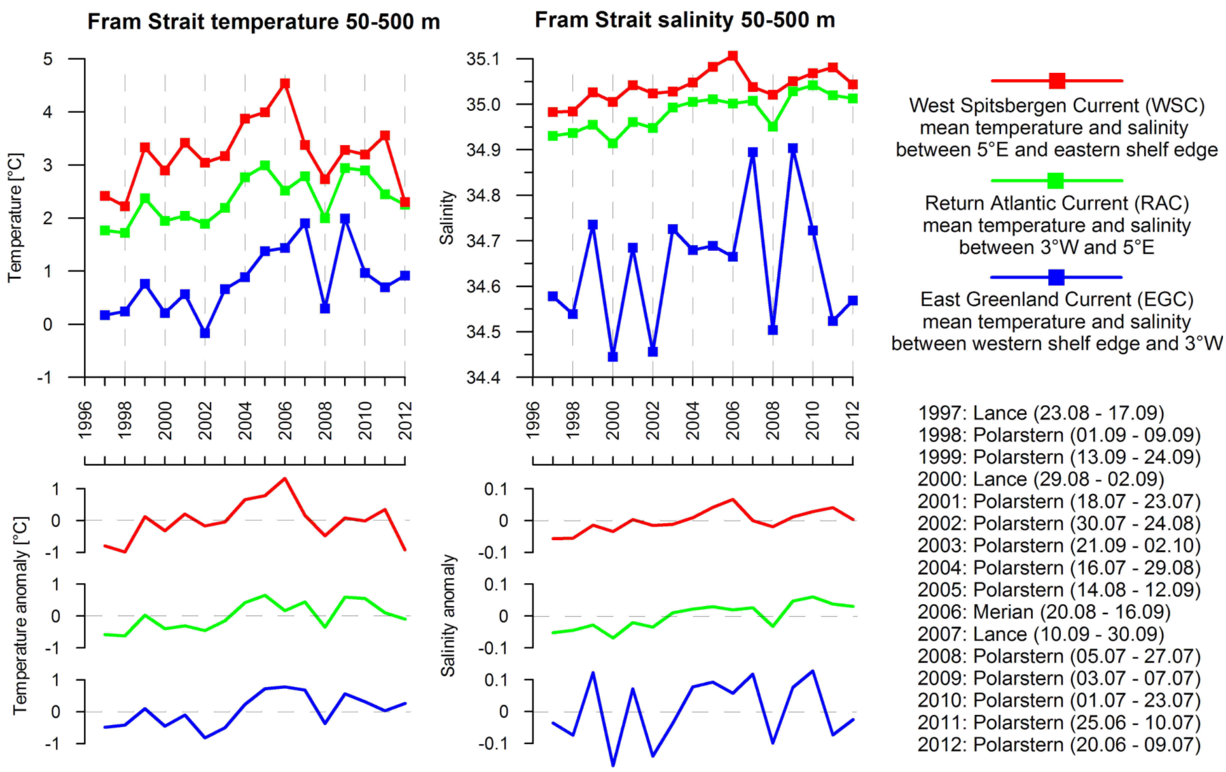


Fig. 3.5: Interannual variations of the mean temperatures and salinities in the Fram Strait in the West Spitsbergen Current (WSC), Return Atlantic Current (RAW) and East Greenland Current (EGC)

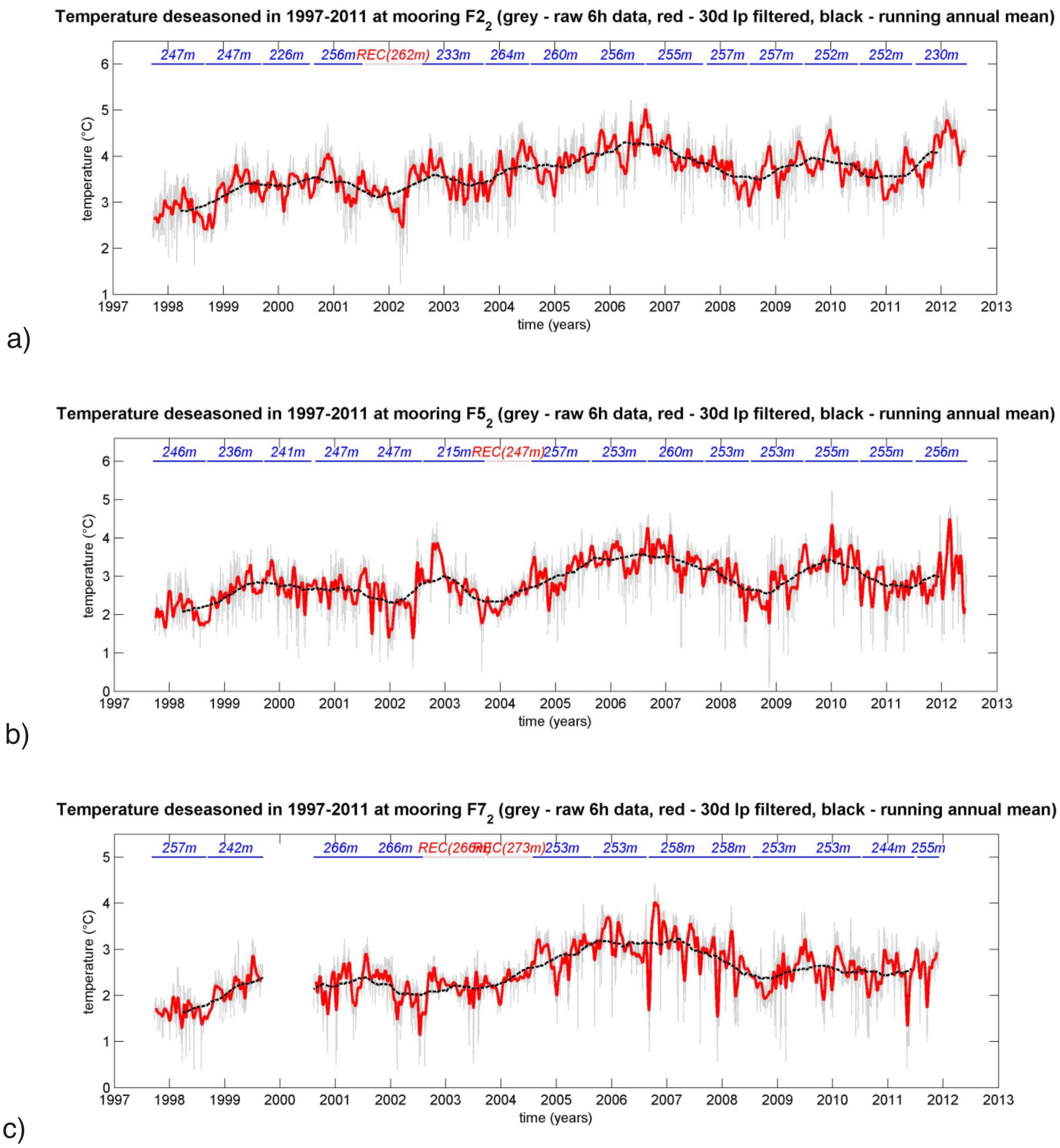


Fig. 3.6: Time series of the Atlantic Water temperature (a) in the West Spitsbergen Current core, (b) at the West Spitsbergen Current western edge and (c) in the AW recirculation branch in 1997-2012, measured by CTD sensors or temperature sensors of current meters at the nominal depth 250 m

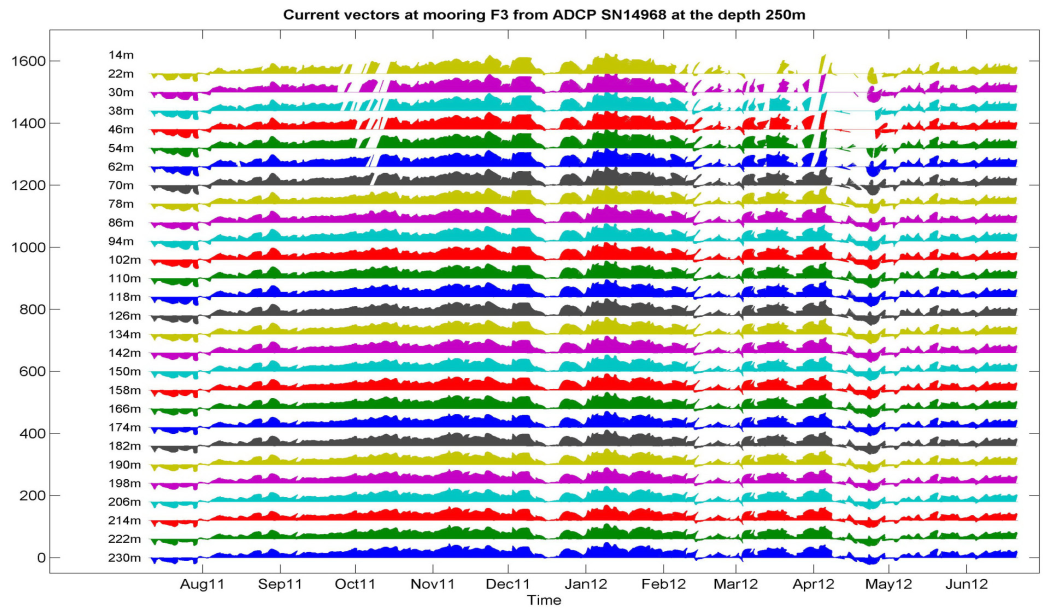


Fig. 3.7: Example of time series of current vectors in the upper layer of 230m depth measured in the WSC core by the upward looking ADCP at mooring F3 in 2011-2012

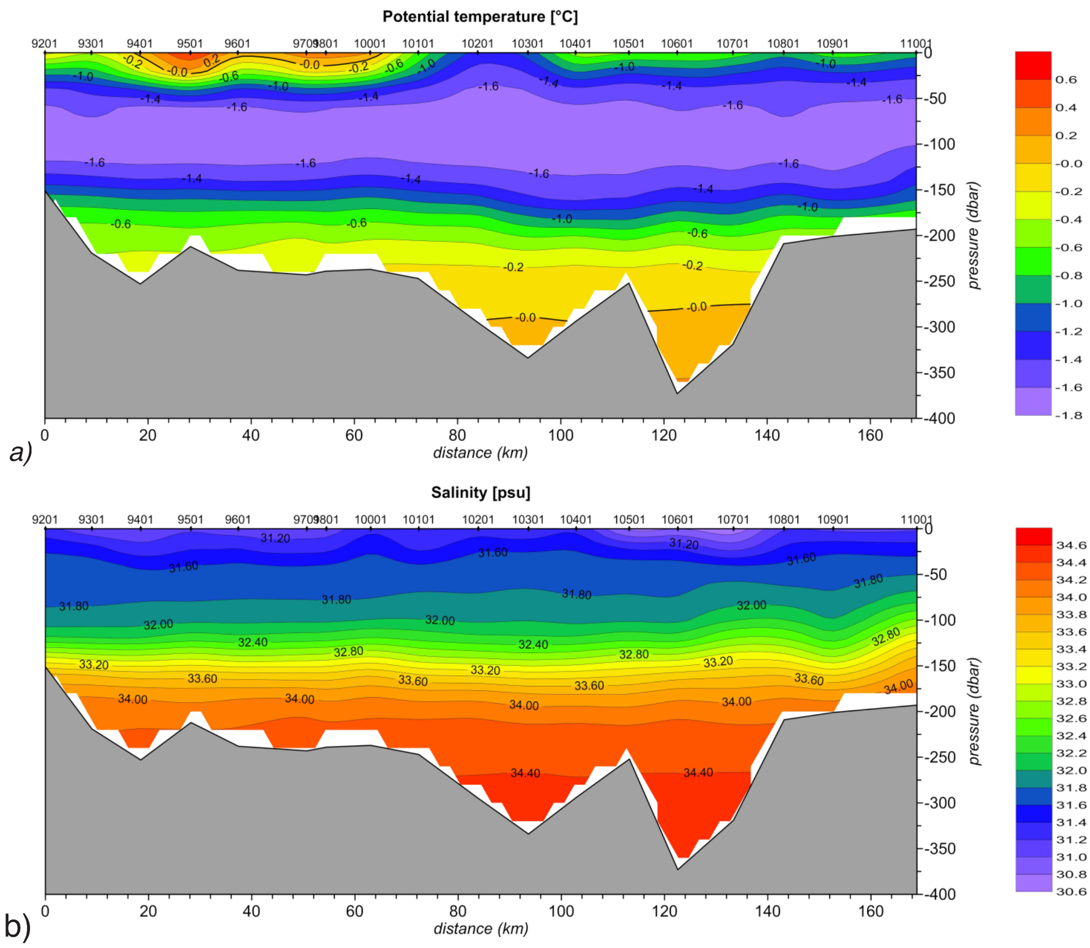


Fig. 3.8: Vertical distribution of (a) potential temperature and (b) salinity at the section along the fast ice edge in the western Fram Strait measured during ARK-XXVII/1

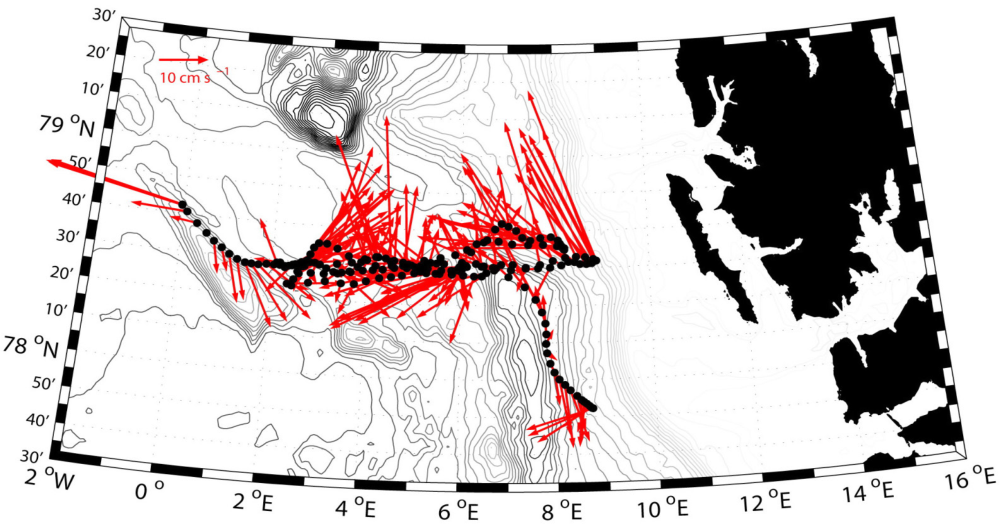


Fig. 3.9: The track of Seaglider SG127 during the summer mission in 2012. Red arrows represent the depth-averaged currents for each single dive.

