Expeditionsprogramm Nr. 81

FS POLARSTERN

ANT-XXV/1

ANT-XXV/2

Koordinator:
Dr. E. Fahrbach

Fahrtleiter:

ANT-XXV/1
Gerhard Kattner

ANT-XXV/2
Olaf Boebel

IFTUNG ALFRED-WEGENER-INSTITUT
R POLAR- UND MEERESFORSCHUNG
R HERMANN VON HELMHOLTZ-GEMEINSCHAFT
CHER FORSCHUNGSZENTREN E.V. (HGF)

BREMERHAVEN, OKTOBER 2008

EXPEDITION PROGRAMME No. 81

RV POLARSTERN

ANT-XXV/1
31 October 2008 - 3 December 2008
Bremerhaven - Cape Town

ANT-XXV/2
5 December 2008 - 5 January 2009
Cape Town - Cape Town

Coordinator
Eberhard Fahrbach

Chief Scientists
ANT-XXV/1: Gerhard Kattner
ANT-XXV/2: Olaf Boebel

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ANT-XXV/1

31 October - 3 December 2008

Bremerhaven - Cape Town

Chief scientist
Gerhard Kattner

CONTENTS

1. ÜBERBLICK UND FAHRTVERLAUF

Gerhard Kattner (AWI)

Der erste Fahrtabschnitt der 25. Antarktis-Kampagne mit dem Forschungsschiff *Polarstern* geht von Bremerhaven nach Kapstadt und umfasst zum einen chemische, biologische und atmosphärische Forschungsaufgaben und dient zum anderen zum Test der Posidonia und Podas-Anlagen an Bord sowie des Scanfishs, einem geschleppten, ondulierenden System. Die Reise beginnt am 31. Oktober 2008 und wird nach einem Bunkeraufenthalt in Rotterdam mit einem Zwischenstopp zum Ausschiffen einiger Teilnehmer in Las Palmas (Gran Canaria) nach Kapstadt gehen (Abb. 1), wo der Fahrtabschnitt am 3. Dezember endet. Die wissenschaftlichen Arbeiten werden überwiegend vom fahrenden Schiff aus durchgeführt. Die Wasserproben werden kontinuierlich mit einem geschleppten System und der schiffsinternen Seewasserversorgung genommen. Für Stationsarbeiten und Tests sind ca. 4 Tage vorgesehen.

Eine große interdisziplinäre Studie wird sich mit den gelösten organischen Substanzen (DOM) befassen. Die Charakterisierung des DOM auf molekularer Ebene im Oberflächenwasser in den verschiedenen, klimatischen Zonen sowie die Entstehung von refraktären Verbindungen bilden den Schwerpunkt dieser Untersuchungen. Parallel dazu wird die chemische Zusammensetzung des Aerosols untersucht. Spurenelemente und der Fluss von elementarem Quecksilber zwischen Wasser und Atmosphäre werden kontinuierlich während der gesamten Fahrt bestimmt. Ein weiteres Projekt befasst sich mit der Bestimmung und Charakterisierung sowie dem Transport von mehrfach fluorierten Pestiziden ebenfalls im Oberflächenwasser und in der Atmosphäre.

Der Kohlenstoffkreislauf im Oberflächenwasser wird mit dem Ziel untersucht, ein autonomes System zur Messung der verschiedenen Komponenten zu entwickeln. Außerdem gehört die Bestimmung von Dimethylsulfid (DMS) in der Wasseroberfläche und in der Atmosphäre zum Messprogramm. Um die globale marine Primärproduktion aus Satellitendaten besser abschätzen zu können, werden optische *in-situ* Bestimmungen durchgeführt, sowie die Zusammensetzung und Produktivität des Phytoplanktons und der partikuläre organische Kohlenstoff bestimmt. Eine weitere Arbeitsgruppe im Rahmen der WGL-PAKT-Initiative OCEANET befasst sich mit der Strahlung in der Atmosphäre, deren Ergebnisse ebenfalls in die Fernerkundung und Klimamodelle eingehen sollen.

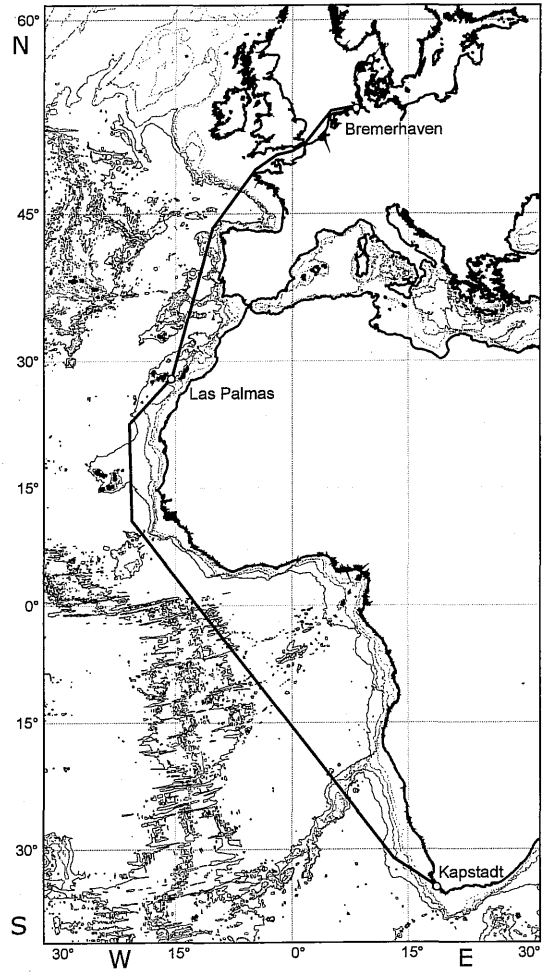

Abb. 1: Fahrtroute während ANT-XXV/1
Fig. 1: Cruise track during ANT-XXV/1

ITINERARY AND SUMMARY

The first leg of the 25th campaign of the research vessel *Polarstern* to the Antarctic will start in Bremerhaven on 31 October 2008 and will end in Cape Town on 3 December. After a bunker stop in Rotterdam and a stop in Las Palmas (Canary Islands) to disembark some cruise participants the cruise track will be taken to Cape Town (Fig. 1). About 4 days are available for scientific station work. The scientific programme comprises atmospheric, biological and chemical investigations. Scientific instrumentation (Posidonia and Podas) as well as an undulating instrument package Scanfish will be tested during the first period of the cruise. Surface seawater will be continuously pumped by a towed clean-seawater supply system and the internal seawater system of *Polarstern*.

A detailed interdisciplinary study focusing on the molecular characteristics of dissolved organic matter will be performed in the Atlantic surface ocean to relate the data to different climatic, hydrographical, biological and meteorological regimes as well as to terrestrial input from riverine and atmospheric sources. In parallel, the chemical composition of aerosols will be determined. Trace elements and the flux of mercury between water and atmosphere will be continuously measured during the cruise. Another project is focused on the determination of per- and polyfluorinated compounds (PFCs) and organic fluorinated pesticides to characterize the distribution of novel PFCs in the atmosphere and sea water of the Atlantic Ocean and evaluate the air-sea gas exchange process intervening in the transport of PFCs.

The marine carbon cycle in the surface ocean will be investigated to provide operational approaches for unattended operation. In addition to the carbon measurements, dimethylsuphide (DMS) measurements will be conducted in the surface seawaters and the atmosphere. *In-situ* measurements of ocean optics, phytoplankton productivity and composition and particulate organic carbon will be performed to improve estimates of global marine primary production and the distribution of major phytoplankton functional groups by using remote sensing data. Another project in the context of the WGL-PAKT initiative OCEANET aims at observing both the radiation budget and the state of the atmosphere as accurate as possible to provide realistic atmosphere-radiation relationships for use in climate models and in remote sensing.

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

Boris Koch, Ruth Flerus, Gerhard Kattner, Oliver Lechtenfeld (AWI), Lei Zhang, Zhuoyi Zhu (ECNU), I Suryaputra, David Podgorski (FSU), Norbert Hertkorn, Philippe Schmitt-Kopplin (HZM), Blazenka Gasparovic (IRB), Michael Gonsior (UCI), Leigh McCallister, Amy Jenkins, Anne Stuart (VCU), Dieter Peterke, Neogi Sucharit Basu (ZMT), Thorsten Dittmar (FSU, not on board)

Objectives

One of the most important aspects to understand the global fluxes of marine 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 to relate the data to different climatic, hydrographical, biological and meteorological regimes as well as to terrestrial input from riverine and 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 North to the South Atlantic. We hypothesize that:

The majority of the molecular changes in DOM are taking place in the uppermost water column. This conversion occurs almost instantaneously after release by primary production or atmospheric input and is mediated by microbial and photochemical processes. After this quick process the reworked material is more similar to the refractory deep-sea DOM than to the fresh initial DOM.

We also intend to examine whether the input of aerosols can explain the occurrence of thermogenic compounds which were recently identified in marine DOM.

Work at sea

Sampling will be carried out using filtered water from a Teflon fish sampler and from the moon pool. We will continuously monitor salinity, water temperature and meteorological parameters, such as air temperature, rainfall and radiation. Satellite images for surface chlorophyll will provide complementary data in high spatial resolution. Aerosols will be continuously collected at the observation deck.

Sampling for most parameters will concertedly be performed every 12 hours using the fish sampler. DOC and fluorescence will be sampled in higher time resolution to get a detailed dataset of background parameters. Bacterial abundance and production will be tightly coupled to DOC sampling and fluorescence characteristics. Solid phase extraction (SPE), and sampling for radiocarbon analyses will be coordinated and performed in larger time intervals. All samples will be classified according to differences in climatic zones (temperature, radiation, etc.), primary production and extend of aerosol/rainwater input. In

addition, depth profiles will be taken at stations along the transect. During the CTD station time we are planning to perform a test for an *in-situ* DOM sampling method.

