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The Expedition of the Research Vessel "Polarstern" to the Antarctic in 2008/2009 (ANT-XXV/2)

Edited by
Olaf Boebel
with contributions of the participants

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ANT-XXV/2

5 December 2008 – 5 Januar 2009

Cape Town – Neumayer Station – Cape Town

Chief scientist
Olaf Boebel

Coordinator
Eberhard Fahrbach

CONTENTS

APPENDIX

1. ZUSAMMENFASSUNG UND FAHRTVERLAUF

Olaf Boebel
Alfred-Wegener-Institut für Polar- und Meeresforschung

Der Fahrtabschnitt 2 der Antarktisexpedition ANT-XXV führte in das östliche Weddellmeer und diente der Durchführung logistischer und wissenschaftlicher Vorhaben, die sich a) in stationsgebundene, b) vom fahrenden Schiff aus durchführbare, sowie c) helikoptergestützte Arbeiten unterteilen lassen.

Folgende stationsgebundene Aufgaben wurden durchgeführt:
- Auslegung von 3 Bodendrucksensoren (PIES) entlang des Good–Hope–Schnittes;
- Auslegung von 2 passiv-akustischen Horchstationen (MARU) auf dem 0° Schnitt;
- Wiederaufnahme des MABEL Ozeanbodenlaboratoriums;
- Logistische Versorgung der Neumayer-Station;
- Transport des Überwintererteams und Retourtransport eines Wissenschaftlerteams;
- Aufnahme und Neuauslegung der Schallquellenverankerung ANT-240-1/2;
- Auslegung von 16 Argo-Floats (5 Argo-GER, 11 Argo-NL);
- Fahren von 25 CTD-Stationen mit Rosette zur Kalibrierung der Float-Daten und zur Gewinnung von Wasserproben für biochemische Untersuchungen.

Folgende Arbeiten wurden vom fahrenden Schiff aus durchgeführt:
- Erfassung des Vorkommens von Vögeln und Robben mittels visueller Sichtungsmethoden von der Brücke aus;
- Erfassung des Vorkommens und des Verhaltens von Walen mittels visueller Sichtungsmethoden vom Krähennest aus;
- Messung der Verteilung von polyfluorierten Verbindungen und gelöstem organischem Material in Wasser und Luft;
- Messung des Atmosphärenzustands und der Strahlungsbilanz an der Grenzfläche Atmosphäre/Ozean.

Weitere Arbeiten nutzten die Helikopter als Plattform bzw. zur logistischen Unterstützung:
- Erfassung der Verbreitung von Walen mittels visueller Sichtungsmethoden (50 Flüge);
- Auslage und Aufnahme von PALAOA-S Horchstationen (10 Flüge);
- weitere Flüge erfolgten zur Eiserkundung (5 Flüge), Transport von Außenlasten (2 Flüge) sowie Logistik bei Neumayer (23 Flüge).

Die Reise begann formal am 5. Dezember 2008, 18:00 in Kapstadt; der Zeitpunkt des Auslaufens verschob sich jedoch aufgrund von Lieferschwierigkeiten von Brennstoff für die Neumayer-Station auf die Mittagsstunden des nächsten Tages. Die zunächst anstehenden Auslegungen der als Freifallsysteme konzipierten PIES und MARU–Sensoren verliefen problemlos, auf ein Verfolgen des Posidonia–Transponders bis zum Boden wurde zu Gunsten der Zeitersparnis verzichtet. Das nächste operationelle Ziel der Reise war die Aufnahme des MABEL–Observatoriums. Begünstigt durch die herrschenden Wetter- und Eisbedingungen gelang die Aufnahme mit dem geringsten möglichen Zeitaufwand. Hierdurch konnte auch das aus logistischen Gründen angestrebte Anlaufen der Neumayer-Station wie geplant umgesetzt und noch am gleichen Tag mit den Löscharbeiten begonnen werden (Anlaufen NM am 17. Dez. 2008, 08:00 UTC, Ablaufen NM am 20. Dez. 2008, 03:00 UTC). Zu diesem Zeitpunkt war die Atka-Bucht bis etwa einen Kilometer vor der Schelfeiskante vollständig eisbedeckt. Die Fracht konnte daher bis zum Nachmittag vollständig über das Meereis gelöscht werden. Zum Löschen der Brennstoffe verholte *Polarstern* westlich vom „Nordanleger" an die Schelfeiskante, und brach dazu das der Kante vorgelagerte Meereisfeld auf. Auf dem Rückweg von Neumayer nach Kapstadt stand die Bergung der Verankerung ANT-240-1 auf dem Plan, die bereits vor 6 Jahren ausgelegt worden war. Auch diese Bergung gelang in der kürzest möglichen Zeit. Das zu diesem Zeitpunkt deutlich abschmelzende Meereis erlaubte eine problemlose Passage. Hierdurch standen die im Vorfeld eingeplanten Reserven von ca. 1,5 Schiffstagen für Forschungsarbeiten zur Verfügung, die für einen CTD-Schnitt über den Antarktischen Zirkumpolarstrom sowie in einem Agulhas–Ring und einer Agulhas–Zyklone genutzt wurden. Zusammenfassend ist festzustellen, dass alle geplanten Aktivitäten in vollem Umfang umgesetzt werden konnten und die Zusammenarbeit zwischen Wissenschaftlern und Schiffsbesatzung über den gesamten Verlauf der Reise stets einvernehmlich und zielgerichtet war.

ITINERARY AND SUMMARY

Leg 2 of the Antarctic expedition ANT-XXV operated in the western Weddell Sea and served both logistic and scientific objectives, which can be grouped as station-bound, on-transit and helicopter-borne activities. The following station-bound activities were conducted:

- Deployment of 3 bottom pressure gauges (PIES) along the Good Hope Section;
- deployment of 2 passive acoustic listening stations (MARU) along the 0° section;
- recovery of the MABEL laboratory;
- logistic operations at Neumayer Station;
- transportation of the wintering team and return transportation of a scientific team;
- recovery and redeployment of sound source mooring ANT-240-1/2;
- deployment of 16 Argo floats (5 Argo-GER, 11 Argo NL);
- operation of 25 CTD stations (including rosette sampler) for float calibration and sampling of water for biochemical studies.

The following research was conducted on transit:

- Observation of the occurrence of birds and seals by visual sightings from the bridge;
- observation of the occurrence and behavior of whales by visual sightings from the crow's nest;
- sampling of the distribution of polyfluorinated compounds and dissolved organic matter in water and air;
- sampling of the state of atmosphere and radiation budget at the ocean-atmosphere interface.

Additional studies were conducted from the helicopters directly or by using the helicopter for logistic support:

- distribution of whales by visual observations from the helicopter (50 flights);
- deployment and recovery of PALAOA-S acoustic listening stations on ice floes (10 flights);
- additional flights for ice recognition (5 flights), in-air transport of equipment (2 flights) as well as flights for logistic purposes at Neumayer Station (23 flights).

The cruise was scheduled to commence on 5 December 2008, 18:00 in Cape Town. However, the time of departure was delayed to the next day, noon, due to logistic difficulties in the provision of fuel for the Neumayer Station. First station work concerned the deployment of the free fall systems PIES and MARU, which proceeded without difficulties. However, in order to save time, steaming was resumed right after deployment, prohibiting tracking of the Posidonia transponders during their descent to the sea-floor. Our next goal was the recovery of the MABEL laboratory, which succeeded with minimal time effort due to favorable weather and ice conditions at the time. This permitted to immediately proceed to Neumayer Station, allowing logistic operations to commence as scheduled (arrival on 17 Dec. 2008, 08:00 UTC, departure on 20 Dec. 2008, 03:00 UTC). At this time the Atka Bay was fully ice-covered up to one kilometer in front of the ice shelf edge. Hence, loading operations needed to be conducted via sea-ice, and loading operations commenced in the afternoon and were completed after having repositioned the ship westerly of the "Nordanleger" at the shelf ice break for the pumping of fuel for the Neumayer Station. A major task for the return leg to Cape Town was the recovery and redeployment of sound source mooring AWI 240, which had been deployed 6 years earlier. Nevertheless, the recovery proceeded with a minimum of time while further melting sea ice allowed steady steaming. This permitted to assign the spare time, previously reserved for the MABLE and sound source recovery, to be assigned to research, which took form in a CTD section across the Antarctic Circumpolar Current and in an Agulhas ring and – cyclone. Overall, we were able to fully achieve all goals set while the collaboration between scientific staff and the ship's crew was cordially and dedicated throughout the whole cruise.

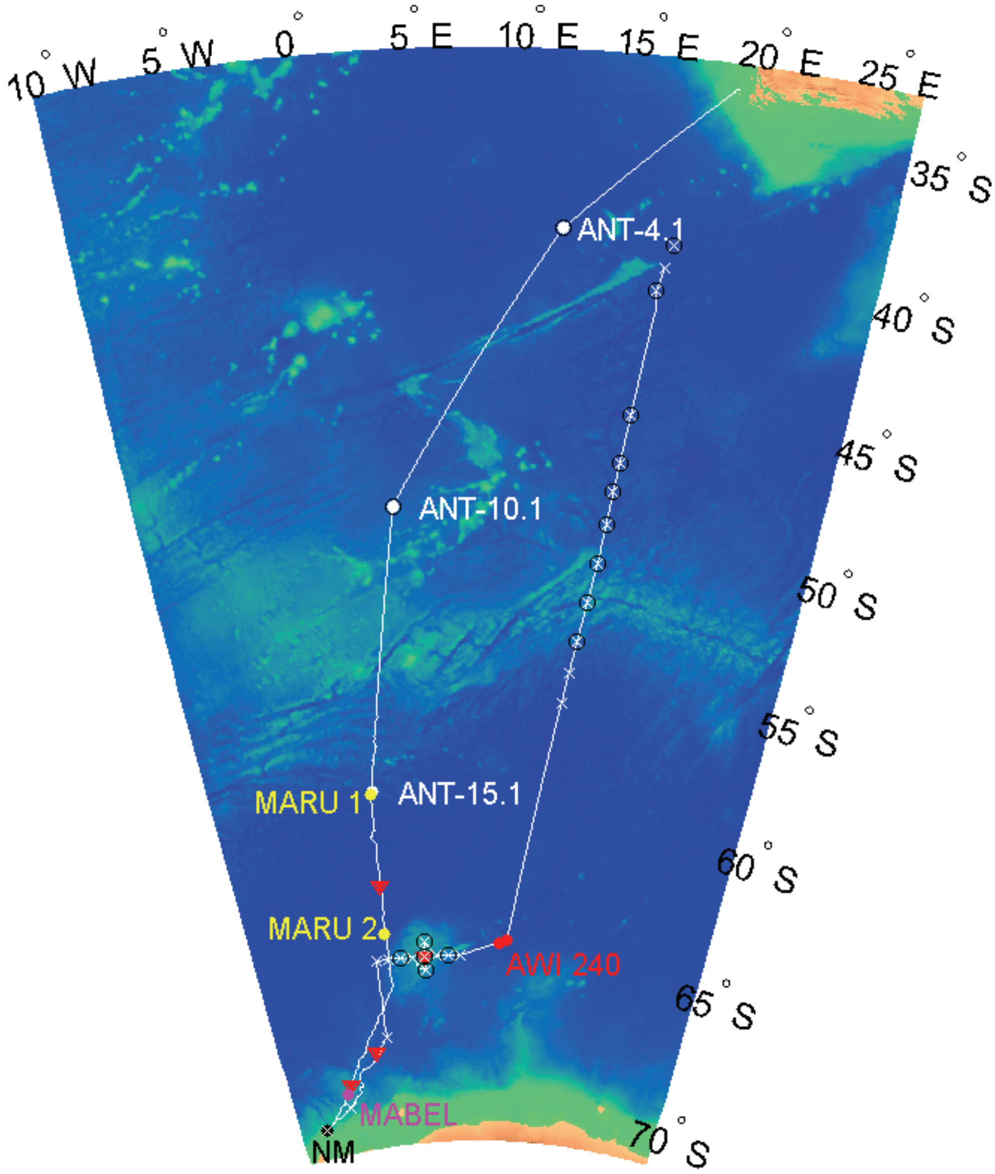

Abb. 1.1: Kurskarte der Polarstern Reise ANT-XXV/2. Weiße Punkte zeigen die Auslegeposition von PIES, gelbe Punkte die von MARU Verankerungen. Schwarze Kreise geben dies Auslegepositionen von Argo-Floats an. Rote Symbole kennzeichnen Positionen auf denen für jeweils ca. 16 Stunden PALAOA-S Unterwasserrekorder auf Eisschollen ausgebracht wurden, während weiße Kreuze die Orte von CTD Stationen kennzeichnen. Die Aufnahmeposition von MABEL ist durch einen magentafarbenen Punkt markiert, während NM die Lage der Neumayer-Station angibt.

Fig. 1.1: Cruise track of Polarstern during the expedition ANT-XXV/2. White dots indicate deployment positions of PIES, yellow dots those of MARU moorings. Black circles indicate deployment positions of Argo floats. Red symbols indicate the ~16h long deployment positions of PALAOA-S recorders, while white crosses stand for CTD casts. The recovery site of MABEL is indicated by a magenta dot. NM stand for the location of Neumayer Station.

2. WEATHER CONDITIONS

Christoph Joppich
Deutscher Wetterdienst

Polarstern left the port of Cape Town in the afternoon of 6 December, 2008. While there were only light winds in the harbour, the wind speed increased immediately right after departure, reaching Bft 8 from southeasterly directions. The relatively short waves were a good indicator for the fact that these winds resulted from the high mountains near Cape Town. With increasing distance to the African continent the wind decreased steadily. On 7 December, the average wind speed was only Bft 5. This wind was caused by a subtropical high pressure system with a core pressure of 1025 hPa westsouthwest of South Africa. A ridge of this high pressure system extended with 1020 hPa to the region southeast of South Africa. On 7 December, *Polarstern* crossed the axis of this ridge of high pressure. Most of the day the sky was clear and the temperatures were high. The swell was about 3 meters. On 8 December, the relatively weak winds shifted to southern to southwesterly directions. In the morning of 8 December, the weak cold front of a cold front wave extended to the cruise track of *Polarstern*. Therefore, visibility was poor in the morning hours and the cloud bottom height was very low. Conditions improved in the course of the morning so that the operation of the helicopters became possible. In the afternoon, the visibility was good and the cloud bottom height was at 1,500 ft.

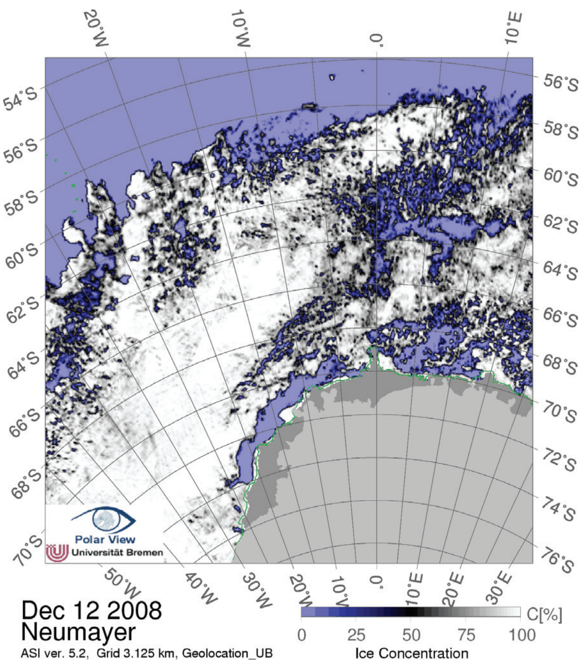

Fig. 2.1: Sea-ice conditions on 12 December 2008

On 9 December, *Polarstern* sailed at the warm side of another weak cold front wave with low cloud bottom heights, occasional drizzle and poor visibility making operations of the helicopters impossible for some time. In the afternoon, flying conditions improved.