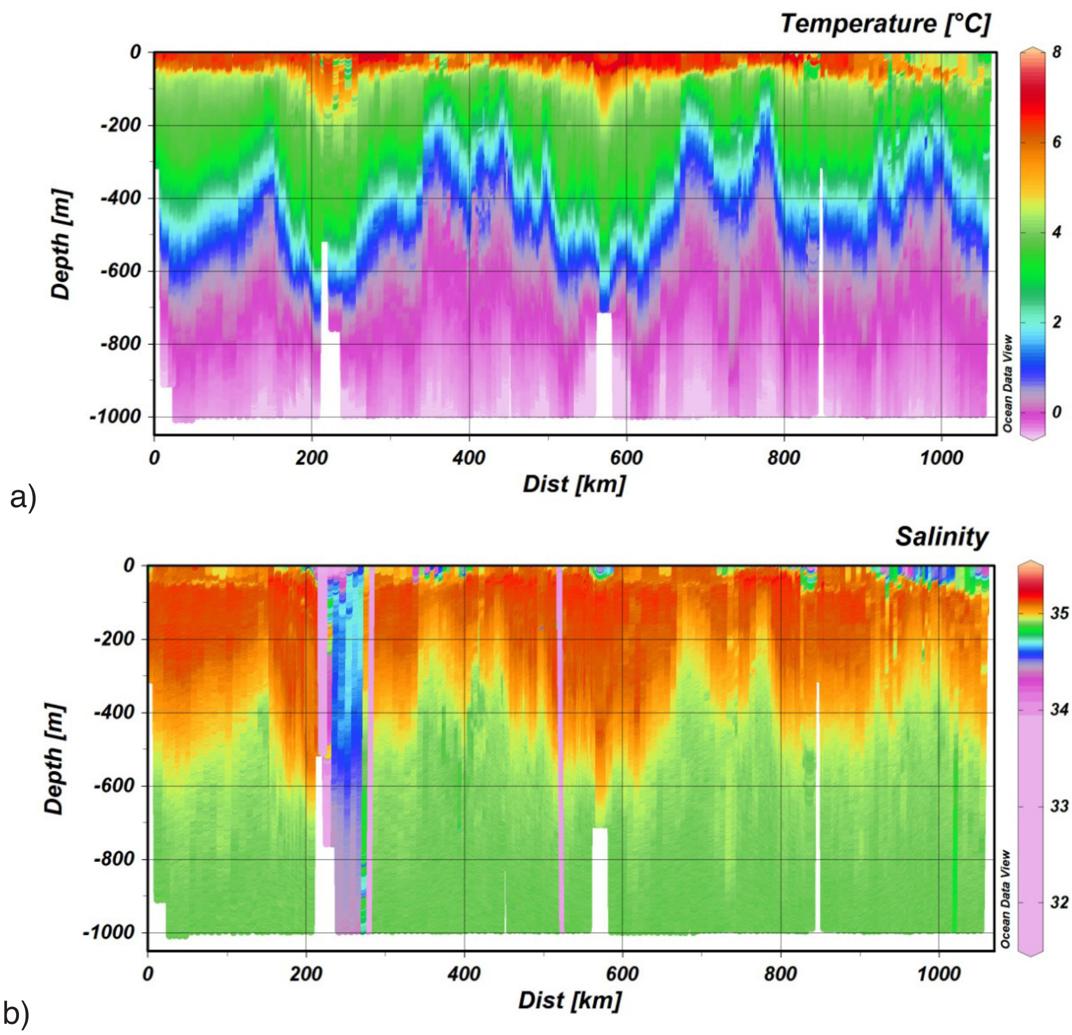


Fig. 3.10: (a) Temperature and (b) salinity measured by Seaglider SG127 along the entire track during its mission in Fram Strait in summer 2012

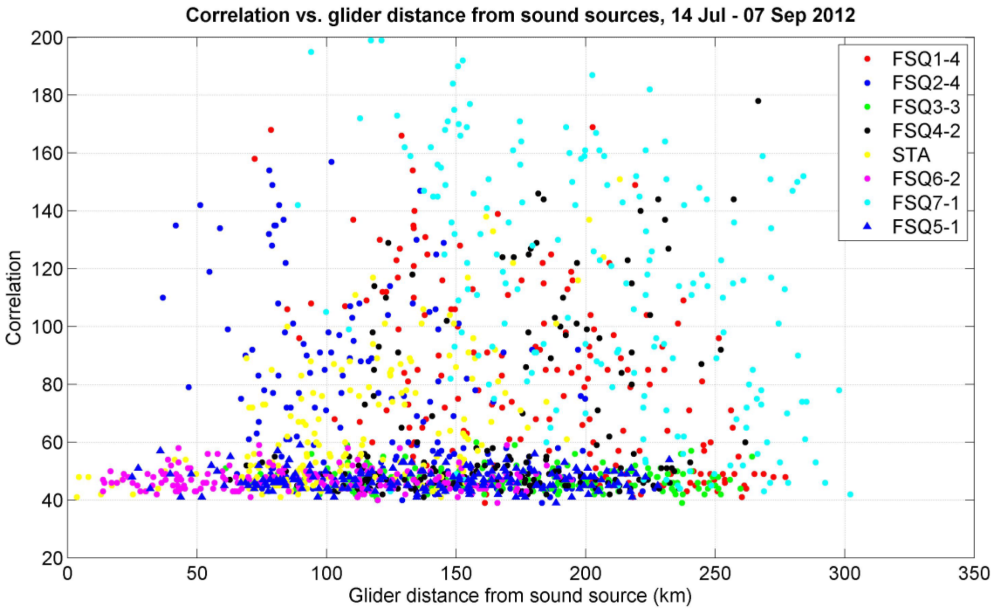


Fig. 3.11: The quality of RAFOS receptions collected during the summer mission by the glider SG127. Correlation values above 60 are used to obtain the navigation solution.

4. PLANKTON ECOLOGY AND BIOGEOCHEMISTRY IN A CHANGING ARCTIC OCEAN (PEBCAO)

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AWI

Objectives

The project PEBCAO (Plankton Ecology and Biogeochemistry in a Changing Arctic Ocean) focuses on the plankton community of the Arctic Ocean, an area which is highly sensitive to climate change. Here, the temperature increases about twice as fast as the global mean. In addition, large pH changes are predicted for the 21th century as the general decline in seawater pH is amplified by an increasing freshwater input from melting sea ice and river discharge that reduces alkalinity and hence the buffering capacity of the sea. Such physical and chemical changes may have enormous consequences for the pelagic system and for the net carbon balance of the ecosystem.

Recent investigations suggest that increasing pH, rising temperatures and freshening of surface waters promote a shift in phytoplankton community towards a dominance of smaller cells. Such shift will have significant consequences for the entire food web as well as for the cycling and sequestering of organic matter in polar waters. Therefore, the phyto- and zooplankton abundance and taxonomic composition need to be studied intensely to improve our understanding of biological processes mechanisms and feedback processes in the Fram Strait. Contributing to a long-term sampling program, one objective during this cruise was to collect samples along a west-east transect across the Fram Strait where cold water masses originating from the southward flowing East Greenland Current meet warm water masses of the West Spitsbergen Current flowing northward.

Changing environmental conditions may also have direct effects on distribution and performance of key plankton species. The prymnesiophyte *Phaeocystis* is a cosmopolitan algal species, which forms large blooms and is, thus, ecologically important in many ecosystems. In the Arctic, the colony-forming cold-water species *P. pouchetii* dominates. The genetic diversity within this species is largely unknown but may determine the flexibility of the species to respond to environmental changes. The present study aimed at isolating *P. pouchetii* cells from different regions in the Fram Strait and establishing new cultures, which will later be used for genetic comparisons with the sibling Antarctic species *P. antartica*. In addition, experiments will be conducted with these cultures to elucidate whether genetic differences are reflected in different ecophysiological responses, which in turn could explain specific biogeographic distribution patterns of this micro-alga.

In Arctic waters, three large *Calanus* species (Copepoda, Crustacea) dominate the mesozooplankton (i.e. passively drifting organisms that range between 0.2 & 20 mm in size). These mostly herbivorous copepods are key components of the Arctic food web as they account for up to 80 % of the zooplankton biomass and link primary production to higher trophic levels. Furthermore, they play an important role in transporting carbon from the surface to the deep sea. To date, only few studies investigated the ecological effects of ocean acidification on copepods, indicating that egg production, hatching success and/or mortality rates of nauplii and adults are negatively influenced by lowered pH values due to increased pCO_2 (*Acartia steueri* and *A. erythraea*, *Calanus finmarchicus*, several epi- and meso/bathypelagic species). No information is yet available on the influence of increasing CO_2 concentrations on feeding activities. To fill this gap, one objective during ARK 27/1 was to determine grazing rates of *C. finmarchicus*, which inhabits Atlantic waters and *C. glacialis,* which is typically found in Arctic waters, at ambient and elevated CO_2 concentrations.

4.1 Phytoplankton abundance and distribution

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AWI

Work at sea and preliminary results

During ARK-XXVII/1, we have taken water samples with the CTD rosette from six different depths down to 100 meters and filtered these through Whatman GF/F glass fibre and cellulose acetate filters (pore size 0.4 – 0.8 µm). In total 180 samples from the entire transect over the Fram Strait will be analyzed with respect to chlorophyll *a* and other pigments (HPLC), which serve as proxies for algal abundance and taxonomic composition. We have also taken 84 samples each for (1) analyzing the particulate organic carbon and nitrogen, (2) particulate biogenic silica measurement and (3) analyzing nutrients. Filters are stored deep-frozen at -20°C or -80°C for later analyses in the home laboratory.

For determining the phytoplankton species composition, we used three approaches. For microscopic investigation of mainly microplanktonic protists with the Utermöhl technique, we took 69 water samples, poured them into brown glass bottles and fixed them with formalin (~1 %) buffered with hexamine. These samples will be processed in the laboratories at the AWI. The abundances of autotrophic pico- and nanoplankton and small microplankton will be determined with a flow cytometer, also at the AWI. Onboard, these samples were preserved in glutaraldehyde in cryo-vials and stored cold in the dark. In addition, molecular methods are well suited to provide detailed information on the composition and bio-geographical differences of Arctic phytoplankton, especially on the smallest fraction e.g. picoplankton and cyanobacteria. The assessment of the biodiversity and biogeography of Arctic phytoplankton will thus also be based on the analysis of ribosomal genes, using 454-sequencing, Automated Ribosmal Intragenic Sequence Analysis (ARISA), or ribosomal probe-based hybridization methods. For such analyses, water samples from 35 CTD-stations (three depths) were filtrated. In order to separate communities with different cell sizes, three size fractions were separated by using different filter pore sizes (10, 3, and 0.4µm). In total, 482 filters were deep frozen for genetic analyses.

4.2 Genetic diversity of Phaeocytis pouchetii in the Fram Strait

Steffi Gäbler-Schwarz, Imke Petersen AWI

Work at sea and preliminary results

To isolate *Phaeocytis pouchetii* from different regions in the Fram Strait, in total 60 field samples were taken by hand with an Apstein net along the east-west transect (78.5°N) from the surface down to 10 m depth. From these samples, 492 isolates were achieved to establish new cultures for studying genetic diversity of *P. pouchetii* within the Fram Strait. Most of the successfully isolated cultures were collected in the surface waters from Spitsbergen towards the middle of the Fram Strait (2°W to 10°E). These cultures will be used for population genetic studies and for comparison to cultures of the sister species *P. antarctica* obtained in the Southern Ocean.

4.3 Zooplankton abundance, distribution and feeding activities

Barbara Niehoff, Nicole Hildebrandt AWI

Work at sea and preliminary results

To study abundance and distribution of the mesozooplankton vertical hauls were taken from 5 different depth strata from the surface down to 1500 m depth with the medium sized multi-net (Hydrobios, mesh size 150 µm) at 11 stations on the transect. These net samples were dominated by the copepod genus *Calanus* spp. with the species *C. finmarchicus*, *C. hyperboreus* and *C. glacialis*. Preliminary results indicate that the different *Calanus* species are associated with different water masses in the Fram Strait. *C. finmarchicus* dominated in the samples from the eastern stations of the transect, whereas *C. glacialis* is associated with the polar water on the shelf. *C. hyperboreus*, the largest *Calanus* species, was found at every station but was especially abundant in the central Fram Strait.

To investigate potential effects of changes in pCO_2 on feeding activity and survival of dominating copepod species, two experiments were conducted onboard. Almost 2,000 individuals of *C. finmarchicus (*copepodite stage V = CV) were sampled close to Svalbard in the North Atlantic current. On the Greenland shelf in Polar water, 1,350 CV of *C. glacialis* were sorted. Both species were incubated in gas tight glass bottles for about two weeks at three different CO_2 concentrations, including ambient ppm, 1,120 ppm and 3,000 ppm. From the incubation, animals were sorted every three days for measuring grazing rates and body weights. These samples will be analysed in the laboratories at the AWI.

Data management

Almost all sample processing will be carried out in the home laboratory at AWI. It usually takes one to three years depending on the parameter as well as analyzing methods such as chemical measurements or tedious swimmer picking in trap material and species enumerations and identifications, respectively. As soon as the data sets are available they can be used by other cruise participants after request. When the data will be published, they will be submitted to PANGAEA and are open for external use.

5. ARCTIC PELAGIC AMPHIPODA (APA)

Angelina Kraft, Nadine Knüppel, AWI
not on board: Ulrich Bathmann

Objectives

Pelagic Amphipoda are key components in marine ecosystems. They are the link between herbivores and higher trophic levels. However, their role in the polar ecosystems, especially in ice-covered Arctic seas, is still poorly understood. Data, especially on their year round distribution in Arctic waters and nutritional value for marine sea-birds and mammals are scarce. Nowadays, the amphipods in the Arctic are faced with a drastically changing environment including increasing ocean temperatures and acidification as well as a rapidly declining sea ice cover. As the sea ice disappears, we expect that typical large cold water amphipods, such as the Arctic specialist *Themisto libellula*, will be replaced by smaller and more temperature tolerant Atlantic generalists. Therefore, the BMBF-funded 'Arctic pelagic Amphipoda' project will investigate the following aspects: 1) The biological performance of the true pelagic amphipods *Themisto* and *Cyclocaris* in the context their geographical migration and association to respective water masses. 2) The ecological impact of pelagic amphipods on polar food webs under the aspect of changing temperature and sea ice properties.

Work at sea

During ARK-XXVII/1, we investigated the amphipod composition with the use of a large multinet (HYDRO-BIOS type Maxi with an aperture of 0.5m² and nine 1,000 mircon net bags). The net sampling included vertical hauls from 2,000 m to the surface. The net was hoisted at 0.8-1 m/s with stops at 1,500 m, 1,000 m, 800 m, 600 m, 400 m, 200 m, 100 m and 50 m in order to analyze the occurrence of pelagic amphipods at the different depth horizons. In total, amphipod were sampled with 10 vertical hauls along the 78'50°N transect (T1-T10, Fig. 5.1). The samples were transported to the cooling container, sorted, identified to species level and measured. Afterwards, the collected amphipods were preserved or frozen at -80 °C for further analyses in the home laboratory at the AWI.

Preliminary results

With the mulitnet hauls, eight different epi-, meso- and bathypelagic amphipod species from six families (Table 5.1) were collected along the transect. The sampled amphipods included the epipelagic target species *Themisto abyssorum*, *T. libellula* and *T. compressa*, typical deep-water species (e.g. *Cyclocaris guilelmi*) and ice-associated amphipods.

Tab. 5.1: Sampled amphipod species at ten multinet stations along the 78°50'N transect in the northern Fram Strait during ARK-XXVII/1.