Ultrahigh resolution Fourier Transform ion cyclotron resonance mass spectrometry (FT-ICR-MS), 3D-fluorescence spectra, low-molecular weight free organic acids, amino acids, chitin, pigments and other biogeochemical parameters will be measured onboard or after the cruise in the laboratories of the various international participants. In addition, the DOM samples will be characterized by molecular size, polarity and electrochemical properties. Fluctuations in DOM concentration and composition will be related to biological activity. The high-resolution dataset of bacterial abundance and production will provide a metabolic context for the DOM characterization work and pCO_2 concentrations. In addition, we will study chitin degrading bacteria (genus *Vibrio*). Radiocarbon data will be used to assess the residence time of specific DOM components.

DOC concentration and composition will also be related to the nutrient and oxygen regimes, i.e. oligotrophic in open ocean or sub-eutrophic at shelf fronts, in samples from and below the euphotic zone to assess, e.g. the influence of photodegradation. The results will be related to the isotopic signature of particulate and dissolved components, which in turn will reflect the adaptation of phytoplankton and heterotrophic bacterioplankton to the predominant nutrient regime.

In addition, the relation of hydrogen peroxide to DOM, chlorophyll and wet/dry deposition under open ocean conditions will be examined. Hydrogen peroxide levels may also be related to changes in the quality of the DOM pool, and a comparison of hydrogen peroxide to molecular characteristics determined by FT-ICR-MS may reveal additional information about hydrogen peroxide production/decay in the open ocean.

Links will be established to the investigations on aerosols as possible external source of these compounds. We also aim to define the typical marine-source fingerprint of aerosols as a function of various weather conditions and compare the structural features of marine aerosols and marine surface water samples. The Atlantic is an extremely good testing ground for this work as a transect from Bremerhaven to Cape Town covers the high dust region of the Sahara, the low dust regions south of the equator, thus allowing a wide scale look at the effects of dust supply, phytoplankton activity and the impact of DOM on metal speciation. Post-cruise sampling will include analysis of the relevant satellite data for the cruise period combined with air-mass back trajectory analysis using HYSPLIT. Samples will also be collected from profiles with high depth resolution in the upper 100 m to compare DOM dominated by fast surface transformations and old DOM which was subject to long-term processes. DOM samples from deeper water will be taken as a reference for the refractory deep ocean DOM background.

3. TRACE ELEMENTS (HG, CD, PB, MN, CO, NI, FE) IN THE SURFACE WATERS OF THE EAST ATLANTIC. A CONTRIBUTION TO GEOTRACES

Christa Pohl, Enrique Fernández Otero (IOW)

Objectives and work at sea

In our study we will analyse the trace elements Hg, Cd, Pb, Zn, Co, Mn, Fe, Co, Ni, Al and Ti in the surface water and deep water profiles at selected stations in eastern Atlantic waters. Accompanying measurements of Fe (II) species, a possible bioavailable fraction of iron supporting phytoplankton growth, will be carried out directly on board of *Polarstern*.

For the element mercury this is a unique chance to repeat our measurements carried out in 2005 and to deliver the total and reactive Hg concentrations in surface waters of the East Atlantic. This is a perfect symbiosis and essential support to the mercury exchange studies with the atmosphere (see chapter 4, proposal of Joachim Kuß).

The determination of the trace elements Cd, Pb, Zn, Co, Mn, Fe, Co and Ni are of special interest for an intercomparison exercise in addition to the project "Sail & Research". This is a separate project and will be carried out between October 2008 and July 2010 in the eastern and western Atlantic and the Southern Ocean by sailing boat and parallels this eastern Atlantic cruise. With this background it would be a unique chance for us to compare the different sampling techniques for trace elements carried out with the equipment of *Polarstern* and from a sailing boat.

4. ELEMENTAL MERCURY SEA-AIR FLUX

Joachim Kuß, Hildegard Kubsch, Klaus-Peter Wlost (IOW) (until Las Palmas, Canary Islands), Bernd Schneider (not on board) (IOW)

Objectives

The objective of the study is to determine the elemental mercury (Hg^0) sea-air flux in various geochemical provinces of the Atlantic Ocean. The transect Bremerhaven - Cape Town in November 2008 is the first study and will be complemented by a transect Punta Arenas – Bremerhaven in April/May 2009 (ANT-XXV/5) as a seasonal intercomparison in the frame of a project funded by the German Science Foundation (DFG). The spatial variability of the Hg^0 flux will be investigated in relation to biological conditions and physical forcing factors like wind and solar radiation.

Mercury mobilized by anthropogenic activity is introduced into the sea by wet and dry deposition and by river drainage. But the sea could also become a significant source because of Hg^0 sea-air gas exchange. Transformation of ionic mercury to volatile Hg^0 is possibly caused by direct photon-induced reactions and/or by biotic processes in surface waters. The spatial and seasonal variability of the Hg^0 emission has been shown for the Baltic Sea in 2006 (Kuss and Schneider, 2007) and will be investigated in the Atlantic Ocean

by the two cruises of *Polarstern*. The following questions are attempted to be answered during the study:

- How do the atmospheric and oceanic circulations and thus the biogeochemical regimes determine the Hg^0 concentration in surface waters?
- Is the Hg^0 concentration in surface water related to biological processes?
- Do enhanced Hg^0 concentrations occur mainly in regions with a predominance of primary production or of heterotrophic respiration?
- Is the elemental mercury (Hg^0) emission of the Atlantic Ocean variable in space and time?
- Is the release of Hg^0 controlled by latitudinal-dependent solar radiation?

Work at sea

The Hg^0 concentration in Atlantic surface water will be determined with a new method that rely on measurements of air that is equilibrated with surface water concerning Hg^0 (Kuss and Schneider, 2007). During the transect seawater is pumped continuously by a clean-seawater supply system and dispersed into the headspace of a 20 l gas bottle by a shower head and drained afterwards. Two water supply systems will be compared during the cruise. Either water is analyzed that will be pumped from below the ship's hull by a "snorkel" or from a "fish sampler" (streamlined body that keeps the intake of the tubing at a few metres depth) that will be towed alongside. After about 1 hour the headspace air is in equilibrium with the surface water and Hg^0_{equ} will be subsequently measured by cold-vapour atomic fluorescence spectroscopy. Alternately Hg^0_{atm} will be measured in the marine atmosphere. The Hg^0 sea-air flux is then calculated by using $F=k*(Hg^0_{equ}-Hg^0_{atm})/H$; with the gas exchange transfer velocity k dependent on wind speed, and Henry's law constant H.

Water samples will be regularly taken and subjected to a filtration procedure for the determination of dissolved and particulate organic carbon (DOC/POC), Chlorophyll *a*, and phaeopigments. Filters and filtrates will be stored deep-frozen until analyses that will be done after the campaign in the laboratories of the IOW. From continuously pumped seawater also the partial pressure of CO_2 will be measured by an Equilibrator coupled to a non-dispersive infrared spectrometer. In addition, recording of ship data from PODAS of solar radiation, temperature and salinity of the surface water (thermosalinograph) and wind (relative and true wind speed and direction) will be optimized and used for preliminary calculations or saved during the cruise for later calculations and interpretation of the data set.

Reference

Kuss, J. and Schneider, B., 2007. Variability of the gaseous elemental mercury sea-air flux of the Baltic Sea. Environmental Science and Technology, 41(23): 8018–8023.

5. INVESTIGATION OF POLYFLUORINATED SUBSTANCES IN THE ATLANTIC OCEAN

Zhiyong Xie (GKSS)

Objectives

Per- and polyfluorinated compounds (PFCs), e.g. perfluorooctanoate (PFOA), perfluorooctane sulfonate (PFOS), perfluoro alkyl sulfonamide (PFOSA), and N-substituted sulfonamides and fluorotelomer alcohols (FTOHs) have been produced in high volumes for several decades and are widely used to make consumer products such as polymerisation aids, stain repellents in carpets, textile, and leather and paper products. Scientific concern about PFCs increased due to their global distribution and ubiquitous detection in the environment, fish and marine mammals, as well as in human blood. Some PFCs have been shown to cause developmental delays and cancer in lab animals. Recent studies conducted in the presence of PFCs in wildlife from the Arctic have demonstrated that these chemicals are widespread in these regions and accumulated in the food chain. More studies are required to resolve how PFCs are transported from the sources to the coast and marine environment.

For the *Polarstern* cruise, the project is focused on the determination of PFCs and organic fluorinated pesticides in surface waters and air through the North to South Atlantic Ocean. The aim of the project is to characterize the distribution of novel PFCs in the atmosphere and sea water of the Atlantic Ocean and evaluate the air–sea gas exchange process intervening in the transport of PFCs into coastal regions. The cruise is quite optimal for these investigations as it ranges from the likely sources (European continent) to remote areas without direct inputs.

Work at sea

Air samples are collected using a high-volume air sampler operating at a constant flow rate of 200 - 500 l min^{-1}. The high volume air sampler consists of a high volume pump, a digital flow meter, a metal filter holder and a PUF/XAD-2 column. GF/F 8 filter is used to collect atmospheric particles. The ship-borne air samples are collected on the upper deck of *Polarstern*. Field blanks are prepared by spiking surrogate standards in the PUF/XAD-2 column and short exposure to the sampling site.

Different sampling procedures for determination of PFCs in the water phase will be applied and compared. High volume water samples are collected using Kiel In-Situ Pump (KISP) equipped with PAD-3 column which is optimal for unpolar substances. 2-l water samplers followed with solid-phase extraction are compared with PAD-4 column samples for determination of perfluorinated acids. A glass fiber filter (GF/F 52) is used to collect suspended particular matters (SPM).

By combining short-term atmospheric samples and the collections of reprehensive water samples across different region of the North and South Atlantic Ocean, findings are sought as to whether atmospheric transport or ocean current are controlling the transport and setting flux of these organic pollutants.

