EXPEDITIONSPROGRAMM NR. 88

FS POLARSTERN

ANT-XXVIII/1
ANT-XXVIII/2
ANT-XXVIII/3
ANT-XXVIII/4
ANT-XXVIII/5

Koordinator:
Dr. E. Fahrbach

Fahrtleiter:

ANT-XXVIII/1
Dr. Saad El Naggar
ANT-XXVIII/2
Prof. Dr. Gerhard Kattner
ANT-XXVIII/3
Prof. Dr. Dieter Wolf-Gladrow
ANT-XXVIII/4
Dr. Magnus Lucassen
ANT-XXVIII/5
Dr. Karl Bumke

STIFTUNG ALFRED-WEGENER-INSTITUT
FÜR POLAR- UND MEERESFORSCHUNG

MITGLIED DER HERMANN VON HELMHOLTZ-GEMEINSCHAFT
DEUTSCHER FORSCHUNGSZENTREN E.V. (HGF)

BREMERHAVEN, OKTOBER 2011

Adresse:

Alfred-Wegener-Institut
für Polar- und Meeresforschung
MITGLIED DER HERMANN VON HELMHOLTZ-GEMEINSCHAFT
DEUTSCHER FORSCHUNGSZENTREN E.V. (HGF)
Am Handelshafen 12
D-27570 Bremerhaven

Telefon: ++49 471 4831- 0
Telefax: ++49 471 4831 – 1149

E-mail der Fahrtleiter:
Saad.El.Naggar@awi.de
Gerhard.Kattner@awi.de
Dieter.Wolf-Gladrow@awi.de
Magnus.Lucassen@awi.de
kbumke@ifm-geomar.de

EXPEDITION PROGRAMME NO. 88

RV POLARSTERN

ANT-XXVIII/1
28 October - 1 December 2011
Bremerhaven - Las Palmas – Cape Town

ANT-XXVIII/2
3 December 2011 – 5 January 2012
Cape Town - Cape Town

ANT-XXVIII/3
7 January 2012 – 11 March 2012
Cape Town – Punta Arenas

ANT-XXVIII/4
13 March 2012 – 09 April 2012
Punta Arenas – Punta Arenas

ANT-XXVIII/5
11 April 2012 – 16 May 2012
Punta Arenas – Bremerhaven

Coordinator
Dr. E. Fahrbach

Chief Scientists

ANT-XXVIII/1	**Saad El Naggar**
ANT-XXVIII/2	**Gerhard Kattner**
ANT-XXVIII/3	**Dieter Wolf-Gladrow**
ANT-XXVIII/4	**Magnus Lucassen**
ANT-XXVIII/5	**Karl Bumke**

INHALT / CONTENTS

ANT-XXVIII/1

28 October - 1 December 2011

Bremerhaven - Las Palmas – Kapstadt

Chief scientist

Saad El Naggar

Contents

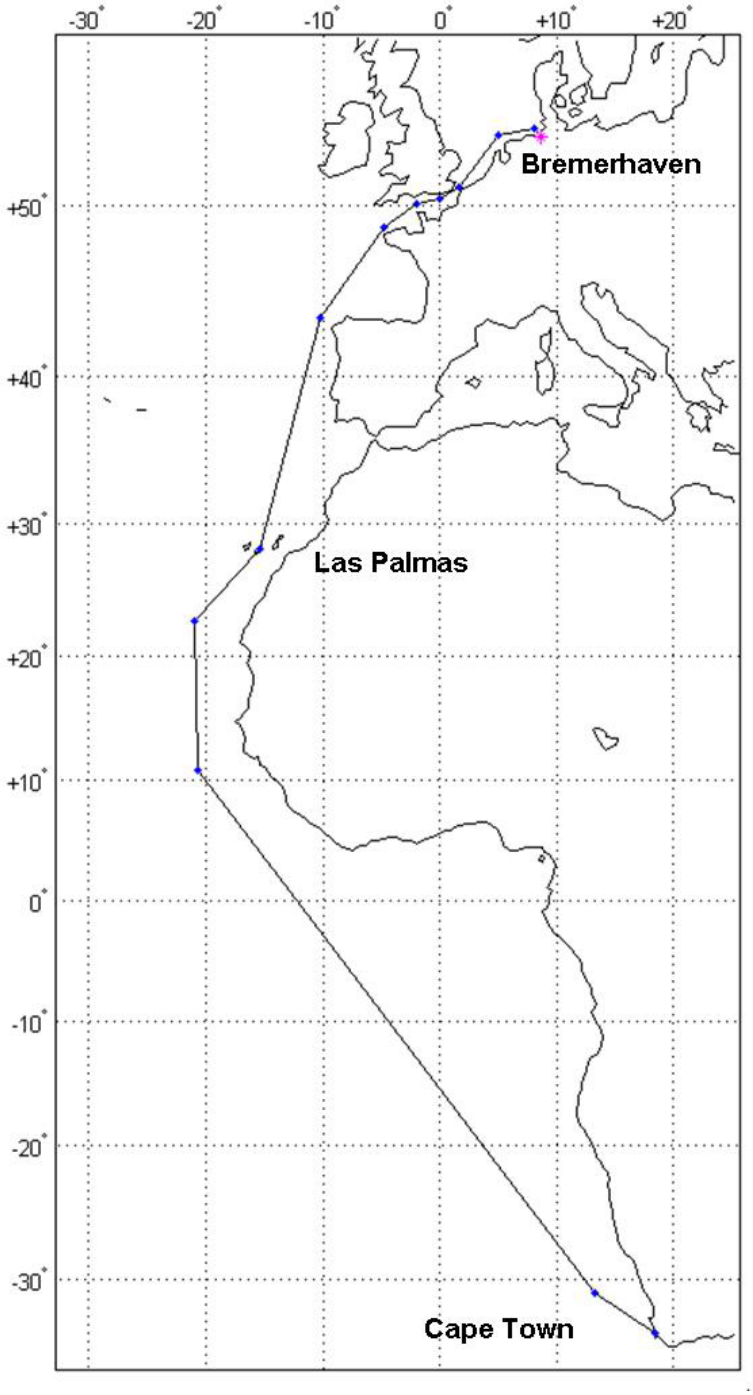

Abb.1: Reiseroute ANT-XXVIII/1 Bremerhaven – Kapstadt, 28. Oktober 2011 – 01. Dezember 2011

Fig. 1: Cruise track during ANT-XXVIII/1 Bremerhaven - Cape Town, 28 October 2011 – 01 December 2011

1. ÜBERBLICK UND FAHRTVERLAUF

Saad El Naggar (AWI)