During the night, the wind speed increased again up to Bft 7 in the morning. The cold front of a storm low at 59°S 6°W extended to the area of *Polarstern* on 10 December. Compact clouds, poor visibility and low cloud base prevented the helicopters from flying. While conditions improved in the course of the afternoon after the front had passed through, the wind speed increased up to 7 Bft again. The wave height reached 4 meters. In the evening the wind blew with Bft 8 and the wave heights grew larger to 5 to 6 meters. In the course of the day of 11 December, the west winds decreased continuously to Bft 5 in the evening, but the swell remained still at 5 meters. During this day, the first icebergs were observed at about 54° south. The temperatures of the air and the water reached minus 1°C. On 12 December, *Polarstern* reached the sea ice border at about 58°S. A storm low, lying north of *Polarstern*, moved eastward and did not influence the cruise area. While sailing into the sea ice covered ocean, sight conditions were good and the wind blew from southeast with Bft 4 on the average.

On 13 December, a storm low was located southwest of *Polarstern* at 67°N 24°W. In the morning, the cold front of this low was about 600 nm away and moved eastward into the direction of the cruise area. At that time *Polarstern* was still in the area of the pre-situated ridge, measuring weak winds from northwesterly directions. In the evening of 13 December, the cold front approached from northwest but was retarded by the development of a low at 60°S 04°W. Therefore *Polarstern* stayed at the front side of this cold front on 14 December. The wind from northwest temporarily increased to Bft 8 and in the relatively humid air flight conditions were bad because of temporarily poor visibility and low ceiling. On 15 December, the weather conditions improved. The extensive low with a pressure of 958 hPa in the centre at 61°S 01°W slowly moved eastward and the wind from southeast decreased to Bft 4 in the evening. Beginning on 16 December, a flat high determined the weather in the region around the Neumayer Station. The dominant weak winds blew from southeasterly to southwesterly directions. The temperatures during daytime were about minus 4°C, the minimum in the night around minus 10°C. The skies were partly cloudy and made operations of the helicopter possible without any restrictions during the stay at Atka Bay. After leaving the shelf ice edge on 20 December, the air pressure gradients were weak in the cruise area which was situated in the region of a ridge of high pressure. Therefore the winds were weak and came from northwesterly directions. On 21 December, a cold front approached from the west which brought some light snow showers at its front side. On 24 December, another cold front approached from northwest, which first was moving backward due to the development of a secondary low, but then crossed *Polarstern* moving southeastward with light snowfall on 25 December. Thereafter, a low with its centre northwest of the Neumayer Station determined the weather conditions of the cruise area. On 26 December, *Polarstern* was sailing at the foreside of the cold front belonging to the low in the warm sector with snowfall and poor flight conditions. During the following days until the morning of 29 December, a frontal zone was lying over the cruise area in which wave disturbances quickly moved south-eastward. The bad weather conditions prevented the helicopters from flying. During this time, the wind came from westerly to northwesterly directions with Bft 5 to 7. The waves were about 3 meters high. On 29 December, the wind decreased and shifted to westerly directions and the weather conditions improved. However, with a relative humidity of 90 percent. Fields of fog still were observed in the vicinity of *Polarstern*. On 30 December, a subtropical high of 1029 hPa, centred at 46°S 01°E, influenced the cruise area of *Polarstern*. A ridge belonging to this high extended to 48°S 38°E. Under weak wind conditions, overcast cloud coverage was located under a sinking inversion. Its bottom height ascended until noon, making helicopter operations possible thereafter. During the following days, *Polarstern* crossed the subtropical high pressure area. The sinking inversion was temporarily at only 300 meters and the stratiform clouds dissolved not before the morning hours. The wind first came from southwesterly directions with Bft 5 to 6 and later from south-easterly to easterly directions with Bft 4 to 5. On 3 January, a low with its centre of 1009 hPa at 33°S 16°E moved south-eastward in the south of Cape Town. The cruise area was near the southern side of this low. The easterly winds increased to Bft 6 to 7, around the cape temporarily to Bft 7 to 8, before *Polarstern* entered the harbour of Cape Town in the morning of 5 January 2009.

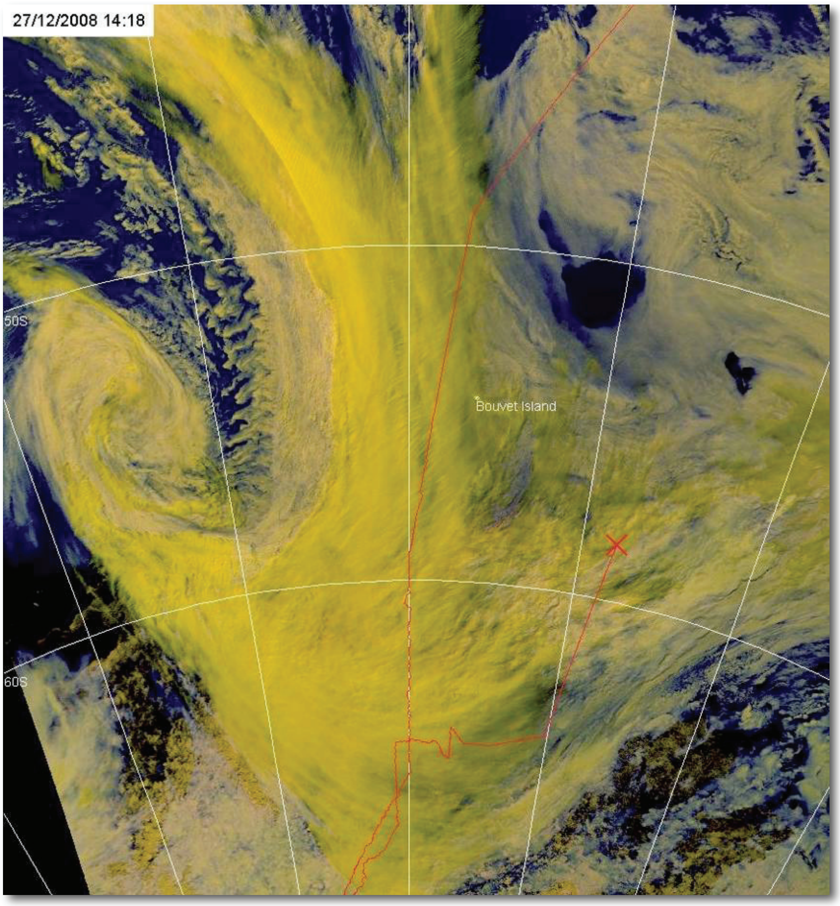

Fig. 2.2: Cloud coverage of 27 December 2008

3. MARINE MAMMAL PERIMETER SURVEILLANCE (MAPS)

Olaf Boebel
Alfred-Wegener-Institut für Polar- und Meeresforschung

Introduction

Data on the abundance of cetaceans in the Southern Ocean is still sparse. Dedicated line-transect surveys of the past have been rare due to logistic and financial limitations. Such studies are characterized by large spatial and temporal inter-leg distances, causing substantial uncertainties in the calculation of abundance and density estimates. However, emerging analysis tools appear promising to help overcome these difficulties. So-called “environmental suitability models” (ESM) use proxies such as distance to sea-ice edge, water depth and sea surface temperature to describe and anticipate the abundance of cetaceans in a given area. The basis of ESM is being formed by a data set of cetacean sightings (both visually and acoustically) in conjunction with the respective environmental parameters. The goal of this study is to a) collect appropriate sighting and environmental data to feed into region specific ESMs and to b) perform a comparison of different sighting techniques (standardized shipboard and helicopter observations by trained cetacean observers, opportunistic shipboard observations by the ship’s nautical officers on the bridge, and acoustic observations from autonomous recorders). The collected data sets shall be evaluated in terms of direct estimates of cetacean densities as well of indirect density estimates using ESM. The data will also be used to investigate if and how possible changes in cetacean behaviour in reaction to the survey vessel influence the estimates.

3.1 Visual surveys

Meike Scheidat, Hans Verdaat	IMARES Wageningen, NL
Karl-Hermann Kock	Institut für Seefischerei, Johann Heinrich von Thünen Institut
Stefan Bräger	German Oceanographic Museum (DMM)
Helena Herr, Kristina Lehnert, Linn Sophia Lehnert	Forschungs- und Technologiezentrum Westküste
Rob Williams	Marine Mammal Research Unit, University of British Columbia, Canada

Objectives

In a recent study Scheidat et al. (2007) confirmed earlier investigations (Plötz et al., 1991; Franeker, 1992) that helicopters provide a useful means to survey cetaceans in the pack-ice. This studies' goal is to extend these efforts by conducting helicopter surveys from *Polarstern* en route from Cape Town to Atka Bay and back. We report here on preliminary results of cetacean observations in the course of this cruise.

Work at sea

The cetacean survey started in the morning of 6 December 2008 and ended close to Cape Town in the evening of 4 January 2009.

Methods followed during the survey were similar to those provided in Scheidat et al. (2007). The only modification involved adding a third observer behind the pilot to observe the starboard side of the helicopter. In addition to the helicopter surveys, shipboard observations were conducted from the crow's nest, with both naked eye and high powered binoculars. Both datasets will still have to be analyzed.

We were unable to conduct cetacean observations from 63° to 58° S on the return journey to Cape Town due to almost 3 days of dense fog (visibility < 300m) and heavy swell.

The collection of information on ancillary environmental parameters followed the procedure described in Scheidat et al. (2007). The following information was recorded for each whale sighting: species, group (pod) size, group composition, inclination angle, behaviour, cue, swimming direction, dive, and possible reaction to the helicopter. When the sighting was abeam the helicopter, an inclinometer was used to record the vertical angle, which was then converted into perpendicular distance from transect. Most sightings were documented by photographs, which made it possible to later confirm tentative species identifications.

Preliminary and expected results

The helicopter survey covered 13,569 km of track line (Fig. 3.1). 11 cetacean species were observed (Table 3.1) from the helicopter. In addition, hourglass dolphins *(Lagenorhynchus cruciger) and one* Shepherd's beaked whale (*Tasmacetus shepherdi*) at 44° 17.3 S/15° 28.9 W were observed during the shipboard survey.

Sei Whales (*Balaenoptera borealis*), sperm whales (*Physeter macrocephalus*) and rough-toothed dolphins (*Steno bredanensis*) were the only species seen in the north of the area (Fig. 3.1). The area from 38° to 48° S was almost devoid of cetaceans: only one fin whale (*Balaenoptera physalus*), one sperm whale and a group of killer whales (*Orcinus orca*) were observed. From 49° to 57° S humpback (*Megaptera novaeangliae*) and fin whales which were on their southward migration, predominated our sightings (Fig. 3.1). In addition a mother-calf pair of the southern right whale (*Eubalaena australis*) was recorded.

Minke whales (*B. bonaerensis*) became the dominant species south of 57° S when the vessel approached the pack-ice. A total of 24 minke whale groups were seen on the inward and outward journey of the pack ice (Fig. 3.1). They consisted of 28 animals. Maximum group size was 3. In addition to minke whales, two groups of southern bottlenose whales (*Hyperoodon planifrons*) consisting of 5 individuals were sighted in at the northern rim of the pack-ice (Fig. 3.1). One killer whale (*Orcinus orca*) was observed in a coastal polyna to the east of Neumayer (Fig. 3.1).

By far the largest concentrations of whales were found in the vicinity of 53° S, consisting primarily of humpback and fin whales (close up in Fig. 3.1). These species were also seen at this latitude, albeit in much smaller number, on the southbound leg. Other species detected were sperm whales and one southern bottlenose whale. Whales seen further north were sperm whales, sei whales and fin whales.

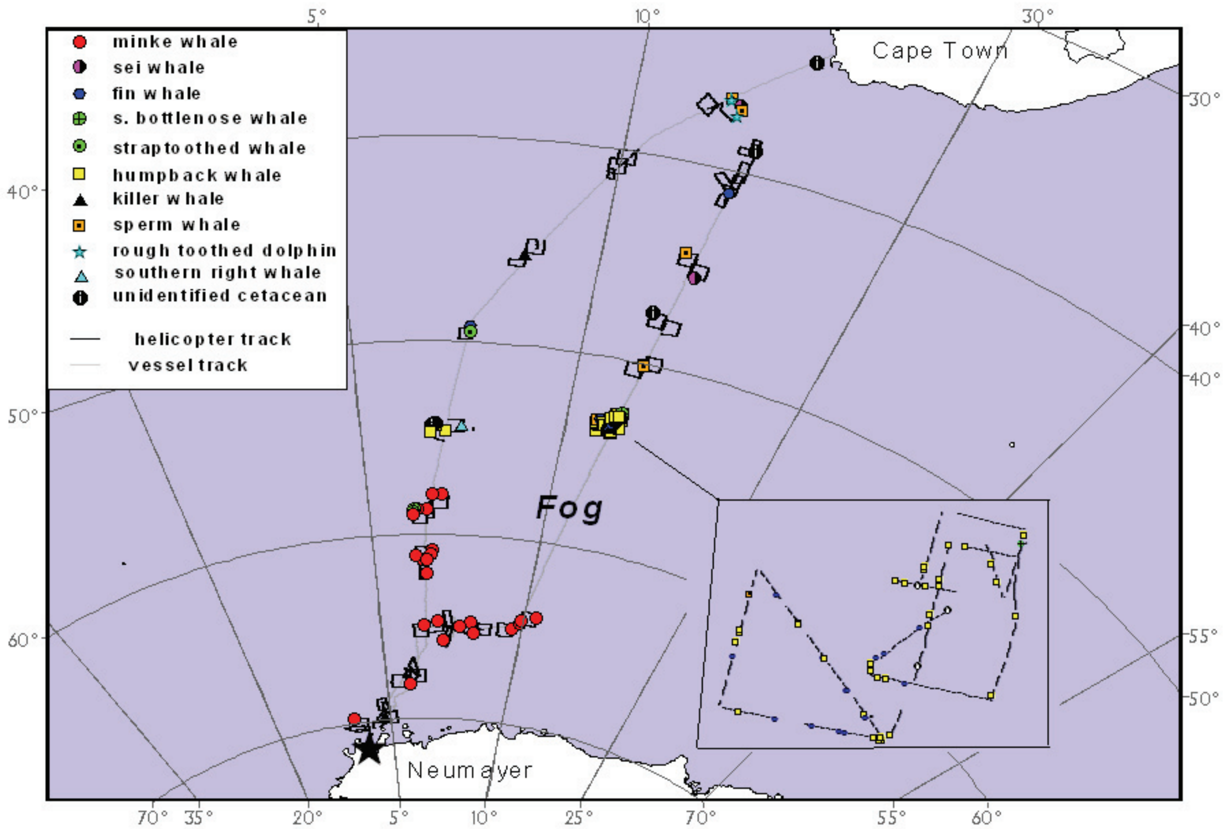

Fig. 3.1: Visual whale sightings along two transects in the Southern Ocean in December 2008/early January 2009

In total, 114 sightings of 392 whales were conducted during the survey. The total number of whales seen by species in the course of the survey is shown in Table 3.1. By far the most commonly seen species were humpback (106 individuals) and fin whales (52 individuals) north of the pack ice, and minke whales (27 individuals) in the pack-ice. Another species seen regularly was sperm whale. All other species were only encountered occasionally (Table 3.1).

Tab. 3.1: Cetacean sightings by species from the helicopter during ANT-XXV/2		
species	number of groups	number of individuals
humpback whale	41	106
southern right whale	1	2
fin whale	17	52
sei whale	2	5
minke whale	24	28
sperm whale	7	25
killer whale	2	5
pilot whale	1	1
southern bottlenose whale	3	7
strap-toothed whale	1	3
rough toothed dolphin	3	143
unidentified cetacean	12	15
Total	114	392

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3.2 Acoustic surveys

Ilse van Opzeeland, Lars Kindermann, Olaf Boebel — Alfred-Wegener-Institut für Polar- und Meeresforschung
Harold Figueroa — Cornell Lab or Ornithology, Cornell University, USA

Objectives

While the distribution, abundance, and migratory patterns of marine mammals within the Southern Ocean are currently poorly understood, newly developed hydroacoustic recorders now offer the opportunity for long-term monitoring of the acoustic presence of marine mammals. For example, the PALAOA acoustic observatory, located on the Antarctic ice-shelf at 70°31'S 8°13'W (Boebel et al. 2006), records the underwater soundscape year-round near the Neumayer Station. Preliminary analyses of the PALAOA data reveal a strong seasonality in the temporal patterns of marine mammal vocal activity within this specific section of the Southern Ocean. A spatial extension of these observations is offered by PALAOA-S (-satellite) recorders, which are sea ice based, portable autonomous acoustic recorders with GPS/Iridium tracking. Their deployment at various locations between Cape Town and Neumayer Station along the cruise track of *Polarstern* is aimed at complementing the PALAOA recordings to study the spatial patterns of marine mammal vocal activity and distribution, also in relation to various environmental parameters, such as sea-ice cover, bathymetry, and temperature.