6. AUTONOMOUS MEASUREMENT PLATFORMS FOR SURFACE OCEAN BIOGEOCHEMISTRY (OCEANET): OCEAN

Tobias Steinhoff (until Las Palmas, Canary Islands), Peer Fietzek, Christa Marandino, Cathleen Zindler (IFM-GEOMAR)
not on board: Arne Körtzinger (IFM-GEOMAR), Mario Hoppema (AWI Bremerhaven), H. Zemmelink (NIOZ)

Objectives

This project is part of the WGL-PAKT-Initiative OCEANET which aims to combine the existing expertise of IFM-GEOMAR, GKSS and AWI to further develop, test and install on *Polarstern* autonomous instrumentation for measurement of exchange of energy and matter between the atmosphere and the surface ocean. The long term goal of this initiative is to provide operational approaches for unattended operation on "Voluntary Observing Ships".

The oceanic component of this study focuses on the marine carbon cycle in the surface ocean which is of high climate relevance, but at the same time susceptible to climate change. The surface ocean's CO_2 source/sink function is maintained by a complex interaction of physical and biological processes. A deconvolution of these driving forces requires both a rather comprehensive observational approach as well as high spatial and temporal coverage. These requirements can only be met with multi-parameter observational approaches that can be operated in unattended mode on platforms such as merchant vessels.

During the first OCEANET cruise in April/May 2008 the feasibility of autonomous underway measurements was assessed for a wide range of instruments for measurement of physical (temperature, salinity, turbidity), chemical (CO_2 partial pressure, pH, oxygen, total gas tension, nutrients), and biological parameters (chlorophyll *a*, photosynthetic parameters) and a small inter-comparison for measurements of CO_2 partial pressure and oxygen took place.The main focus of this cruise will be field tests for newly developed CO_2 partial pressure sensors and a broader inter-comparison of different sensors to point out the differences of the sensors and their pro and cons. It is a great chance to study their behaviour in different biogeochemical regions.

In addition to the pCO_2 measurements we will also conduct DMS measurements in the surface seawaters and the atmosphere of the East Atlantic Ocean by comparing two different methods: gas chromatography and Atmospheric Pressure Chemical Ionization Mass Spectrometry (API-CIMS). The atmosphere/ocean flux of DMS should be estimated as oceanic DMS is supposed to have the capacity to regulate local or regional climate through its effect on cloud condensation nuclei concentrations.

Work at sea

Measurements will be made continuously on pumped surface seawater using the following approaches:

- Autonomous continuous measurements of CO_2 partial pressure in surface waters with different instruments (AWI, NIOZ, IFM-GEOMAR)
- autonomous continuous measurements of fluorescence, dissolved oxygen and total gas tension in surface waters (IFM-GEOMAR)

- discrete water samples for dissolved inorganic carbon and alkalinity will be taken every 6 hours (IFM-GEOMAR)
- eddy correlation air/sea flux measurements of DMS will be performed by using the API-CIMS (IFM-GEOMAR)
- measurements of dissolved DMS will be made from pumped surface seawater by using both the GC and the API-CIMS technique (IFM-GEOMAR)
- the surface distribution of the major DMS precursor, dimethylsulfoniopropionate (DMSP), will be determined by the GC method (IFM-GEOMAR)

We will generate high-quality data in a high temporal resolution along the meridional surface transect through the Atlantic Ocean. The combined data set of autonomously recorded and discrete samples will provide a detailed insight in the carbon chemistry of the surface waters. In addition, the comparison of instruments for the measurements of CO_2 partial pressure along the transect will show the pro and cons of the different methods and have the potential to guide further developments.

7. SATELLITE GROUND TRUTH: BIO-OPTICAL MEASUREMENTS

Erika Allhusen, Anja Theis (AWI)

Introduction and objectives

It has been estimated that marine phytoplankton contributes 30 to 60 % to global primary production. The large uncertainty range is a result of the lack of global information on phytoplankton absorption and light penetration depth, which cannot be supplied by the current ocean colour satellite sensors. The spectral resolution of these sensors is not sufficient to extract the relevant information. The variation of phytoplankton absorption in ocean waters also affects the retrieval of chlorophyll *a* concentrations (a measure of phytoplankton biomass) derived from satellite data which are important input data used in primary production models. Results by Bracher et al. (2006) show that specific phytoplankton absorption spectra as well as information on the light penetration depth can be derived by combining information from measurements of the two satellite instruments, MERIS with high spatial, and SCIAMACHY with high spectral resolution (both operating on board of the European environmental satellite ENVISAT).

Besides the analysis of satellite data and applied model studies, field measurements in the open ocean of phytoplankton pigment composition, optical characteristics of phytoplankton and other water constituents, reflectance and underwater light measurements are highly precise input parameters for the validation of results from the analyses of satellite data and modelling.

Thus, the aim of this research project is to improve estimates of global marine primary production and the distribution of major phytoplankton functional groups by using remote sensing data in combination with *in-situ* measurements of ocean optics, phytoplankton productivity and composition and particulate organic carbon. In particular, data will be collected during this cruise to improve our understanding of the oceans variability in optical properties and to improve/develop remote sensing algorithms for the investigated research area. Through a better knowledge of the sinks and sources of CO_2 in the ocean a

contribution will be made to a better understanding of changes in the world's climate as well as to the understanding of the marine food web.

Work at sea

Water samples will be taken frequently from the surface and at the stations from CTD/rosette casts and processed for various analyses:

- Water samples will be filtered onto GF/F filters for pigment analysis, particulate absorption measurements and total suspended matter.
- Water samples will be preserved for flow cytometry measurements later in the laboratory in Bremerhaven.
- Particulate absorption in suspension and absorption of Gelbstoff will be measured during the cruise using the point-source integrating-cavity absorption meter (PSICAM) (Röttgers et al. 2005).

Online and *in-situ* optical measurements

- A FastTracka Fast Repetition Rate Fluorimeter (FRRF) will be used in a flow-through system with water continuously pumped from the moon pool to provide online data of chlorophyll fluorescence during the cruise.
- A second FastTracka FRRF will be attached to the CTD to take measurements in the water column
- Remote sensing reflectance will be measured firstly from onboard the ship with a set of three radiometers and secondly in the water column (0 - 150 m) at the stations.

References

Bracher A., Vountas M., Dinter T., Röttgers R., Doerffer R., Burrows J.P. (2006) Retrieval of phytoplankton distribution and light absorption from space borne SCIAMACHY data using Differential Optical Absorption Spectroscopy. Proceedings of the Ocean Optics XVIII, 9-13 Oct 2006, Delta CentreVille, Montreal, Canada.

Röttgers R., Schönfeld W., Kipp P.-R., Doerffer R. (2005) Practical test of a point-source integrating cavity absorption meter: the performance of different collector assemblies. Applied Optics 44(26): 5549-5560.

8. COMPOSITION OF THE ATMOSPHERE AND RADIATION BUDGET AT THE ATMOSPHERE/OCEAN INTERSECTION (OCEANET - ATMOSPHERE)

Katharina Lengfeld, Timo Hanschmann, Andreas Macke (not on board) (IFM-GEOMAR)

Introduction and objectives

In the framework of the WGL-PAKT initiative OCEANET the state of the atmosphere and its effect on the net radiation budget at the sea surface will be obtained by a combination of ceilometer, full sky imager as well as pyrano- and pyrgeometer. A further goal is to characterize aerosol column properties, check their consistency with associated

measurements of broadband radiative fluxes, and to monitor temporal evolution of aerosol properties in order to explore aerosol-cloud interactions and to establish meridional gradients of tropospheric aerosols. Finally, the spatial and temporal variability of the solar irradiance at various depths will be determined together with the sea surface wave variability.

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. The project aims at observing both the radiation budget and the state of the atmosphere as accurate as possible to provide realistic atmosphere-radiation relationships for use in climate models and in remote sensing. While similar experiments have been performed from land stations, only few data from measurements over ocean areas exist. The present project is also part of the "Meridional Ocean Radiation Experiment" (MORE) which uses Atlantic transfers of various research vessels for the combined measurements of the atmospheric state. In the long run, based on the experiences of this and later Atlantic transects, an autonomous measurement sea container is planned for operational atmospheric monitoring on board voluntary observing ships.

Work at sea

Upon departure from Bremerhaven the following instruments will be installed on board *Polarstern* for continuous measurements:

- Pyranometer and pyrgeometer,
- whole sky imager for cloud structure measurement,
- handheld sun photometer (Microtops) for aerosol and cloud optical thickness,
- inclinometer for sea surface tilt measurements,
- underwater camera for observations of light fluctuations.

Expected results are surface radiation budget, cloud cover and clout types, aerosol optical thickness, sea surface wave statistics, underwater light fluctuations

9. SHIPBOARD ADCP-MEASUREMENTS OF EQUATORIAL CURRENT SYSTEM

P. Brandt (not on board) (IFM-GEOMAR)

Objectives

Shipboard ADCP measurements with *Polarstern* will enhance the availability of current sections and thus will allow in the future to address the intra-seasonal to seasonal variability of the transport of the main current branches. Furthermore, they will be used as a reference data set for the moored observation at the equator at 23°W.

While for the near-surface flows seasonal cycles can be determined from drifter currents and altimetry, reliable transports and seasonal cycle analyses of the subsurface flows from the interior tropical Atlantic that could serve as a calibration base for model simulations have not become available. Recently, however, time series from moored ADCPs were obtained within the context of the Pilot Research Moored Array in the Tropical Atlantic (PIRATA). The mooring activity was continued in the frame of the project BMBF *Nordatlantik*. Within this

project a current meter mooring array was deployed at 23°W for the first time in August 2006. While the moored instruments will yield multi-year current observations at fixed positions, ship sections are needed to resolve the complicated structure of the equatorial current system (Fig. 2).

Shipboard current observations were used to obtain mean transports of the primary equatorial current branches, particularly the Equatorial Undercurrent (EUC) at 35°W and 26°W. However, the available ship sections are up to now not conclusive concerning the seasonal cycle of EUC transports.