Am 28. Oktober 2011 wird FS *Polarstern* den ersten Fahrtabschnitt der 28. Antarktisreise ANT-XXVIII/1 von Bremerhaven nach Kapstadt mit einem kurzen Stopp in Las Palmas antreten. Die Fahrt wird zur kontinuierlichen Messung atmosphärischer und ozeanischer Eigenschaften sowie der Energie- und Stoffflüsse zwischen Ozean und Atmosphäre genutzt. An verschiedenen Stationen werden Messungen vorgenommen und Geräte getestet. Die Reise wird in Kapstadt am 01. 12. 2011 enden. Folgende Projekte werden durchgeführt:

Autonome Messplattformen zur Bestimmung des Stoff- und Energieaustausches zwischen Ozean und Atmosphäre (OCEANET)

Um die experimentelle Erfassung von Stoff- und Energieaustausch zwischen Ozean und Atmosphäre auf eine solide Basis zu stellen, ist im Rahmen dieses Projektes mittels der Vernetzung der Expertisen des IFM-GEOMAR (CO_2-/O_2-Flüsse, photosynthetischer Status, Energiehaushalt, Fernerkundung), des IfT (Lidarmessungen), Helmholtz-Zentrum Geesthacht (HZG) („FerryBox“ und Fernerkundung der marinen Biologie mit ENVISAT/MERIS), und des AWI-Bremerhaven (CO_2-System, marine Infrastruktur von FS *Polarstern*) die Entwicklung autonomer Messsysteme geplant, die langfristig für den operationellen Betrieb an Bord von Fracht- und Forschungsschiffe vorgesehen sind.

Auf diesem Abschnitt werden die Experimente fortgeführt und erweitert.

Untersuchung der Brutgebiete von Bartenwalen

Auf der Anfahrt nach Kapstadt soll die Tiefseeverankerung AWI 247-1, verankert auf 20° 58.90‘ S 05° 059.59‘ E vor Namibia nahe des Walfischrückens, ausgewechselt werden. Die Verankerung trägt ein passiv-akustisches Registriergerät, Sonovault, um die Anwesenheit großer Bartenwale in ihren vermuteten, bislang jedoch weitgehend unbestätigten, Brut-Gebieten zu erfassen.

Verteilung von Seevögeln und Meeressäugetieren

Seevögel und Meeressäugetiere werden auf diesem Abschnitt visuell erfasst, um ihre Präsenz-Verteilung zu ermitteln.

Messung kosmischer Teilchen zur Untersuchung ihrer Breiten- und Wetterabhängigkeit

Kontinuierliche Messungen kosmischer Teilchen dienen der Untersuchung der Breitenabhängigkeit auf Grund des Erdmagnetfeldes und des „kosmischen Wetters“. Im Zusammenhang mit Wolkenbeobachtungen soll der Zusammenhang zwischen Wolken und der Anzahl kosmischer Teilchen ermittelt werden.

Test, Kalibrierung und Abnahme des Fächersonars „Hydrosweep DS III“

Die Wandler des Fächersonars „Hydrosweep DS III“ wurden im Oktober 2011 ausgetauscht. Eine erneute Kalibrierung des Systems ist nach dem Umbau erforderlich. Diese wird zwischen Bremerhaven und Las Palmas durchgeführt.

Bestimmung von Schallgeschwindigkeitsprofilen an Hand von CTD-Messungen

Zur Erstellung globaler Verteilungen der Schallgeschwindigkeit werden normalerweise globale CTD-Daten-Banken eingesetzt. Zur Validierung dieser Methode werden auf diesem Abschnitt berechnete und gemessene Schallgeschwindigkeitsprofile miteinander verglichen.

Test und Kalibrierung des Unterwasser-Navigations-System „POSIDONIA“

Das Unterwasser-Navigations-System „POSIDONIA“ wurde mit einem mobilen Eisschutzfenster ausgestattet. Daher müssen die hydroakustischen Eigenschaften des Systems erneut ermittelt werden.

Aussetzen von Argos-Floats

Argos-Floats sind vertikal profilierende Driftbojen. Sie werden auf diesem Abschnitt zur Bestimmung globaler ozeanographischer und atmosphärischer Parameter für das IFREMER ausgesetzt, um das weltweite Argo-System zu erhalten.

Umstellung des zentralen Datenerfassungssystems „D-Ship“ auf LINUX

Das Zentrale Datenerfassungssystem an Bord und an Land wurde auf LINUX umgestellt. Hier wird das System, neu konfiguriert, getestet und abgenommen.

ITINERARY AND SUMMARY

On 28 October 2011 RV *Polarstern* will start its Atlantic transfer from Bremerhaven to Cape Town with a short stop in Las Palmas as first leg of the 28th of Antarctic cruise ANT-XXVIII/1. The cruise will be utilized for continuous measurements of atmospheric and marine properties as well as of energy and material fluxes between ocean and atmosphere. The cruise will be end in Cape Town on 01 December 2011. The following projects will be carried out:

Autonomous measurement platforms for energy and material exchange between ocean and atmosphere (OCEANET - Atmosphere & Ocean)

In order to provide a solid basis for the observational monitoring of energy and material exchange between ocean and atmosphere it is planned to develop an autonomous observation system for operational use onboard cargo- and research vessels. The project is based on a network of expertise from IFM-GEOMAR (CO_2-/O_2-fluxes, photosynthetic status, energy budget, remote sensing), IfT (lidar measurements), the Helmholtz-Zentrum Geesthacht (HZG) (ferry box, remote sensing of marine biology with ENVISAT/MERIS) and AWI-Bremerhaven (CO_2-system, marine infrastructure of RV *Polarstern*).

Atlantic breeding grounds of mysticetes (Baleen Whales) of the southern hemisphere

Steaming towards Cape Town, deep-sea mooring AWI 247-1, deployed at 20° 58.90‘ S; 05° 059.59‘ E off Namibia near Walvis Ridge, shall be turned around. The mooring hosts a passive acoustic monitoring device, SonoVault, to verify the presence of large mysticetes species on their supposed, yet largely unconfirmed, breeding grounds.

Distribution of seabirds and marine mammals at sea

Visual observations of seabirds and marine mammals will be carried out during this cruise to determine the population distributions of those animals from higher to lower latitude.

Rate measurement of cosmic particles in dependence of latitude and weather conditions

Continuous rate measurements of cosmic particles allow the estimation of their dependency on latitude due to the Earth’s magnetic field. Simultaneous cloud observations allow investigating whether the concentration of cosmic particles influences cloudiness or vice versa.

Sea trials and calibration of the multibeam sonar "Hydrosweep DS III"

Transducers of the multibeam sonar "Hydrosweep DS III" were replaced in October 2011. A recalibration of the system will be carried out between Bremerhaven and Las Palmas.