Fig. 3.2: Deployment of PALAOA-S

During this cruise, PALAOA-S recorders were deployed via Helicopter some 80 nm ahead of the ship near the projected ship's track and recovered after passing (Fig. 3.2). This deployment strategy allowed recordings to be made in sections where MAPS would also conduct visual surveys (see section 3.1). This approach is aimed at improving the understanding the relation between visual and acoustic survey techniques. In particular, the observation of marine mammal vocal behavior before, during, and after the ship's passing should provide guidance on how the presence of the ship affects the local (and hence detectable by ship-based visual observations) distribution of marine mammals.

Work at sea

The autonomous PALAOA-S recorders are designed to collect continuous sound records for a period of 15 to 46 hours, depending on the recording format and sampling rate. The PALAOA-S system consisted of an insulated Zarges box (60x40x40cm) with two solar panels. The box contained a solar charger, 12V battery, an M-Audio solid state recorder, a GPS and a custom-made iSiTEC box to acoustically encode the NMEA and 1PPS GPS-signal in the second audio channel of the recorder. A differential RESON TC4032 hydrophone (sens. -170dB re 1 V/μPa; 5Hz - 120kHz) connected to the M-Audio recorder through a 100m cable. The hydrophone was deployed through a small hole that was drilled into the ice floe.

Two different PALAOA-S recorders were used during the cruise (BOX 1 and BOX 4, see Table 3.2). The recorders were transported by helicopter to suitable ice floes within an area typically 80 nm ahead of the ship (Table 3.3). At this distance the vessel noise was not present in the recordings. A tracking pop-up (Optimare) as placed on the ice along with the recorder which transmitted via Iridium SBD service the GPS position of the ice floe every 15 minutes to enable relocation and retrieval after the ship had passed the PALAOA-S station, a technology that worked reliably and proved most advantageous.

Tab. 3.2: Overview of PALAOA-S components

Deployment ID	Hydrophone ID	Cable ID	M-Audio ID	Solar charger ID	iSiTEC box ID
P1	1	1	4	4	4
P2	1	1	5	-	4
P3	2 (cage)	2	4	1	1
P4	2 (cage)	1	4	1	1
P5	2 (cage)	2	4	1	1
P6	2 (cage)	2	4	1	1

Tab. 3.3: Deployments of PALAOA-S (Time in UTC)-GPS NMEA DATA

Depl. ID	Box	Depl. location	Depl. Position Lat	Depl. Position Lon	Depl. date and time	Recov. Position Lat	Recov. Position Lon	Recov. date and time
P1	# 4	First dense ice field	62°24.00'S	00°01.34'W	13.12.08 12:56	62°27.04'S	00°00.80'W	13.12.08 20:18
P2	# 4	Pack ice	69°07.99'S	04°59.28'W	15.12.08 18:24	69°08.09'S	05°03.06'W	15.12.08 22:17
P3	# 1	Pack ice	68°10.51'S	02°07.67'W	20.12.08 20:48	68°10.32'S	02°03.15'W	21.12.08 11:22
P4	# 1	Pack ice	65°00.18'S	01°00.38'W	22.12.2008 08:35	65°00.18'S	01°00.38'W	22.12.2008 08:35
P5	# 1	Maud Rise Center	65°00.31'S	02°58.23'E	22.12.08 19:36	64°57.67'S	02°58.86'E	23.12.08 11:02
P6	# 1	Western slope of Maud Rise	65°00.56'S	05°58.95'E	23.12.2008 ca 13:00	65°02.49'S	05°57.15'E	24.12.2008 ca 7:37

Preliminary and expected results

PALAOA-S recorders were deployed on ice floes (Fig. 3.3) on six occasions during ANT-XXV/2. Due to technical problems, acoustic recordings were only retrieved on four of these occasions (Table 3.4).

Tab. 3.4: List of PALAOA-S recordings

ID	Hydrophone depth	Sampling rate [kHz]	Recording duration [hh:mm]	File name
P1	90m	88.2	7:22	ANT-XXV/2-PALAOA-S-20081213
P2	90m	48	3:53	ANT-XXV/2-PALAOA-S-20081215
P3	90m	48	14:34	ANT-XXV/2-PALAOA-S-20081220
P4	90m	-	-	-
P5	90m	96	14:26	ANT-XXV/2-PALAOA-S-20081222
P6	90m	96	-	-

Leopard seal (*Hydrurga leptonyx*) vocalizations were found to be present in all PALAOA-S recordings. One recording also contained the vocalizations of killer whales (*Orcinus orca*), Ross (*Ommatophoca rossii*) and crabeater seals (*Lobodon carcinophaga*). Although the limited number of PALAOA-S deployments during this cruise does not yet allow for any systematic comparisons of the acoustic presence and spatial distribution of species between acoustic sections, the recordings indicate differences between the areas where the recorders were deployed. However, more systematic acoustic recordings are needed to be able to investigate how sections differ acoustically and how these relate to e.g. ice cover and oceanographic features. We expect that in the future knowledge on spatial distribution patterns may be gained not only through sampling of distant locations, but also by deploying arrays of time-synchronized recorders to investigate smaller scale spatial distribution and movement patterns of marine mammals within acoustic sections.

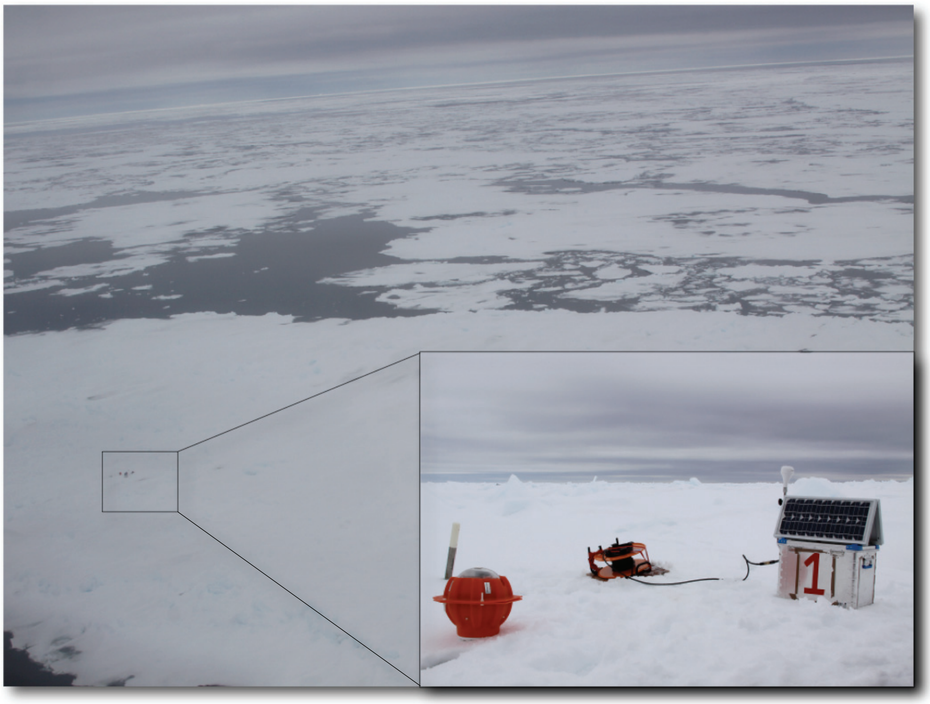

Fig. 3.3: PALAOA-S set-up on an ice-floe

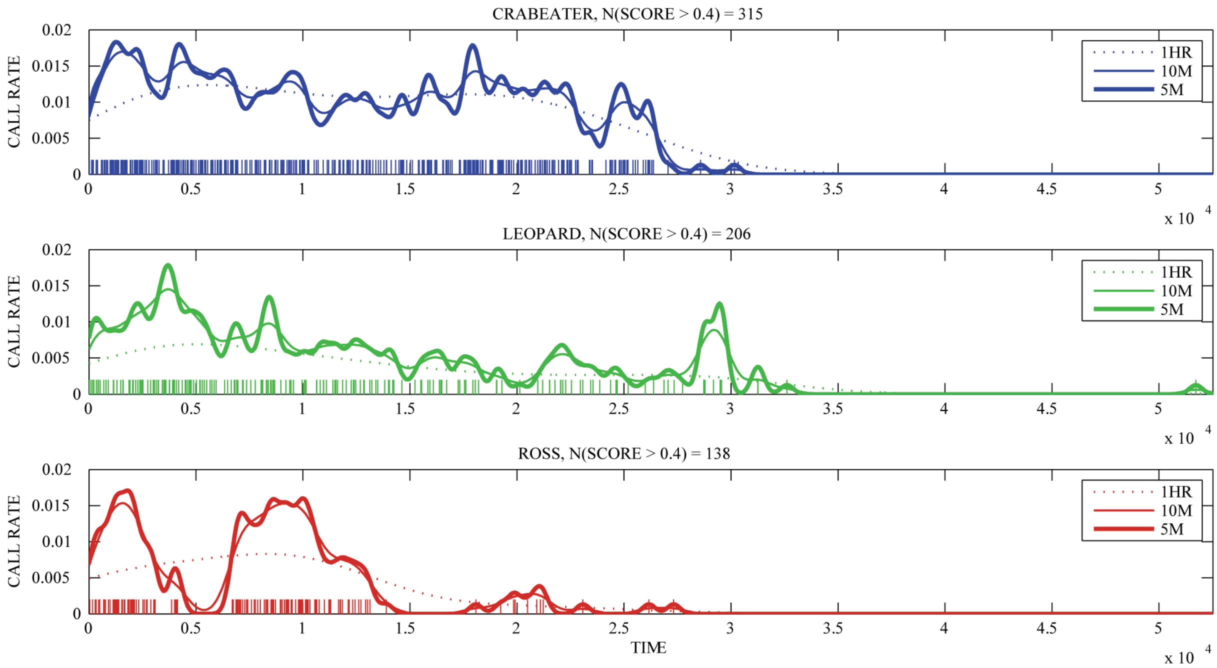

Fig. 3.4: Call rate curves for three pinniped species based on automated detection

Recorders were deployed within the general areas where visual surveys were conducted concurrently (see section 3.1). Killer whales were not sighted during the visual survey of the area where the PALAOA-S system recorded killer whale vocalizations. Nevertheless, a better understanding of the range over which animals can be acoustically detected is needed to match recordings to the area that is being surveyed. This question could be addressed using acoustic array recordings.

Preliminary analyses of the PALAOA-S recordings using spectrogram correlation (XBAT, http://xbat.org) show that various stereotyped calls of leopard, Ross and crabeater seals can be reliably detected during the time before the ship arrived in the area where the recorder was deployed. As the ship noise starts to mask the bioacoustic signatures, the number of automatic detections decreases until zero calls were detected. This pattern was observed in the call detection curves of all three pinniped species (Fig. 4). Further analyses entail the calculation of sound source levels from the calibrated recordings which can then be related to the ship's track and distance to the recorder. In addition, the recordings will be further analysed to explore the presence of other marine mammal species.

References

Boebel, O., Kindermann, L., Klinck, H., Bornemann, H., Ploetz, J., Steinhage, D., Riedel, S. & Burkhardt, E. 2006. Real-time underwater sounds from the Southern Ocean. *Eos Transactions, American Geophysical Union*, 87, 361-362.

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

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not on board: Claude Joiris

Objectives

The aim of this project is to quantify the at-sea distribution of seabirds, cetaceans and pinnipeds as a function of the main hydrographic parameters (water temperature and salinity, ice coverage) allowing to identify the main water masses (Atlantic, Pacific oceanic, polar water) and ice conditions (outer marginal ice zone, closed pack ice), as well as various fronts and the ice edge. The data will be discussed as reflecting food availability, i.e. the ecological structure of the whole water column. Another aspect will be to detect possible changes in numbers and distribution, with special attention to climate change and possible changes in pack ice extend, by comparison with previously collected data.

This is part of a long-term study of seabirds and marine mammals in polar regions, which reveal very low numbers of animals in the Arctic pack ice (with the exception of the outer marginal ice zone), and extremely high numbers in Antarctica, including the inner marginal ice zone and the closed pack ice (Joiris, 2000). This difference is mainly due to the presence of krill eaters in very large numbers on the pack ice: penguins (Adélie, chinstrap) and seals (crabeater, leopard).

Work at sea

Transect counts took place from the bridge of *Polarstern*, but only while the ship was sailing, since seabirds can be massively attracted by ships during station work. Observations started on 16 December, 18:30 UTC and ended on 4 January 17:30 UTC.

Preliminary and expected results

During this expedition about 700 transect counts of one half-hour duration each were conducted. In total, more than 10,000 birds (total of 59 species including 11 of albatrosses), 232 pinnipeds (7 species including 2 sightings of Ross seals) and 196 cetaceans (7 species) were counted.

References

Joiris, C.R. 2000. Summer at-sea distribution of seabirds and marine mammals in polar ecosystems: comparison between the European Arctic seas and the Weddell Sea, Antarctica. J. Mar Syst. **27**, 267-276.

NASA http://www.nasa.gov/centers/news/topstory/2006/arcticice-decline.html

5. MARINE AUTONOMOUS RECORDING UNITS - MARU

Harold Figueroa, Christopher Clark
Cornell Lab or Ornithology, Cornell University, USA

Objectives

Long-term acoustic recordings are an important tool to gain insights into the movement and distribution patterns of marine mammals. To date, the annual migration of large baleen whales to and from Antarctica is only known at the largest of scales and data on how migration patterns are linked to e.g. sea-ice coverage and oceanographic features is lacking. Autonomous recording devices have the advantage that they can be deployed in a wide variety of areas, including polar environments. MARUs (Marine Acoustic Recording Units), developed at Cornell Lab of Ornithology, are free-falling instrument packages, which typically settle on the sea floor and record ambient sound for extended periods. The typical mooring used for these recorders has not been tested for the length of the current deployment, in this case the recorder will be suspended at a distance of 100 m from the bottom by a mooring developed and provided by AWI. The objective of this project during ANT-XXV/1 is to deploy two MARUs to a) obtain long-term (at least one year) acoustic recordings from the Southern Ocean b) analyze those recordings for marine mammal sounds and c) interpret those data with respect to species, location, time of year, and oceanographic variables. Along with the expected recordings of marine mammals, we will obtain recordings of ambient ocean sounds, which are critical for documenting ambient noise levels which can be regressed against ocean noise conditions.

Work at sea

During ANT-XXV/2 two MARUs were deployed along the cruise track at suitable intersections with the Greenwich meridian, in the wider vicinity of moorings AWI-230 and AWI-233, which also contain autonomous acoustic recorders (see Table 5.1 and Figures 1.1 and 5.1). The MARU units are set to sample 6 consecutive minutes every hour (using a sample rate of 2kHz) and will be recovered during ANT-XXVII/2 in December 2010.

Tab. 5.1: MARU Deployment locations

MARU ID	Station number	Latitude	Longitude	Date (UTC)	Time (UTC)	Depth [m]
1	PS73/068-1	59° 10.10'S	0° 00.24'E	12.12.2008	17:15	4775.2
2	PS73/069-1	64° 50.20'S	0° 49.30'W	14.12.2008	08:54	5193.7

Fig. 5.1: Deployment of Marine Autonomous Recording Unit (Foto: Hans Gerber)

Preliminary and expected results

It is expected that the recordings will contain vocalizations of marine mammals, and possibly fish, along with sounds of abiotic origin. By supplementing these data sets with the collection of appropriate environmental data, we also hope to improve our understanding of marine mammal population distributions and numbers, and to place these results in a larger oceanographic context. The focus of the analysis will be on large baleen whales. The ambient ocean noise recordings will also be useful to interpret the relative changes in ocean noise conditions occurring in the Northern Hemisphere over the last five to six decades.