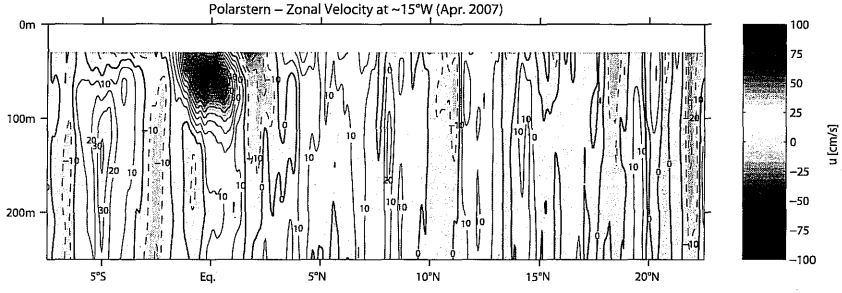

Fig. 2: Zonal current velocity along a meridional section at 15 to 20°W during Polarstern cruise ANT–XXIII/10 in April 2007. Most prominent is the equatorial current system with the Equatorial Undercurrent (EUC) at 50 m depth at the equator (up to 1 m/s) and the South Equatorial Undercurrent (SEUC) at 100 to 200 m depth at 5°S (up to 0.4 m/s). Further north there are several eastward and westward current bands mainly associated with the enhanced eddy field in the region.

Work at sea

Polarstern is equipped with a shipboard 150 kHz Ocean Surveyor ADCP. Velocity data were acquired during *Polarstern* cruises ANT-XXII in June 2005 (Brandt et al. 2006) and ANT–XXIII/10 in April 2007 (Fig. 1). The velocity data obtained after processing were of good quality. Depth range is 200 to 250 m for the whole cruise. Thanks to frequent purposeful deviations from a straight cruise track, the transducer misalignment - which is an essential factor in data processing - could be determined quite well. Those purposeful deviations prove most suitable if the time intervals between course changes are 10 minutes at least and course changes are 10 degrees at least. During the second cruise in April 2007, heading data were available from the Laser-navigation-platform. This heading resulted in slightly lower data quality compared to previous cruise in June 2005, when the heading from the ASHTECH array were used. It is thus recommended to store heading information from both the Laser-navigation-platform and the ASHTECH array together with the ADCP data. The ADCP should run as long as possible, i.e. outside the 200 nm zone. Frequent purposeful deviations from the course should be performed in the region 10°S to 20°N twice daily.

10. TESTING A TOWED, UNDULATING INSTRUMENT PACKAGE SCANFISH

Anselm Almeida, Anand Methar (NIO), NN (Scanfish)

Objectives and work at sea

For the iron fertilization experiment LOHAFEX (ANT-XXV/3) from January to March 2009 an undulating instrument package Scanfish will be employed to carry out surveys of the patch and the surrounding eddy core. To this end the National Institute of Oceanography (NIO) in Goa, India has purchased an instrument which will be directly shipped to Bremerhaven. This instrument will be tested and scientists participating in LOHAFEX trained in its use during ANT-XXV/1.

Testing and training would be done during 3 deployments along the stretch Bremerhaven-Canary Islands. Scanfish has been successfully used from *Polarstern* during earlier cruises. Scanfish is deployed from the A-frame at the stern of the ship using a special winch fixed to the deck. Towing is possible at speeds of up to 10 knots although 8 would be preferable. While lowering Scanfish into the sea, ship speed is reduced to about 3 – 4 knots for a few minutes. The same procedure is followed during retrieval. Three deployments with tows of about 1 hour each are planned. We estimate the total amount of ship time required for slowing the ship for deployments, retrievals and towing, relative to constant cruising speed of 10.5 – 11 knots, to be in the range of a few hours.

11. SEA TRIAL AND TESTS OF THE NEW UPGRADED UNDER WATER NAVIGATION SYSTEM "POSIDONIA"

Saad El Naggar, Peter Gerchow, Gerd Rohardt (AWI), Johannes Rogenhagen (Laeisz), Frederic Bellier (IXSEA) (all until Las Palmas, Canary Islands)

Introduction

The underwater navigation system POSIDONIA was upgraded during the last ship yard stay of *Polarstern* in Bremerhaven between 20.05.08 and 12.06.08. Newly designed hard and software were installed and tested in the harbour of Bremerhaven. New acoustic array and window were fix-installed nearby the moon pool in addition to the mobile acoustic array. A complete new electronic cabinet was installed, modified and tested.

The first operational test under real conditions at sea was carried out during the cruise ARK–XXIII/1 and 2. The final sea trial and calibration will be carried out during the cruise on the way to Las Palmas during the period of 03.11.08 and 10.11.08. For a proper testing, water depths of more than 3,000 m are required.

Work at sea

- Complete and tune the final installation according to the claims found out during the first sea trial tests on ARK-XXIII/1+2.
- Mooring of the calibration transponder.
- Sea trial, calibration and acceptance tests at location (about 24 hours).
- Recovering of the Transponder.
- Data analysis and validations.
- Real operations between test location and Las Palmas.
- Disembarking the test team in Las Palmas on 10.11.08.

12. SEA TRIAL AND TESTS OF THE NEW UPGRADED DATA ACQUISITION SYSTEM "PODAS" TO "DAVIS-SHIP"

Saad El Naggar, Peter Gerchow (AWI), Johannes Rogenhagen (Laeisz), Uwe Zenker, Ralf Löwenberg (WERUM) (all until Las Palmas, Canary Islands)

Introduction

The data acquisition system PODAS was upgraded during the last ship yard stay of *Polarstern* in Bremerhaven between 19.10.08 and 03.11.08 to DAVIS-Ship. New designed software were installed and tested in the harbour of Bremerhaven.

The final sea trial under real condition will be carried out during the cruise on the way from Bremerhaven to Las Palmas in the mean time between 03.11.08 and 10.11.08. The full functionality and integrity of the complete system will be checked and tested.

Work at sea

- Complete and tune the final installation according to the technical specifications.
- Sea trial and acceptance tests during the cruise (no ship time required).
- Data analysis and validations.
- Monitoring the real operations.
- Disembarking the test team in Las Palmas on 10.11.08.

13. BETEILIGTE INSTITUTE / PARTICIPATING INSTITUTES

	Adresse Address
AWI	Alfred-Wegener-Institut für Polar- und Meeresforschung in der Helmholtz-Gemeinschaft Postfach 120161 27515 Bremerhaven Germany
DWD	Deutscher Wetterdienst Abteilung Seeschiffahrt Bernhard-Nocht-Straße 76 20359 Hamburg Germany
ECNU	East China Normal University The State Key Laboratory of Estuarine and Coastal Research North Zhongshan Rd. 3663 Shanghai 200062 China
FSU	Florida State University Dept. of Oceanography Dept. of Chemistry & Biochemistry 95 Chiefton Way Tallahassee FL 32306-4390 USA
GKSS	GKSS Research Centre Institute for Coastal Research Department for Environmental Chemistry Max-Planck-Straße 1 D-21502 Geesthacht Germany
HZM	Helmholtz Zentrum München German Research Center for Environmental Health Ingolstädter Landstraße 1 Postfach 1129 D-85758 Neuherberg Germany

	Adresse Address
ICBM	Carl von Ossietzky Universität Oldenburg Institute for Chemistry and Biology of the Marine Environment Carl-von-Ossietzky Str. 9-11 Postfach 2503 D-26111 Oldenburg Germany
IFM-GEOMAR	Leibniz Institute of Marine Sciences West Shore Campus Düsternbrooker Weg 20 D-24105 Kiel Germany
IOW	Leibniz Institute for Baltic Sea Research Seestr. 15 D-18119 Warnemünde Germany
IRB	Rudjer Boskovic Institute Bijenicka 54 HR-10000 Zagreb Croatia
IXSEA	IXSEA Rue Rivoalon Sainte-Anne du Portzic 29200 Brest France
Laeisz	Reederei F. Laeisz (Bremerhaven) GmbH Brückenstraße 25 27568 Bremerhaven Germany
NIO	National Institute of Oceanography Dona Paula Goa India
Scan Fish	Danmark A/S Kai Lindbergs Gade 50 -52 DK 7730 HANSTHOLM Denmark
UCI	University of California Irvine Urban Water Research Center Department of Civil & Environmental Engineering 254 Social Ecology I Irvine CA 92697-7070 USA

	Adresse Address
VCU	Virginia Commonwealth University Department of Biology Center for Environmental Studies 1000 W Cary Street Richmond VA 23284 USA
WERUM	Werum Software & Systems AG Wulf-Werum-Straße 3 D-21337 Lüneburg Germany

14. FAHRTTEILNEHMER / PARTICIPANTS

Name/ Last name	Vorname/ First name	Institut/ Institute	Beruf/ Profession
Allhusen	Erika	AWI	Technician
Buldt	Klaus	DWD	Technician
Fietzek	Peer	IfM Geomar	PhD student, chemistry
Flerus	Ruth	AWI	PhD student, chemistry
Gasparovic	Blazenka	IRB	Chemist
Gonsior	Michael	UCI	Chemist
Hanschmann	Timo	IfM Geomar	Meteorologist
Hertkorn	Norbert	HZM	Chemist
Jenkins	Amy	VCU	Student, biology
I	Suryaputra	FSU	Student, chemistry
Kattner	Gerhard	AWI	Chemist
Koch	Boris	AWI	Chemist
Kubsch	Hildegard	IOW	Technician
Kuß	Joachim	IOW	Chemist
Lechtenfeld	Oliver	AWI	PhD student, chemistry
Lengfeld	Katharina	IfM Geomar	Student, chemistry
Marandino	Christa	IfM Geomar	Chemist
McCallister	Leigh	VCU	Biologist
Neogi	Sucharit Basu	ZMT	Student
Otero	Fernández Enrique	IOW	PhD Student, chemistry
Peterke	Dieter	ZMT	Technician
Podgorski	David	FSU	PhD student, chemistry
Pohl	Christa	IOW	Chemist
Schmitt-Kopplin	Philippe	HZM	Chemist
Stuart	Anne	VCU	Student, biology
Theis	Anja	AWI	Student, physics
Xie	Zhiyong	GKSS	Chemist
Zhang	Lei	ECNU	Chemist
Zhu	Zhuo-Yi	ECNU	Chemist
Zindler	Cathleen	IfM Geomar	Biologist
NN		DWD	Meteorologist
Until Las Palmas, Canary Islands			
Almeida	Anselm	NIO	Scientist
Bellier	Frederic	IXSEA	Engineer
El Naggar	Saad	AWI	Physicist
Gerchow	Peter	AWI	Physicist
Methar	Anand	NIO	Scientist
Löwenberg	Ralf	WERUM	Engineer
Rogenhagen	Johannes	Laeisz	Physicist
Rohardt	Gerd	AWI	Oceanographer
Steinhoff	Tobias	IfM Geomar	Chemist
Wlost	Klaus-Peter	IOW	Engineer
Zenker	Uwe	WERUM	Engineer
NN		Scanfish	