Using existing globally available CTD-data for deriving sound velocity profiles

Sound velocity profiles (SVP) are important parameters for multibeam operations. Using the existing globally available CTD-data to derive SVP will provide very useful tools to operate hydro-acoustic instruments globally. The derived SVP will be compared during this cruise with the measured one to validate this method.

Sea trial and tests of the underwater navigation system "POSIDONIA 6000" after installation of a mobile protective window

The underwater navigation system "POSIDONIA 6000" was equipped with a mobile ice protective window in June 2011. The new hydro-acoustical parameters will be measured between Bremerhaven and Las Palmas during this cruise

Deployment of Argo floats

Argo floats are vertically profiling drifters which will be deployed during this cruise for IFREMER to measure global oceanographically and atmospherically parameters in order to maintain the world wide Argo network.

Upgrade the central data acquisition system "D-Ship"

The central data acquisition system "D-Ship" will be upgraded to operate with LINUX-software. Sea trials and tests will be carried out between Bremerhaven and Las Palmas

2. AUTONOMOUS MEASUREMENT PLATFORMS FOR ENERGY AND MATERIAL EXCHANGE BETWEEN OCEAN AND ATMOSPHERE (OCEANET): ATMOSPHERE

Karl Bumke (not on board, IFM-GEOMAR), Andreas Macke (not on board), Dietrich Althausen (not on board), Marlen Brückner (not on board), Wu Zhijun, Laurent Poulain (IfT), Cornelia Kampmann (MPI), Monika Kohn (IAU)

Objectives

Radiation & microwave remote sensing

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 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 part of the "Meridional Ocean Radiation Experiment" MORE which uses Atlantic transfers of various research vessels for the combined measurements of the atmospheric state since 2004. The main project behind this cruise is the WGL-PAKT Initiative OCEANET.

A multichannel microwave radiometer will be applied to continuously retrieve temperature and humidity profiles as well as cloud liquid water path over the ocean. Time series of these profiles will show small scale atmospheric structures as well as the effects of the mean state of the atmosphere and its variability on the co-located measurements of the downwelling shortwave and longwave radiation. The atmospheric profiles will also be used to validate the satellite based profiles from the IASI instrument onboard the new European polar orbiting satellite MetOp. Atmospheric aerosol optical thickness will be measured by means of hand held sun photometer and spectral solar radiometer. Most instruments will be integrated in the container-based atmosphere observatory.

Air-sea interaction and fluxes

Great emphasis has to be put on air-sea fluxes of momentum, sensible and latent heat to improve numerical models of weather forecast and climate simulations since oceans cover 71% of the earth's surface. The fluxes of sensible and latent heat are also of importance for the energy budget of the ocean and the atmosphere. Due to the steady increase of many trace gases in the atmosphere like CO_2, *in-situ* gas flux measurements are required to establish parameterizations that provide flux estimates in climate models.

To estimate the turbulent fluxes of momentum, sensible heat, latent heat, and CO_2 a sonic-anemometer and an open path LiCor will be mounted. Measurements are taken at a sampling rate of 20 Hz (LiCor) respectively 30 Hz (sonic-anemometer) allowing to derive the fluxes by applying the inertial dissipation method. This method relies on measurements at high frequencies, less distorted by the motion and the superstructure of the ship than the covariance technique. Additional measurements of the sea surface temperature (SST) in combination with observations of the standard meteorological parameters and measurements of the CO_2 content in ocean and atmosphere at a lower data rate performed by marine chemist (see section 2) flux parameterizations can be derived.

Aerosol measurements

- The portfolio of the Aerosol Group at IfT includes the *in-situ* characterization of atmospheric aerosols in urban as well as remote background atmospheres, the characterization of regional and urban air quality, the examination of hygroscopic particle properties, the measurement and simulation of *in-situ* aerosol optical properties, the investigation of atmospheric transport processes, and the development of new and improved instruments for physical aerosol characterization. Onboard *Polarstern* all measurements will be conducted inside a temperature-controlled container laboratory, and focus on the particle characterization using high-end scientific instruments in order to study:
- physical aerosol properties using an Aerodynamic Sizer (APS) and Tandem Differential Mobility Analyser (TDMPS) for particle number size distributions from 3 nm to 10 µm, and a Humidifying Differential Mobility Particle Sizer (HDMPS) for the hygroscopic growth of the particles;
- optical properties using a nephelometer and an absorption photometer to measure the particle light scattering and absorption coefficients, respectively; and
- particle chemical composition using a High Resolution Time of Flight Aerosol Mass Spectrometer (HR-ToFAMS) for the non-refractory PM1.

Sea surface chemistry

The main objective of the chemical analysis is to characterize the chemical composition of the ocean surface film in parallel to the chemical and physical characterization of the marine aerosol in order to identify the particle-based exchange of organic compound and hence carbon.

Work at sea

Upon departure both container based atmosphere observatories will be installed at the observation deck of *Polarstern*. Most measurements will be performed underway and continuously. The following individual instruments are combined:

1) Multichannel microwave radiometer HATRPO. The instrument requires occasional calibrations with liquid nitrogen as well as tipp-calibrations under calm sea and homogeneous atmospheric conditions.
2) Whole sky imager for cloud structure measurements
3) Handheld sun photometer (Microtops) for aerosol and cloud optical thickness
4) Sonic anemometer USA-1 to measure the wind components and temperature
5) LiCor to measure water vapour and CO_2
6) M-100 absorption hygrometer to measure water vapour
7) *in-situ* aerosol measurements.

Marine aerosol particles will be sampled and chemically analyzed in detail in parallel to physical particle characterization. During ship stops the ocean surface film will be sampled and chemically analyzed according to the current state-of-the-art.

Expected results

1) Two-dimensional structure of the clear sky atmosphere and corresponding net radiation budget,
2) Horizontal structure of the cloud water path and its effect on the downwelling shortwave and longwave radiation,
3) Vertical structure of temperature and humidity as well as its variability for validation of satellite products,
4) Vertical profiles of tropospheric aerosols and their effect on radiation,
5) Turbulent fluxes of momentum, sensible, and latent heat,
6) Flux of CO_2 between ocean and atmosphere,
7) Near-surface aerosol size distributions and their physical and chemical compositions,
8) Chemical composition of surface films and relation to evaporated organic materials and their aggregation in aerosols.