6. COMPOSITION OF THE ATMOSPHERE AND RADIATION BUDGET AT THE ATMOSPHERE/SEA-ICE/OCEAN INTERSECTION

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not on board: Andreas Macke

Objectives

The net radiation budget at the surface is the driving force for most physical processes in the climate system. It is mainly determined by the complex spatial distribution of humidity, temperature and condensates in the atmosphere. This project aims at observing both the surface radiation budget and the state of the cloudy atmosphere as accurately as possible to provide realistic atmosphere-radiation relationships to be used in climate models and in remote sensing. A special focus is on the role of clouds and sea ice with respect to the downwelling shortwave and longwave radiation. Both act in similar ways on the surface radiation budget by reflecting the incoming solar radiation and by blocking the outgoing thermal radiation of the ocean. Furthermore, the combination of sea ice and clouds may result in feedback mechanisms which surpass the simple ice-albedo or cloud-albedo feedback mechanisms as frequently referred to in the discussion of global warming.

Work at sea

The downwelling broadband short- and longwave radiation flux at the sea surface have been obtained by means of a Kipp & Zonen CM 21 pyranometer and a CG4 pyrgeometer with a temporal resolution of 2 seconds (see Fig. 6.1).

Fig. 6.1: Left: sky – imager, pyranometer and pyrgeometer mounted on top of the container on the observation deck. Right: High thin clouds near Neumayer Station with the optical appearance of a halo around the sun caused by ice particles in the higher troposphere.

This enables the detection of cloud induced (and sea-ice enhanced) high frequency fluctuations of the incoming radiation. A full sky imager (Fig. 6.1) developed at IFM-GEOMAR, enables a continuous monitoring and archiving of the state of the atmosphere. A direct application of the imager is the estimation of the total amount of clouds at a high temporal resolution of 15 seconds. All instruments have been installed and were operated during the previous Polarstern cruise ANT-XXV/1. Radio soundings have been performed every day by the *DWD* while synoptical and sea ice state observations were performed on an hourly basis.

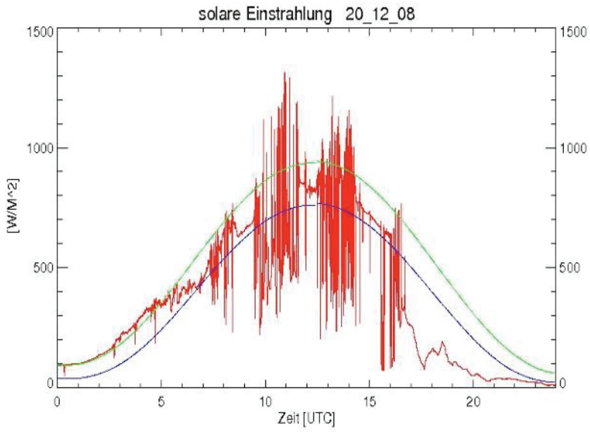

Fig. 6.2: Left: broken cloud conditions observed at 20.12.2008, 11:00 UTC. Right: Time series of the observed and parameterized downwelling solar radiation for 20. 12. 2008. The green curve shows the theoretical incoming solar radiation at the top of the atmosphere. The blue line shows the theoretical incoming radiation at the surface under clear sky conditions according to the parameterization by Zillman (1972).

Preliminary and expected results

The conditions for the radiation measurements and the full-sky-imager have been good. All instruments worked continuously. Some problems have been encountered due to shadows from the crow's nest and from the smokestack that occasionally disturbed the radiation measurement. Vibrations of the ship while breaking through the ice disturbed the camera in some cases. The instruments were mounted on the optimal available position on top of the container on the observation deck to receive as little of the ship's fabric as possible. Several clear sky and broken cloud conditions (see Fig. 6.2) had been observed as well as thin high clouds (see Fig. 6.1). In case of sea ice conditions the incoming shortwave radiation is expected to be higher than without, because of multiple reflections between cloud bottom and sea. As a result, the well known cloud-induced solar radiation enhancement (see Fig. 6.2) at broken cloud conditions (termed as "broken cloud effect") is stronger pronounced over sea ice than over land. Future work will compare the observed radiation budgets under polar conditions with those from climate models.

References

Kalisch, J., and Macke, A. 2008: Estimation of the total cloud cover with high temporal resolution and parameterization of short-term fluctuations of sea surface insolation. Meteorologische Zeitschrift, Volume 17, Number 5, October, pp. 603-611(9).

Zillman, J. 1972: A study of some aspects of the radiation and heat budgets of the southern hemisphere oceans. Meteor. Stud. No. 26, Bureau of Meteorology, Canberra, 526 pp.

7. TRANSECT BASED INVESTIGATIONS OF POLYFLUORINATED COMPOUNDS (PFC) IN SOUTH ATLANTIC AND ANTARCTIC REGIONS

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Objectives

This project focuses on the occurrence and atmospheric transport mechanisms of novel persistent organic pollutants (POPs) in the southern Atlantic Ocean. Persistent and toxic perfluorinated organic acids have been determined in high concentrations in polar biota (e.g. Tao et al. 2006). Two transport modes of these substances to remote regions are being discussed: direct transport of perfluorinated acids via the water phase and transport of volatile polyfluorinated precursor compounds and subsequent degradation to the persistent acids within the atmosphere. The long range transport of polyfluorinated organic compounds is only insufficiently elucidated and information about concentrations in the air and water phase of remote regions is rare. The investigations of per and polyfluorinated organic compounds on *Polarstern* aim at a better understanding of their distribution in the atmosphere and the water phase along a north-south transect and the transportation pathways involved. These measurements will complete data sets from Longyearbyen, Norway to Cape Town, South Africa (MSM05/6, ANT-XXIII-1, ANT-XXIV/1, ANT-XXV/1) in order to show the global contamination with PFC. Additionally, the air–sea gas exchange is evaluated. This project will improve the knowledge for the understanding of the fate and distribution of organic fluorinated substances.

Work at sea

Air Sampling

Air Sampling was conducted from the observation deck of *Polarstern* using up to four high volume air samplers (Fig. 7.1). Parallel samples were taken continuously with two instruments for about two days (~ 1,200 m³). The other two instruments were operated according to the sampling scheme of water samples. Particle-bound pollutants were accumulated on glass fibre filters. Gaseous compounds were enriched in a cartridge filled with adsorption material (polyurethane foam and XAD-2 resin). To assure that ship-based contamination was minimized, sampling was controlled by a computer that was fed by meteorological parameters obtained onboard *Polarstern*. The sampling procedure was stopped whenever the wind was coming from aft directions. Air samples were stored at -20 °C until analysis. See Tables 7.1 and 7.2 for sampling protocol.

a) b)

Fig. 7.1: Air sampling at the observation deck. a: high volume sampler. b: Close-up of filter containing head for particle-bound analytes and cartridge with adsorption material for gas phase analytes.

Tab. 7.1: Overview of position of air samples collected bi-daily onboard *Polarstern*. Time: UTC

	Start				Stop			
Sample	date	time	lat	lon	date	time	lat	lon
ANT-XXV/2-1	06.12.08	15:45	34°01.64'S	18°09.91'E	08.12.08	14:09	41°07.41'S	09°46.89'E
ANT-XXV/2-2	08.12.08	15:07	41°18.09'S	09°38.08'E	10.12.08	10:17	48°59.34'S	02°51.31'E
ANT-XXV/2-3	10.12.08	11:04	49°05.45'S	02°48.77'E	12.12.08	12:56	58°39.15'S	00°12.59'E
ANT-XXV/2-4	12.12.08	13:20	58°42.47'S	00°11.57'E	14.12.08	13:00	64°36.94'S	00°00.64'E
ANT-XXV/2-5	14.12.08	13:20	64°40.39'S	00°01.29'E	16.12.08	13:56	69°24.44'S	05°32.02'W
ANT-XXV/2-6*)	16.12.08	14:34	69°24.37'S	05°32.16'W	20.12.08	10:30	69°53.70'S	05°31.82'W
ANT-XXV/2-7	20.12.08	10:53	69°53.62'S	05°32.26'W	22.12.08	13:27	64°59.87'S	00°28.55'W
ANT-XXV/2-8	22.12.08	13:47	64°59.79'S	00°20.66'W	24.12.08	13:10	65°00.00'S	05°49.72'E
ANT-XXV/2-9	24.12.08	13:32	64°59.96'S	05°58.29'E	26.12.08	13:37	61°42.52'S	10°53.05'E
ANT-XXV/2-10	26.12.08	14:53	61°32.30'S	10°56.76'E	28.12.08	13:28	55°42.65'S	12°52.56'E
ANT-XXV/2-11	28.12.08	13:51	55°39.37'S	12°53.56'E	30.12.08	12:43	50°27.51'S	14°20.54'E
ANT-XXV/2-12	30.12.08	13:03	50°24.63'S	14°21.12'E	01.01.09	12:16	45°13.81'S	15°19.03'E
ANT-XXV/2-13	01.01.09	12:41	45°09.38'S	15°19.81'E	03.01.09	09:27	39°16.34'S	16°33.86'E
ANT-XXV/2-14	03.01.09	09:52	39°13.66'S	16°34.79'E	04.01.09	07:26	36°49.79'S	17°21.15'E

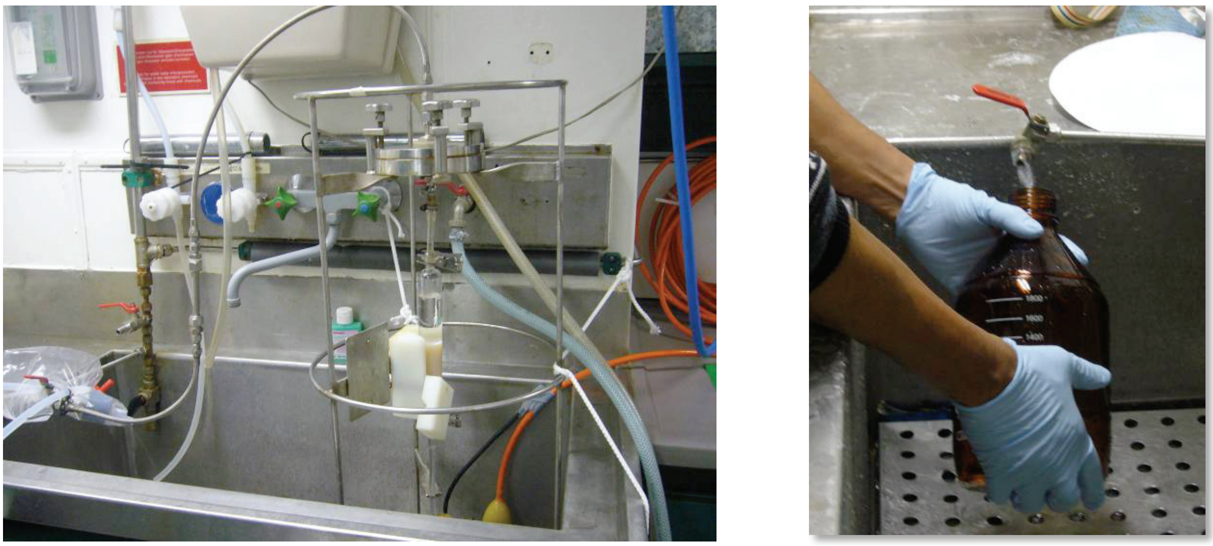
*) with *Polarstern* performing loading operations during this period, samples were collected for four days continuously until steaming was resumed. During this time, samplers were disconnected from the controlling computer.

Tab. 7.2: Overview of position air samples taken in accordance to some water samples. Time: UTC

	Start				Stop			
Sample	date	time	lat	lon	date	time	Lat	Lon
ANT-XXV/2-A14	06.12.08	17:00	34°12.73'S	17°55.98'E	08.12.08	16:07	41°29.53'S	9°28.58'E
ANT-XXV/2-A15	08.12.08	16:27	41°33.25'S	09°25.51'E	10.12.08	10:34	49°00.64'S	2°50.03'E
ANT-XXV/2-A16	10.12.08	10:55	49°03.59'S	02°49.22'E	12.12.08	14:54	58°54.59'S	0°07.84'E
ANT-XXV/2-A17	12.12.08	15:24	58°58.99'S	00°06.50'E	15.12.08	09:45	67°21.21'S	2°03.84'W

Water Sampling

Water Sampling was conducted in the wet laboratory onboard *Polarstern* (Fig. 7.2). An *in-situ* pump attached to the stainless steel sea water intake system was used to sample water continuously for periods between 1 and 2 days. PFC adsorbed onto particles accumulated on a glass fibre filter. Dissolved PFC were enriched on XAD-based material which was contained in a glass cartridge that was place just behind the filter. About 1,000 l of water per sample were sampled with this method. Additionally, 2 l water samples were taken using glass bottles in order to compare the high volume method to a commonly used one. Water samples were stored at 4 °C until analysis. See Tables 7.3 and 7.4 for sampling protocol.



a B

Fig. 7.2: Water sampling in the wet laboratory at Polarstern using a) the in-situ pump and b) 2 l glass bottles.

Tab. 7.3: Position overview on 2 litres water samples collected with glass bottles onboard *Polarstern*. Time: UTC

Sample	date	time	lat	Lon
ANT-XXV/2-1	07.12.08	11:08	37°00.49'S	14°18.05'E
ANT-XXV/2-2	08.12.08	06:20	38°45.50'S	10°05.44'E
ANT-XXV/2-3	08.12.08	18:32	41°55.43'S	09°06.22'E
ANT-XXV/2-4	09.12.08	07:18	44°22 23'S	07°02.14'E
ANT-XXV/2-5	10.12.08	07:18	48°27.24'S	03°21.35'E
ANT-XXV/2-6	11.12.08	06:06	52°57.99'S	01°49.22'E
ANT-XXV/2-7	13.12.08	07:40	60°40.18'S	00°17.31'W
ANT-XXV/2-8	14.12.08	09:46	64°08.01'S	00°03.01'W
ANT-XXV/2-9	15.12.08	09:07	67°21.19'S	02°03.06'W
ANT-XXV/2-10	16.12.08	08:34	69°08.39'S	05°04.59'W
ANT-XXV/2-11	22.12.08	09:11	64°59.93'S	01°00.13'W
ANT-XXV/2-12	23.12.08	09:11	65°28.18'S	02°51.86'E
ANT-XXV/2-13	24.12.08	09:12	64°59.98'S	05°00.78'E
ANT-XXV/2-14	25.12.08	08:27	64°34.89'S	09°04.81'E
ANT-XXV/2-15	26.12.08	08:52	62°19.98'S	10°39.76'E
ANT-XXV/2-16	27.12.08	08:13	59°12.38'S	11°45.47'E
ANT-XXV/2-17	28.12.08	08:54	55°59.94'S	12°48.14'E
ANT-XXV/2-18	29.12.08	07:55	53°45.34'S	13°27.99'E
ANT-XXV/2-19	30.12.08	08:01	50°56.17'S	14°14.72'E
ANT-XXV/2-20	31.12.08	08:12	48°21.69'S	14°43.52'E
ANT-XXV/2-21	01.01.09	07:20	45°37.24'S	15°14.25'E

Tab. 7.4: Position overview on high volume water samples taken with the *in-situ* pump onboard *Polarstern*. Time: UTC

Sample	start date	time	lat	lon	Stop date	time	Lat	lon
ANT-XXV/2-W27	07.12.08	11:58	37°00.49'S	14°18.03'E	07.12.08	18:05	37°50.14'S	13°11.85'E
ANT-XXV/2-W28	08.12.08	06:20	39°45.50'S	10°53.65'E	08.12.08	18:32	41°56.43'S	09°06.22'E
ANT-XXV/2-W29	10.12.08	07:18	48°27.24'S	03°21.35'E	11.12.08	05:58	52°56.43'S	01°50.13'E
ANT-XXV/2-W30	13.12.08	07:39	60°40.18'S	00°17.31'W	14.12.08	07:24	63°55.00'S	00°03.54'W
ANT-XXV/2-W31	14.12.08	09:46	64°08.01'S	00°03.01'W	15.12.08	08:09	67°16.51'S	01°56.94'W
ANT-XXV/2-W32	15.12.08	09:00	67°21.18'S	02°02.89'W	16.12.08	08:19	69°05.91'S	04°58.17'W

Laboratory Work

The majority of air samples were extracted onboard *Polarstern* (Fig. 7.3). A set of air samples was retained for extraction at the GKSS laboratory in case of an onboard contamination, e.g. due to maintenance (incl. painting) adjacent to the labs. Air samples were extracted with acetone and methyl tert-butyl ether (MTBE). The extracts were concentrated (i.e. the sample volume was reduced) using a rotary evaporator and nitrogen. Samples were filled into vials to be analysed at the GKSS research centre. 2 litre water samples were extracted onboard *Polarstern* as well using solid phase extraction (Fig. 7.3c). The extracts were transferred to glass vials for further analysis at the GKSS research centre. High volume water samples were shipped without being extracted onboard.