15. SCHIFFSBESATZUNG / SHIP'S CREW

No.	Name	Rank
1.	Pahl, Uwe	Master
2.	Grundmann, Uwe	1.Offc.
3.	Krohn, Günter	Ch.Eng.
4.	Bratz, Herbert	2.Offc.
5.	Hering, Igor	2.Offc.
6.	Janik, Michael	3.Offc.
7.	Uhlig, Holger	Doctor
8.	Koch, Georg	R.Offc.
9.	Kotnik, Herbert	2.Eng.
10.	Schnürch, Helmut	2.Eng.
11.	Westphal, Henning	2.Eng.
12.	Holtz, Hartmut	Elec.Tech.
13.	Rehe, Lars	Electron.
14.	Dimmler, Werner	Electron.
15.	Fröb, Martin	Electron.
16.	Feiertag, Thomas	Electron.
17.	Clasen, Burkhard	Boatsw.
18.	Neisner,Winfried	Carpenter
19.	Kreis, Reinhard	A.B.
20.	NN	A.B.
21.	Burzan, G.-Ekkehard	A.B.
22.	Schröder, Norbert	A.B.
23.	Moser, Siegfried	A.B.
24.	Pousada Martinez, S.	A.B.
25.	Hartwig-L., Andreas	A.B.
26.	Kretzschmar, Uwe	A.B.
27.	Beth, Detlef	Storekeep.
28.	Kliem, Peter	Mot-man
29.	Fritz, Günter	Mot-man
30.	Krösche, Eckard	Mot-man
31.	Dinse, Horst	Mot-man
32.	Watzel, Bernhard	Mot-man
33.	Fischer, Matthias	Cook
34.	Tupy,Mario	Cooksmate
35.	Völske, Thomas	Cooksmate
36.	Dinse, Petra	1.Stwdess
37.	Hölger, Irene	Stwdss/KS
38.	Streit, Christina	2.Steward
39.	Hischke, Peggy	2.Stwdess
40.	Wartenberg, Irina	2.Stwdess
41.	Hu, Guo Yong	2.Steward
42.	Sun,Yong Sheng	2.Steward
43.	Yu, Chung Leung	Laundrym.
44.	NN	Appr.
45.	NN	Appr.

ANT-XXV/2

5 December 2008 - 5 January 2009

Cape Town - Neumayer Station - Cape Town

Chief Scientist
Olaf Boebel

CONTENTS

1. ÜBERBLICK UND FAHRTVERLAUF

Olaf Boebel

Am 5. Dezember 2008 wird das Forschungsschiff *Polarstern* von Kapstadt zur Antarktisreise ANT-XXV/2 auslaufen. Zunächst wird der Kurs – unter Berücksichtigung der Eislage – möglichst direkt zur Neumayer Station führen (Abb. 1.1). Bereits kurz nach dem Auslaufen, sollen mehrere Projekte begonnen werden und vom fahrenden Schiff aus während der gesamten Reise fortgeführt werden.

Eines dieser Projekte erfasst mittels visueller Beobachtungen die Verbreitung von Vögeln, Robben und Walen als Funktion der ozeanographischen Umgebung. Weitere schiffsgebundene Walbeobachtungen erfassen nicht nur die Präsenz der Tiere, sondern auch deren Verhalten in Schiffsnähe. Detaillierte Informationen über die Verteilung von Zwergwalen sollen durch Helikopter basierte Bestandsaufnahmen ermittelt werden. Anhand der dabei gewonnenen Daten soll versucht werden, Rückschlüsse auf einen möglichen Einfluss des Schiffes auf die vom Schiff aus beobachtbare Waldichte zu ziehen. Diese Fragestellung soll auch durch akustische Horchstationen untersucht werden, die jeweils für einen Tag per Helikopter ausgesetzt und wieder aufgenommen werden sollen. Mehrjährige bioakustische Unterwasseraufnahmen werden durch zwei im Bereich des 0°-Meridians auszulegenden akustischen Langzeitrekordern gewonnen.

Laufende physikalische Untersuchungen konzentrieren sich während der Überfahrt auf den Atmosphärenzustand und die Strahlungsbilanz an der Grenzfläche Atmosphäre/Ozean. Die Daten dienen zur Untersuchung der Wechselwirkung zwischen bewölkter Atmosphäre der Nettostrahlungsbilanz an der Meeresoberfläche sowie zur Validation von Satellitendaten.

Zur Untersuchung der globalen Verteilung toxischer perfluorierter organischer Säuren sollen Luftproben auf dem Peildeck des Schiffes genommen werden und an Bord extrahiert und konzentriert werden. Parallel hierzu werden Wasserproben aus dem oberflächennahen Wasser über das schiffsinterne Reinstwassersystem gezogen und ebenfalls an Bord aufkonzentriert. Beide Probensätze sollen anschließend analysiert und insbesondere auf die Austauschprozesse von perfluorierten organischen Säuren zwischen Wasser und Luft hin untersucht werden. Die meridionale Verteilung von gelöstem organischem Material (DOM) sowie von Spurenmetallen und deren Isotopen (TEI) soll kontinuierlich während der gesamten Reise anhand von Wasserproben aus dem Brunnenschacht sowie über einen parallel geführten Schleppkörper gewonnen werden. Mittels Wasserschöpfer sollen weitere Wasserproben aus tieferen Wasserschichten gezogen werden. Die gewonnenen Proben sollen in Hinblick auf Quellen und Konzentration der DOMs und TEIs sowie der beeinflussenden Prozesse hin analysiert werden. Dies wird zum Teil sofort an Bord, zum Teil aber auch im Heimatlabor geschehen.

Eine erste kurze Unterbrechung der Anreise wird dazu genutzt werden die Funktionsfähigkeit der Aufnahmeeinheit für das MABEL-Observatorium zu überprüfen. Abhängig von Eis- und Wettersituation soll kurz vor oder nach Anlaufen der Neumayer Station versucht werden, das MABEL-Observatorium zu bergen, welches sich seit dem 5. Dez 2005 auf dem Meeresboden bei 69°24'S 5°32'W befindet. Zur Bergung ist es notwendig, die an einem Datenkabel frei hängende Aufnahmeeinheit an das sich auf 1874 m Tiefe befindende Observatorium heranzuführen. Hierzu muß das Heck von *Polarstern* bis auf wenige Meter

genau über dem Observatorium positioniert werden, was angesichts der Kräfte, die Strom, Eis und Wind auf das Schiff ausüben werden, eine große Herausforderung darstellt.
Für einen eventuellen Bergungsversuch vor Anlaufen der Neumayer-Station steht allerdings nur ein enges Zeitfenster zur Verfügung, da die Versorgung der Station als äußerste Priorität hat. *Polarstern* wird zahlreiche Container mit Baumaterialen für die Neumayer-III-Station an Bord haben, auf deren Bereitstellung das mittels des DROMLAN-Flugnetzes bereits eingetroffene Bauteam dringend angewiesen sein wird, um die im Jahr 2007 begonnenen Bauarbeiten an Neumayer-III möglichst noch in dieser Saison abschließen zu können. Mitglieder der Überwinterungsteams 2008/9, die sich in Kapstadt auf *Polarstern* eingeschifft haben werden, werden hier das Schiff ebenfalls verlassen, um an der Inbetriebnahme der neuen Station mitzuwirken. Anschließend werden sich weitere Wissenschaftler nach Beendigung ihrer Experimente bei Neumayer für die Rückreise nach Kapstadt einschiffen.

Die Rückreise wird zunächst nordöstlich zur Maud-Kuppe führen. Zur Untersuchung der Hydrographie und ozeanischen Zirkulation sollen hier im Rahmen des internationalen Argo–Projektes mehrere profilierende NEMO-Floats ausgelegt werden. Bereits auf der Anfahrt zu Neumayer wurden die ozeanographischen Arbeiten durch die Auslegung von 3 PIES Bodensensoren (Pressure sensor equipped Inverted EchoSounder) entlang des GoodHope Schnittes abgerundet. Bei der Rückreise steht nun noch die Aufnahme und Auslegung einer Schallquellenverankerung östlich von der Maud-Kuppe an, woran sich die direkte Rückreise nach Kapstadt anschließt. *Polarstern* wird am 5. Januar 2009 in Kapstadt zurück erwartet.

Die Reise ist ein Beitrag zu "Partnership for Observation of the Global Oceans" - POGO (http://www.ocean-partners.org/).

ITINERARY AND SUMMARY

On 5 December 2008, the research vessel *Polarstern* will depart Cape Town to conduct the Antarctic Expedition ANT-XXV/2 (Fig. 1.1). On direct route to Neumayer Station, Antarctica, several research projects will commence shortly after departure from Cape Town and continue for the entire expedition to and from Neumayer Station.

One of these projects uses visual survey techniques to study the distribution of birds, seals and whales in relation to environmental parameters. Additional cetacean observations aim at understanding the behavioral response of marine mammals to the approaching ship. Helicopter-based marine mammal surveys will focus on the distribution of minke whales and provide additional information on the ship's impact on encounter rates. The latter question will also be addressed using passive acoustic recorders to be deployed from ice floes ahead of the cruise track. While these will provide recordings of only a single day, two marine acoustic recording units (MARU) will be moored at the sea floor along the Greenwich meridian at about 60° and 63°S to obtain two year records of the underwater soundscape.