3. ATLANTIC BREEDING GROUNDS OF MYSTICETES (BALEEN WHALES) OF THE SOUTHERN HEMISPHERE

Ilse van Opzeeland, Olaf Boebel, Matthias Monsees (not on board, AWI)
Rainer Graupner (Optimare)

Objectives

The large baleen whales of the Southern Hemisphere are migratory inhabitants of the open ocean and hence are not easily accessible for direct observation. They are thought to migrate between summer feeding grounds near Antarctica and winter breeding grounds in the subtropical ocean. However, knowledge on summer and particularly winter distribution of true (or Antarctic) blue (*Balaenoptera musculus intermedia*), fin (*Balaenoptera physalus*), sei (*Balaenoptera borealis*) and Antarctic minke whales (*Balaenoptera bonaerensis)* is sparse

and mainly based on historic catch data and the Discovery tagging program. The resulting uncertainty is clearly reflected even in contemporary distribution maps. Interestingly, in the southern Atlantic, the evidence at hand points to similar summer breeding grounds for all these species, namely the northern Angola Basin for Antarctic minke whales (7°S 3°W), the central Angola Basin for sei whales (15°S 5°W), and the southern Angola Basin for fin whales (21°S 1°E) and for true (or Antarctic) blue whales (22°S 7°E).

Given that many of the baleen whale species in the Southern Hemisphere have been severely depleted by commercial whaling, knowledge of the locations of their breeding grounds and an improved understanding of migratory routes and behaviour of these species is important for conservation measures to aid the recovery of these populations. All species are known to vocalize on the breeding grounds, rendering passive acoustic monitoring techniques therefore a valuable tool to study large baleen whale breeding ground distribution patterns. For blue and fin whales, geographic variation in vocalizations even allows identification of different (breeding) populations. Such information may provide insight into the extent to which each baleen whale species is grouped into separate localities on the breeding grounds.

Autonomous recording devices are battery-powered and record and store acoustic data internally. Dependent on data storage capacity of the device, recording bandwidth and sampling regime, recordings can be obtained over extended periods of time, in some cases up to several years. Best results are obtained when deployed in the so-called SOFAR channel, a sound-duct which is located at about 1000 m depth in the subtropical ocean.

Work at sea

A single oceanographic mooring, AWI 247-1 deployed at 20°58.90'S 05°059.59' E in the southern Angola Basin, hosting a passive acoustic recorder (SonoVault) and a recording CTD shall be turned around for the duration of one year (Figs. 3.1, 3.2 and 3.3). The deployment will be coincident with similar recordings in the Antarctic summer feeding grounds. The recorder is deployed at a depth of nominally 900 m, the core of the SOFAR channel, where detections ranges are expected to exceed the order of 200 km. This allows monitoring both the suspected fin and blue whale breeding grounds with only a single mooring. The mooring shall be recovered in 2012, preferably during a consecutive *Polarstern* transit cruise.

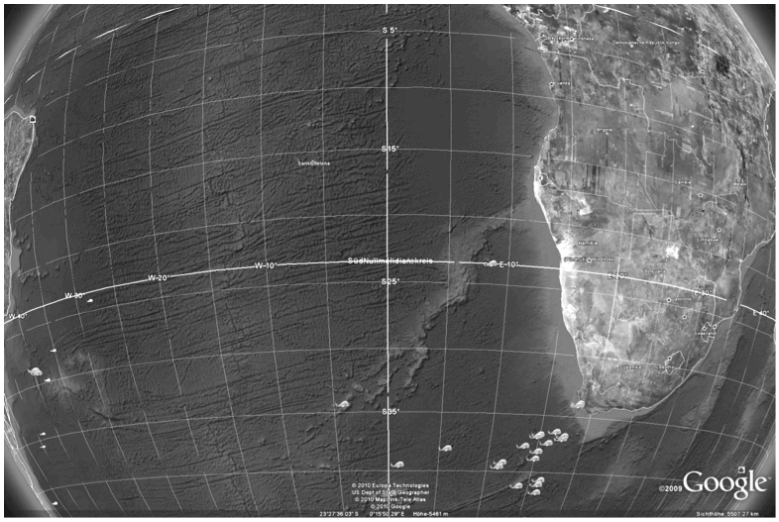

Fig. 3.1: Mooring position at 20°58.90'S 05°059.59' E (white star) close to the northern edge of Walvis Ridge. The white circle indicates a (minimum) listening circle of 200 km.