A B C

Fig. 7.3: Extraction of air and water samples onboard Polarstern. a) fluidized bed extraction of airborne PFC in the particle phase. b) cold extraction of airborne PFC in the gas phase. c) solid phase extraction of PFC in the water

Preliminary and expected results

Since the final analysis of all samples occurs at the GKSS research centre preliminary results cannot be reported at this time. However, based on recent work of Jahnke et al. (2007) and Wei et al. (2007), PFC concentrations in air and water are expected to decline when approaching the Antarctic continent. However, we expect that some of the perfluorinated compounds are still present in Antarctic air and maybe water.

References

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Wei S., Chen L.Q., Taniyasu S., So M.K., Murphy M.B., Yamashita N., Yeung L.W.Y., Lam P.K.S. 2007. Distribution of perfluorinated compounds in surface seawaters between Asia and Antarctica. Marine Pollution Bulletin 54. 1813-1818.

8. SOURCES AND SHORT-TERM MOLECULAR CHANGES OF DISSOLVED ORGANIC MATTER IN THE ATLANTIC SURFACE OCEAN: IMPACT OF CLIMATIC ZONES

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Alfred-Wegener-Institut für Polar- und Meeresforschung
not on board: Boris P. Koch, Gerhard Kattner

Objectives

Dissolved organic matter (DOM) in the oceans contains about the same amount of carbon as the global biomass or atmospheric CO_2 and exhibits an average age of several thousand years. Source, diagenesis and preservation mechanisms of DOM remain elemental questions in contemporary marine sciences and represent a missing link in models of global elemental cycles. One of the most important aspects to understand the global fluxes of marine dissolved organic matter (DOM) is to resolve the molecular mechanisms which convert fresh, labile biomolecules to semi-labile and refractory organic compounds in the ocean.

The major aim of this study is to employ an interdisciplinary approach to complement the detailed molecular characteristics of dissolved organic matter in the Atlantic surface ocean in order to relate the data to different climatic, hydrographical, biological and meteorological regimes as well as to terrestrial input from atmospheric sources. Our goal is to achieve a high spatial resolution data set for the characterisation of the sources and driving processes of DOM from the South Atlantic to the Antarctic. This leg will continue a part of the work from the last cruise ANT-XXV/1 from the North to the South Atlantic.

Work at sea

On the way from Cape Town to Atka Bay DOM sampling was carried out three times a day using filtered surface water from the ships moon pool (Table 8.1). Sampling time was at 5:00 UTC, 13:00 UTC and 21:00 UTC respectively. This scheme was used until the first occurrence of sea ice at 57° S. From there sampling was carried out during scientific stations. Due to the lack of station time water was directly taken from the ocean surface using a teflon tube mounted to an aluminium stick of 4 m length which was operated from the working deck. On the way back from Atka Bay to Cape Town sampling was done using the water from the water rosette to obtain sampling profiles down to the sea floor (Table 8.2). Stations were planned for every region of changing water masses or zones of strong temperature gradients. Salinity, water temperature and meteorological parameters, such as air temperature, and radiation were continuously recorded by the ship. Satellite images for surface chlorophyll provided complementary data in high spatial resolution. Aerosols were continuously collected at the observation deck. Water samples were taken for the analysis of DOM, dissolved organic carbon (DOC), particulate organic carbon (POC), nutrients, chitin, mercury and total dissolved trace metals.

Tab. 8.1: Sampling Stations ANT-XXV/2 Surface Water

Latitude	Longitude	Date (UTC)	Time (UTC)	Sampling Device	Type of Samples
34°14.78'S	17°53.56'E	06.12.2008	17:15	Moonpool	DOC, POC, nutrients, SPE1
34°48.61'S	17°10.59'E	06.12.2008	21:07	Moonpool	DOC, POC, nutrients, SPE1
36°02.21'S	15°34.89'E	07.12.2008	5:16	Moonpool	DOC, POC, nutrients, SPE1, SPE5, Hg, Metalle, Chitin, SPE*, TDM
37°09.02'S	14°06.77'E	07.12.2008	13:00	Moonpool	DOC, POC, nutrients, SPE1, Hg, Metalle, SPE*
38°19.63'S	12°32.22'E	07.12.2008	21:00	Moonpool	DOC, POC, nutrients, SPE1, Hg, Metalle, SPE*, TDM
39°32.95'S	11°03.84'E	08.12.2008	5:10	Moonpool	DOC, POC, nutrients, SPE1, SPE5, Hg, Metalle, Chitin, SPE*
40°56.38'S	09°55.97'E	08.12.2008	13:08	Moonpool	DOC, POC, nutrients, SPE1, Hg, Metalle, SPE*, TDM
42°25.57'S	08°41.84'E	08.12.2008	21:14	Moonpool	DOC, POC, nutrients, SPE1, Hg, Metalle, SPE*
43°52.68'S	07°27.74'E	09.12.2008	5:04	Moonpool	DOC, POC, nutrients, SPE1, SPE5, Hg, Metalle, Chitin, SPE*, TDM
45°17.75'S	06°13.50'E	09.12.2008	13:00	Moonpool	DOC, POC, nutrients, SPE1, Hg, Metalle, SPE*
46°44.73'S	04°55.70'E	09.12.2008	21:08	Moonpool	DOC, POC, nutrients, SPE1, Hg, Metalle, SPE*, TDM
48°02.27'S	03°44.69'E	10.12.2008	4:54	Moonpool	DOC, POC, nutrients, SPE1, SPE5, Hg, Metalle, Chitin, SPE*
49°30.80'S	02°42.56'E	10.12.2008	13:00	Moonpool	DOC, POC, nutrients, SPE1, Hg, Metalle, SPE*, TDM
51°08.94'S	02°18.02'E	10.12.2008	21:06	Moonpool	DOC, POC, nutrients, SPE1, Hg, Metalle, SPE*
52°44.28'S	01°53.34'E	11.12.2008	5:00	Moonpool	DOC, POC, nutrients, SPE1, SPE5, Hg, Metalle, Chitin, SPE*, TDM
54°28.25'S	01°25.38'E	11.12.2008	13:00	Moonpool	DOC, POC, nutrients, SPE1, Hg, Metalle, SPE*
56°14.69'S	00°55.40'E	11.12.2008	21:18	Moonpool	DOC, POC, nutrients, SPE1, Hg, Metalle, SPE*, TDM
57°45.30'S	00°31.92'E	12.12.2008	6:00	Moonpool	DOC, POC, nutrients, SPE1, SPE5, Hg, Metalle, Chitin, SPE*, TDM
60°46.00'S	00°10.91'W	13.12.2008	9:30	Moonpool	DOC, POC, nutrients, SPE1, Hg, Metalle, Chitin, SPE*, TDM
64°05.14'S	00°05.56'W	14.12.2008	9:11	Moonpool	DOC, POC, nutrients, SPE1, Hg,

Latitude	Longitude	Date (UTC)	Time (UTC)	Sampling Device	Type of Samples
					Metalle, Chitin, SPE*, TDM
69°24.46'S	05°31.87'W	16.12.2008	11:00	Moonpool	DOC, POC, nutrients, SPE1, Hg, Metalle, Chitin, SPE*, TDM
34°14.78'S	17°53.56'E	06.12.2008	17:15	Moonpool	DOC, POC, nutrients, SPE1
34°48.61'S	17°10.59'E	06.12.2008	21:07	Moonpool	DOC, POC, nutrients, SPE1
36°02.21'S	15°34.89'E	07.12.2008	5:16	Moonpool	DOC, POC, nutrients, SPE1, SPE5, Hg, Metalle, Chitin, SPE*, TDM
37°09.02'S	14°06.77 E	07.12.2008	13:00	Moonpool	DOC, POC, nutrients, SPE1, Hg, Metalle, SPE*
38°19.63'S	12°32.22'E	07.12.2008	21:00	Moonpool	DOC, POC, nutrients, SPE1, Hg, Metalle, SPE*, TDM
39°32.95'S	11°03.84'E	08.12.2008	5:10	Moonpool	DOC, POC, nutrients, SPE1, SPE5, Hg, Metalle, Chitin, SPE*
40°56.38'S	09°55.97'E	08.12.2008	13:08	Moonpool	DOC, POC, nutrients, SPE1, Hg, Metalle, SPE*, TDM
42°25.57'S	08°41.84'E	08.12.2008	21:14	Moonpool	DOC, POC, nutrients, SPE1, Hg, Metalle, SPE*
43°52.68'S	07°27.74'E	09.12.2008	5:04	Moonpool	DOC, POC, nutrients, SPE1, SPE5, Hg, Metalle, Chitin, SPE*, TDM
45°17.75'S	06°13.50'E	09.12.2008	13:00	Moonpool	DOC, POC, nutrients, SPE1, Hg, Metalle, SPE*
46°44.73'S	04°55.70'E	09.12.2008	21:08	Moonpool	DOC, POC, nutrients, SPE1, Hg, Metalle, SPE*, TDM
48°02.27'S	03°44.69'E	10.12.2008	4:54	Moonpool	DOC, POC, nutrients, SPE1, SPE5, Hg, Metalle, Chitin, SPE*
49°30.80'S	02°42.56'E	10.12.2008	13:00	Moonpool	DOC, POC, nutrients, SPE1, Hg, Metalle, SPE*, TDM
51°08.94'S	02°18.02'E	10.12.2008	21:06	Moonpool	DOC, POC, nutrients, SPE1, Hg, Metalle, SPE*
52°44.28'S	01°53.34'E	11.12.2008	5:00	Moonpool	DOC, POC, nutrients, SPE1, SPE5, Hg, Metalle, Chitin, SPE*, TDM
54°28.25'S	01°25.38'E	11.12.2008	13:00	Moonpool	DOC, POC, nutrients, SPE1, Hg, Metalle, SPE*
56°14.69'S	00°55.40'E	11.12.2008	21:18	Moonpool	DOC, POC, nutrients, SPE1, Hg, Metalle, SPE*, TDM
57°45.29'S	00°31.92'E	12.12.2008	6:00	Moonpool	DOC, POC, nutrients, SPE1, SPE5, Hg, Metalle, Chitin, SPE*, TDM
60°45.99'S	00°10.90'W	13.12.2008	9:30	Tubing	DOC, POC, nutrients, SPE1, Hg, Metalle, Chitin, SPE*, TDM
64°05.14'S	00°05.56'W	14.12.2008	9:11	Tubing	DOC, POC, nutrients, SPE1, Hg, Metalle, Chitin, SPE*, TDM
69°24.45'S	05°31.86'W	16.12.2008	11:00	Tubing	DOC, POC, nutrients, SPE1, Hg, Metalle, Chitin, SPE*, TDM

Tab. 8.2: Sampling Stations ANT-XXV/2 CTD

Station PS 73/	Latitude	Longitude	Date (UTC)	Time (UTC)	Depth	Type of Samples
071-1	70°29.54'S	08°22.10'W	18.12.2008	19:56	252	DOC, POC, nutrients, SPE, Chitin, SPE*, TDM
072-1	69°53.59'S	05°32.47'W	20.12.2008	11:08	2031	DOC, POC, nutrients, SPE, Chitin, SPE*, TDM
073-1	67°40.26'S	00°59.91'W	21.12.2008	12:26	4583	DOC, POC, nutrients, SPE, Chitin, SPE*, TDM
074-1	65°00.02'S	00.59.88'W	22.12.2008	10:27	4939	DOC, POC, nutrients, SPE, Chitin, SPE*, TDM
079-1	64°59.93'S	02°58.76'W	23.12.2008	17:05	2384	DOC, POC, nutrients, SPE, Chitin, SPE*, TDM
083-1	64°59.89'S	06°00.26'E	24.12.2008	15:07	4445	DOC
086-1	56°00.07'S	12°48.86'E	28.12.2008	09:50	4925	DOC, POC, nutrients, SPE, Chitin, SPE*, TDM
087-1	54°54.30'S	13°7.91'E	28.12.2008	21:28	4058	DOC, nutrients
088-1	53°45.29'S	13°28.02'E	29.12.2008	08:30	4332	DOC, POC, nutrients, SPE, Chitin, SPE*, TDM
089-1	52°22.25'S	13°51.42'E	29.12.2008	20:17	3420	DOC, nutrients
090-1	50°56.15'S	14°14.71'E	30.12.2008	08:14	3325	DOC, POC, nutrients, SPE, Chitin, SPE*, TDM
091-1	49°35.73'S	14°32.16'E	30.12.2008	21:01	4095	DOC, nutrients
092-1	48°21.59'S	14°43.43'E	31.12.2008	08:39	4815	DOC, POC, nutrients, SPE, Chitin, SPE*, TDM
093-1	47°18.94'S	14°56.17'E	31.12.2008	18:38	4583	DOC, nutrients
094-1	45°37.26'S	15°14.25'E	01.01.2009	08:36	4548	DOC, POC, nutrients, SPE, Chitin, SPE*, TDM
095-1	41°7.29'S	15°52.68'E	02.01.2009	13:09	4940	DOC, POC, nutrients, SPE
097-1	39°31.54'S	16°28.09'E	03.01.2009	05:46	4931	DOC, nutrients

After each sampling, 5 litres of filtered seawater were extracted using solid phase extraction (SPE) adsorber cartridges for enrichment and desalting of the DOM. At the CTD stations, 5 litres of water were extracted from 200 m depth (the fluorescence maximum), 20 m depth and the ocean surface. DOM samples from the deep ocean were taken as a reference for the old refractory deep ocean DOM background. Each SPE procedure was done once using only glassware for the analysis of DOM via FT-ICR-MS and once using polyethylene labware for the analysis of trace metals complexed by organic molecules via HPLC-ICP-MS. All further analysis will be carried out in the home laboratories. Further samples were collected from additional depths at CTD stations for the analysis of total DOC and nutrients, in order to obtain a highly resolved DOC and nutrient profile of the whole water column.

Preliminary results

In total, we extracted 145 samples with adsorber cartridges and retrieved more than 200 samples for the analysis of bulk parameters such as DOC, POC and nutrients. During the cruise there were five zones of strong temperature gradients reflecting the frontal zones of the Southern Ocean (Fig. 8.1).

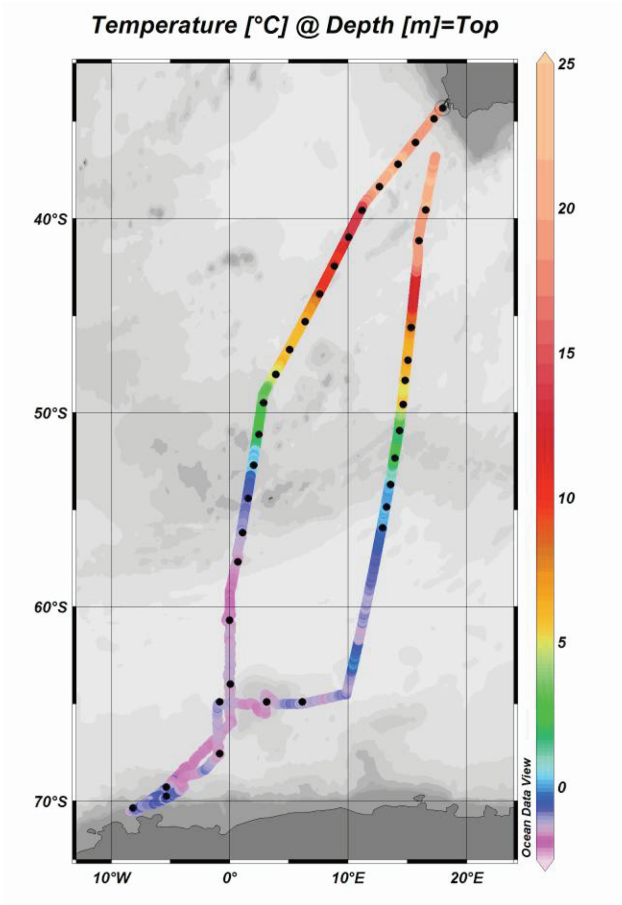

Fig. 8.1: Surface water temperature and salinity distribution and stations during ANT-XXV/2

We passed through two larger phytoplankton blooms which were reflected in very high fluorescence values from CTD measurements and high chlorophyll concentrations observed by satellite (Fig. 8.2). The biogeochemical parameters will be measured after the cruise in the laboratories of various international participants.