Ship-borne studies of the atmosphere will aim at observing both the 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. Continuous sampling of air and water shall provide concentrations of polyfluorinated organic compounds (PFCs) in these highly under-sampled areas and help to distinguish between two alternative

long-range transport mechanisms for PFCs. The distribution of dissolved organic matter and trace metals in the upper ocean layer will be analyzed using water samples to be continuously collected from the ship's moon pool and a towed "fish". Additional water samples from the deeper water column shall be collected with a rosette sampler at selected stations.

The direct approach of Neumayer Station will only be briefly interrupted for the deployment of free falling landers for oceanographic research and a test of the recovery gear for the MABEL observatory. The MABEL observatory is located at the seafloor to the northeast of Neumayer Station and shall be recovered either prior to or after *Polarstern's* visit to Neumayer Station, depending on the local whether and ice conditions.

At Neumayer Station, *Polarstern* will unload containers with construction material urgently needed for the completion of the new Neumayer III Station. Several members of the construction and the new overwintering teams will disembark *Polarstern* here, while a small team of scientists will embark on *Polarstern* to return back home. Once the logistic operations at Neumayer will be completed, *Polarstern* will steam north-east towards Maud Rise, where a set of Argo floats shall be deployed. Last not least, a sound source mooring - used in the acoustic positioning of Argo floats - shall be recovered and redeployed east of Maud Rise before continuing north towards Cape Town.

The cruise is a contribution to the "Partnership for Observation of the Global Oceans" - POGO (http://www.ocean-partners.org/).

The cruise is expected to end in Cape Town on 5 January 2009.

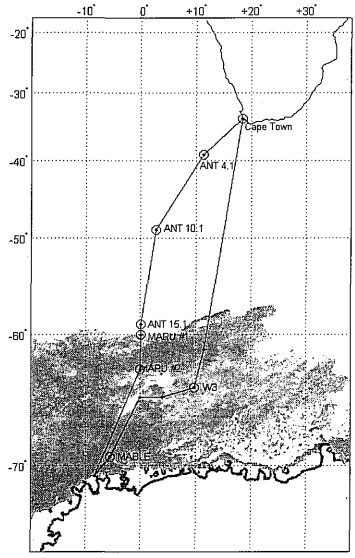

Abb. 1.1: Die geplante Fahrtroute der Polarstern während der Reise ANT-XXV/2 vom 5. Dezember 2008 bis 5. Januar 2009. Die Eisbedeckung vom 15. Dezember 2007 ist als Anhaltspunkt grau schattiert eingezeichnet (hoher Eisbedeckungsgrad = dunkel).
Fig. 1.1: Plannend cruise track of RV Polarstern during ANT-XXV/2 from 5 December 2008 until 5 January 2009. The image shows the ice coverage from 15 December 2007 as a proxy for the ice coverage to be expected. High ice concentrations are represented by dare hues.

2. MAPS: MARINE MAMMAL PERIMETER SURVEILLANCE

Olaf Boebel (AWI), Stefan Bräger (DMM), Helena Herr (FTZ), Karl-Hermann Kock (VTI), Linn Sophia Lehnert (FTZ), Kristina Lehnert (FTZ), Meike Scheidat (IMARES), Rob Williams (UBC)

Objectives

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 and 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 in conjunction with the respective environmental parameters. The objectives of this study are to a) collect

appropriate sighting and environmental data to feed into a region specific ESMs and to b) inter-calibrate 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.

Work at sea

The scientific programme comprises the concurrent acquisition of cetacean sighting data by four different methods: a) ship-borne, opportunistic observations, b) ship-borne, dedicated observations, c) helicopter borne, dedicated observations and d) acoustic records from autonomous recorders deployed from ice-floes ahead of the ship. These datasets will be supplemented by the collection of appropriate environmental data.

Shipborne observations are performed by default by the ship's nautical officers (a) and shall be performed by dedicated observers (b) from either the bridge or the crow's nest. Dedicated observers will use standardized observations methods with appropriate watch cycles (2 – 4 h). Weather conditions permitting, a set of high power binoculars ("big eyes") will be used to track whales before they are in the sighting range to investigate behavioral changes to the presence of the boat.

Helicopter borne observations shall occur twice daily. One will follow the planned cruise track of the ship to a distance of 125 nm from the ships position at lift-off. The return leg to the ship will laterally be offset by 10 nm. The second flight will cover a wider area in a zig zag pattern to investigate overall cetacean density. During each flight environmental conditions, such as sea ice coverage and sea state, will be logged continuously.

Acoustic observations shall be performed using autonomous listening stations carried by ice-floes. A listening station shall be carried along during any of the observation flights and deployed on a suitable ice floe on the way back to the ship (after having noted the position of suitable floes on the way out). At a desired range of 120 nm, no acoustic disturbance is to be expected upon deployment of the station. At an expected speed of 5nm (in ice), the recorder will be in the vicinity of the ship during the next day for recovery by helicopter.

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

Christophe Gruwier, Nicolasse Selosse, Alejandro Cammareri (PolE)
Not on board; Claude Joiris (PolE)

Objectives

The objective of this project is to quantify the at-sea distribution of primarily seabirds, but also cetaceans and pinnipeds, as a function of the main hydrological parameters (water

temperature and salinity, ice coverage) allowing to identify the main water masses and ice conditions (outer marginal ice zone, closed pack ice), as well as fronts and 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, in comparison with previously collected data.

This is part of a long-term study of seabirds and marine mammals in polar regions, with a very low number in Arctic pack ice, except for the Outer Marginal Ice Zone, and extremely high numbers in the Antarctic, including the Inner Marginal Ice Zone and the Closed Pack Ice. This difference is mainly due to the presence of krill eaters in very large numbers on the Antarctic pack ice: penguins (Adélie, chinstrap) and seals (crabeater, leopard).

Work at sea

Transect counts will take place when *Polarstern* is sailing, since seabirds can be massively attracted by ships during station work.

4. MARINE AUTONOMOUS RECORDING UNITS - MARU

Harold Figuerola (Cornell Lab of Ornithology)
Not on board: Chris Clark (Cornell Lab of Ornithology)

Objectives

The annual migration of large baleen whales to and from Antarctica is only known at the largest of scales. Details on how this migration is linked to important environmental parameters such as food availability and sea-ice coverage are lacking. Data on the presence of marine mammals can be obtained by using bioacoustic recording packages MARU (marine autonomous recording units) developed by the Cornell Lab of Ornithology. MARUs are free falling instrument packages, which settle on the sea floor and record ambient sound for extended periods. The project plans to deploy and recover two of Cornell's Marine Autonomous Recording Units (MARUs) a) to 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 within the very basic constraints of species, location, time of year and oceanographic variables. Along with the expected biological detections, we will obtain ocean ambient acoustic recordings which are critical for documenting ambient noise levels which can be regressed against ocean conditions. Such data are extremely valuable for understanding an interpreting the relative changes ambient ocean noise occurring in the Northern Hemisphere over the last five to six decades.

Work at sea

At two locations (cf. Table 9.1) along the cruise track, MARU units will be deployed for a 3 year mission. The recovery of the units shall occur on ANT-XXVII/2 in December 2010.

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

Viktoria Mohr (IFM-GEOMAR), not on board: Andreas Macke (IFM-GEOMAR)

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. The project aims at observing both the 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 given on the interaction between clouds and sea ice with respect to the downwelling shortwave and longwave radiation. Atmospheric profiles from radio soundings will be used to validate the satellite based profiles from the IASI instrument onboard the new European polar orbiting satellite MetOp.

Work at sea

All required instruments (pyranometer, pyrgeometer, sky imager) have been installed on *Polarstern* during the previous cruise ANT-XXV/1. Radio soundings will be performed close to the overpass times of the MetOp satellite. Synoptical observations will be executed every hour. During direct sun situations the aerosol optical thickness will be measured with a hand-held sun photometer. Sea ice coverage and brightness will be monitored by visual inspection and camera images.

6. TRANSECT-BASED INVESTIGATIONS OF POLYFLUORINATED COMPOUNDS IN SOUTH ATLANTIC AND ANTARCTIC REGIONS

Annekatrin Dreyer and Armando Caba (GKSS)

Objectives

Persistent and toxic perfluorinated organic acids have been determined in high concentrations in polar biota. 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. However, so far the long range transport of polyfluorinated organic compounds (PFC) is only insufficiently elucidated and information about concentrations in the air and water phase of remote regions is rare. The investigation of per- and polyfluorinated organic compounds on *Polarstern* aims 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) in

order to show the global contamination with PFC. Furthermore, the partitioning of PFC between the air and the water phase will be studied.

Work at sea

Air samples will be taken using High Volume Air Samplers located at the observation deck of *Polarstern* (Fig. 6.1). Particle-bound PFC will be collected on pre-cleaned glass fibre filters. Gaseous PFC will be trapped in glass cartridges filled with polyurethane foam and a polymeric resin. Water sampling will be performed simultaneously to the air sampling in order to investigate mechanisms controlling the air-sea exchange of PFC. The water samples will be taken from the clean water system (stainless steal pipe) of *Polarstern*. Samples will be extracted in a laboratory of *Polarstern*. For the air samples Acetone: MTBE will be used for extraction of PFC. After the extraction, samples will be concentrated to using a Syncore Analyst evaporator and nitrogen. Waterborne compounds will be enriched using solid phase extraction (SPE) with methanol as elution solvent. Instrumental detection of PFC will be done after the cruise in a land-based laboratory.