Family Calliopiidae
Apherusa glacialis
Family Cyclocaridae
Cyclocaris guilelmi
Family Eusiridae
Eusirus holmii
Family Hyperiidae
Themisto abyssorum
Themisto compressa
Themisto libellula
Family Lanceolidae
Lanceola clausi
Family Uristidae
Onisimus glacialis

At all stations, the amphipod community consisted of typical Arctic and sub-arctic species, including the most prominent Arctic pelagic amphipod *T. libellula* and its sub-arctic congener *Themisto abyssorum* (Fig. 5.1 a-b). The highest density of *T. abyssorum* was recorded within the upper 50 m of the water column at the sampling station at 05°52' E (T4; Fig. 5.1a), with 3,893 ind. 1,000 m^{-3}. Another frequently observed amphipod at the same water depth (0-50 m) was *Themisto libellula*, with peak appearances up to 8,097 ind. 1,000 m^{-3} at 01°55' E (T5; Fig. 5.1b). The vertical amphipod distribution varied among the stations, with the presence of mostly juvenile individuals of *T. abyssorum* and *T. libellula* in the upper 50-100 m and 0-50 m of the water column, respectively. Most adult individuals of both species could be found at a water depth of 100-600 m (Fig. 5.1a-b). Below 600 m, the amphipod density decreased rapidly and pelagic deep-water species such as *Cyclocaris guilelmi* and *Lanceola clausi* became more prominent in the species composition. A detailed analysis of abundances with the relation to temperature and salinity data and a comparison to the results from last year's expedition, where the same stations were sampled (ARK-XXVI/1), are expected to provide new insights regarding the variances in summer distributions and vertical migration capacities of pelagic amphipods in the northern Fram Strait.

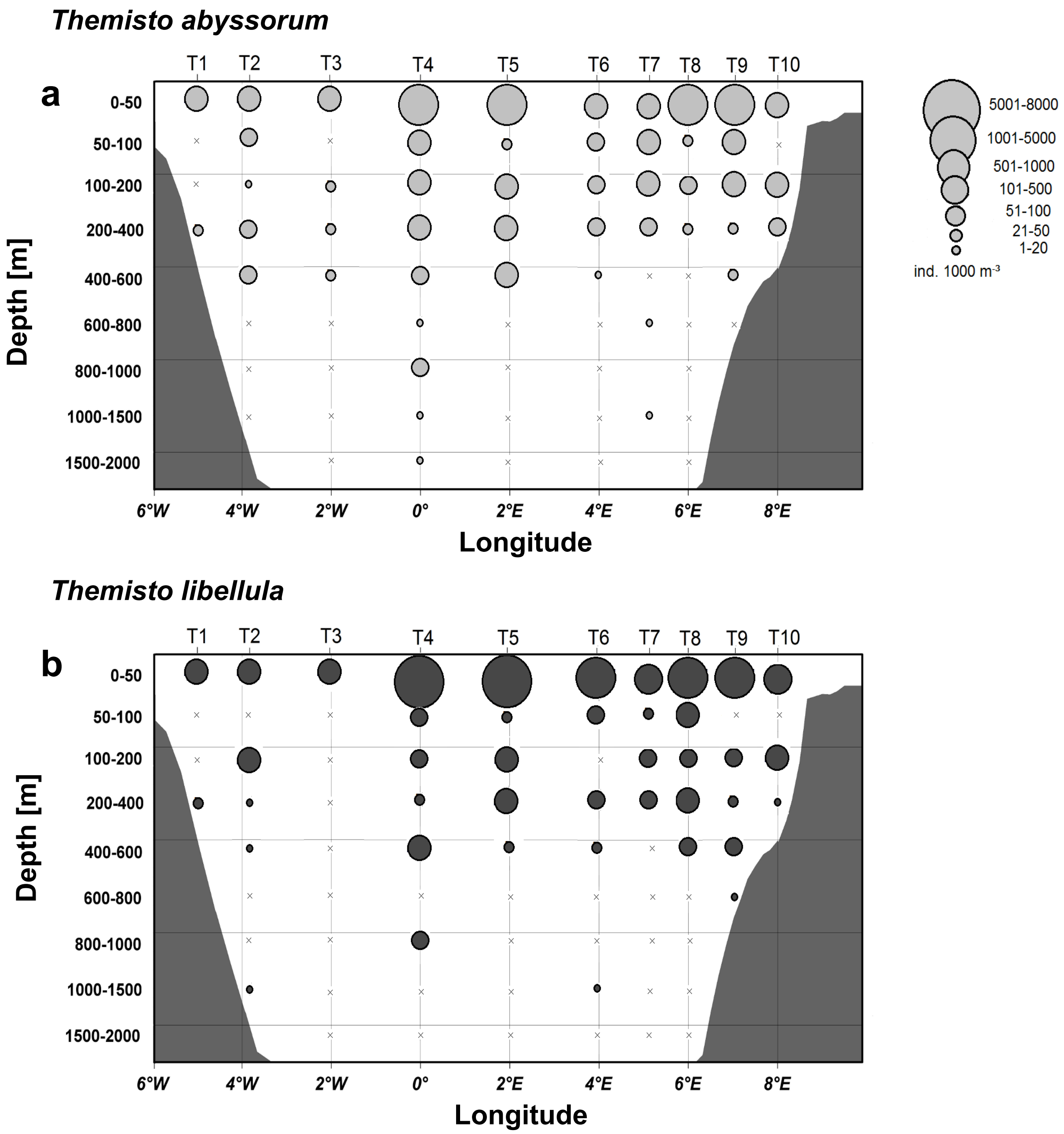

Fig. 5.1: Abundance and vertical distribution (ind. 1000 m-³) of the pelagic amphipods Themisto abyssorum (a) and T. libellula (b) recorded at 10 sampling stations along the 78°50' N transect in the northern Fram Strait

Data management

During ARK-XXVII/1 the obtained amphipod counts and length-measurements were pre-processed in EXCEL software, showing depth distribution, abundances and length-frequncy distributions for each species at the respective water column sampled. This preliminary dataset will be further refined and diagrams will be produced to be included in manuscripts as part of a PhD thesis on Arctic pelagic amphipods at the end of the project. At the end of the PhD project, the datasets will be included within the PANGAEA database.

6. SEA OF CHANGE

Katrin Schmidt, Mariam Rizkallah, AWI
not on board: Klaus Valentin, Thomas Mock, Gerhard Dieckmann

Objectives

Global warming has led to a significant reduction of sea-ice coverage in the Arctic Ocean over the last 50 years with consequences for the earth system as a whole. Of special interest are marine eukaryotic phytoplankton communities, which are the basis of the entire Arctic food web supporting large stocks of fish, contributing significantly to carbon cycling and emission of climate active trace gases (e.g. Dimethylsulfide, DMS). Ice extent and its interannual variability in the marginal ice zone have a strong influence on Arctic phytoplankton productivity. It is expected that many sea-ice phytoplankton species will not be able to adapt because the predicted environmental changes will occur on a time scale too fast for evolutionary processes. Thus, it is more likely that species well adapted to the low-temperature Arctic environment (e.g. psychrophiles) will be replaced by intruders from lower-latitudes outside the Arctic Circle, a process that may already be underway. Despite the severity of current climate changes in the Arctic Ocean caused by global warming, there is a significant lack of fundamental data about phylogenetic and functional diversity in eukaryotic phytoplankton communities from Arctic seawater and sea ice. These data are urgently needed in addition to those from intruder communities to identify differences in phylogenomic metabolism of both groups, which will help to make predictions about changes in biogeochemical cycles of elements in a warmer and ice-free Arctic Ocean. We therefore conduct the first targeted metagenomic and metatranscriptomic study of eukaryotic phytoplankton communities from inflowing North Atlantic currents to high Arctic sea ice covered water masses. A comparison between DNA and mRNA will enable us to identify whether a change in community composition is reflected in metabolism underpinning biology driven cycles of CO_2 and other trace gases relevant for climate (e.g. DMS). All sequencing results will be analyzed in the context of environmental conditions (e.g. temperature, nutrients, CO_2, DMS) that have shaped these communities.

Work at sea

We sampled seawater of the chlorophyll maximum by a CTD/rosette sampler at 22 stations overall, 6 at the transect to Svalbard and 16 across the Fram Strait focusing on the chlorophyll maximum. The water samples we gained from the rosette sampler were filtered for DNA, RNA as well as pigments and nutrients. All samples were preserved or frozen at -20°C or -80°C.

With this we have about 350 samples that will be analysed at the home institute. The DNA and RNA will be isolated, sequenced and the data processed at the

JGI. Furthermore we managed to cultivate some microalgae that will be used for evaluating experiments in the home laboratory. One station in the Fram Strait highlighted our work as we were able to collect algae that usually grow underneath the ice. The *Polarstern* crew did their best to help us collecting algal filaments out of the water from the mummy chair (Fig. 6.1).

Fig. 6.1: Sampling of under ice algae with the so called mummy chair (Photo by K. Castro-Morales, AWI)

Preliminary results

A first look at the cultures revealed a broad range of diatoms (Fig. 6.2), dinoflagellates (Fig. 6.3) and ciliates. The cultures will be used for population genetic studies and ecophysiological experiments to evaluate whether genetic differences are reflected in different ecophysiological response patterns which could well explain specific biogeographic distribution patterns of this microalga.

Data management

The data of all measured physical parameters will be deposited in PANGEA with no limitations for access. All sequence data will submitted to Genbank and made available for the public after the DFG and JGI projects, respectively, are terminated, or published in scientific journals.

Fig. 6.2: Microscopic picture of the cultures phytoplankton community dominated by diatoms (Photo by K. Schmidt, AWI)

Fig. 6.3: Microscopic picture of a dinoflagellate found in the phytoplankton community (Photo by K. Schmidt, AWI

7. DISSOLVED BLACK CARBON FLUXES THROUGH FRAM STRAIT

Aron Stubbins SkIO

Objectives

Dissolved black carbon (DBC) is the most refractory component of the oceanic dissolved organic carbon (DOC) pool identified to date. The quantity of these molecules in the oceans is such that their conversion to carbon dioxide and release to the atmosphere would have a significant impact upon global temperatures. The global DBC cycle is poorly understood. In previous work, the input of DBC from Arctic Rivers to the Arctic Ocean was quantified.

The aim of the work on *Polarstern* was to determine how much of the riverine DBC entering the Arctic Ocean is subsequently exported to the Atlantic Ocean in order to better constrain the global DBC cycle and to allow a first order estimate of the degradation of terrestrial DBC that occurs in the Arctic Ocean.

Work at sea

On the cruise approximately 250 samples for dissolved organic carbon, coloured dissolved organic matter (40 CTD casts) and 100 for DBC (20 CTD casts) were collected. All samples were filtered on board. Samples for DBC quantification were extracted on to PPL material on board. These samples will be analysed in laboratories at the Skidaway Institute of Oceanography, Savannah, Georgia, USA and with colleagues at the Max Plank Group for Marine Geochemistry in Oldenburg, Germany. Table 1 includes a list of all samples collected.

Preliminary results

Elevated concentrations of DBC are expected in Polar Water within the East Greenland Current. Other Arctic Ocean water masses with significant contributions from Arctic river water are also expected to have elevated DBC concentrations. Lowest concentrations are expected in the Atlantic Water carried north in the West Spitsbergen Current.

Concentrations of DBC are expected to correlate with coloured dissolved organic matter (CDOM) absorbance, providing a rapidly measurable proxy for DBC in these waters. In the current study ~100 samples will be analysed for DBC and CDOM. A further 150 samples were analysed just for CDOM. It is expected that relationships between CDOM and DBC will enable estimates of DBC concentrations to be made for these extra 150 samples.

Data management

Responsible data manager and point of contact: Aron Stubbins. aron.stubbins@ skio.usg.edu. Tel:+1(912)598-2320.

Types of data: Data and metadata for this project will be generated at SkIO and the Max Planck Institute Marine Geochemistry Group, Oldenburg, Germany. Data will consist primarily of DBC, CDOM, DOC, and high resolution Fourier transform ion cyclotron mass spectrometry data. These data will be accompanied by detailed metadata. The total number of data files will be ~1000.

Data and metadata formats, standards, and organization

a. Formats. Data and metadata will be delivered to ACADIS in Excel or ASCII format in order to allow ready access to the data by all interested parties.

b. Metadata. Metadata will be at the file level, as well as at the collection level. The ACADIS metadata authoring tool will aid in developing the metadata profile at the collection level. Where appropriate, standard vocabularies, keywords, or other conventions will be integrated with the help of ACADIS.

c. Organization. Stubbins will plan fieldwork, conduct analyses and curate the data.

d. Data quality. Data will be collated by PI Stubbins and organized in Microsoft Excel spreadsheets. While the individual labs that generate the various data streams will be responsible for maintaining records of data quality (standard curves, measures of analytical error, etc.), the collated data will also be screened for anomalies. Where possible, re-analyses of archived samples will be completed to check anomalous values. Possible outliers included in the data will be flagged to alert subsequent data users.

Data access and sharing: The data and metadata generated will be made public and submitted to ACADIS no more than one year after the above quality checks. There are no exceptional arrangements needed to provide appropriate ethical restriction to data access and use.

Data Reuse: Data will be described in accordance with ACADIS standards (which are being developed). The investigators will work closely with ACADIS curators to ensure accurate and complete documentation in accordance with the ACADIS designated level of service.

Data Preservation: Upon collection data will be stored on a local hard drive and the Skidaway Institute of Oceanography's virtual drive which is backed up daily and at the University System of Georgia's online repository. ACADIS will endeavour to archive the data according to the ISO-standard Open Archives Information System Reference Model, and will ensure that the data end up in a relevant long-term archive. Project investigators will work closely with ACADIS curators to provide all information necessary for data preservation in accordance with the ACADIS designated level of service.

Tab. 7.1: Samples collected for dissolved organic carbon (DOC), coloured dissolved organic matter (CDOM) and solid phase extracted for dissolved black carbon measurements (PPL) during ARK-XXVII/1.