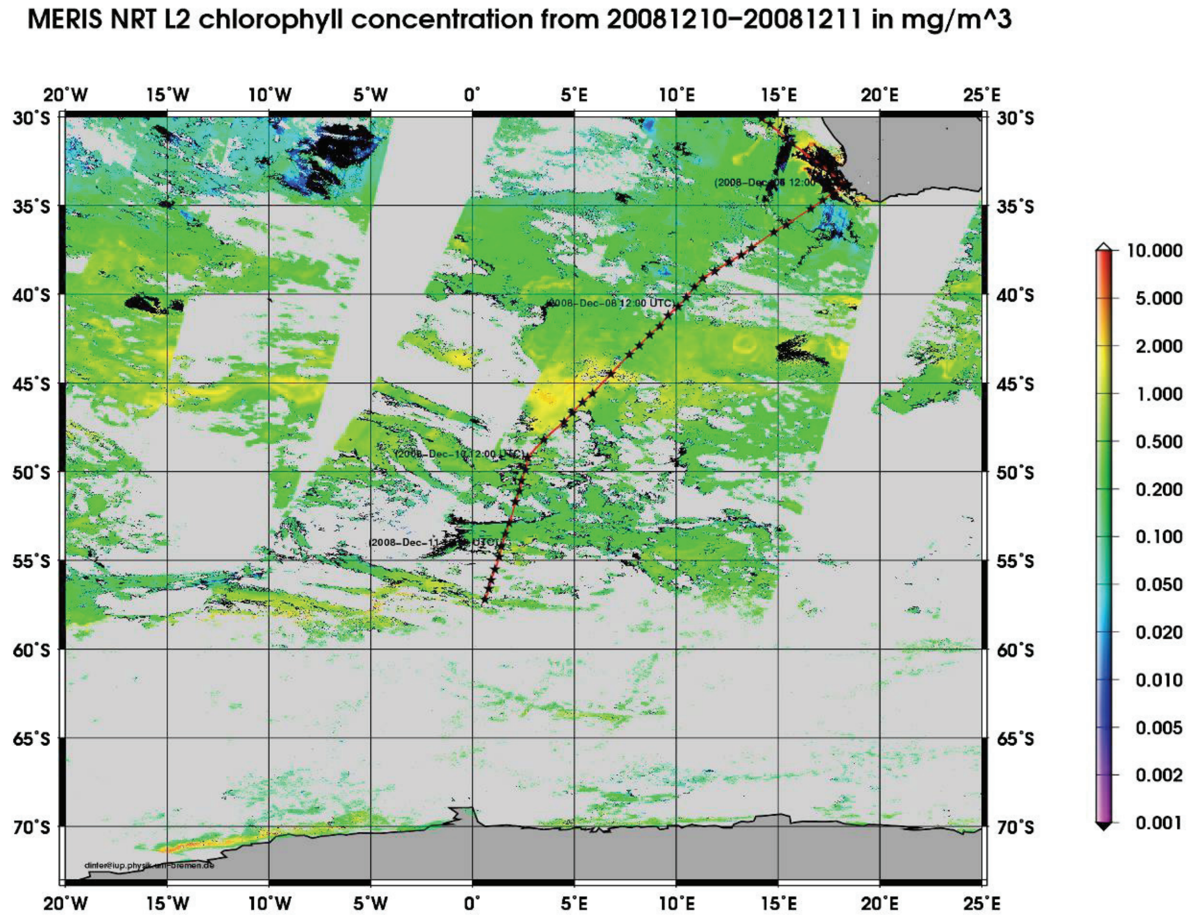

Fig. 8.2: Example of provided satellite data of chlorophyll concentration by the IUP in Bremen. The yellow spot at 45° S 5° E shows an area of high phytoplankton concentration.

All samples will be classified according to differences in climatic zones (temperature, radiation, etc.), primary production and extend of aerosol input. Regarding the first cruise leg ANT-XXV/1 we expect high variability in the composition and transformation processes of the fresh organic matter when comparing the different climatic zones and oceanographic situations.

9. MABEL RECOVERY MISSION

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Objectives

MABEL (Multidisciplinary Antarctic Benthic Laboratory) is an Italian PNRA (Programma Nazionale di Ricerche in Antartide) project developed and conducted by INGV (Istituto Nazionale di Geofisica e Vulcanologia) in collaboration with AWI. MABEL is a deep sea multidisciplinary observatory for long-term autonomous observations. It was deployed by *Polarstern* on 5 December 2005 on the seafloor in the eastern Weddell Sea at 69°24.29'S and 05°32.20'W at 1884 meters water depth.

MABEL is able to measure and record autonomously and automatically data for one year with the following instruments:

three component broad band seismometer (100 Hz per 3 channel);
vectorial current meter (2 Hz);
conductivity, pressure and temperature (CDT, 1 sample hour);
light transmissometer (1 data/hour);
chemical electrode analyser presently equipped with pH and redox electrodes (1 data every two days);
off-line water sampler (1 sample/week).

All these instruments and service packages are time referenced with a high precision rubidium clock. Data acquisition started on 6 December 2005 and lasted until 31 December 2006, when the observatory automatically ended acquisition and all instruments were switched off. On 16 December 2008 the recovery of MABEL was conducted with the aid of MODUS (Mobile Docker for Underwater Sciences) of the TFH Berlin and TU Berlin.

Work at sea

Recovery operations were performed with dedicated infrastructure; the concept is shown in Fig. 9.1. The main items are the vehicle MODUS (Fig. 9.2) and the winch equipped with an electro-opto-mechanical cable. Using this infrastructure it is possible to recover the observatory with a controlled and accurate procedure.

MODUS is a remotely controlled vehicle, equipped with sonar (with a range of more than 100 m) and four cameras for the control of the close to the station operation mode.

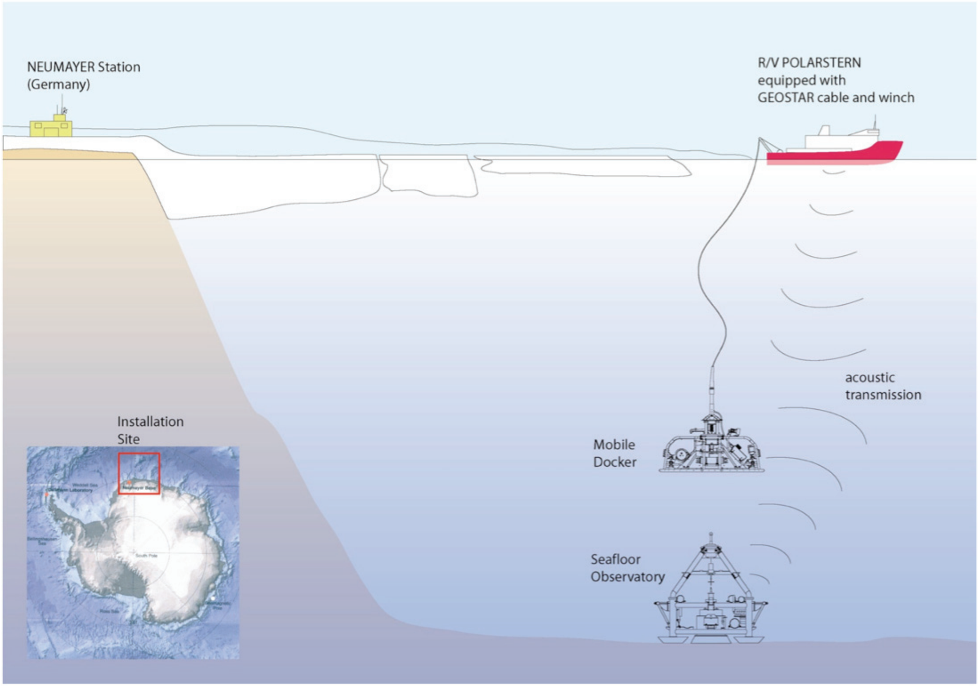

Fig. 9.1: Recovery concept

The recovery concept requires pre-position *Polarstern* at the spot of deployment, with MODUS, hanging from the ship's stern by some 1,850 m of cable. Using the sonar onboard MODUS, the MABLE station will then be searched for acoustically. Once detected, *Polarstern* will be re-positioned so that MODUS is within its own operational range of about 25 m (at the given depth). Only then MODUS can start to approach MABEL and finally dock onto the station. During the approach, the ship needs to be maneuvered at the lowest possible speed to avoid juxtaposing movements.

Fig. 9.2: deployment of MODUS

A failed recovery attempt in 2007 indicated the need to monitor the exact position of MODUS, which was accomplished by installing a Posidonia transponder. In addition a new best-guess position for MABEL (69°24.295'S 05°32.376'W) and a search pattern were agreed upon, based on a close analysis of the ship's track from the 2005 deployment cruise as shown in Fig. 9.3.

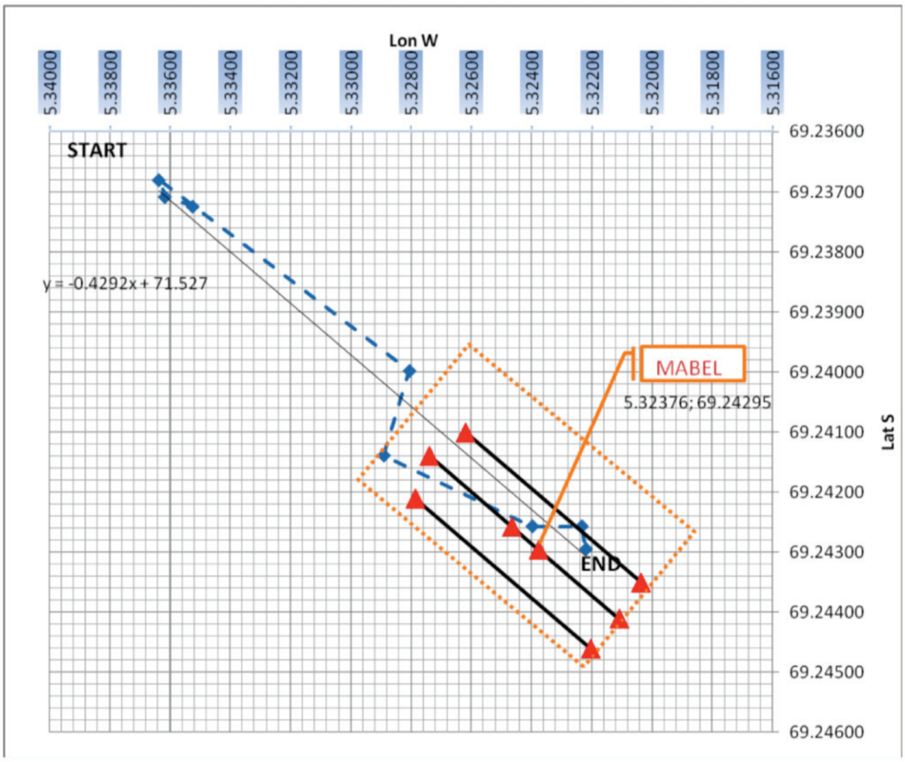

Fig. 9.3: Tracks for Polarstern to search MABEL

Arriving at the presumed position in the morning of 16 December, a patch of open waters hundreds of meters in diameter covered the projected search area. However, to the north, a massive ice floe was slowly approaching the presumed location of MABLE. MODUS was deployed at 12:35 and continuously lowered to the sea floor; once it reached a distance of about 40 m from the sea floor, the search started by *Polarstern* moving at the minimum speed (0,2 knots) along the central search track (Fig. 9.3, central black line), close to the track taken during deployment of MABEL (Fig. 9.3, dashed blue line).

When the bow of the ship finally nearly touched the approaching ice floe, MABEL was detected in the sonar image. It was located at about 69°24.31'S 5° 32.57' W. *Polarstern* moved at its minimum speed to position its stern as close as possible on this point. The MODUS operators approaching MABEL using first sonar image and later, when MODUS was very close to MABEL, its visual cameras. The docker was remotely positioned just above MABEL. MABLE was docked just in time at 16:40, as minutes later the sea ice had drifted over the position of MABEL, which would have prevented the slow-speed positioning efforts of *Polarstern* against the drifting ice.

After successful docking, the heaving operation commenced, which was successfully completed at 17:32 with MABEL and MODUS being safely on board (Fig. 9.4).

Preliminary and expected results

After three years in deep sea environment the mechanical status of MABEL was almost good. Most anodes, used to prevent the station from corrosion, were completely consumed and the oil compensators for no-deep pressure vessels were damaged. However, sensors and high pressure vessels were in good conditions. There was no water intrusion inside these vessels and the most important part of MABEL, which is the DACS (Data Acquisition and Control Unit) was found in excellent condition. The two flash cards and the hard disk used for data storage were removed from their cases and data was downloaded. The data acquisition covered the whole period of the mission, from 6 December 2005 to 31 December 2006 as expected, with a total amount of data of more than 13 GBytes.

Fig. 9.4: MABEL and MODUS on board

A first and fast data quality check showed that all the sensors hosted by MABEL had worked properly throughout the mission and, if confirmed also by a more accurate analysis, these data will constitute a unique data set of polar deep sea environment.

The continuous recording and acquisition of several parameters will allow to focus on tectonic features, structures and eventual local activity, also with the integration of the seismic data collected on Neumayer "on-land" seismometers; oceanographic and chemical data will depict evolution of water masses, their behaviour in the deepest water state, near to the sea bottom, with physical, chemical and thermodynamic distinct point of view. The overall data could also be useful in pointing out eventual crustal contribution.

10. PHYSICAL OCEANOGRAPHY

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Introduction

The Southern Ocean forms a key element of the global climate system. Its major feature is the Antarctic Circumpolar Current (ACC) which flows around Antarctica and connects the Atlantic, Indian and Pacific Oceans. Superimposed on the zonal ACC flow are meridional transports which result in an exchange of waters north and south of the ACC. While these processes make the Southern Ocean a key element in the global overturning circulation, they also render this oceanic system susceptible to anthropogenic impacts such as global warming.

An understanding of these processes and their interrelation with climate change requires long-term measurements of fundamental oceanographic properties across the ACC and in the Weddell Sea, a research field that is addressed in the AWI's research program PACES. The activities listed below are thereby direct contributions to WP 4 "Antarctic Circumpolar Climate and Ecosystem Study" of Topic 1 "The changing Arctic and Antarctic" of PACES.

10.1 Argo

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Objectives

The international Argo-project maintains order of 3,000 profiling floats distributed throughout the world ocean, to establish a real-time operational data stream of mid- and upper (< 2,000m) ocean temperature and salinity profiles. In addition, the array provides the mid-depth oceanic circulation pattern. During the past years, the AWI pushed technological developments to extend the operational range of Argo floats into seasonally ice-covered regions. To this end and with additional support by the EU project MERSEA and the BMBF Project German Argo, the NEMO float (Navigating European Marine Observer) was developed and tested, which is now fully operational (Klatt et al., 2007). NEMO floats are equipped with ISA-2, an ice-sensing algorithm which triggers the abort of a floats' ascent to the sea surface, when the presence of sea ice is likely as determined from the existence of a layer of near surface winter water. To nevertheless be able to (retrospectively) track the floats that actively remained under the sea ice, acoustic tracking via RAFOS (Rossby et al., 1986) (Ranging And Fixing Of Sound) is used. All NEMO floats are equipped with RAFOS-receivers and an array of 10 moored sound sources has been installed.