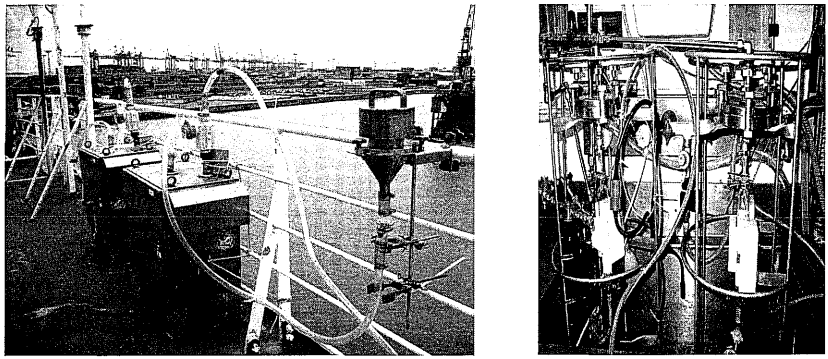

Fig. 6.1: High Volume Air Samplers at the observation deck and in-situ pumps attached to the sea water intake system of Polarstern for air and water sampling of PFC

7. DISSOLVED ORGANIC MATTER AND TRACE ELEMENTS (CD, PB, MN, CO, NI, FE) IN THE SURFACE WATERS OF THE SOUTHERN OCEAN: A CONTRIBUTION TO GEOTRACES

Christa Pohl, Enrique Frenandez-Otero (IOW), Ruth Flerus, Oliver Lechtenfeld (AWI)
Not on board: Gerhard Kattner and Boris P. Koch (AWI)

Objectives

Organic Matter

Marine dissolved organic matter (DOM) represents one of the largest active pools of organic carbon in the global carbon cycle. It is initially formed by primary producers (terrestrial plants, marine plankton) from atmospheric CO_2 and transported by rivers into the oceans or released either directly by plankton organisms or is formed during their decomposition. This results in a gradient of dissolved organic carbon (DOC) concentration decreasing from the surface to the deep ocean.

The goal of the dissolved organic matter (DOM) sampling is to achieve a high spatial resolution data set for the characterization of the sources and driving processes of DOM transformation in the surface of the South Atlantic (for details see goals of ANT-XXV/1). We aim at resolving the molecular mechanisms which convert fresh, labile biomolecules to semi-labile and refractory organic compounds in the Southern Ocean. The major analytical focus of this cruise leg is to study the relation of the molecular DOM composition and trace metal speciation.

Trace Metals

The ocean is mainly affected by anthropogenic and natural TEI`s (Trace Elements and Isotopes) by atmospheric- and riverine input. Entering the surface waters, the transport of trace metals is closely linked to the seasonal variation of the biological production and the composition of suspended particulate matter (SPM). Particle reactive metals such as lead (Pb) and trace metals with nutrient like behaviour, for example, cadmium (Cd) are mostly removed from surface waters by adsorption on or incorporation into particles and the transport through the water column. They can accumulate at horizontal interfaces / boundaries such as the pycnocline, the OMZ (oxygen minimum zone) or the redox boundary because of slow sinking rates.

Still, many questions remain to be answered to understand the processes which drive this removal and the rates at which they occur. At present those are central themes in the biogeochemistry of oceans in the GEOTRACES programme. For example, the removal of micro nutrients (Fe, Mn, Co) from the euphotic zone is presumed to be a recurrent process, induced by primary producers. This removal is closely connected to sinking fluxes of these elements with the geochemical cycles of C, N, S, and O. However, these particle fluxes also have a cleaning effect on the ocean, by removing elements like Pb, Cd which might otherwise build up toxic levels in the water column. In the context of GEOTRACES, this expedition's objectives are to contribute a) to the determination of the global distributions of selected TEI`s in the ocean; and b) to the evaluation of oceanic sources, sinks, and internal cycling of these TEI`s in an effort to characterize more completely their global biogeochemical cycles. Particular focus of this cruise is the determination of the

concentrations of the anthropogenic heavy metals (lead & cadmium) beyond the direct realm of civilization and the concentrations of climate relevant micro nutrients (iron, manganese & cobalt) in the surface waters of the different regions in the Southern Ocean. A third objective is to study possible fertilization effects in relation to wind direction, distance to continents and fluctuations of salinity and temperature with regard to phytoplankton blooms or organic matter. Finally, the distribution of Fe(II) and Fe(III) in surface waters of the Southern Ocean shall be determined.

Work at Sea

As a continuation of the sampling during leg ANT-XXV/1, we will sample surface water using the ship's moon pool and a fish sampler. Both techniques guarantee a continuous flow of uncontaminated surface water without the need of additional station time. We will continuously monitor salinity, water temperature and meteorological parameters, such as air temperature, rainfall and radiation. Satellite images for surface chlorophyll will provide complementary data in high spatial resolution.

Sampling for most parameters will concertedly be performed every 12 hours with the fish sampler. Samples for DOC and trace elements will be sampled at a higher time resolution and filtered to get a detailed dataset of background parameters. Solid phase extraction (SPE) of DOM from filtered water will be performed at larger time intervals because this procedure requires time-consuming laboratory work.

Depending on the availability of additional station time, CTD stations will enable us to sample deeper water in the Weddell Sea (20 samples per profile). For this, the ship's CTD and most of the water volume of the entire 24-bottle rosette per station will be used. In the upper water column the CTD depth intervals will be at a higher resolution while a lesser resolution is required at greater depth. DOM will be extracted onboard using solid phase extraction.

8. MABEL RECOVERY MISSION

Hans Gerber (TFHB), Marcantonio Lagalante, Giuditta Marinaro, Haiko de Vries (TUB)
Not no board: Nadia Lo Bue, Massimo Calcara, Paolo Favali (INGV)

Objectives

The deep sea plays a key role in global climate change and is a strategic region for geodynamics studies. The scientific community needs to extend the existing land-based network of permanent observatories to ocean basins, especially to the poorly explored abyssal depths. Efforts aiming at a direct monitoring on the seafloor have been made worldwide. Since 1995, the European Commission has supported and funded the GEOSTAR (GEophysical and Oceanographic STation for Abyssal Research) project, which developed a new concept of seafloor observatory, focusing on modularity, manageability and flexibility for long-term continuous multidisciplinary monitoring. The technological and scientific evolution in the GEOSTAR prototypes led to the deployment of a networked system in Southern Tyrrhenian Sea at the base of the Marsili volcanic seamount (over 3,300 m water depth) in December 2003, which collected geophysical, oceanographic and geochemical data for more than one year. GEOSTAR is a user configurable, relatively low-cost observatory, which may quite easily be handled by MODUS, a vehicle for precise deposition and recovery using

normal research vessels. From this experience, a first step toward Antarctic observatories was made with the Italian PNRA MABEL project (Multidisciplinary Antarctic BEnthic Laboratory). Derived from the GEOSTAR concepts, the MABEL project was adapting and developing a new observatory to be deployed north of the German Antarctic Station Neumayer.

MABEL's service and communication devices are summarized as follow: Data acquisition and control system (DACS), central high precision rubidium clock, attitude observatory control, 12 VDC and 24 VDC battery container, acoustic link for command and data transmission. MABEL is equipped with a wide range of sensors. Commercial instruments, custom service packs and home-made instruments were tested both in Hamburgische Schiffbau Versuchsanstalt (HSVA) and in dedicated labs in Pordenone (Italy). Some parts of the Data Acquisition and Control System (DACS) as well as some parts of experimental chemical analyzer have already been tested and used in a former Antarctic cruise (Calcara, 2003). The scientific payload onboard MABEL comprises the following components:

Tab. 8.1: Scientific payload of the of MABEL observatory

Instrument	Sampling rate
PMD 3-C broadband seismometer	100 Hz (per channel)
Falmouth 3-axial single-point current meter	2 Hz
Sea Bird CTD SBE 16	1 sample/hour
Alphatrack light transmissometer	1 sample/hour
pH and Eh autocalibrating analyser (INGV-Tecnomare prototype)	1 sample/2 days
McLane Water sampler	1 sample/8 days

On 5 December 2005, MABEL was deployed at a depth of 1,874 m at 69°24,295' S - 5° 32.220'W). Data acquisition started automatically on 6 December 2005, 16.00 UTC with the seismometer release, allowing it to be coupled directly with the sea bottom, and with other instruments' acquisition. The data recording had been performed up to 31 December 2006, when the station automatically ended acquisition and all instruments were switched to stand-by modus. Data have been stored in the DACS on dedicated hard disks. Some of the data were however already recovered by acoustic modem after 20 days of MABEL mission. This interrogation of the station served to demonstrate the overall validity of the system, including its service parts, e.g. acoustic link and data transmission.

Work at sea

The recovery mission of MABEL observatory will be conducted with the aid of the deployment/recovery vehicle MODUS, a winch and a sheave. The dimensions of the different parts are described in the following (see Tab. 8.2).

Tab. 8.2: Size and weight of MABEL, MODUS and winch

Item	Dimensions (m) (L x W x H)	Weight (kN) (in air)	Weight (kN) (in water)
MABEL	2.90 x 2.90 x 2.90	14.0	8.5
MODUS	2.88 x 2.35 x 1.70	10.0	7.0
Winch	3.80 x 2.35 x 2.40	181	-
Sheave	1.05 (Ø)	0.2	-

The winch will be placed on the aft deck, with the sheave mounted on the *Polarstern*'s A-frame. MODUS will be placed in water, once the sheave (i.e. the ships stern) is positioned directly overhead of MABEL. Once MODUS is at depth, an instrumental and visual detection of MABEL will be performed using MODUS sensor and control system, which includes 4 (or 6) thrusters, 4 cameras and lights, sonar, heading, tilt, pitch and roll sensors as well as an altimeter.

First contact is expected to be made by sonar. Once the signal reflected from MABEL is acquired and visible to the control station, fine movements of the ship and of the vehicle will lead to the closest approach of the station, guided also with the images acquired with the cameras. Once MODUS is placed exactly overhead of the pin of the MABEL, the ultimate action of MODUS is its physical latching to MABEL. A telemetric signal to the control room verifies that a safe latch between MODUS and MABEL has been executed. At this point, recovery may commence.

When the recovery is completed, the winch can be handled as a normal container ISO 20" and stowed, MABEL will be disassembled and stored. Data present in the DACS will be recovered on board, starting with a first quality check and analysis of the acquired data.

9. PHYSICAL OCEANOGRAPHY

Olaf Klatt, Olaf Boebel (AWI)
Not on board: Andreas Macrander (AWI)

Objectives

Determining the impact of climate change and decadal variability on oceanic properties requires long-term *in-situ* hydrographic observations of the deep ocean. Embedded in the AWI MARCOPOLI and PACES programmes, three complementing systems contribute to such a observation: hydrographic moorings, PIES (Pressure sensor equipped inverted echosounders) and autonomous floats, which also contribute to the international Argo programme.