CTD#	Niskin ID	Depth (m)	DOC & CDOM ID	PPL ID
001	13	5	CTD#001_01	
001	7	20	CTD#001_02	
001	1	50	CTD#001_03	
002	15	5	CTD#002_01	CTD#002_01A
002	12	15	CTD#002_02	CTD#002_02A
002	4	25	CTD#002_03	CTD#002_03A
002	2	50	CTD#002_04	CTD#002_04A
002	1	200	CTD#002_05	CTD#002_05A
003	15	5	CTD#003_01	
003	10	10	CTD#003_02	
003	3	25	CTD#003_03	
003	2	75	CTD#003_04	
003	1	200	CTD#003_05	
004	14	5	CTD#004_01	
004	7	11	CTD#004_02	
004	5	40	CTD#004_03	
004	2	100	CTD#004_04	
004	1	200	CTD#004_05	
007	11	5	CTD#007_01	
007	4	20	CTD#007_02	
007	3	30	CTD#007_03	
007	2	50	CTD#007_04	
007	1	90	CTD#007_05	
012	11	15	CTD#012_01	CTD#012_01A
012	9	30	CTD#012_02	CTD#012_02A
012	5	50	CTD#012_03	CTD#012_03A
012	3	90	CTD#012_04	CTD#012_04A
012	1	165	CTD#012_05	CTD#012_05A
014	5	5	CTD#014_01	
014	4	30	CTD#014_02	
014	3	125	CTD#014_03	
014	2	165	CTD#014_04	
014	1	211	CTD#014_05	
016	13	20	CTD#016_01	
016	10	50	CTD#016_02	
016	7	100	CTD#016_03	
016	4	150	CTD#016_04	

CTD#	Niskin ID	Depth (m)	DOC & CDOM ID	PPL ID
016	1	190	CTD#016_05	
019	14	20	CTD#019_01	CTD#019_01B
019	11	100	CTD#019_02	CTD#019_02B
019	8	300	CTD#019_03	CTD#019_03B
019	7	500	CTD#019_04	
019	4	700	CTD#019_05	CTD#019_04B
019	1	1000 - Bottom + 50	CTD#019_06	CTD#019_05B
026	1	1300 - Bottom +50	CTD#026_01	CTD#026_01C
026	21	18	CTD#026_010	CTD#026_05C
026	5	1200	CTD#026_02	
026	8	700	CTD#026_03	CTD#026_02C
026	11	600	CTD#026_04	
026	12	500	CTD#026_05	
026	13	400	CTD#026_06	CTD#026_03C
026	16	200	CTD#026_07	CTD#026_04C
026	19	50	CTD#026_08	
026	20	20	CTD#026_09	
028	1	Bottom -50	CTD#028_01	
028	3	800	CTD#028_02	
028	5	400	CTD#028_03	
028	7	100	CTD#028_04	
028	9	18	CTD#028_05	
035	1	1680	CTD#035_01	CTD#035_01A
035	19	15	CTD#035_010	CTD#035_05A
035	3	1200	CTD#035_02	
035	5	800	CTD#035_03	CTD#035_02A
035	7	650	CTD#035_04	
035	9	500	CTD#035_05	CTD#035_03A
035	11	300	CTD#035_06	
035	13	200	CTD#035_07	CTD#035_04A
035	15	100	CTD#035_08	
035	17	50	CTD#035_09	
042	1	2327	CTD#042_01	
042	5	800	CTD#042_02	
042	7	300	CTD#042_03	
042	9	100	CTD#042_04	
042	11	20	CTD#042_05	
050	1	2525	CTD#050_01	CTD#050_01B
050	4	2000	CTD#050_02	CTD#050_02B
050	7	1200	CTD#050_03	
050	8	800	CTD#050_04	CTD#050_03B

CTD#	Niskin ID	Depth (m)	DOC & CDOM ID	PPL ID
050	11	400	CTD#050_05	
050	12	200	CTD#050_06	
050	13	100	CTD#050_07	CTD#050_04B
050	16	20	CTD#050_08	CTD#050_05B
055	1	2205	CTD#055_01	CTD#055_01C
055	4	1000	CTD#055_02	CTD#055_02C
055	7	500	CTD#055_03	CTD#055_03C
055	10	400	CTD#055_04	CTD#055_04C
055	13	200	CTD#055_05	CTD#055_05C
055	22	5	CTD#055_06	CTD#055_01A
057	8	600	CTD#057_01	
057	11	200	CTD#057_02	
057	12	100	CTD#057_03	
057	15	50	CTD#057_04	
057	19	10	CTD#057_05	
061	1	2480	CTD#061_01	
061	24	5	CTD#061_010	CTD#061_05B
061	4	1500	CTD#061_02	CTD#061_01B
061	5	1200	CTD#061_03	
061	6	1000	CTD#061_04	CTD#061_02B
061	7	700	CTD#061_05	
061	9	400	CTD#061_06	
061	13	200	CTD#061_07	
061	15	100	CTD#061_08	CTD#061_03B
061	18	35	CTD#061_09	CTD#061_04B
068	1	2425	CTD#068_01	CTD#068_01A
068	22	5	CTD#068_010	CTD#068_05A
068	4	2000	CTD#068_02	
068	7	1300	CTD#068_03	
068	8	1000	CTD#068_04	
068	9	800	CTD#068_05	CTD#068_02A
068	12	600	CTD#068_06	
068	13	400	CTD#068_07	
068	16	100	CTD#068_08	CTD#068_03A
068	19	15	CTD#068_09	CTD#068_04A
076	1	2533	CTD#076_01	
076	22	10	CTD#076_010	CTD#076_05C
076	6	1750	CTD#076_02	
076	8	1250	CTD#076_03	
076	9	1000	CTD#076_04	CTD#076_01C
076	10	800	CTD#076_05	

CTD#	Niskin ID	Depth (m)	DOC & CDOM ID	PPL ID
076	12	400	CTD#076_06	
076	16	200	CTD#076_07	CTD#076_02C
076	18	100	CTD#076_08	CTD#076_03C
076	21	25	CTD#076_09	CTD#076_04C
079	2	2500	CTD#079_01	
079	6	1250	CTD#079_02	
079	8	800	CTD#079_03	
079	10	400	CTD#079_04	
079	13	100	CTD#079_05	
088	1	2500	CTD#088_01	
088	14	5	CTD#088_010	CTD#088_05B
088	2	1700	CTD#088_02	CTD#088_01B
088	3	1400	CTD#088_03	
088	4	1100	CTD#088_04	
088	5	800	CTD#088_05	CTD#088_02B
088	6	500	CTD#088_06	
088	7	300	CTD#088_07	
088	8	175	CTD#088_08	CTD#088_03B
088	13	25	CTD#088_09	CTD#088_04B
091	1	149	CTD#091_01	CTD#091_01C
091	4	120	CTD#091_02	CTD#091_02C
091	7	80	CTD#091_03	CTD#091_03C
091	11	30	CTD#091_04	CTD#091_04C
091	16	2	CTD#091_05	CTD#091_05C
111	1	223	CTD#111_01	CTD#111_01A
111	2	170	CTD#111_02	CTD#111_02A
111	4	60	CTD#111_03	CTD#111_03A
111	6	20	CTD#111_04	CTD#111_04A
111	9	5	CTD#111_05	CTD#111_05A
113	2	220	CTD#113_01	
113	6	140	CTD#113_02	
113	10	70	CTD#113_03	
113	13	55	CTD#113_04	
113	16	15	CTD#113_05	
116	3	350	CTD#116_01	
116	5	200	CTD#116_02	
116	6	100	CTD#116_03	
116	10	50	CTD#116_04	
116	15	15	CTD#116_05	
118	2	180	CTD#118_01	
118	6	125	CTD#118_02	

CTD#	Niskin ID	Depth (m)	DOC & CDOM ID	PPL ID
118	10	75	CTD#118_03	
118	14	20	CTD#118_04	
118	19	10	CTD#118_05	
121	3	145	CTD#121_01	
121	8	100	CTD#121_02	
121	11	50	CTD#121_03	
121	16	20	CTD#121_04	
121	18	10	CTD#121_05	
124	2	245	CTD#124_01	CTD#124_01A
124	5	180	CTD#124_02	CTD#124_02A
124	8	120	CTD#124_03	CTD#124_03A
124	9	90	CTD#124_04	CTD#124_04A
124	16	15	CTD#124_05	CTD#124_05A
126	2	Bottom -30	CTD#126_01	
126	5	300	CTD#126_02	
126	10	150	CTD#126_03	
126	14	50	CTD#126_04	
126	18	10	CTD#126_05	
128	2	1036	CTD#128_01	
128	5	500	CTD#128_02	
128	9	250	CTD#128_03	
128	13	100	CTD#128_04	
128	15	60	CTD#128_05	
128	19	10	CTD#128_06	
130	1	1350	CTD#130_01	CTD#130_01B
130	24	11	CTD#130_010	
130	4	1200	CTD#130_02	
130	5	100	CTD#130_03	CTD#130_02B
130	8	840	CTD#130_04	
130	9	600	CTD#130_05	CTD#130_03B
130	12	200	CTD#130_06	CTD#130_04B
130	16	75	CTD#130_07	
130	20	25	CTD#130_08	
130	21	14	CTD#130_09	CTD#130_05B
131	1	1600	CTD#131_01	
131	2	1200	CTD#131_02	
131	3	1000	CTD#131_03	
131	4	600	CTD#131_04	
131	5	300	CTD#131_05	
131	6	200	CTD#131_06	

CTD#	Niskin ID	Depth (m)	DOC & CDOM ID	PPL ID
131	7	100	CTD#131_07	
131	8	10	CTD#131_08	
132	2	1880	CTD#132_01	
132	4	1550	CTD#132_02	CTD#132_01C
132	6	1000	CTD#132_03	CTD#132_02C
132	8	600	CTD#132_04	
132	9	400	CTD#132_05	
132	12	200	CTD#132_06	CTD#132_03C
132	16	50	CTD#132_07	CTD#132_04C
132	20	10	CTD#132_08	CTD#132_05C
133	2	2139	CTD#133_01	
133	3	1500	CTD#133_02	
133	4	1325	CTD#133_03	
133	5	1250	CTD#133_04	
133	6	800	CTD#133_05	
133	7	400	CTD#133_06	
133	8	200	CTD#133_07	
133	9	50	CTD#133_08	
133	10	5	CTD#133_09	
134	1	2320	CTD#134_01	CTD#134_01A
134	4	1600	CTD#134_02	CTD#134_02A
134	7	900	CTD#134_03	
134	11	600	CTD#134_04	
134	14	200	CTD#134_05	CTD#134_03A
134	17	50	CTD#134_06	CTD#134_04A
134	20	20	CTD#134_07	
134	21	15	CTD#134_08	
134	22	11	CTD#134_09	CTD#134_05A
135	1	2458	CTD#135_01	
135	3	2000	CTD#135_02	
135	5	1500	CTD#135_03	
135	7	1000	CTD#135_04	
135	8	800	CTD#135_05	
135	10	400	CTD#135_06	
135	13	200	CTD#135_07	
135	17	50	CTD#135_08	
135	22	10	CTD#135_09	

8. IR-SEA EXCHANGE OF GREENHOUSE GASES IN RELATION TO BIOLOGICAL NET AND GROSS PRODUCTION IN THE FRAM STRAIT

Natalie Wager[1], Karel Castro-Morales[2], not on board: Jan Kaiser[1], Dorothee Bakker[1], Gareth Lee[1], Imke Grefe[1]

[1]UEA
[2]AWI

Objectives

The Arctic Ocean is an important source of climatically active gases such as nitrous oxide (N_2O), methane (CH_4) and carbon dioxide (CO_2) and can act as source or sink for carbon monoxide (CO). This project aims to find links between biological production rates and trace gas exchange fluxes. The results will be combined with air-sea gas exchange parameterisations to derive net biological and gross photosynthetic O_2 as well as trace gas fluxes. The project aims to:

- quantify air-sea exchange fluxes of CO_2, CH_4, N2O and CO in Fram Strait.
- derive estimates of mixed layer net community production
- derive estimates of photosynthetic gross production
- establish empirical relationships between trace gas fluxes and productivity estimates
- compare the p(CO_2) measurements by AWI's shipborne GO-LICOR instrument with UEA's ICOS analyser

Work at sea

After initial complications, identified later as pump failure of the CO_2/CH_4 Los Gatos ICOS mass spectrometer, we were left with only the N_2O /CO analyser functioning for the cruise. This was attached to a glass bed equilibrator (connected to the underway water supply of the ship). The headspace was sampled continuously, measuring the dry mixing ratio of N_2O, CO and water (H_2O). Daily calibrations were made using 3 standard gas mixtures running for 20 minutes each, along with regular analysis of clean air (10 minutes approximately every 5 hours). Dry mixing ratio measurements of N_2O, CO and H_2O were made from 78°50'N 1°40'W to 78°40'N 3°50'E across the Fram Strait. These results will be combined with ship-based wind-speed measurements and suitable wind speed-gas exchange parameterisations (Ho et al., 2006; Nightingale et al. 2000; Sweeney et al., 2007) to calculate air-sea gas exchange fluxes.

A membrane-inlet mass spectrometer (MIMS) was used to continuously measure dissolved oxygen-argon (O_2/Ar) ratios from the underway water supply of the ship.

Measurements were made from Bremerhaven up to 79°N and across the Fram Strait. This data will be used to calculate biological oxygen fluxes (Kaiser et al., 2005).

Discrete water samples were collected approximately every 8 hours from the underway water supply throughout the cruise in air-evacuated bottles. These will be utilised for both calibrating the O_2/Ar measurements made by MIMS and for analysing the triple oxygen isotope composition of dissolved oxygen. The ^{17}O isotope excess in the dissolved O_2 will be used to estimate the contribution of atmospheric and photosynthetic O_2 in the mixed layer. This will in turn be used to calculate gross productivity using suitable wind-speed gas exchange parameterisations (Kaiser 2011).

Water samples were collected from 18 CTD stations across the Fram Strait (CTD stations: 26, 34, 54, 56, 58, 61, 63, 81, 111, 113, 116, 118, 10, 122, 124, 126, 130 and 134) and measured by MIMS to create depth profiles of O_2/Ar ratios in the water column. Between 6 and 9 samples were collected from each CTD, dependant on the depth of the station. The samples were collected from surface water, the mixed layer, the chlorophyll max, the top and bottom of the oxycline, the oxygen max and from near-bottom waters. These depth profiles will also be used to correct for the vertical entrainment of thermocline waters, which may otherwise bias net community production estimates.

Preliminary (expected) results

Data is currently being analysed and samples processed using the methods described in Kaiser et al., (2005, 2011).

Data management

We anticipate collecting the following datasets:

- surface water concentrations of CO_2, CH_4, N_2O and CO;
- atmospheric mixing ratios of CO_2, CH_4, N_2O and CO;
- surface water O_2/Ar ratios (three datasets), measured by membrane inlet mass spectrometry, equilibrator-inlet mass spectrometry and isotope ratio mass spectrometry;
- surface water $\delta^{17}O$ and $\delta^{18}O$ isotope delta values of dissolved O_2, measured by isotope ratio mass spectrometry;
- depth profiles of dissolved CH_4 and N_2O.

Data will be controlled for quality and flagged according to international metadata and data standardisation initiatives. Quality-controlled data collected during the proposed research activities will be submitted for archiving to the British Oceanographic Data Centre (BODC, http://www.bodc.ac.uk) and the British Atmospheric Data Centre (BADC, http://badc.nerc.ac.uk). The $\delta^{17}O$ and $\delta\ ^{18}O$) isotope delta values and the O_2/Ar ratios that are to be measured by isotope ratio mass spectrometry will be analysed after the cruise in the Stable Isotope Lab of the School of Environmental Sciences at the University of East Anglia. The CO_2 data will also be entered into the Surface Ocean CO_2 Atlas SOCAT (http://www.socat.info), which is led by Co-I Dorothee Bakker.

To protect the intellectual property of the PhD student who will be gathering data the data will not be released publicly until the end of the PhD thesis project (about October 2015).

References

Ho, D. T., Law, C. S., Smith, M. J., Schlosser, P., Harvey, M., and Hill, P. (2006). Measurements of air-sea gas exchange at high wind speeds in the Southern Ocean: Implications for global parameterizations, Geophys. Res. Lett., 33, L16611, 10.1029/2006GL026817.

Kaiser, J., Reuer, M. K., Barnett, B., and Bender, M. L. (2011). Marine productivity estimates from continuous oxygen/argon ratio measurements by shipboard membrane inlet mass spectrometry, Geophys. Res. Lett., 32, L19605, 10.1029/2005GL023459, 2005.