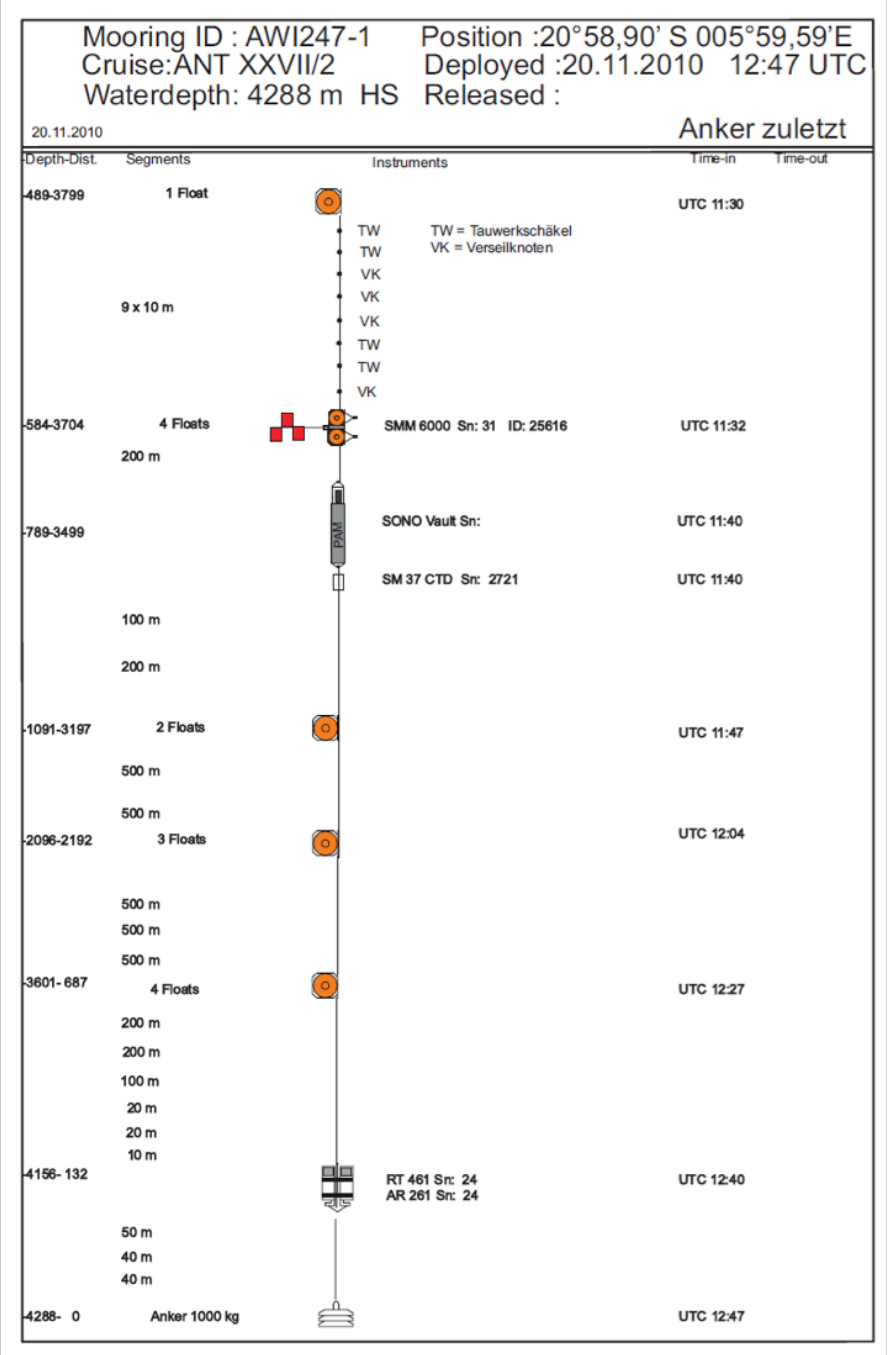

Figure 3.2: Schematic of mooring AWI 247-1 (to be recovered)

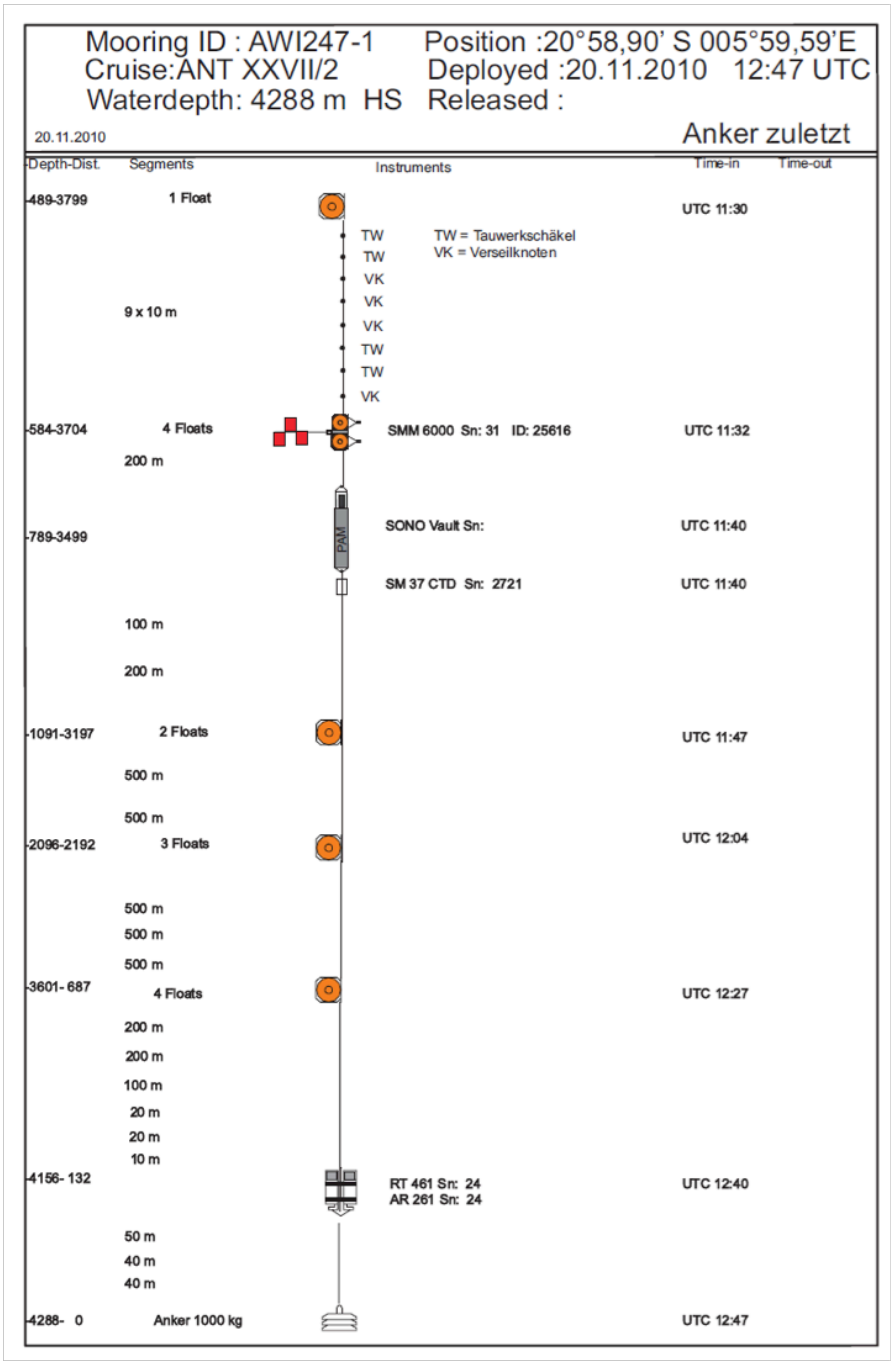

Figure 3.3: Schematic of mooring AWI 247-2 (to be deployed)

4. DISTRIBUTION OF SEABIRDS AND MARINE MAMMALS AT SEA

Claude R. Joiris (not on board), Xavier Vandevyvre, Philippe Goffart and Nadine Massart (PolE)

Objectives

The aims are:

- To quantify the at-sea distribution of seabirds and marine mammals between Bremerhaven and Cape Town. It is the first time that such count will be done on this transect from Polarstern and especially in a full transect. Censuses already exist for some restricted areas (Bay of Biscay, Cape Town Atlantic Islands surroundings)

- To ensure a « long-time survey » allowing better knowledge of movements and distribution for some localized and migratory species. For example, the wintering grounds of Cape Verde Shearwater (*Calonectris edwardsii*) are still unknown, movements of most of the Beaked Whales (*Mesoplodon ssp*.) and Pygmy & Dwarf Sperm Whales (*Kogia breviceps & K. sima)* are very poorly known.

Although distribution of seabirds and marine mammals is already relatively well known between Bremerhaven and Canary Islands , winter censuses are occasional and can therefore bring some surprises especially in Northern Atlantic Sea (e.g. where disappears the Zino's Petrel (*Pterodroma madeira*) during winter?). Furthermore huge gaps remain further south, between Cape Verde Islands and Namibia, including the Gulf of Guinea.

Work at sea

Counts are made by 30 minutes and only when the boat is moving; this to avoid the attraction of the boat during its stops. Data such as coordinates, depth, salinity are recorded. Every individual detected with naked eyes is counted and binoculars are used to confirm the species identification.