Work at sea

Deployment of Argo floats

Six NEMO 2000 floats (Navigating European Marine Observer, produced by Optimare, Germany) were scheduled for deployment during ANT-XXV/2 as part of the German Argo programme. All NEMO floats are equipped with RAFOS Navigation System, an adjustable Ice Sensing Algorithm (ISA-2), set to -1.79°C with a 'retarded' response. However, the later feature has been disabled in order to reduce the possibility of firmware induced defects. Interim data storage (iStore) stores any profiles that could not be transmitted in real time due to ISA aborts and transmits these profiles during ice-free condition.

Tab. 10.1: Float launch positions and times (Serial numbers A xxxx – Apex floats, N xx – NEMO Floats). All float launches – despite the first and the second – were preceded by a CTD cast (see Table 10.2)

Float Serial Number	Argos Id Hex Dec	Station [PS73/]	Latitude	Longitude	Date (UTC)	Time (UTC)	Depth [m]
A 4302	742EC4C 52708	PS73/065-2	39°12.78' S	11° 19.90' E	08/12/2008	03:16	5122
A 4294	825CCF2 89087	PS73/066-2	49°0.66' S	2°50.08'E	10/12/2008	10:37	4060
N 69	8494779	PS73/076-2	64°59.70'S	0°58.69'E	22/12/2008	22:40	2868
N 68	849476A	PS73/078-2	65°29.46'S	2°59.44'E	23/12/2008	12:06	2607
N 48	8494726	PS73/079-2	65°0.15'S	2°57.2'E	23/12/2008	17:58	2392
N 67	849475F	PS73/080-2	64°29.58'S	3°0.61'E	23/12/2008	23:30	2148
N 59	8494735	PS73/082-2	64°59.79'S	5°1.50'E	24/12/2008	11:01	3808
A4295	8261800 89088	PS73/088-2	53°45.21'S	13°28.40'E	29/12/2008	09:55	4333
A4296	8261813 89089	PS73/089-2	52°22.00'S	13°51.56'E	29/12/2008	21:25	3490
A4297	8261826 89090	PS73/090-2	50°55.93'S	14°14.45'E	30/12/2008	09:28	3325
A4300	543C126 57730	PS73/091-2	49°35.31'S	14°33.39'E	30/12/2008	22:42	4187
A4301	742EC35 52707	PS73/092-2	48°21.11'S	14°43.17'E	31/12/2008	10:06	4813
A4293	825CCE1 89086	PS73/093-2	47°18.56'S	14°55.94'E	31/12/2008	20:04	4611
A4298	52A7AF2 57727	PS73/094-2	45°37.53'S	15°13.93'E	01/01/2009	10:07	4544
A4292	825CCD4 89085	PS73/095-2	41°05.09'S	15°53.18'E	02/01/2009	14:49	4847
A4299	543C113 57729	PS73/097-2	39° 30.93' S	16° 30.16' E	03/01/2009	07:25	4920

At the beginning of the cruise the internal pressures of these floats were higher than 12.7 psi (between 12.8 and 13.1 psi), hence the startup self-test failed for all floats. After re-evacuating the floats the mission-startup was successfully completed for five floats which then were deployed in the Weddell Sea in the vicinity of Maud Rise (see Table 10.1. and Fig. 10.1, red circles). The sixth NEMO float could not be switched on again and was not deployed. Furthermore, both the mission and the expert parameters of all NEMO floats were carefully inspected and adapted for the use in ice covered areas.

Tab. 10.2: Location of CTD stations

Station [PS73/]	Latitude	Longitude	Date (UTC)	Time (UTC)	Depth [m]
PS73/064-1	26°4.69'S	10°43.46'E	30/11/2008	13:19	4478.7
PS73/071-1	70°29.54'S	8°22.10'W	18/12/2008	19:56	251.7
PS73/072-1	69°53.59'S	5°32.47'W	20/12/2008	11:08	2031.2
PS73/073-1	67°40.26'S	0°59.91'W	21/12/2008	12:26	4583.0
PS73/074-1	65°0.02'S	0°59.88'W	22/12/2008	10:27	4938.7
PS73/075-1	64°59.79'S	0°0.76'W	22/12/2008	16:05	3744.2
PS73/076-1	64°59.78'S	0°59.28'E	22/12/2008	21:47	2860.2
PS73/077-1	64°59.85'S	1°59.75'E	23/12/2008	03:05	2548.0
PS73/078-1	65°29.99'S	3°0.52'E	23/12/2008	11:33	2628.2
PS73/079-1	64°59.93'S	2°57.76'E	23/12/2008	17:05	2383.7
PS73/080-1	64°29.60'S	3°0.60'E	23/12/2008	22:43	2148.5
PS73/081-1	65°0.05'S	3°59.70'E	24/12/2008	04:42	2585.7
PS73/082-1	64°59.87'S	5°0.97'E	24/12/2008	09:53	3799.2
PS73/083-1	64°59.88'S	6°0.61'E	24/12/2008	15:07	4444.5
PS73/086-1	56°0.07'S	12°48,86'E	28/12/2008	09:50	4925.2
PS73/087-1	54°54.30'S	13°7.91'E	28/12/2008	21:28	4057.7
PS73/088-1	53°45.29'S	13°28.02'E	29/12/2008	08:30	4331.5
PS73/089-1	52°22.25'S	13°51.42'E	29/12/2008	20:17	3419.5
PS73/090-1	50°56.15'S	14°14.71'E	30/12/2008	08:14	3324.5
PS73/091-1	49°35.73'S	14°32.16'E	30/12/2008	21:01	4796
PS73/092-1	48°21.59'S	14°43.43'E	31/12/2008	08:39	4814
PS73/093-1	47°18.56'S	14°55.94'E	31/12/2008	18:38	4611
PS73/094-1	45°37.53'S	15°13.93'E	01/01/2009	08:36	4544
PS73/095-1	41°05.09'S	15°53.18'E	02/01/2009	14:45	4847
PS73/096-1	40°18.59'S	16°04.25'E	02/01/2009	22:00	4349
PS73/097-1	39° 31.54' S	16° 28.09' E	03/01/2009	05:46	4930

In addition eleven APEX floats (produced by Webb Research Corporation, USA) provided by Andreas Ster, Koninklijk Nederlands Meteorologisch Instituut (KNMI), were deployed. These instruments were launched at quasi-regular intervals between the floats of the Antarctic Circumpolar Current (see Fig. 10.1 and Table 10.1).

All floats (NEMO and Apex) using the ARGOS-system for communication. The German and KNMI floats were ballasted to drift at a drift depth of 800 m and 1,000 m, respectively, and will acquire profiles from 2,000 m up. Most of the float launches were preceded by a CTD cast (see Table 10.2).

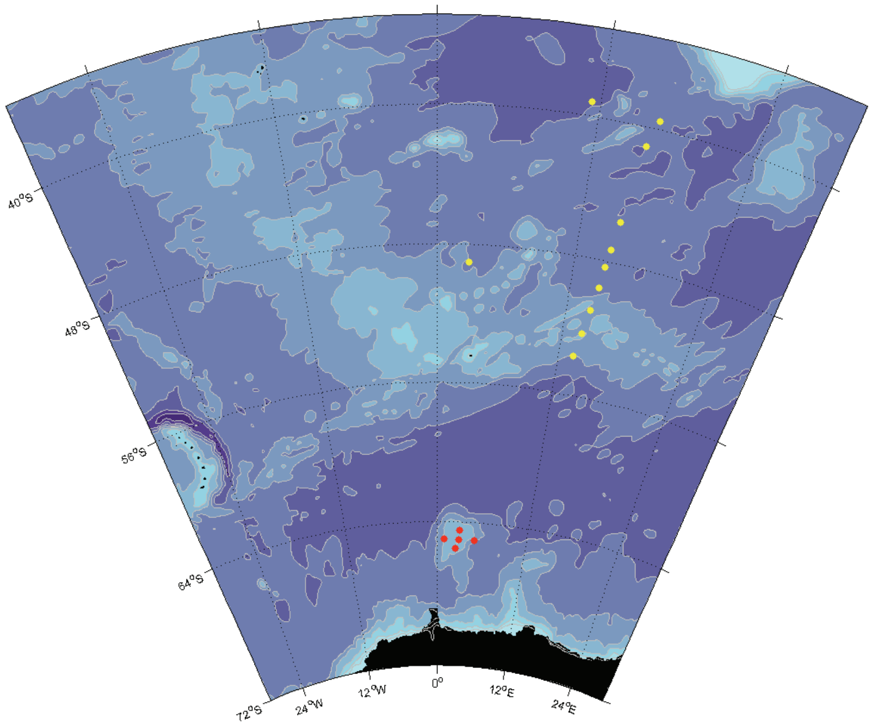

Fig. 10.1: Deployment positions of Argo floats (yellow dots – APEX floats (KNMI), red dots – German NEMO floats.

Installation of RAFOS Sound sources

During this cruise we recovered and redeployed a new sound source at the location W3 (AWI 240-2) see Tables 10.3 and 10.4. The recovered Webb sound source (sn. 21) was deployed in December 2002 and was still active as of December 2008. However, post-recovery communication efforts with the sound source failed. In order to stop the ponging of the source the battery supply of the electronic was cut off after recording on pong on deck (26.12.2008 01:35). The sound source was 51s late according to the time schedule.

Tab. 10.3: Sound sources recovered. (Note the difference between GPS and UTC times.)

site / mooring pong time	position water depth recovery date	sound source status
W3a / 240 01:35 GPS	64° 29.48' S 9° 49.07'E 4016m 25 Dec 2008 14:11 UTC	Webb 21 @ 800 m; aluminum resonator Pong @ 26.12.08 01.35:51 → 51s late GPS general status at recovery: ok but no communications with sound source could be established

Tab. 10.4: Sound source deployments. Note that times are given in GPS, not UTC

site / mooring pong time	position water depth deployment date	sound source status
W3b / 240 01:20 GPS	64° 33.96' S 9° 7.91' E 4783.2m 25 Dec 2008 11:11 UTC	R 33 @ 800 m; piggy-back design, aluminum resonator t offset @ deployment = 3s Vbat-2 = 8.77 Vdc High Voltage = 20.62 Vdc Internal Pressure = 627.95 hPa

The Rossby sound source (sn. 33) was deployed about 20 nm to the south from the original W3 location (see Fig. 10.2 and Table 10.2) and tuned to a deployment depth of 800 m.

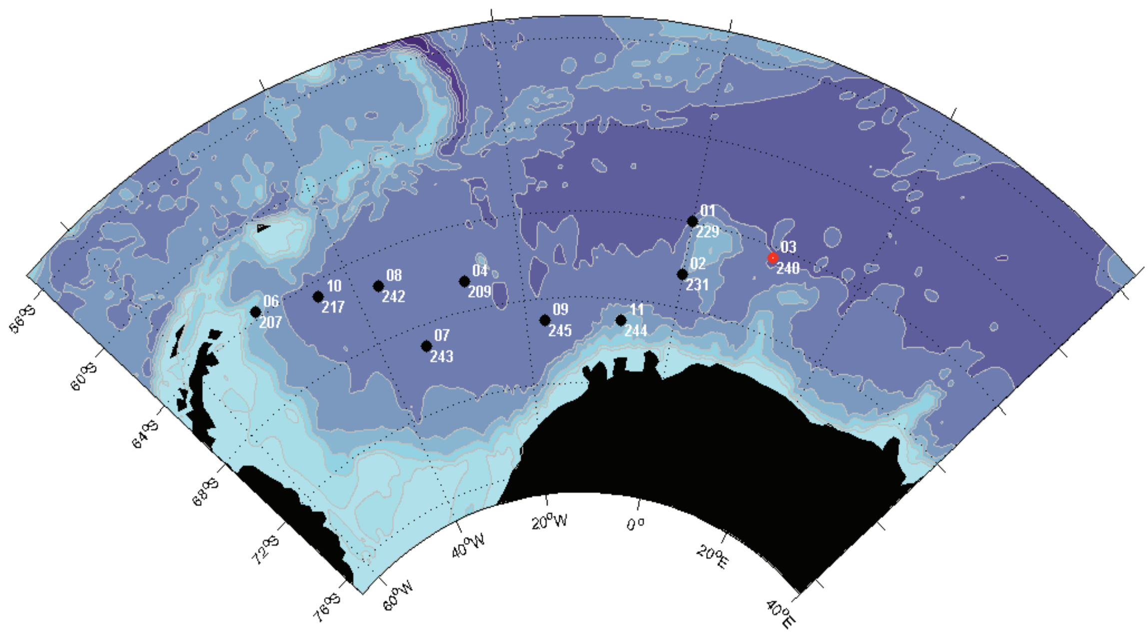

Fig. 10.2: Current state of the Weddell Sea RAFOS array. Red dots depict positions where sound sources were deployed and redeployed during ANT-XXV/2, the black dots represent positions of sound sources deployed during earlier cruises.

Preliminary and expected results

The project aimed at two different goals. First, the deployment of five NEMO floats and the replacement of the sound source are part of a detailed investigation of the hydrographic structure in the vicinity of Maud Rise.

Second, the deployment eleven Apex floats into the Antarctic Circumpolar Current increases significantly the number of active floats within this region.

References

Klatt, O., Boebel, O., and Fahrbach, E. 2007: A profiling float's sense of ice. Journal of Atmospheric and Oceanic Technology, 24, 1301-1308. DOI: 10.1175/JTECH2026.1

Rossby, T., Dorson, D., and Fontaine, J. 1986: The RAFOS-System. Journal of Atmospheric and Oceanic Technology.

10.2 Transport variations of the Antarctic Circumpolar Current

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Helmke Schulze John Lennon Gymnasium, Berlin

Objectives

Pressure Inverted Echo Sounders (PIES) deliver bottom pressure, bottom temperature and travel times of sound signals from the bottom to the sea-surface, effectively providing a measure of average temperatures, bottom temperature and pressure variations and sea surface height.

PIES data are used to extract transport variations of the Antarctic Circumpolar Current (ACC) as part of the AWI program to observe the decadal variability of the ACC. PIES are placed along the Good Hope section between South Africa and Antarctica, which in large parts coincides with satellite ground track # 133 of the Jason (previously TOPEX/Poseidon) satellite mission to allow direct comparison with altimetry data. PIES to PIES distances are selected to allow resolution of the major oceanic fronts of this region.

Work at sea

During ANT-XXV/2, three PIES at were deployed across the ACC (see Table 10.4 and Fig. 10.3). Although all PIES are equipped with POSIDONIA-releasers none of them was observed during the decent via the POSIDONIA-system due to sparse station time during the expedition. The second PIES (PIES S/N 135) is equipped with two PopUp buoys; their planed auto release dates are 10.08.2008 12:00h and 11.04.2010 12:00h (see Table 10.4).