Kaiser, J.(2011) Technical note: Consistent calculation of aquatic gross production from oxygen triple isotope measurements, Biogeosciences, 8, 1793-1811, 10.5194/bg-8-1793-2011.

Nightingale, P. D., Malin, G., Law, C. S., Watson, A. J., Liss, P. S., Liddicoat, M. I., Boutin, J., and Upstill-Goddard, R. C. (2000) In situ evaluation of air-sea gas exchange parameterizations using novel conservative and volatile tracers, Global Biogeochem. Cycles, 14, 373-387.

Sweeney, C., Gloor, E., Jacobson, A. R., Key, R. M., McKinley, G., Sarmiento, J. L., and Wanninkhof, R. (2007). Constraining global air-sea exchange for CO2 with recent bomb 14C measurements, Global Biogeochem. Cycles, 21, GB2015, 10.1029/2006GB002784.

9. TRANSIENT TRACERS DYNAMICS, CARBON DIOXIDE AND DISSOLVED OXYGEN OF FRAM STRAIT

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Hanna Schade[1], Chris Schrammar[2]
not on board: Toste Tanhua[1],
Mario Hoppema[2]

[1]IFM-GEOMAR
[2]AWI

Objectives

The main goal of the Fram Strait expedition ARK-XXVII/1 was to obtain detailed profiles of SF_6, CFC-12, DIC, ^{13}C, oxygen and nutrients along the east-west section at 78°N50′. The distribution and the relation between the two transient tracers CFC-12 and SF_6 combined with the other sampled parameters should provide a detailed look into the transport processes of Fram Strait.

Work at sea

All parameters were sampled at same stations and depths whereas the ^{13}C samples were taken at specific depths due to the limited amount of glass bottles.

Two purge and trap GC systems have been set up to measure the transient tracers in parallel. However, two GCs broke down during the first week following that the first 7 profiles had to be sealed in 300 ml ampoules for a post cruise onshore measurement at the IFM-GEOMAR in Kiel. After fixing all problems we measured 35 stations in total with the third GC system. The sampling was performed with 250 ml glass syringes to avoid contact with the atmosphere. An aliquot of about 200 ml was injected manually into a purge tower of the GC system equipped with a trap cooled with liquid nitrogen. Standardization was performed by injecting small volumes of a gaseous standard containing SF_6 and CFC-12. This working standard was prepared by the company Dueste-Steiniger (Germany). The CFC-12 and SF_6 concentrations in the standard has been calibrated vs. a reference standard obtained from R.F Weiss group at SIO, and the CFC-12 data are reported on the SIO98 scale and SF_6 on the NOAA-2000 scale. Another calibration of the working standard will take place in the lab after the cruise, to determine any possible drift in the working standard. Calibration curves were measured every few days, depending on work load and system performance, to determine the non-linearity of the detector. Point calibrations were always performed between stations to determine the short term drift in the detector. Replicate measurements of surface and bottom samples were normally run each profile.

Oxygen samples were measured on board based on the Winkler titration method with at least two replicate measurements each profile. DIC and ^{13}C samples were poisoned with mercury chloride. Nutrient samples were always taken twice per depth to enhance the precision of the phosphate and silicate measurements. The samples were directly frozen in a -85°C freezer after sampling and then stored at -20°C. The DIC and nutrient samples will be measured onshore at the IFM-GEOMAR in Kiel. The ^{13}C samples will be send to Are Olsen, IMR Norway for analysis.

Preliminary results

The calibration and data processing of the obtained tracer raw data will be performed at IFM-GEOMAR in Kiel so that first results will be available in December 2012. DIC, ^{13}C and nutrient samples will not be measured before March 2013. First results can be expected in late spring 2013.

Data management

The data of all measured parameters including the raw data, calibrations and further calculations will be administrated by the data management system of IFM-GEOMAR. The access authorization to the database will be controlled by the project leaders. The final data set will be submitted to CDIAC three years after the cruise by the latest.

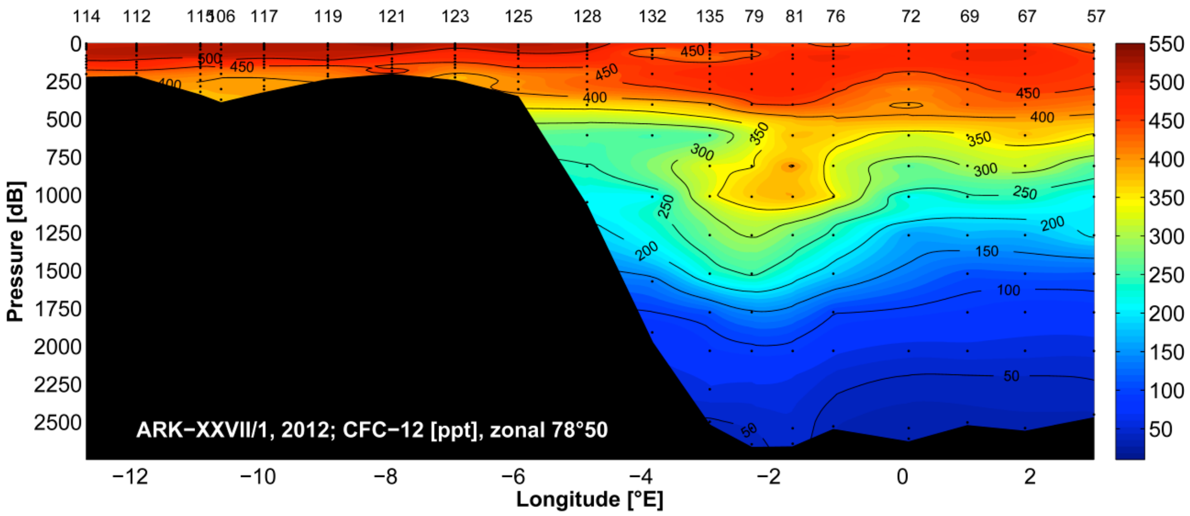

Fig.9.1: Zonal section along 78°50' of CFC-12 in ppt

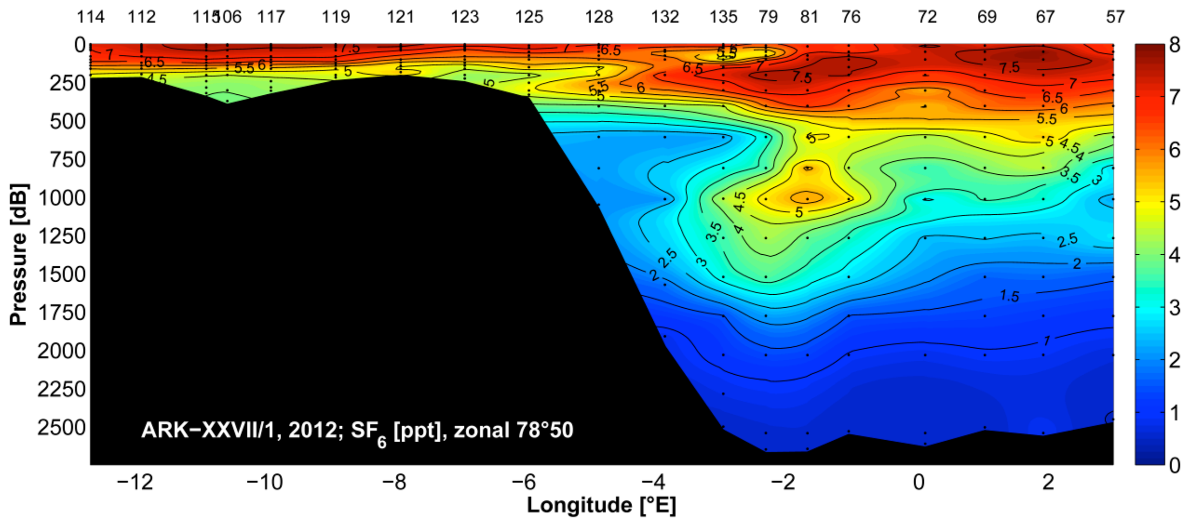

Fig.9.2: Zonal section along 78°50' of SF_6 in ppt

10. HIGHER TROPHIC LEVELS: AT-SEA DISTRIBUTION OF SEABIRDS AND MARINE MAMMALS

Diederik D'Hert, Jeremy Demey, Raphaël Lebrun PolE
not on board: Claude Joiris

Objectives

This campaign forms part of a long-term study of seabirds and marine mammals in the Arctic as well as the Antarctic polar regions (Joiris, 2000).

The main objective is to improve the knowledge of and quantify the at-sea distribution of seabirds, cetaceans and pinnipeds and detect possible links with main hydrological parameters (water temperature and salinity, ice coverage) that identify the main water masses (Atlantic, Pacific oceanic, polar water) and ice conditions (Outer Marginal Ice Zone, Closed Pack ice), as well as fronts between water masses or ice edge. The integration of the data into a time series running since 1973, might unravel possible changes in numbers and distribution that might be caused by climate changes and pack ice extend during the last 30-35 years.

Work at sea

Birds and mammals were recorded by 30'-transect counts from the bridge while sailing with a minimum speed of 5 knots, in a 90° angle on either starboard of portside of the *Polarstern* (depending on the light condition) without width limitation. Animals were detected with naked eye, observations being confirmed and detailed with high quality binoculars (Swarovision 10*42 and Bynnex 10*42 10*50) or telescope (Swarovski ATS 80 with 25-50x eyepiece and Leica Televid 77 with 30x eyepiece). When the *Polarstern* was not sailing, additional sightings were done to improve and refine the distributional knowledge of marine mammals and birds. Additional helicopter counts were done as to cover a wider working area and investigate regions and habitats out of the ships, and to allow comparison between data obtained from different observation platforms. On multiple occasions, a digital camera was used to ease and strengthen the identification of some animals.

Preliminary results

A total of 514 periods of data recording, each consisting of 30 minutes were conducted (257 hours). During this effort counts, 29 bird species and 17 species of marine mammals (12 cetaceans, 4 species of pinniped and polar bear) where observed. The total number of seabirds observed is 10,103 (see Table10.1). The mean number of seabirds was nearly 20 per count, which is less than the mean number during the second leg (35).

The species composition seems to be similar to – as could be expected – previous campaigns, but in general the numbers of each species are lower. This might be the result of sailing longer times in the ice and less time close to land.

The most numerous species are the same as those recorded during previous censuses, being Northern Fulmar (*Fulmarus glacialis*), Little Auk (*Alle alle*), Brünnich's Guillemot (*Uria lomvia*) and Kittiwake (*Rissa tridactyla*). Compared to previous expeditions, the number of observed Little Auks is rather low, but this might be due to sailing less time close to breeding colonies.

Tab. 10.1: Numbers of birds observed during the 514 recording periods from the moving ship during ARK-XXVII/1 (RP) as well as observations outside these periods (ORP).

English name	German name	Scientific name	RP	ORP
Red-Throated diver	Nordseetaucher	*Gavia stellata*	1	0
Fulmar	Eissturmvogel	*Fulmarus glacialis*	4106	458
Manx Shearwater	Schwarzschnabelsturmtaucher	*Puffinus puffinus*	1	0
Gannet	Basstölpel	*Morus bassanus*	178	0
Eider	Eiderente	*Somateria mollissima*	3	0
King Eider	Prachteiderente	*Somateria spectabilis*	1	0
Spectacled Eider	Plüschkopfente	*Somateria fischeri*	2	0
Common Scoter	Trauerente	*Melanitta nigra*	2	0
Turnstone	Steinwälzer	*Arenaria interpres*	1	1
Pomarine Skua	Mittlere Raubmöwe	*Stercorarius pomarinus*	30	12
Arctic Skua	Schmarotzer Raubmöwe	*Stercorarius parasiticus*	33	5
Long-Tailed Skua	Kleine Raubmöwe	*Stercorarius longicaudus*	33	17
Great Skua	Grosse Raubmöwe	*Stercorarius skua*	11	6
Sabine's Gull	Schwalbenmöwe	*Xema sabini*	2	0
Common Gull	Sturmmöwe	*Larus canus*	3	0
Lesser Black-backed Gull	Heringsmöwe	*Larus fuscus*	29	1
Iceland Gull	Polarmöwe	*Larus glaucoides*	0	1
Glaucous Gull	Eismöwe	*Larus hyperboreus*	47	108
Great Black-Backed Gull	Mantelmöwe	*Larus marinus*	24	0
Kittiwake	Dreizehenmöwe	*Rissa tridactyla*	1259	445
Ivory Gull	Elfenbeinmöwe	*Pagophila eburnea*	352	488
Arctic Tern	Küstenseeschwalbe	*Sterna paradisaea*	8	11
Guillemot	Trottellumme	*Uria aalge*	14	0
Brunnich's Guillemot	Dickschnabellumme	*Uria lomvia*	1606	804
Razorbill	Tordalk	*Alca torda*	1	0
Black Guillemot	Gryllteiste	*Cepphus grylle*	58	24
Little Auk	Krabbentaucher	*Alle alle*	2092	426
Puffin	Papageitaucher	*Fratercula arctica*	205	98
Snow Bunting	Schneeammer	*Plectrophenax nivalis*	1	0

During this expedition, the observed number of Ivory Gulls (*Pagophila eburnea*) was exceptionally high, more than tenfold of the maximum number ever recorded during an expedition. The majority of the observed animals were adults, only a handful immature/young birds were seen. The unusual high number of adults and the skewed age composition might indicate a general breeding failure of the population.

The number of Glaucous Gull (*Larus hyperboreus*) further (strongly) decreased compared to the censuses of 2010, which was also noted on ARK-XXVII/2.

The sighting of the couple Spectacled Eiders (*Somateria fischeri*) on 20 June represent the 5th record ever for the Western Palearctic region. This species normally breeds on the coast of Alaska and north-eastern Siberia. One Iceland Gull (*Larus glaucoides*) was seen during the trip. Although this species breeds on Iceland and Greenland, it has never been observed by the PolE team in the Arctic region before.

One of the most important finding of this long term study is the remarkably increase of cetaceans in the Greenland and Norwegian seas since 2005. As a consequence of the decrease of pack-ice coverage in the Arctic and a severe Atlantic Oscillation in 2005, the ice coverage in the study area was extremely low in 2005, leading to the opening of both the north-eastern and north-western passages, enabling the rich North Pacific stock to merge with the depleted populations of the NE Atlantic. During ARK-XXVII/1 a total of 1,542 marine mammals were identified from the *Polarstern*, belonging to 15 species (1,401 individuals of 14 species during recording periods; see Table 10.2). The helicopter surveys proved to be efficient for gathering information about species difficult to spot from ships like Narwhal (*Monodon monoceros*), and to survey areas out of reach of observation from the ship.

85 Fin Whales (*Balaenoptera physalus*) were recorded, but only 41 of them during effort counts, which is less than in 2010. One Sei Whale (*Balaenoptera borealis*) was recorded, 2.5 nautical miles from the sighting in 2010 that represented the northernmost sighting of this species. This indicates that the species might be expanding its distribution to the north and is nowadays more common than in the past, which is strengthened by further sightings of this species during ARK-XXVII/2.