5. RATE MEASUREMENT OF COSMIC PARTICLES IN DEPENDENCE OF LATITUDE AND WEATHER CONDITIONS

Michael Walter (not on board), Achim Stoessl (DESY, Zeuthen)

Objectives

Galactic cosmic rays (GCR) are high-energy charged particles, mainly protons, doubly ionized helium, and other fully ionized nuclei originating in the galaxy and bombarding the Earth from all directions. They are a direct sample of material from far beyond the solar system. Measurements by various particle detectors have shown that the intensity varies on different timescales, caused by the Sun's activity and geomagnetic variation. The role of Interplanetary Coronal Mass Ejections (ICMEs) in causing Forbush decreases, and Corotating Interaction Regions causing recurrent decreases in the GCR intensity observed at Earth, has been well established since the last twenty years. However, these interplanetary disturbances cause space weather effects, which warrant a more detailed study. Most of the research on GCR intensity variations is based on the analysis of ground-based neutron monitors and muon

telescopes. Their measurements, as explained in what follows, depend on the geomagnetic position, and the processes in the Earth's atmosphere. Beside the modulation of cosmic rays in the heliosphere there are two possible lines of defense: while the atmosphere shields life against cosmic radiation uniformly, the Earth magnetosphere acts as a rigidity filter. Before the primary particles can enter the atmosphere they are subject to the deviations in the magnetic field in the vicinity of the Earth, and as a consequence the intensity of charged particles on top of the atmosphere is reduced with respect to interplanetary space.

The cosmic particle detector installed at the *Polarstern* consists of two scintillation counters working in coincidence mode. Silicon photomultipliers have become available recently, and are utilized for the scintillation counters. In addition there are three other devices to measure the GPS coordinates and time, the temperature and air pressure as well as the inclination of the detector correlated with the vessel movement. A python program runs under Linux at a notebook to steer data taking and storage on disk.

The scientific goals of the experiment are:

- The investigation of the cosmic particle rate in dependence on the latitude. The rate is smallest at the equator and increases to poles due to the influence of the Earth magnetic field. This geomagnetic cut-off will be measured.
- The possible measurement of sudden increase of the cosmic particle rate due to sun flares. Such flares of high particle intensities influence the "cosmic weather" and especially electronics systems installed on Earth or in satellites. There exists a net of detectors installed in different countries for an early warning system of such dangerous events. Our measurements can contribute to possible future extensions of this warning system.
- The investigation of the influence of cosmic particles on cloud formation. There are measurements which seem to show an influence on cloud formation with increasing rates of cosmic particles. But the existing data are not good enough to establish this hypothesis. Also here our measurements could contribute to clarify the situation.
- The test of the utilized silicon photomultipliers and the study of their characteristics under conditions of operation.

Work at sea

It is planned to run the detector during the whole expedition ANT-XXVIII. The data will be made public via a web-interface.

6. SEA TRIALS AND CALIBRATION OF THE MULTIBEAM SONAR "HYDROSWEEP DS III"

Hans-Werner Schenke (not on board), Saad El Naggar, Fred Niederjasper, Nadia Sandhop, Ralf Krocker, NN (AWI), Rolf Alfke, Jörn Ewert (Atlas Hydrographic)

Objectives

Transducers of the Hydrosweep sonar were replaced in October 2011 during the last dock time of *Polarstern* in Bremerhaven, due to normal aging process. Since the replacement may change the systems correction values for pitch and roll, a full offshore calibration has to be conducted. In general calibrations are performed in selected areas.

In addition, a new version of the Hydrosweep DS III beam-former (SPM2-Module) will be tested for stability and performance. In case that the module meets the demands, further sea trials

and a sea acceptance test will be performed by ATLAS Hydrographic and AWI-Bathymetry.

Work at sea

Calibration work will be done during the transit from Bremerhaven to Las Palmas in an area north of the Ampere Seamount and at the seamount itself (about 34° 57' N; 12° 55' W). The estimated

The transit from Bremerhaven to the calibration area will be used to tests the new SPM2-Module of the Hydrosweep system. Depending on the results of these tests and the clearance of the system by the manufacturer Atlas Hydrographic, sea trials and the sea acceptance test will be done in the Ampere Seamount area too.

If there is, for technical reasons, a need for further tests or development of the SPM2-Module, this work will be done during transit from Las Palmas to Cape Town. On the route to Cape Town several well-surveyed areas with known seafloor topography can be used for the deep-sea trials and acceptance tests.

7. USING EXISTING GLOBALLY AVAILABLE CTD-DATA FOR DERIVING SOUND VELOCITY PROFILES (SVP)

Hans-Werner Schenke (not on board), Daniel Damaske (AWI)

Objectives

Adequate sound velocity profiles (SVP) during bathymetric surveys especially during transit cruises of *Polarstern* are crucial to improve results and avoiding depth and positioning error due to refraction. In consequence of restricted ship time during *Polarstern* cruises CTD casts for deriving SVP cannot always be performed sufficiently. Therefore it is tried with a new approach to bypass the lack of *in-situ* CTD data acquired at sea by using existing globally available CTD data from several oceanographic projects which can be processed with the software package Ocean Data View (ODV) (Schlitzer, 2011).

ODV provides to the operator on board a tool to study changes in physical properties (conductivity, pressure, temperature) of oceans water vertically and horizontally, thus it can be used to derive SVP and supports making a decision during transits whether the applied SVP for the area of operation is still satisfactory or if a new SVP should be used for the Hydrosweep DS3. Abrupt changes of sound speed in the water column are observed especially during Southern Ocean transits when passing oceanic fronts, e.g. the subtropical front. Sudden changes in seawater physical properties can result in poor bathymetric measurement accuracy. Due to the lack of a cross fan calibration function (a method to determine the mean sound velocity of the water column) with the new Hydrosweep DS3 (upgraded from DS2 to DS3 in 2010), this approach enhances the quality of a bathymetric survey. In addition, many regions of the ocean are still under sampled what can be seen in ODV. The operator is informed, if a new CTD cast should be performed during the cruise or if the existing CTD data (derived SVP) is still adequate enough for the current task.

Work at sea

Testing this new approach using ODV compatible data (e.g. the World Ocean Database and/or the World Ocean Atlas data) during the cruise and the development of workflow processes on board is necessary and could assist future *Polarstern* cruise participants to improve bathymetric work and saving ship time.

8. SEA TRIAL AND TESTS OF THE UNDERWATER NAVIGATION SYSTEM POSIDONIA 6000 AFTER INSTALLATION OF A MOBILE PROTECTIVE WINDOW

Saad El Naggar, Gerd Rohardt (AWI), Werner Dimmler (Fielax)

Objectives

The underwater navigation system POSIDONIA was upgraded during the ship yard stay of *Polarstern* in Bremerhaven from 20 May to 12 June 2008.