Tab. 10.4: PIES deployments

Mooring	Station book (deploy)	PIES S/N	launch date & time [GPS]	Launch lat & lon	POS. ID	depth [m]	PopUp	Auto release date & time [UTC]
ANT 4-1	PS73/065-1	071	08.12.08 03:12	39°12.78'S 11°19.95'E	462	4709.2	-	-
ANT-10-1	PS73/066-1	135	10.12.08 10:35	49°00.64'S 02°50.03'E	390	4059.0	#13 #16	10.08.2009 12:00 11.04.2010 12:00
ANT-15-1	PS73/067-1	74	12.12.08 15:56	59°02.36'S 00°05.28'E	467	4647.0	-	-

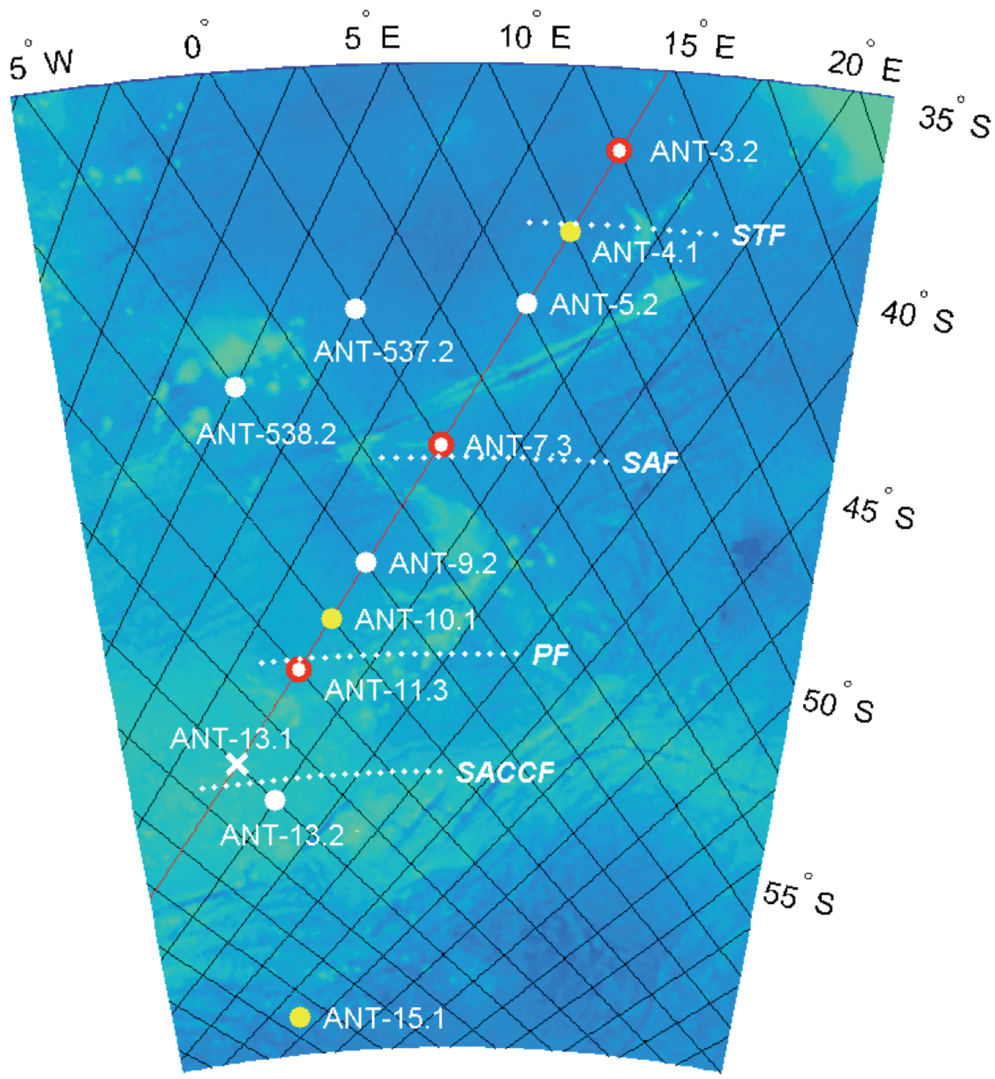

Fig. 10.3: Positions of PIES deployments during Polarstern cruise ANT-XXV/2 (yellow dots) and of previously deployed PIES (other colors/symbols). Red line: ground track #133 of Jason satellite mission (previously TOPEX/Poseidon). White dotted lines: nominal positions of fronts: STF = Subtropical Front, SAF = Subantarctic Front, PF = Polar Front, SACCF = Southern Antarctic Circumpolar Current Front.

Preliminary results

During this expedition PIES have only been deployed, hence no preliminary results are available at this time. First results are expected when PopUp #13 is due to surface on 10.08.2009.

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 für Polar- und Meeresforschung in der Helmholtz-Gemeinschaft Am Handelshafen 12 27570 Bremerhaven/ Germany
Cornell Lab of Ornithology	Bioacoustics Research Program Cornell Laboratory of Ornithology Department of Neurobiology and Behavior Cornell University 159 Sapsucker Woods Rd. Ithaca, NY 14850/USA
DWD	Deutscher Wetterdienst Geschäftsbereich Wettervorhersage Seeschifffahrtsberatung Bernhard Nocht Str. 76 20359 Hamburg Germany
FTZ Westküste	Research and Technology Center Westcoast Christian-Albrechts-University Kiel Werftstr. 6 25761 Büsum/Germany
GKSS	GKSS Research Centre Geesthacht Institute for Coastal Research Department for Environmental Chemistry Max-Planck-Str. 1 21502 Geesthacht/Germany
HeliTransair	HeliTransair GmbH Am Flugplatz 63329 Egelsbach/Germany
IFM-GEOMAR	Leibnitz-Institut für Meereswissenschaften Düsternbrooker Weg 20 24105 Kiel/Germany
IMARES	Wageningen IMARES Location Texel Landsdiep 4, 1797 SZ 't Horntje Postbus 167, 1790 AD Den Burg/The Netherlands
INGV	Istituto Nazionale di Geofisica e Vulcanologia Via di Vigna Murata 605 00143 Roma/Italy
IOW	Institut für Ostseeforschung Warnemünde Seestrasse 15 18119 Warnemünde/Germany

	Address
PolE	Laboratory for Polar Ecology Rue du Fodia 18 B-1367 Ramillies/Belgium
TFHB	Technische Fachhochschule Berlin FB VIII – Maschinenbau, Verfahrens- und Umwelttechnik Luxemburger Strasse 10 13353 Berlin/Germany
TUB	Technische Universität Berlin Arbeitsgruppe Tiefseesysteme Salzufer 17-19 10587 Berlin/Germany
UBC	Marine Mammal Research Unit University of British Columbia 2329 West Mall Vancouver BC Canada V6T 1Z4
DMM	Deutsches Meeresmuseum Katharinenberg 14-20 18439 Stralsund
VTI	Johann Heinrich von Thünen - Institut Bundesforschungsinstitut für ländliche Räume, Wald und Fischerei Institut für Seefischerei Palmaille 9 D-22767 Hamburg/Germany

A.2 FAHRTTEILNEHMER / CRUISE PARTICIPANTS

Name/ Last name	Vorname/ First name	Institut/ Institute	Beruf/Profession
Boebel	Olaf	AWI	Chief scientist
Bornemann	Horst	AWI	Veterinarian
Bräger	Stefan	DMM	Biologist
Brauer	Jens	HeliTransair	technician
Brüggemann	Jörg	realnature.tv	Media producer
Büchner	Jürgen	HeliTransair	Pilot
Caba	Armando	GKSS	Engineer
Camareri	Alejandro	PolE	Technician
de Vries	Haiko	TUB	Engineer
Dreyer	Annekatrin	GKSS	Chemist
Figueroa	Harold	Cornell University	IT scientist
Flerus	Ruth	AWI	Technician
Gentile	Emanuele	INGV	Captain
Gerber	Hans	TFHB	Engineer/professor.
Gruwier	Christophe	PolE	Biologist
Hansen	Felicitas	DWD	Stud. met.
Heckmann	Hans	HeliTransair	Pilot
Helmschmidt	Jessica	AWI	Physicist
Herr	Helena	FTZ Westküste	Biologist
Joppich	Christoph	DWD	Meteorologist
Kazanc	Tamer	AWI	Cook
Klatt	Olaf	AWI	Physicist
Kindermann	Lars	AWI	Physicist
Klimmeck	Jens	realnature.tv	Student
Knuth	Edmund	DWD	Biologist
Kock	Karl-Hermann	VTI Hamburg	Biologist
Kreiss	Cornelia	AWI	Stud. Biol.
Lagalante	Marcantonio	INGV	Technician
Lechtenfeld	Oliver	AWI	Chemist
Lehnert	Kristina	FTZ Westküste	Biologist
Lehnert	Linn Sophia	FTZ Westküste	Stud. Biol.
Männl	Ulrich	AWI	Geophysicist
Marinaro	Giuditta	INGV	Physicist
MacIntyre	Trevor		Stud. Bio.
Möllendorf	Carsten	HeliTransair	Technician
Mohr	Viktoria	IfM Geomar	Stud. met.
Ochs	Peter	Hessischer Rundfunk	Journalist
Petersen	Christoph	AWI	Technician
Plötz	Joachim	AWI	Biologist
Pruin	Berndt		Engineer
Rentsch	Harald	DWD	Meteorologist
Scheidat	Meike	IMARES	Biologist
Schulze	Helmke	AWI	Teacher
Selosse	Nicolas	PolE,	Biologist
Steinhage	Daniel	AWI	Geophysicist
Trapp	Michael	realnature.tv	Media producer
Turpeinen	Heidi	AWI	Geophysicist
van Opzeeland	Ilse Catharina	AWI	Biologist
Varga	Martin	realnature.tv	Image design
Verdaat	Hans	IMARES	Biologist
Williams	Rob	UBC	Biologist
Zöllner	Mathias	AWI	Meteorologist

A.3 SCHIFFSBESATZUNG / SHIP'S CREW

No.	Name	Rank
1.	Schwarze, Stefan	Master
2.	Spielke, Steffen	1. Offc.
3.	Ziemann, Olaf	Ch. Eng.
4.	Ettin, Margrith	2. Offc.
5.	Fallei, Holger	2. Offc.
6.	Janik, Michael	3. Offc.
7.	Uhlig, Holger	Doctor
8.	Hecht, Andreas	R. Offc.
9.	Minzlaff, Hans-Ulrich	2. Eng.
10.	Sümnicht, Stefan	2. Eng.
11.	Schaefer, Marc	2. Eng.
12.	Scholz, Manfred	Elec. Eng.
13.	Dimmler, Werner	ELO
14.	Himmel, Frank	ELO
15.	Muhle, Helmut	ELO
16.	Nasis, Ilias	ELO
17.	Loidl, Reiner	Boatsw.
18.	Reise, Lutz	Carpenter
19.	Guse, Hartmut	A.B.
20.	Hagemann, Manfred	A.B.
21.	Löscher, Andreas	A.B.
22.	Pousada Martinez, S.	A.B.
23.	Scheel, Sebastian	A.B.
24.	Schmidt, Uwe	A.B.
25.	Wende, Uwe	A.B.
26.	Winkler, Michael	A.B.
27.	Preußner, Jörg	Storek.
28.	Elsner, Klaus	Mot-man
29.	Pinske, Lutz	Mot-man
30.	Teichert, Uwe	Mot-man
31.	Voy, Bernd	Mot-man
32.	Watzel, Bernhard	Mot-man
33.	Müller-Homburg, R.-D.	Cook
34.	Martens, Michael	Cooksmate
35.	Silinski, Frank	Cooksmate
36.	Jürgens, Monika	1. Stwdess
37.	Holger, Irene	Stwdess/N.
38.	Czyborra, Bärbel	2. Stwdess
39.	Gaude, Hans-Jürgen	2. Steward
40.	Huang, Wu-Mei	2. Stwdess
41.	Möller, Wolfgang	2. Steward
42.	Silinski, Carmen	2. Stwdess
43.	Yu, Chung Leung	Laundrym.
44.	Firek, Marlin	Apprent.
45.	Geske, Ina	Apprent.

A.4 STATIONSLISTE / STATION LIST PS073

Station PS073	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
064-1	30.11.2008	13:19		26°04.69’ S	10°43.46’ E	4479	CTD
065-1	08.12.2008	03:12		39°12.78' S	11°19.95' E	4709	PIES Depl
065-2	08.12.2008	03:16		39°12.78' S	11°19.90' E	5122	Argo Float
066-1	10.12.2008	10:35		49°00.64' S	02°50.03' E	4059	PIES Depl.
066-2	10.12.2008	10:37		49°00.66' S	02°50.08' E	4060	Argo Float
067-1	12.12.2008	15:56		59°02.36' S	00°05.28' E	4647	PIES Depl
068-1	12.12.2008	17:15		59°10.10’ S	00°00.24’ E	4775	MARU Depl
069-1	14.12.2008	08:54		64°50.20’ S	00°49.30’ W	5194	MARU Depl.
069-2	14.12.2008	09:11		64°05.14‘ S	00°05.56‘ W	5193	Surf wat smpl.
070-1	16.12.2008	11:21		69°24.19‘ S	05°31.90‘ W	1885	Surf wat smpl.
070-2	16.12.2008	12:34		69°24.41‘ S	05°31.69‘ W	1881	MABLE recov.
071-1	18.12.2008	19:56		70°29.54' S	08°22.10' W	252	CTD
072-1	20.12.2008	11:08		69°53.59' S	05°32.47' W	2031	CTD
073-1	21.12.2008	12:26		67°40.26' S	00°59.91' W	4583	CTD
074-1	22.12.2008	10:27		65°00.02' S	00°59.88' W	4939	CTD
075-1	22.12.2008	16:05		64°59.79’ S	00°00.76’ W	3744	CTD
076-1	22.12.2008	21:47		64°59.78’ S	00°59.28’ E	2860	CTD
076-2	22.12.2008	22:40		64°59.70’ S	00°58.69’ E	2868	Argo Float
077-1	23.12.2008	03:05		64°59.85’ S	01°59.75’ E	2548	CTD
078-1	23.12.2008	11:33		65°29.99’ S	03°00.52’ E	2628	CTD
078-2	23.12.2008	12:06		65°29.46’ S	02°59.44’ E	2607	Argo Float
079-1	23.12.2008	17:05		64°59.93' S	02°58.76' E	2384	CTD
079-2	23.12.2008	17:58		65°00.15’ S	02°57.20’ E	2392	Argo Float
080-1	23.12.2008	22:43		64°29.60’ S	03°00.60’ E	2149	CTD
080-2	23.12.2008	23:30		64°29.58’ S	03°00.61’ E	2148	Argo Float
081-1	24.12.2008	04:42		65°00.05’ S	03°59.70’ E	2586	CTD
082-1	24.12.2008	09:53		64°59.87’ S	05°00.97’ E	3799	CTD
082-2	24.12.2008	11:01		64°59.79’ S	05°01.50’ E	3808	Argo Float
083-1	24.12.2008	15:07		64°59.89' S	06°00.26' E	4445	CTD
084-1	25.12.2008	11:11		64° 33.96' S	09°07.91' E	4783	Soso Depl.
085-1	25.12.2008	14:11		64° 29.48' S	09° 49.07' E	4016	Soso Recov.
086-1	28.12.2008	09:50		56°00.07' S	12°48.86' E	4925	CTD
087-1	28.12.2008	21:28		54°54.30' S	13°07.91' E	4058	CTD
088-1	29.12.2008	08:30		53°45.29' S	13°28.02' E	4332	CTD
088-2	29.12.2008	09:55		53°45.21’ S	13°28.40’ E	4333	Argo Float
089-1	29.12.2008	20:17		52°22.25' S	13°51.42' E	3420	CTD
089-2	29.12.2008	21:25		52°22.00’ S	13°51.56’ E	3490	Argo Float
090-1	30.12.2008	08:14		50°56.15' S	14°14.71' E	3325	CTD
090-2	30.12.2008	09:28		50°55.93’ S	14°14.45’ E	3325	Argo Float
091-1	30.12.2008	21:01		49°35.73' S	14°32.16' E	4095	CTD
091-2	30.12.2008	22:42		49°35.31’ S	14°33.39’ E	4187	Argo Float
092-1	31.12.2008	08:39		48°21.59' S	14°43.43' E	4815	CTD
092-2	31.12.2008	10:06		48°21.11’ S	14°43.17’ E	4813	Argo Float
093-1	31.12.2008	18:38		47°18.94' S	14°56.17' E	4583	CTD

Station PS073	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
093-2	31.12.2008	20:04		47°18.56’ S	14°55.94’ E	4611	Argo Float
094-1	01.01.2009	08:36		45°37.26' S	15°14.25' E	4548	CTD
094-2	01.01.2009	10:07		45°37.53’ S	15°13.93’ E	4544	Argo Float
095-1	02.01.2009	13:09		41°07.29' S	15°52.68' E	4940	CTD
095-2	02.01.2009	14:49		41°05.09’ S	15°53.18’ E	4847	Argo Float
096-1	02.01.2009	22:00		40°18.59’ S	16°04.25’ E	4349	CTD
097-1	03.01.2009	05:46		39°31.54' S	16°28.09' E	4931	CTD
097-2	03.01.2009	07:25		39°30.93' S	16°30.16' E	4920	Argo Float

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