Thick pack-ice prevented approaching the Greenland coast and foggy weather conditions prevented helicopter flights towards polynia's before the Greenland coast in order to gather information about distribution and population size of Narwhal (*Monodon monoceros*). Although Narwhals are typically found during this period of the year in the polynia's close to the Greenland coast, a total of 17 individuals were counted on three different locations, ranging from 40 to 138 nautical miles from the Greenland coast.

1309 seals belonging to four species were observerd: 20 Bearded Seals (*Cystophora cristata*), 8 Hooded Seals (*Cystophora cristata*), 23 Ringed Seals (*Pusa hispida*) and 1,250 Harp Seals (*Phoca groenlandica*). The high number of Harp Seals is mainly due to the observation of a group of no less than 1,180 individuals.

During this expedition, 28 Polar Bears (*Ursus maritimus*), the largest living terrestrial carnivore, were seen. On two occasions, a female was seen with cubs, one and two respectively.

Tab. 10.2: Numbers of mammals seen during the 514 recording periods from the moving ship during ARK-XXVII/1.

English name	German name	Scientific name	RP	Heli	ORP
Bowhead Whale	Grönlandwal	*Balaena mysticetus*	0	1	0
Northern Minke Whale	Zwergwal	*Balaenoptera acutorostrata*	4	0	3
Sei Whale	Seiwal	*Balaenoptera borealis*	0	0	1
Blue Whale	Blauwal	*Balaenoptera musculus*	4	0	8
Fin Whale	Finnwal	*Balaenoptera physalus*	41	16	28
Humpback Whale	Buckelwal	*Megaptera novaeangliae*	1	0	3
White-beaked Dolphin	Weißschnauzen-delfin	*Lagenorhynchus albirostris*	9	17	36
Killer Whale	Schwertwal	*Orcinus orca*	54	0	7
Narwhal	Narwal	*Monodon monoceros*	0	17	0
Harbour Porpoise	Schweinswal	*Phocoena phocoena*	10	0	4
Sperm Whale	Pottfisch	*Physeter macrocephalus*	8	0	2
Northern Bottlenose Whale	Nördlichen Entenwal	*Hyperoodon ampullatus*	9	0	3
Bearded Seal	Bartrobbe	*Erignathus barbatus*	8	7	5
Hooded Seal	Klappmütze	*Cystophora cristata*	7	0	1
Ringed Seal	Ringelrobbe	*Pusa hispida*	7	0	16
Harp Seal	Sattelrobbe	*Phoca groenlandica*	1224	12	14
Polar Bear	Eisbär	*Ursus maritimus*	15	3	10

Data management

All mammal and seabird data are stored in the PolE data set (joiris@gmail.com). Data will made available to the public as summary: joiriscr@gmail.com, and will soon be published in international scientific journals.

References

Joiris CR (2000) Summer at-sea distribution of seabirds and marine mammals in polar ecosystems: a comparison between the European Arctic seas and the Weddell Sea, Antarctic, Journal of Marine Systems, 27, 267-276.

Reeves RR, Stewart BS, Clapham PJ, Powel JA (2002) Sea mammals of the world. A&C Black, London. 528pp.

Shirihai H, Jarrett B (2006) Whales, Dolphins and Seals – A field guide to the Marine Mammals of the World. A&C Black, London. 384pp.

Joiris CR (2011). Possible Impact of Decreasing Arctic Pack Ice on the Higher Trophic Levels – Seabirds and Marine Mammals. In : Advances in Environmental Research 23: 227-241.

Jefferson, T.A., Karczmarski, L., Laidre, K., O'Corry-Crowe, G., Reeves, R.R., Rojas-Bracho, L., Secchi, E.R., Slooten, E., Smith, B.D., Wang, J.Y. & Zhou, K. (2008). Monodon monoceros. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1. <www.iucnredlist.org>. Downloaded on 21 August 2012.

Heide-Jørgensen, M.P., Dietz, R., Laidre, K. L., Richard, P. (2002). Autumn movements, home ranges, and winter density of narwhals (*Monodon monoceros*) tagged in Tremblay Sound, Baffin Island. In : Polar Biol (2002) 25: 331–341.

11. GPS OBSERVATIONS IN NORTH-EAST GREENLAND TO DETERMINE VERTICAL AND HORIZONTAL DEFORMATIONS OF THE EARTH'S CRUST

Ralf Rosenau, Katharina Krawutschke TU Dresden
not on board: Mirko Scheinert

Objectives

The main goal of the geodetic work was the re-observation of GPS stations at up to 10 ice-free locations in the coastal area of North-East Greenland between 78° and 81°N, which were installed and firstly observed during *Polarstern's* ARK XXIII/1+2 (2008) and ARK XXIV/3 cruises in 2009.

The network configuration of the stations contains, on the one hand, a west-east component (stations at the ice edge and close to the coast, respectively) and covers, on the other hand, the entire area of investigation between 78° and 81°N. A repetition of the GPS observations at marked stations results in two precise station coordinates, the difference of which yields information on deformations of the Earth's crust. As independent information, it delivers a valuable contribution to the validation and improvement of models of the glacial-isostatic adjustment and of the recent mass balance in North-East Greenland. The significance of horizontal deformations will be checked to contribute to the investigation of the tectonic situation in the area of investigation.

Work at sea and land

Polarstern with its two helicopters provided a basis for the realization of the work. To reach the locations on land, *Polarstern* had to sail to positions close enough to the Greenlandic coast (within the helicopter flight range of approx. 100 Nm). The geodetic flight programme was fitted to the ship's route such that no additional anchoring had to be done.

Between 3rd of July and 6th of July 2012 *Polarstern* was located in the range of helicopter flights to reach the coastal GPS stations. Unfortunately, the weather situation did not permit flight operations in this period, because of persistent fog and snow falls all between the *Polarstern* position and positions of the planned stations. Moreover, even when the weather conditions in a direct vicinity of the ship improved slightly and allowed the flight, very low cloud ceiling on the way towards Greenland and in particular at the positions of the planned stations (all stations were located in high altitude areas) prohibited reaching the coast and landing. Three reconnaissance flights were performed during this period but all had to be cancelled before reaching Greenland due to a lack of flight permitting visibility and icing the aircraft. Finally, we were not enable to re-observe any of our planned GPS stations.

Preliminary results and data management

Due to the lack of flight permitting weather, no data could be collected during the cruise

APPENDIX

A.1 PARTICIPATING INSTITUTIONS

A.2 CRUISE PARTICIPANTS

A.3 SHIP'S CREW

A.4 STATION LIST

A.1 TEILNEHMENDE INSTITUTE / PARTICIPATING INSTITUTIONS

	Address
AWI	Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung Postfach 120161 27515 Bremerhaven Germany
DWD	Deutscher Wetterdienst Geschäftsbereich Wettervorhersage Seeschifffahrtsberatung Bernhard Nocht Str. 76 20359 Hamburg Germany
HeliService	Heli Service International GmbH Am Luneort 15 27572 Bremerhaven Germany
IFM-GEOMAR	Leibniz-Institut für Meereswissenschaften an der Christian-Albrechts Universität zu Kiel Wischofstr. 1-3 24148 Kiel Germany
PolE	Laboratory for Polar Ecology Rue du Fodia 18 B-1367 Ramilles Belgium
Skidaway IO	Skidaway Institute of Oceanography 10 Ocean Science Circle Savannah, GA-31411/USA
TU Dresden	Technische Universität Dresden Institut für Planetare Geodäsie 01062 Dresden/ Germany
UEA	University of East Anglia School of Environmental Sciences Norwich, NR4 7TJ United Kingdom

A.2 FAHRTTEILNEHMER / CRUISE PARTICIPANTS

Name/ Last name	Vorname/ First name	Institut/ Institute	Beruf/ Profession
Baudorff	Christian	HeliService	Pilot
Beszczynska-Möller	Agnieszka	AWI	Oceanographer
Bogner	Boie	IFM-GEOMAR	Technician
Buldt	Klaus	DWD	Technician
Caesar	Levke	AWI/Student	Student, oceanography
Castro-Morales	Karel	AWI	Oceanographer
Demey	Jeremy	PolE	Ecologist
D'Hert	Diederik	PolE	Ecologist
Gäbler-Schwarz	Steffi	AWI	Biologist
Gall	Fabian	HeliService	Mechanic
Greil	Florian	AWI	Physicist
Grimm	Dennis	AWI/Student	Student, oceanography
Heckmann	Hans	HeliService	Pilot
Heinze	Jutta	IFM-GEOMAR	Technician
Hempelt	Juliane	DWD	Technician
Hildebrandt	Nicole	AWI	PhD student, biology
Knüppel	Nadine	AWI	Technician
Kohls	Katharina	AWI	Biologist
Kölling	Jannes	AWI/Student	Student, oceanography
Krawutschke	Katharina	TU Dresden	Geodesist
Lax	Gordon	AWI/Student	Student, biology
Lebrun	Raphaël	PolE	Ecologist
Menze	Sebastian	AWI/Student	Student, oceanography
Möllendorf	Carsten	HeliService	Mechanic
Monsees	Matthias	AWI	Technician
Niehoff	Barbara	AWI	Biologist
Petersen	Imke	AWI/Student	Student, biology
Rentsch	Harald	DWD	Meteorologist
Rizkallah	Imke	AWI/Student	Student, biology
Rosenau	Ralf	TU Dresden	Geodesist
Schade	Hanna	IFM-GEOMAR	Student, chemistry
Schmidt	Katrin	AWI	PhD student, biology
Schramm	Stefanie	Media	Journalist
Schrammar	Chris	IFM-GEOMAR	Student, chemistry
Stärz	Michael	AWI	PhD student, oceanography
Stöven	Tim	IFM-GEOMAR	PhD student, chemistry

Name/ Last name	**Vorname/ First name**	**Institut/ Institute**	**Beruf/ Profession**
Strothmann	Olaf	AWI	Technician
Stubbins	Aron	Skidaway IO	Biogeochemist
Wager	Natalie	UEA UK	PhD student, chemisty
Walter	Jörg	AWI	Technician
Winkler	Maria	AWI	Student, biology
Wisotzki	Andreas	AWI	Oceanographer
Wolanin	Aleksandra	AWI/Student	PhD student, biology
Zieringer	Moritz	IFM-GEOMAR	PhD student, chemistry

A.3 SCHIFFSBESATZUNG / SHIP'S CREW

Name	Rank
Schwarze, Stefan	Master
Grundmann, Uwe	1. Offc.
Farysch, Bernd	Ch. Eng.
Fallei, Holger	2. Offc.
Lesch, Florian	2. Offc.
Rackete, Carola	2. Offc.
Pohl, Claus	Doctor
Hecht, Andreas	R.Offc.
Sümnicht, Stefan	2. Eng.
Minzlaff, Hans-Ulrich	2. Eng.
Holst, Wolfgang	3. Eng.
Scholz, Manfred	Elec. Tech.
Dimmler, Werner	Electron.
Hebold, Catharina	Electron.
Nasis, Ilias	Electron.
Himmel, Frank	Electron.
Voy, Bernd	Boatsw.
Reise, Lutz	Carpenter
Scheel, Sebastian	A.B.
Brickmann, Peter	A.B.
Winkler, Michael	A.B.
Hagemann, Manfred	A.B.
Schmidt, Uwe	A.B.
Guse, Hartmut	A.B.
Wende, Uwe	A.B.
Bäcker, Andreas	A.B.
Preußner, Jörg	Storek.
Teichert, Uwe	Mot-man
Schütt, Norbert	Mot-man
Elsner, Klaus	Mot-man
Plehn, Markus	Mot-man
Pinske, Lutz	Mot-man
Müller-Homburg, Ralf-Dieter	Cook
Silinski, Frank	Cooksmate
Martens, Michael	Cooksmate
Czyborra, Bärbel	1. Stwdess
Wöckener, Martina	Stwdss/KS

Name	Rank
Gaude, Hans-Jürgen	2. Steward
Silinski, Carmen	2.Stwdess
NN	2.Steward
Möller, Wolfgang	2.Steward
Sun, Yong Shen	2.Steward
Yu, Kwok Yuen	Laundrym.

A.4 STATIONSLISTE / STATION LIST PS 80

Station	Date	Time	Gear Abbrev.	Action	Position Latitude	Position Longitude	Depth (m)
PS80/001-1	17.06.2012	04:08	CTD/RO	on ground/max depth	64° 59.93' N	5° 22.09' E	673.2
PS80/001-2	17.06.2012	04:13	HN	on ground/max depth	64° 59.93' N	5° 22.07' E	673.2
PS80/002-1	17.06.2012	15:19	CTD/RO	on ground/max depth	66° 59.93' N	6° 31.15' E	1250
PS80/002-2	17.06.2012	15:24	HN	on ground/max depth	66° 59.93' N	6° 31.16' E	1251.2
PS80/003-1	18.06.2012	03:10	CTD/RO	on ground/max depth	68° 59.96' N	7° 43.97' E	2683.7
PS80/003-2	18.06.2012	03:14	HN	on ground/max depth	68° 59.95' N	7° 43.85' E	2670.2
PS80/003-3	18.06.2012	03:24	NFLOAT	on ground/max depth	68° 59.99' N	7° 43.65' E	2683
PS80/003-4	18.06.2012	03:26	FLOAT	on ground/max depth	69° 00.07' N	7° 43.65' E	2685.7
PS80/004-1	18.06.2012	09:08	NFLOAT	on ground/max depth	69° 59.76' N	8° 07.05' E	3070
PS80/005-1	18.06.2012	15:37	CTD/RO	on ground/max depth	70° 59.67' N	8° 36.41' E	2825.1
PS80/005-2	18.06.2012	15:47	HN	on ground/max depth	70° 59.48' N	8° 36.29' E	2827.8
PS80/005-3	18.06.2012	16:05	BONGO	on ground/max depth	70° 59.18' N	8° 35.99' E	2827.5
PS80/005-4	18.06.2012	16:27	NFLOAT	on ground/max depth	70° 58.76' N	8° 35.43' E	2827.3
PS80/005-5	18.06.2012	16:29	FLOAT	on ground/max depth	70° 58.78' N	8° 35.01' E	2828
PS80/006-1	18.06.2012	22:09	NFLOAT	on ground/max depth	71° 59.91' N	9° 11.78' E	2528.1
PS80/007-1	19.06.2012	03:48	CTD/RO	on ground/max depth	73° 00.00' N	9° 46.11' E	2243.5
PS80/007-2	19.06.2012	03:49	HN	on ground/max depth	72° 59.98' N	9° 46.07' E	2243.6
PS80/007-3	19.06.2012	04:18	MN	on ground/max depth	72° 59.99' N	9° 45.76' E	2244.8
PS80/007-4	19.06.2012	04:31	MN	on ground/max depth	72° 59.86' N	9° 45.50' E	2246.1
PS80/007-5	19.06.2012	04:42	FLOAT	on ground/max depth	72° 59.74' N	9° 45.16' E	2248
PS80/008-2	19.06.2012	15:56	HN	on ground/max depth	75° 00.03' N	11° 06.17' E	2481.2
PS80/008-1	19.06.2012	16:27	CTD/RO	on ground/max depth	74° 59.97' N	11° 05.88' E	2481.4
PS80/008-3	19.06.2012	17:24	FLOAT	on ground/max depth	74° 59.66' N	11° 05.05' E	2482.1
PS80/009-1	20.06.2012	03:55	HN	on ground/max depth	77° 00.29' N	11° 59.13' E	769.5
PS80/009-2	20.06.2012	03:58	FLOAT	on ground/max depth	77° 00.45' N	11° 59.45' E	756.3
PS80/010-1	20.06.2012	07:08	HN	on ground/max depth	77° 35.08' N	10° 58.60' E	354.7
PS80/011-1	20.06.2012	09:43	HN	on ground/max depth	77° 59.63' N	10° 01.03' E	169
PS80/012-1	20.06.2012	14:30	CTD/RO	on ground/max depth	78° 49.97' N	9° 29.94' E	172
PS80/012-2	20.06.2012	14:33	HN	on ground/max depth	78° 49.98' N	9° 30.01' E	175.5
PS80/013-1	20.06.2012	15:17	CTD/RO	on ground/max depth	78° 50.09' N	9° 19.83' E	206.5
PS80/014-1	20.06.2012	16:03	CTD/RO	on ground/max depth	78° 49.95' N	9° 10.53' E	223
PS80/015-1	20.06.2012	16:54	CTD/RO	on ground/max depth	78° 50.10' N	9° 00.07' E	221.2
PS80/016-1	20.06.2012	17:45	CTD/RO	on ground/max depth	78° 50.06' N	8° 49.98' E	235.5
PS80/017-2	20.06.2012	19:01	HN	on ground/max depth	78° 50.05' N	8° 29.77' E	130.5
PS80/017-3	20.06.2012	19:04	HN	on ground/max depth	78° 50.09' N	8° 29.77' E	211.5
PS80/017-1	20.06.2012	19:06	CTD/RO	on ground/max depth	78° 50.12' N	8° 29.77' E	211.5
PS80/017-4	20.06.2012	19:09	HN	on ground/max depth	78° 50.14' N	8° 29.77' E	590
PS80/018-1	20.06.2012	20:23	CTD/RO	on ground/max depth	78° 50.03' N	8° 12.08' E	919
PS80/019-1	20.06.2012	21:53	CTD/RO	on ground/max depth	78° 49.94' N	7° 49.69' E	983.7
PS80/020-2	20.06.2012	23:13	HN	on ground/max depth	78° 51.09' N	8° 01.06' E	894.7
PS80/020-1	20.06.2012	23:16	CTD/RO	on ground/max depth	78° 51.10' N	8° 01.04' E	891.2