New hard and software were installed and tested still in harbour in Bremerhaven. A new acoustic array and a new 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+2. The final sea trial and calibration were planned to be carried out during the cruise ANT-XXV/1 on the way to Las Palmas from 3 to10 November 2008 at water depths of more than 3,000 m. Due to technical problems this could not occur because the system was faulty and not operational.

The system was repaired by IXSEA in Bremerhaven during the ship-yard stay of *Polarstern* from 24 May to 20 June 2009. The damaged acoustic array and the window were replaced by new components. POSIDONIA was successfully used during ARK -XXIV cruise, but the new acoustic array was not working properly due to the diffraction by the protection window. The system was not able to locate the target correctly within the expected error limits.

A new sea trial and calibration were done on both POSIDONIA systems during ANT-XXVI/1 and on the way from Bremerhaven to Las Palmas (16 to 27 October 2009). The new fixed installed acoustic array was not fully operational again and it was not able to be calibrated. The protection window generated frequent disturbances of transponder positions. Further investigations were necessary to improve the acoustical characteristic of the fixed array.

During ANT-XXVI/4 on the way from Las Palmas to Bremerhaven (8 to 17 May 2010) new calibration tests were carried out on the new POSIDONIA system after removal of the protective window in Punta Arenas in April 2010. The main objectives then were to eliminate the effects of the protective window on the system as well as to check and to calibrate the system without the protective window. The sea trial showed that the fixed installed acoustic array works without window properly. Positioning data obtained were within the specifications and good enough to carry out the calibration. The housing of the acoustic array was modified again during the ship yard stay of *Polarstern* in Bremerhaven (17 May to 10 June 2010) and the acoustic window was reinstalled again.

A new calibration and trials of the modified acoustic window were done during ANT-XXVII/1 on the way from Bremerhaven to Las Palmas from 25 October to 8 November 2010 at water depths of more than 3000 m. The tests showed that the modified acoustic window was still affecting the accuracy and the functionality of the system. About 30% of target locations were wrong. Under these conditions the system was not usable for ROV applications.

The fixed protective window was replaced by a mobile Polyethylene window during the ship yard stay of *Polarstern* in Bremerhaven (20 May to 15 June 2011). The mobile window can be moved hydraulically by two hydraulic cylinders and allows the use of the acoustic array cover free during operations. The system was used successfully during ARK-XXVI/2 for mooring

deployments and recovery also for ROV operations.

New calibration and sea trials including the modified acoustic window will be carried out during ANT-XXVIII/1 on the way from Bremerhaven to Las Palmas from 28 October to 9 November 2011 and at water depth of more than 3,000 m.

The objectives of the tests are to provide a new data set of the acoustical characteristics of the new system as accuracy, range, symmetry and limitations.

Work at sea

- System operational check including transponder test,
- Preparing the transponder mooring,
- Carrying out the sea trial and calibration (about 12 hours),
- Recovering of the transponder,
- Data analysis and validations,
- Disembark the tests personal in Las Palmas.

9. SAMOC: SOUTH ATLANTIC MERIDIONAL OVERTURNING CIRCULATION AND CLIMATE

Sabrina Speich (LPO, not on board), N. Lebreton (SHOM, not on board), Saad El Naggar (AWI)

Objectives

SAMOC aims at the role of the Atlantic Ocean Meridional Overturning Circulation (MOC) for climate variability and change. A particular focus is to develop a monitoring array in the South Atlantic, within a broad international partnership, to continue a time series started in 2004 in the South Atlantic and Southern Ocean. The main goals of SAMOC are: (1) to characterize the time-mean and time-varying components of the MOC, as well as the heat and salt carried by the MOC in the South Atlantic; (2) to observe the changes in the ventilation characteristics and relative contributions of different water masses to the MOC, and (3) to contribute with regional studies in the assessment of the sensitivity of the South American and African climate conditions to the SAMOC variability and changes.

The continuous implementation of Argo profiling floats is an essential element of SAMOC. Indeed, beyond the importance of these floats in the global coverage goal of the Argo programme we would like to keep-on the effort to improve the knowledge on regional processes and their impact on the global scale ocean circulation and climate.

Work at sea

Within ANT-XXVIII we want to continue the implementation of Argo profiling float observations in the turbulent regions of the eastern Atlantic and Atlantic sector of the Southern Ocean. In 2010/11, we will deploy 15 PROVOR and 15 ARVOR Argo floats. Additionally to temperature / conductivity / pressure, 3 of the PROVOR floats will be instrumented with a dissolved oxygen sensor.

The deployment strategy is the following:

- 6 ARVOR floats during ANT-XXVIII/1 on the transit from Bremerhaven to Cape Town at approximately 40°N, 22°N, 12°N, 0°N, 10°S, 20°S.

- 15 PROVOR and 5 ARVOR floats will be deployed by S.A. Agulhas along the GoodHope section and during a transit from South Africa to South Georgia between December 2011 and February 2012.

- 4 ARVOR floats in the Antarctic Circumpolar Current during ANT-XXVIII/3.

All floats will be drifting at 1000 dbar, and will be obtaining profiles from 2000 dbar to surface in regular intervals. By increasing the number of profiling floats in the turbulent regions of the Atlantic and Southern Ocean we will be able to improve quantitatively the knowledge on regional mesoscale dynamics and better estimate the zonal and meridional exchanges of mass, heat and freshwater. The real-time data will be made available through the Coriolis Data Assembly Centre (DAC). Delayed mode data will be available on the same DAC within a 6-month period. We will integrate the SAMOC Argo data on the SAMOC observing platform.

10. UPGRADE OF THE CENTRAL DATA ACQUISITION SYSTEM “D-SHIP”

Peter Gerchow (AWI), Ralf Löwenberg (WERUM)

Objectives

The SOLARIS based data acquisition system (D-Ship) on board of *Polarstern* was installed in the year 2000. It was necessary to upgrade the system to a LINUX based one to use the common Hardware-Server. The upgrade was carried out during the last ship yard stay in Bremerhaven (7 to 28 October 2011) by the company WERUM.

A full sea trials and functionality tests under real working conditions will be carried out from Bremerhaven to Las Palmas (28 October to 9 November 2011).