The Argo programme aims at systematically observing global ocean upper temperatures and circulation patterns by means of free floating Argo floats. The project consists of about 3,000 autonomous profiling instruments (floats), 800 of which will have to be renewed annually as their batteries run low with time. 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, the so-called NEMO float (Navigationg European Marine Observer) was developed and tested, which is now fully operational. The objective of this cruise is to seed

NEMO floats to enhance the global Argo array with special emphasis to the hydrographic patterns around Maud Rise. Additionally, it is planned to provide acoustic navigation signals for the floats while under the seasonal sea-ice, a so called RAFOS sound source mooring shall be turned around.

PIES units have been deployed by the AWI along the GoodHope Line to record bottom pressure and acoustic travel time between the seafloor and the sea-surface since 2002. The array aims at determining fluctuations of the heat and bulk transports of the Antarctic Circumpolar Current as it passes the gateway between Africa and Antarctica. Additionally, these bottom pressure records complement measurements by the GRACE satellite mission which aims at observing the gravity field of the Earth. Gravity field products provided by the GRACE Science Data System allow assessing both the static geoid, as well as time-varying signals associated with changes of global water mass distribution. To detect temporal variability of oceanic currents and mass transports, it is critical to validate the space-born GRACE data by both observed and modeled Ocean Bottom Pressure (OBP) time series, which are collected by our PIES. The objective of ANT-XXV/2 is to increase the resolution of the PIES array by deploying additional instruments along the GoodHope Line.

Work at sea

During ANT-XXV/2 six NEMO floats will deployed in the vicinity of Maud Rise. The floats are provided by the Bundesamt für Seeschifffahrt and Hydrography as a contribution to the international Argo programme. To obtain the position of the hydrographic profiles collected by these floats during the winter season, a RAFOS sound source had been installed over the past pentade. During ANT-XXV/2, one of these sound sources (W3) shall be recovered and redeployed (Fig. 9.1 and Tab. 9.1).

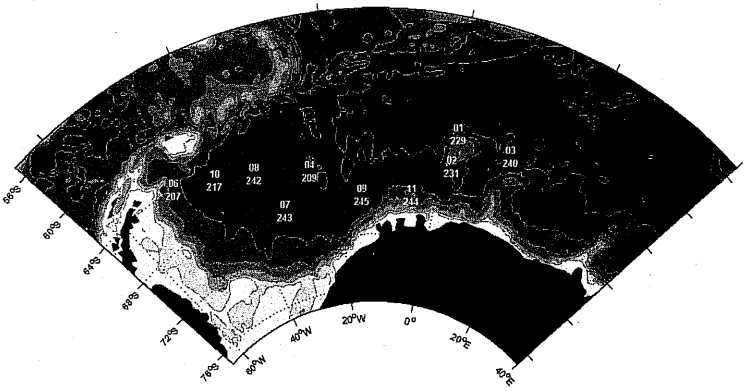

Fig. 9.1: Sound source array as currently installed. Numbers next to the dots indicate sound source labels and corresponding mooring numbers. Mooring 240 / sound source W3 will be recovered and redeployed during ANT-XXV/2.

Last not least, 3 PIES shall be deployed during ANT-XXV/2 (Fig. 9.2 and Tab. 9.1).

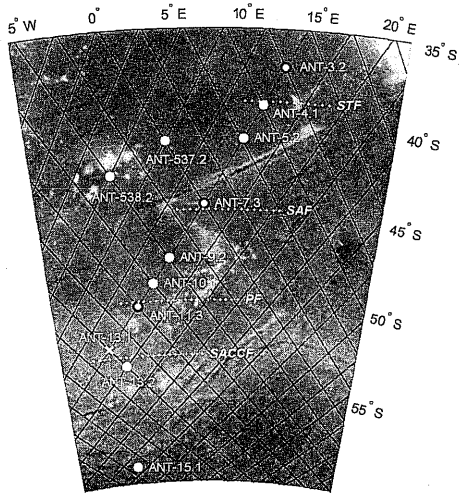

Fig. 9.2: Positions of planned PIES deployments during Polarstern cruise ANT-XXV/2 (grey dots at positions ANT-IV/1, ANT-X/1 and ANT-XV/1). Black lines: ground tracks of Jason satellite mission (previously TOPEX/Poseidon). White dotted lines: nominal positions of fronts: STF = Subtropical Front, SAF = Subantarctic Front, PF = Polar Front, SACCF = Southern Antarctic Circumpolar Current Front.

Tab. 9.1: Planned mooring operations during ANT-XXV/2

Mooring	Descript -ion	PIES S/N	Start date	Launch lat & lon	Depth [m]	Auto release date
ANT-4-1	TP-X	135-PopUp	12/2008	39°12.75'S 011°20.07'E	4822	12/2013 (5yr)
ANT-10-1	TP-X	58	12/2008	49°00.68'S 002°49.95'E	3890	12/2013 (5yr)
ANT-15-1	AWI 227	74	12/2008	59°04.11'S 000°04.92'E	4798	12/2013 (5yr)
W3	AWI 240	-	-	64°29.49'S 009°49.53' E	5005	-
MARU#1	-	-	-	60°00.00'S 000°00.00'E	5192	-
MARU#1	-	-	-	63°00.00'S 000°00.00'E	5293	-

18. FAHRTTEILNEHMER / PARTICIPANTS

Name	Vorname/ First Name	Institut/ Institute	Beruf/ Profession
Boebel	Olaf	AWI	Oceanographer
Bornemann	Horst	AWI	Vetinarian
Bräger	Stefan	DMM	Biologist
Caba	Armando	GKSS	Engineer
Cammareri	Alejandro	PolE	Technician
de Vries	Haiko	TUB	Engineer
Dreyer	Annekatrin	GKSS	Chemist
Fernández Otero	Enrique	IOW	Chemist
Figureroa	Harold	Cornell University	IT scientist
Flerus	Ruth	AWI	Technician
Gerber	Hans	TFHB	Engineer / Prof.
Gruwier	Christophe	PolE	Biologist
Hansen	Felicitas	DWD	Stud. met.
Helmschmidt	Jessica	AWI	Physikerin
Herr	Helena	FTZ Westküste	Biologist
Joppich	Christoph	DWD	Meteorologist
Kazanc	Tamer	AWI	Cook
Klatt	Olaf	AWI	Physicist
Kindermann	Lars	AWI	Physicist
Knuth	Edmund	DWD	Technician
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
Mohr	Viktoria	IfM Geomar	Stud. Met.
Ochs	Peter	Hessischer Rundfunk	Journalist
Plötz	Joachim	AWI	Biologist
Pohl	Christa	IOW	Chemist
Rentsch	Harald	DWD	Meteorologist
Scheidat	Meike	IMARES	Biologist
Schmidt	Jens	Bundespresseamt	Journalist
Schulze	Helmke	AWI	Teacher
Selosse	Nicolas	PolE,	Biologist
Steinhage	Daniel	AWI	Geophysicist
Turpeinen	Heidi	AWI	Geophysicist
van Opzeeland	Ilse Catharina	AWI	Biologist
Williams	Rob	UBC	Biologist
Zöllner	Mathias	AWI	Meteorologist
NN		IMARES	Biologist
NN	NN	INGV	NN
NN		HeliTransair	Pilot

Name	Vorname/ First Name	Institut/ Institute	Beruf/ Profession
NN		HeliTransair	Pilot
NN		HeliTransair	Technician
NN		HeliTransair	Technician

19. BETEILIGTE INSTITUTE / PARTICIPATING INSTITUTES

	Adresse /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 Bernhard-Nocht Strasse 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

	Adresse /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

20. SCHIFFSBESATZUNG / SHIP'S CREW

No.	Name	Rank
1.	Schwarze, Stefan	Master
2.	Spielke, Steffen	1.Offc.
3.	Farysch, Bernd	Ch. Eng.
4.	Peine Lutz	2. Offc.
5.	Fallei, Holger	2. Offc.
6.	Ettlin, Margrith	2.Offc.
7.	Uhlig, Holger	Doctor
8.	Hecht, Andreas	R.Offc.
9.	Minzlaff, Hans-Ulrich	2.Eng.
10.	Sümnicht, Stefan	2.Eng.
11.	Schaefer, Marc	3.Eng.
12.	Scholz, Manfred	Elec.Tech.
13.	Nasis, Ilias	Electron.
14.	Verhoeven, Roger	Electron.
15.	Muhle, Helmut	Electron.
16.	Himmel,Frank	Electron
17.	Loidl, Reiner	Boatsw.
18.	Reise, Lutz	Carpenter
19.	Guse, Hartmut	A.B.
20.	NN	A.B.
21.	Winkler, Michael	A.B.
22.	Vehlow, Ringo	A.B.
23.	Hagemann, Manfred	A.B.
24.	Schmidt, Uwe	A.B.
25.	Bäcker, Andreas	A.B.
26.	Wende, Uwe	A.B.
27.	Preußner, Jörg	Storek.
28.	NN	Mot-man
29.	Voy, Bernd	Mot-man
30.	Elsner, Klaus	Mot-man
31.	Hartmann,Ernst-Uwe	Mot-man
32.	Pinske, Lutz	Mot-man
33.	Müller-Homburg, Ralf-Dieter	Cook
34.	Silinski, Frank	Cooksmate
35.	Martens, Michael	Cooksmate
36.	Jürgens, Monika	1.Stwdess
37.	Hölger, Irene	Stwdss/KS
38.	Czyborra, Bärbel	2.Stwdess
39.	Silinski, Carmen	2.Stwdess
40.	Gaude, Hans-Jürgen	2.Steward
41.	Möller, Wolfgang	2.Steward
42.	Huang, Wu-Mei	2.Steward
43.	Yu, Kwok Yuen	Laundrym.
44.	NN	Appr.
45.	NN	Appr.