Station	Date	Time	Gear Abbrev.	Action	Position Latitude	Position Longitude	Depth (m)
PS80/020-3	21.06.2012	00:24	MN	on ground/max depth	78° 51.19' N	8° 00.42' E	1048
PS80/020-4	21.06.2012	01:34	MN	on ground/max depth	78° 51.48' N	8° 01.03' E	1051
PS80/021-1	21.06.2012	03:31	CTD/RO	on ground/max depth	78° 50.20' N	8° 39.82' E	246.7
PS80/021-2	21.06.2012	04:28	MOR	on ground/max depth	78° 50.01' N	8° 40.04' E	246.7
PS80/022-1	21.06.2012	06:35	MOR	on ground/max depth	78° 50.88' N	8° 22.19' E	749
PS80/023-1	21.06.2012	08:21	MOR	on ground/max depth	78° 50.49' N	8° 02.23' E	1020.7
PS80/024-1	21.06.2012	10:22	MOR	on ground/max depth	78° 50.18' N	7° 02.23' E	1436.5
PS80/025-1	21.06.2012	12:52	MOR	on ground/max depth	78° 50.41' N	6° 00.18' E	2474.2
PS80/026-1	21.06.2012	16:50	CTD/RO	on ground/max depth	78° 50.00' N	6° 51.31' E	1598
PS80/027-2	21.06.2012	18:28	HN	on ground/max depth	78° 49.76' N	7° 01.01' E	1460.7
PS80/027-1	21.06.2012	18:39	CTD/RO	on ground/max depth	78° 49.75' N	7° 01.34' E	1455.7
PS80/027-3	21.06.2012	20:01	MN	on ground/max depth	78° 49.60' N	7° 02.00' E	1448.7
PS80/027-4	21.06.2012	21:23	MN	on ground/max depth	78° 49.60' N	7° 01.69' E	1457
PS80/028-1	21.06.2012	23:05	CTD/RO	on ground/max depth	78° 49.88' N	7° 09.92' E	1361.7
PS80/029-1	22.06.2012	00:49	CTD/RO	on ground/max depth	78° 49.98' N	7° 19.79' E	1243.7
PS80/030-1	22.06.2012	02:14	CTD/RO	on ground/max depth	78° 50.13' N	7° 30.10' E	1175.2
PS80/031-1	22.06.2012	04:21	CTD/RO	on ground/max depth	78° 50.06' N	8° 19.23' E	809.5
PS80/031-2	22.06.2012	06:18	MOR	on ground/max depth	78° 50.05' N	8° 20.17' E	792.2
PS80/032-1	22.06.2012	07:31	CTD/RO	on ground/max depth	78° 50.05' N	8° 00.16' E	1035.7
PS80/032-2	22.06.2012	09:12	MOR	on ground/max depth	78° 49.91' N	8° 00.29' E	1034
PS80/033-1	22.06.2012	12:16	MOR	on ground/max depth	78° 50.01' N	7° 00.04' E	1465.2
PS80/033-1	22.06.2012	12:45	MOR	on ground/max depth	78° 50.01' N	7° 00.01' E	1466
PS80/034-1	22.06.2012	14:25	CTD/RO	on ground/max depth	78° 50.03' N	7° 40.85' E	1110.2
PS80/035-1	22.06.2012	17:12	CTD/RO	on ground/max depth	78° 49.97' N	6° 40.41' E	1777.2
PS80/036-1	22.06.2012	19:12	CTD/RO	on ground/max depth	78° 49.96' N	6° 30.06' E	1980
PS80/036-2	22.06.2012	19:27	HN	on ground/max depth	78° 49.96' N	6° 30.09' E	1979.5
PS80/037-2	22.06.2012	20:57	HN	on ground/max depth	78° 50.02' N	5° 59.58' E	2027
PS80/037-1	22.06.2012	21:39	CTD/RO	on ground/max depth	78° 50.02' N	5° 59.97' E	2015.2
PS80/037-3	22.06.2012	23:33	MN	on ground/max depth	78° 50.03' N	5° 59.99' E	2017.7
PS80/037-4	23.06.2012	01:12	MN	on ground/max depth	78° 49.98' N	5° 59.97' E	2016.5
PS80/037-5	23.06.2012	06:08	MOR	on ground/max depth	78° 50.01' N	6° 00.04' E	2471.5
PS80/038-1	23.06.2012	07:54	MOR	on ground/max depth	78° 50.27' N	5° 30.61' E	2622.2
PS80/039-1	23.06.2012	09:57	MOR	on ground/max depth	78° 49.74' N	5° 01.88' E	2703.2
PS80/040-1	23.06.2012	11:12	HN	on ground/max depth	78° 50.08' N	5° 29.49' E	2623.5
PS80/040-2	23.06.2012	13:15	GLD	on ground/max depth	78° 50.30' N	5° 27.10' E	2630.3
PS80/041-1	23.06.2012	16:28	CTD/RO	on ground/max depth	78° 50.17' N	6° 19.28' E	2215
PS80/042-1	23.06.2012	18:18	CTD/RO	on ground/max depth	78° 50.06' N	6° 09.76' E	2374.2
PS80/043-1	23.06.2012	20:29	CTD/RO	on ground/max depth	78° 50.12' N	5° 49.04' E	2544.4
PS80/044-1	23.06.2012	22:30	CTD/RO	on ground/max depth	78° 50.19' N	5° 39.33' E	2589.6
PS80/045-1	24.06.2012	01:22	CTD/RO	on ground/max depth	78° 44.99' N	5° 30.11' E	2442.2
PS80/045-2	24.06.2012	06:01	MOR	on ground/max depth	78° 45.00' N	5° 29.96' E	2469.2
PS80/046-1	24.06.2012	08:20	GLD	on ground/max depth	78° 51.80' N	5° 09.06' E	2666.3
PS80/047-1	24.06.2012	11:05	MOR	on ground/max depth	78° 49.99' N	5° 00.00' E	2716.5
PS80/048-1	24.06.2012	13:37	MOR	on ground/max depth	78° 45.00' N	5° 15.03' E	2376
PS80/049-1	24.06.2012	15:28	CTD/RO	on ground/max depth	78° 49.99' N	5° 27.37' E	2626.1

Station	Date	Time	Gear Abbrev.	Action	Position Latitude	Position Longitude	Depth (m)
PS80/050-1	24.06.2012	17:26	CTD/RO	on ground/max depth	78° 50.02' N	5° 20.70' E	2636.8
PS80/051-2	24.06.2012	19:00	HN	on ground/max depth	78° 50.06' N	5° 06.85' E	2675.2
PS80/051-1	24.06.2012	19:45	CTD/RO	on ground/max depth	78° 50.02' N	5° 06.82' E	2672.8
PS80/051-3	24.06.2012	21:37	MN	on ground/max depth	78° 49.99' N	5° 06.44' E	2677.2
PS80/052-2	24.06.2012	23:17	HN	on ground/max depth	78° 49.93' N	4° 39.74' E	2586.6
PS80/052-1	25.06.2012	00:06	CTD/RO	on ground/max depth	78° 49.99' N	4° 39.84' E	2606.1
PS80/053-1	25.06.2012	05:17	MOR	on ground/max depth	78° 49.11' N	4° 01.97' E	2365.4
PS80/053-2	25.06.2012	06:26	CTD/RO	on ground/max depth	78° 49.73' N	4° 00.51' E	2352.7
PS80/053-4	25.06.2012	08:19	HN	on ground/max depth	78° 49.53' N	3° 59.87' E	2347.4
PS80/053-3	25.06.2012	08:28	MN	on ground/max depth	78° 49.52' N	3° 59.95' E	2347.2
PS80/053-5	25.06.2012	10:18	MN	on ground/max depth	78° 49.77' N	4° 00.00' E	2346.7
PS80/053-6	25.06.2012	12:50	MOR	on ground/max depth	78° 49.72' N	4° 00.51' E	2351.3
PS80/054-1	25.06.2012	14:36	CTD/RO	on ground/max depth	78° 49.96' N	4° 20.26' E	2409.9
PS80/055-1	25.06.2012	17:12	CTD/RO	on ground/max depth	78° 49.43' N	3° 39.72' E	2313.8
PS80/056-2	25.06.2012	19:13	HN	on ground/max depth	78° 49.93' N	3° 20.09' E	2397.5
PS80/056-1	25.06.2012	19:41	CTD/RO	on ground/max depth	78° 49.78' N	3° 20.00' E	2395.3
PS80/057-2	25.06.2012	21:38	HN	on ground/max depth	78° 49.70' N	2° 59.48' E	2475.7
PS80/057-1	25.06.2012	21:58	CTD/RO	on ground/max depth	78° 49.56' N	2° 59.17' E	2469.7
PS80/058-1	26.06.2012	00:43	CTD/RO	on ground/max depth	78° 49.69' N	2° 32.08' E	2534.1
PS80/059-1	26.06.2012	05:40	MOR	on ground/max depth	78° 49.99' N	2° 43.93' E	2503
PS80/060-1	26.06.2012	08:14	MOR	on ground/max depth	78° 49.83' N	1° 36.20' E	2556
PS80/061-1	26.06.2012	12:46	MOR	on ground/max depth	78° 50.00' N	0° 24.26' E	2590.3
PS80/061-3	26.06.2012	17:03	HN	on ground/max depth	78° 50.30' N	0° 22.62' E	2594.3
PS80/061-2	26.06.2012	17:43	CTD/RO	on ground/max depth	78° 50.44' N	0° 21.96' E	2545.4
PS80/062-2	26.06.2012	19:47	HN	on ground/max depth	78° 50.25' N	0° 41.86' E	2426.6
PS80/062-1	26.06.2012	20:26	CTD/RO	on ground/max depth	78° 50.45' N	0° 40.82' E	2432.3
PS80/063-2	26.06.2012	23:03	HN	on ground/max depth	78° 49.90' N	1° 35.76' E	2500.2
PS80/063-1	26.06.2012	23:54	CTD/RO	on ground/max depth	78° 49.70' N	1° 35.32' E	2499.9
PS80/064-1	27.06.2012	02:51	CTD/RO	on ground/max depth	78° 49.97' N	2° 12.77' E	2497.6
PS80/065-1	27.06.2012	05:43	CTD/RO	on ground/max depth	78° 49.54' N	2° 47.36' E	2455
PS80/065-2	27.06.2012	08:40	MOR	on ground/max depth	78° 49.37' N	2° 45.33' E	2458.2
PS80/066-1	27.06.2012	12:46	MOR	on ground/max depth	78° 50.12' N	1° 35.08' E	2499.6
PS80/067-2	27.06.2012	14:20	HN	on ground/max depth	78° 49.89' N	1° 54.00' E	2514.3
PS80/067-1	27.06.2012	14:48	CTD/RO	on ground/max depth	78° 49.91' N	1° 53.19' E	2514.5
PS80/067-3	27.06.2012	16:56	MN	on ground/max depth	78° 50.59' N	1° 51.29' E	2515.1
PS80/067-4	27.06.2012	18:37	MN	on ground/max depth	78° 51.38' N	1° 50.25' E	2557
PS80/068-1	27.06.2012	21:30	CTD/RO	on ground/max depth	78° 50.09' N	1° 19.55' E	2473.5
PS80/069-2	27.06.2012	23:27	HN	on ground/max depth	78° 50.29' N	1° 02.12' E	2469.6
PS80/069-1	27.06.2012	23:57	CTD/RO	on ground/max depth	78° 50.56' N	1° 03.51' E	2523.5
PS80/070-1	28.06.2012	03:07	CTD/RO	on ground/max depth	78° 49.91' N	0° 25.12' E	2537.5
PS80/070-2	28.06.2012	05:47	MOR	on ground/max depth	78° 49.77' N	0° 25.69' E	2579.7
PS80/071-1	28.06.2012	09:00	MOR	on ground/max depth	78° 50.01' N	0° 48.96' W	2615.4
PS80/072-1	28.06.2012	18:46	CTD/RO	on ground/max depth	78° 49.73' N	0° 03.30' E	2636.7
PS80/072-2	28.06.2012	19:08	HN	on ground/max depth	78° 49.54' N	0° 02.31' E	2592.3

Station	Date	Time	Gear Abbrev.	Action	Position Latitude	Position Longitude	Depth (m)
PS80/072-3	28.06.2012	20:31	MN	on ground/max depth	78° 50.19' N	0° 04.79' E	2589
PS80/072-4	28.06.2012	21:39	MN	on ground/max depth	78° 49.85' N	0° 03.84' E	2592.6
PS80/072-5	28.06.2012	23:12	MN	on ground/max depth	78° 49.11' N	0° 01.73' E	2576.4
PS80/073-1	29.06.2012	01:28	CTD/RO	on ground/max depth	78° 49.01' N	0° 14.98' W	2621.9
PS80/074-1	29.06.2012	04:18	CTD/RO	on ground/max depth	78° 49.49' N	0° 51.97' W	2583
PS80/074-2	29.06.2012	07:32	MOR	on ground/max depth	78° 49.57' N	0° 50.79' W	2603
PS80/075-1	29.06.2012	09:58	MOR	on ground/max depth	78° 49.83' N	2° 00.65' W	2672.1
PS80/076-1	29.06.2012	17:52	CTD/RO	on ground/max depth	78° 50.03' N	1° 05.50' W	2504.1
PS80/077-1	29.06.2012	21:29	CTD/RO	on ground/max depth	78° 50.04' N	0° 33.30' W	2642.4
PS80/078-1	30.06.2012	01:16	CTD/RO	on ground/max depth	78° 49.21' N	1° 21.56' W	2641.8
PS80/079-1	30.06.2012	08:37	CTD/RO	on ground/max depth	78° 49.18' N	2° 24.00' W	2617.7
PS80/079-2	30.06.2012	08:46	HN	on ground/max depth	78° 49.13' N	2° 24.44' W	2617.7
PS80/079-3	30.06.2012	10:43	MN	on ground/max depth	78° 48.69' N	2° 30.22' W	2605.2
PS80/079-4	30.06.2012	12:27	MN	on ground/max depth	78° 48.38' N	2° 35.17' W	2593
PS80/080-1	30.06.2012	18:01	MOR	on ground/max depth	78° 49.87' N	2° 3.46' W	2666.2
PS80/081-1	30.06.2012	20:00	CTD/RO	on ground/max depth	78° 50.34' N	1° 44.81' W	2663.9
PS80/082-1	01.07.2012	05:05	MOR	on ground/max depth	78° 30.08' N	2° 01.41' W	2646.8
PS80/083-1	01.07.2012	07:38	MOR	on ground/max depth	78° 30.30' N	2° 04.44' W	2584.4
PS80/084-1	01.07.2012	10:28	MOR	on ground/max depth	78° 29.16' N	2° 28.52' W	2713.1
PS80/085-1	01.07.2012	13:00	ZODIAK	on ground/max depth	78° 42.71' N	2° 10.87' W	2680.4
PS80/086-1	01.07.2012	16:38	CTD/RO	on ground/max depth	78° 50.21' N	1° 53.83' W	2666.4
PS80/087-1	01.07.2012	20:49	CTD/RO	on ground/max depth	78° 50.39' N	2° 40.67' W	2563.4
PS80/088-1	02.07.2012	05:40	MOR	on ground/max depth	79° 9.40' N	1° 32.14' W	2594
PS80/088-2	02.07.2012	07:45	MOR	on ground/max depth	79° 10.05' N	1° 31.20' W	2601.8
PS80/089-1	02.07.2012	12:46	MOR	on ground/max depth	78° 57.12' N	2° 57.53' W	2455.8
PS80/090-1	02.07.2012	14:00	ZODIAK	on ground/max depth	78° 58.45' N	3° 13.15' W	2355.2
PS80/091-1	03.07.2012	13:13	HN	on ground/max depth	79° 40.03' N	11° 59.99' W	267.4
PS80/091-2	03.07.2012	13:48	BONGO	on ground/max depth	79° 40.21' N	11° 59.64' W	261.2
PS80/091-3	03.07.2012	14:15	BONGO	on ground/max depth	79° 40.32' N	11° 59.43' W	263.5
PS80/091-4	03.07.2012	14:32	BONGO	on ground/max depth	79° 40.43' N	11° 59.22' W	262.3
PS80/091-5	03.07.2012	14:47	BONGO	on ground/max depth	79° 40.54' N	11° 58.97' W	262.3
PS80/091-6	03.07.2012	15:23	BONGO	on ground/max depth	79° 40.22' N	11° 59.43' W	264.6
PS80/091-7	03.07.2012	15:42	BONGO	on ground/max depth	79° 40.34' N	11° 59.19' W	263.8
PS80/092-1	03.07.2012	17:13	CTD/RO	on ground/max depth	79° 50.04' N	12° 0.08' W	163.1
PS80/093-1	03.07.2012	18:32	CTD/RO	on ground/max depth	79° 45.18' N	11° 59.62' W	230.3
PS80/094-1	03.07.2012	19:34	CTD/RO	on ground/max depth	79° 40.11' N	12° 0.47' W	265.2
PS80/095-1	03.07.2012	20:40	CTD/RO	on ground/max depth	79° 34.88' N	12° 03.41' W	226.1
PS80/096-1	03.07.2012	21:52	CTD/RO	on ground/max depth	79° 30.12' N	11° 55.47' W	249.5
PS80/097-1	04.07.2012	00:21	CTD/RO	on ground/max depth	79° 24.92' N	11° 28.82' W	252.7
PS80/098-1	04.07.2012	12:21	CTD/RO	on ground/max depth	79° 22.90' N	11° 26.27' W	251.7
PS80/099-1	04.07.2012	14:00	EF	on ground/max depth	79° 22.28' N	11° 15.46' W	255.7
PS80/100-1	04.07.2012	14:54	CTD/RO	on ground/max depth	79° 20.01' N	11° 06.55' W	247.6
PS80/101-1	04.07.2012	16:24	CTD/RO	on ground/max depth	79° 15.11' N	11° 01.21' W	254.8
PS80/102-1	04.07.2012	18:13	CTD/RO	on ground/max depth	79° 9.88' N	10° 43.23' W	302.2

Station	Date	Time	Gear Abbrev.	Action	Position Latitude	Position Longitude	Depth (m)
PS80/103-1	04.07.2012	20:29	CTD/RO	on ground/max depth	79° 4.78' N	10° 36.83' W	343.2
PS80/104-1	04.07.2012	21:48	CTD/RO	on ground/max depth	79° 0.15' N	10° 27.79' W	302.1
PS80/105-1	04.07.2012	23:04	CTD/RO	on ground/max depth	78° 54.99' N	10° 38.53' W	259.1
PS80/106-1	05.07.2012	00:17	CTD/RO	on ground/max depth	78° 49.90' N	10° 40.25' W	383.9
PS80/107-1	05.07.2012	02:07	CTD/RO	on ground/max depth	78° 44.94' N	10° 24.78' W	328.8
PS80/108-1	05.07.2012	03:37	CTD/RO	on ground/max depth	78° 39.99' N	10° 15.62' W	216.3
PS80/109-1	05.07.2012	04:59	CTD/RO	on ground/max depth	78° 35.07' N	10° 24.21' W	209.7
PS80/110-1	05.07.2012	06:52	CTD/RO	on ground/max depth	78° 30.00' N	10° 59.84' W	201.8
PS80/111-1	05.07.2012	22:15	CTD/RO	on ground/max depth	78° 50.13' N	11° 30.49' W	235.6
PS80/112-1	06.07.2012	00:15	CTD/RO	on ground/max depth	78° 49.98' N	11° 59.87' W	207
PS80/113-1	06.07.2012	03:25	CTD/RO	on ground/max depth	78° 49.56' N	12° 27.31' W	257.1
PS80/114-1	06.07.2012	08:38	CTD/RO	on ground/max depth	78° 45.23' N	12° 47.17' W	218.6
PS80/115-1	06.07.2012	16:52	CTD/RO	on ground/max depth	78° 49.94' N	10° 59.87' W	329.3
PS80/116-1	06.07.2012	18:38	CTD/RO	on ground/max depth	78° 49.86' N	10° 26.83' W	377
PS80/116-2	06.07.2012	19:14	MN	on ground/max depth	78° 49.58' N	10° 26.95' W	388.4
PS80/117-1	06.07.2012	21:17	CTD/RO	on ground/max depth	78° 49.83' N	10° 00.44' W	312.5
PS80/118-1	06.07.2012	23:24	CTD/RO	on ground/max depth	78° 48.82' N	9° 29.91' W	224.2
PS80/119-1	07.07.2012	00:53	CTD/RO	on ground/max depth	78° 50.05' N	9° 00.24' W	223.5
PS80/120-1	07.07.2012	02:08	CTD/RO	on ground/max depth	78° 49.94' N	8° 30.05' W	284.7
PS80/121-1	07.07.2012	03:31	CTD/RO	on ground/max depth	78° 50.00' N	7° 59.84' W	180
PS80/122-1	07.07.2012	04:46	CTD/RO	on ground/max depth	78° 49.85' N	7° 30.46' W	194.9
PS80/122-2	07.07.2012	05:12	MN	on ground/max depth	78° 49.80' N	7° 30.54' W	181.6
PS80/123-1	07.07.2012	09:15	CTD/RO	on ground/max depth	78° 42.38' N	7° 01.07' W	233.7
PS80/124-1	08.07.2012	00:10	CTD/RO	on ground/max depth	78° 50.31' N	6° 30.58' W	286
PS80/125-1	08.07.2012	02:17	CTD/RO	on ground/max depth	78° 50.57' N	6° 02.16' W	340.6
PS80/126-1	08.07.2012	04:05	CTD/RO	on ground/max depth	78° 49.85' N	5° 42.03' W	422
PS80/127-1	08.07.2012	06:13	CTD/RO	on ground/max depth	78° 49.50' N	5° 22.02' W	637.4
PS80/127-2	08.07.2012	06:54	MN	on ground/max depth	78° 48.96' N	5° 23.60' W	582.8
PS80/127-3	08.07.2012	07:36	MN	on ground/max depth	78° 48.40' N	5° 25.04' W	523.4
PS80/128-1	08.07.2012	10:55	CTD/RO	on ground/max depth	78° 49.39' N	4° 57.37' W	1043.3
PS80/129-1	08.07.2012	16:45	MOR	on ground/max depth	78° 44.25' N	4° 02.75' W	1760.5
PS80/130-1	08.07.2012	19:47	CTD/RO	on ground/max depth	78° 49.55' N	4° 35.14' W	1389.5
PS80/130-2	08.07.2012	21:10	CTD/RO	on ground/max depth	78° 49.96' N	4° 35.78' W	1389.9
PS80/131-1	08.07.2012	22:59	CTD/RO	on ground/max depth	78° 49.33' N	4° 15.57' W	1663.2
PS80/132-1	09.07.2012	01:35	CTD/RO	on ground/max depth	78° 49.44' N	3° 56.34' W	1922.5
PS80/132-2	09.07.2012	03:34	CTD/RO	on ground/max depth	78° 49.13' N	3° 55.40' W	1932.8
PS80/132-3	09.07.2012	05:28	MN	on ground/max depth	78° 50.36' N	3° 56.36' W	1941.6
PS80/132-4	09.07.2012	07:16	MN	on ground/max depth	78° 50.06' N	3° 59.66' W	1924
PS80/133-1	09.07.2012	10:23	CTD/RO	on ground/max depth	78° 49.64' N	3° 39.74' W	2139.7
PS80/134-1	09.07.2012	13:14	CTD/RO	on ground/max depth	78° 49.90' N	3° 19.68' W	2348.8
PS80/135-1	09.07.2012	15:52	CTD/RO	on ground/max depth	78° 50.07' N	3° 02.82' W	2466.4
PS80/136-1	09.07.2012	21:18	MOR	on ground/max depth	78° 49.51' N	1° 29.05' W	2643.4
PS80/137-1	10.07.2012	04:51	MOR	on ground/max depth	78° 59.32' N	0° 01.27' W	2544.5

Station	Date	Time	Gear Abbrev.	Action	Position Latitude	Position Longitude	Depth (m)
PS80/138-1	10.07.2012	07:20	MOR	on ground/max depth	79° 0.20' N	0° 00.63' E	2558.2
PS80/139-1	10.07.2012	11:46	MOR	on ground/max depth	79° 9.12' N	1° 28.77' W	2596.6
PS80/140-1	10.07.2012	16:56	MOR	on ground/max depth	78° 59.08' N	2° 56.97' W	2437.8
PS80/141-1	11.07.2012	03:41	MOR	on ground/max depth	78° 29.84' N	2° 04.67' W	2774.5
PS80/142-1	11.07.2012	07:40	MOR	on ground/max depth	78° 34.97' N	1° 00.01' W	2801.4
PS80/142-2	11.07.2012	09:00	ZODIAK	on ground/max depth	78° 34.58' N	1° 02.21' W	2794.8
PS80/143-1	11.07.2012	12:13	ZODIAK	on ground/max depth	78° 46.03' N	0° 07.38' W	2635.3
PS80/144-1	11.07.2012	20:02	CTD/RO	on ground/max depth	78° 52.70' N	2° 27.10' E	2454.8
PS80/145-1	11.07.2012	22:28	CTD/RO	on ground/max depth	78° 48.66' N	2° 45.85' E	2458.4
PS80/146-1	12.07.2012	00:41	CTD/RO	on ground/max depth	78° 46.26' N	3° 07.74' E	2440.1
PS80/147-1	12.07.2012	03:01	CTD/RO	on ground/max depth	78° 43.57' N	3° 26.30' E	2356.6
PS80/148-1	12.07.2012	05:19	CTD/RO	on ground/max depth	78° 40.55' N	3° 48.77' E	2326.2
PS80/149-1	12.07.2012	07:36	CTD/RO	on ground/max depth	78° 37.33' N	4° 08.66' E	2351.3
PS80/150-1	12.07.2012	09:52	CTD/RO	on ground/max depth	78° 34.23' N	4° 29.40' E	2357.6
PS80/151-1	12.07.2012	12:03	CTD/RO	on ground/max depth	78° 31.16' N	4° 49.52' E	2284.3
PS80/152-1	12.07.2012	14:01	CTD/RO	on ground/max depth	78° 28.06' N	5° 09.80' E	2001.9
PS80/153-1	12.07.2012	15:51	CTD/RO	on ground/max depth	78° 24.99' N	5° 29.02' E	1868.7
PS80/154-1	12.07.2012	17:42	CTD/RO	on ground/max depth	78° 21.99' N	5° 48.60' E	1723.9
PS80/155-1	12.07.2012	19:29	CTD/RO	on ground/max depth	78° 18.94' N	6° 08.47' E	1841.7
PS80/156-1	12.07.2012	21:17	CTD/RO	on ground/max depth	78° 15.90' N	6° 28.20' E	1840.3
PS80/157-1	12.07.2012	23:20	CTD/RO	on ground/max depth	78° 12.83' N	6° 47.15' E	2461.8
PS80/158-1	13.07.2012	01:37	CTD/RO	on ground/max depth	78° 9.85' N	7° 06.49' E	3031.2
PS80/159-1	13.07.2012	04:09	CTD/RO	on ground/max depth	78° 6.83' N	7° 27.49' E	3454.4
PS80/160-1	13.07.2012	10:09	CTD/RO	on ground/max depth	78° 3.66' N	7° 45.05' E	3078.2
PS80/161-1	13.07.2012	12:30	CTD/RO	on ground/max depth	78° 0.66' N	8° 03.83' E	2342.9
PS80/162-1	13.07.2012	14:33	CTD/RO	on ground/max depth	77° 57.54' N	8° 23.13' E	1879.3
PS80/163-1	13.07.2012	16:11	CTD/RO	on ground/max depth	77° 55.01' N	8° 38.98' E	1501.2

Abbreviation list:

BONGO	Bongo net cast
CTD/RO	CTD cast with water samples
CAL	Posidonia calibration
FLOAT	float/drifter deployment
GLD	Glider deployment or recovery
HN	Handnet cast
MOR	Mooring recovery or deployment
NFLOAT	NEMO float deployment
MN	Multinet cast
ZODIAK	action from the rubber boat

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