Work at sea

- System configuration check and sensors data import
- Parameter check and validation
- Sensors integration and update
- Functionality testes
- Data bank validations
- Data validations
- Data export-import functionality
- Interfacing and data telegrams checks
- Documentation

11. THE MULTI AXIS DIFFERENTIAL OPTICAL ABSORPTION SPECTROMETER (MAX-DOAS)

Johannes Lampel (Uni Heidelberg)

Objectives

Reactive Halogen Species (RHS) are of great importance due to their influence on atmospheric ozone chemistry. The involved sources and processes are not fully understood yet, nor their spatial distribution. The MAX-DOAS (Multi Axis Differential Optical Absorption Spectroscopy) instrument on board the research vessel *Polarstern* can autonomously provide measurement data about RHS in the marine boundary layer and is suitable for satellite data validation of various trace gases. These types of measurements are already conducted for more than ten years on *Polarstern.* In 2009 the old instrument was replace with an improved one, which failed to function properly a year later and was finally repaired at Heidelberg University earlier in 2011.

On cruises in 2010, iodine oxide was detected with column densities of 4.5*1013 cm-1, thus three times above the detection limit. The aim is to gather further continuous data, which is now more reliable due to reduced stray light. The formerly strongly stray light affected UV Spectrometer might then also measure marine bromine oxide at a significantly lower detection limit than with the old instrument.

Work at sea

On ANT-XXXVIII/1 it is planned to reinstall the system to prepare it for unsupervised continuous measurements on subsequent *Polarstern* cruises.

12. BETEILIGTE INSTITUTE / PARTICIPATING INSTITUTES

	Adresse/Address
Atlas Hydrographic	Atlas Hydrographic Kurfürstenallee 130, 28211 Bremen, Germany
AWI	Alfred-Wegener-Institut für Polar- und Meeresforschung Am Handelshafen 12 27570 Bremerhaven, Germany
DESY	Deutsches Elektronen-Synchrotron DESY Platanenallee 6 15738 Zeuthen, Germany
DWD	Deutscher Wetterdienst Geschäftsbereich Wettervorhersage Seeschifffahrtsberatung Bernhard-Nocht-Strasse 76 20359 Hamburg, Germany
Fielax	*Fielax* Gesellschaft für wissenschaftliche Datenverarbeitung mbH Barkhausenstr. 4 27568 Bremerhaven, Germany
HZG	Helmholtz-Zentrum Geesthacht - Zentrum für Material- und Küstenforschung GmbH Max Planck- Str. 1, 21502 Geesthacht, Germany
IAU	Institut für Atmosphäre und Umwelt Institute for Atmospheric and Environmental Sciences J.W.Goethe-Universität Altenhöferallee 1 60438 Frankfurt am Main
IFM-GEOMAR	Leibniz-Institute for Marine Sciences Düsternbrooker Weg 20 24105 Kiel, Germany
IfT	Institute for Tropospheric Research Permoserstraße 15 04318 Leipzig, Germany

Laeisz	Reederei F. Laeisz (Bremerhaven) GmbH Brückenstr. 25 D-27568 Bremerhaven, Germany
LPO	Laboratoire de Physique des Oceans UMR6523 CNRS/IFREMER/IRD/UBO Universite de Bretagne Occidentale - UFR Sciences 6, av Le Gorgeu C.S. 93837 29238 Brest Cedex 3, France
MPI	Max-Planck-Institut für Meteorologie Bundesstrasse 53, 20146 Hamburg, Germany
Optimare	Am Luneort 15a 27572 Bremerhaven, Germany
PolE	Laboratory for Polar Ecology Rue du Fodia 18, B-1367 Ramillies, Belgium
SHOM	Service hydrographique et océanographique de la marine DMGS/DIES/DISE Responsable de la cellule CORIOLIS Deploiement Centre militaire d'océanographie SHOM - BP 30316 - 29603 BREST CEDEX, France
University of Heidelberg	Institute of Environmental Physics University of Heidelberg Im Neuenheimer Feld 229 69120 Heidelberg, Germany
WERUM	Wulf-Werum-Str. 3 21337 Lüneburg, Germany

13. FAHRTTEILNEHMER / PARTICIPANTS

Name/Last Name	**Vorname/ First Name**	**Institut/Institute**	**Beruf/ Profession**	**1 BHV - LP 2 LP- CPT**
Alfke	Rolf	Atlas Hydrographic	Engineer	1
Bult	Klaus	DWD	Technician/ Meteorology	
Damaske	Daniel	AWI	Student	
El Naggar	Saad	AWI	Physicist Chief Scientist	
Ewert	Jörn	Atlas Hydrographic	Engineer	1
Gerchow	Peter	AWI	Engineer	1
Goffart	Philippe	PolE	Biologist	
Graupner	Rainer	Optimare	Technician	
Höpner	Friederike	IfT	Student	
Huang	Shan (Ms.)	IfT	Student	
Kampmann	Cornelia	MPI	Meteorologist	
Kapfhammer	Meriam	AWI	Student	
Kohn	Monika	IAU	Student, meteorology	
Krocker	Ralf	AWI	Geophysicist	
Lampel	Johannes	Uni Heidelberg	Physist	1
Massart	Nadine	PolE	Photographer	
Niederjasper	Fred	AWI	Technician	
Poulain	Laurent	IfT	Chemist	
Rohardt	Gerd	AWI	Oceanographer	1
Schäfer	Michael	IfT	Meteorologist	
Springer	André Michael	IfT	Project manager	
Stößl	Achim	DESY	Physicist	
Tomczak	Tim	WERUM	Computer scientist	
Vandevyvre	Xavier	PolE	Technician	
Wenzel	Julia	IfT	Student	
Wolf	Veronika	IfT	Student	
Wu	Zhijun (Mr.)	IfT	Physicist	

14. SCHIFFSBESATZUNG / SHIP'S CREW

Name	Rank
Pahl, Uwe	Master
Spielke, Steffen	1.Offc.
Ziemann, Olaf	Ch.Eng.
Peine, Lutz	2.Offc.
Hering, Igor	2.Offc.
NN	Doctor
Koch, Georg	R.Offc.
Kotnik, Herbert	2.Eng.
Schnürch, Helmut	2.Eng.
Westphal, Henning	2.Eng.
Brehme, Andreas	Elec.Tech.
Fröb, Martin	Electron.
Muhle, Helmut	Electron.
Winter, Andreas	Electron.
Feiertag, Thomas	Electron.
Clasen, Burkhard	Boatsw.
Neisner,Winfried	Carpenter
Schultz, Ottomar	A.B.
Burzan, G.-Ekkehard	A.B.
Schröder, Norbert	A.B.
Moser, Siegfried	A.B.
Hartwig-L., Andreas	A.B.
Kretzschmar, Uwe	A.B.
Kreis, Reinhard	A.B.
Schröter, Rene	A.B.
Beth, Detlef	Storekeep.
NN	Mot-man
Fritz, Günter	Mot-man
Krösche, Eckard	Mot-man
Dinse, Horst	Mot-man
Watzel, Bernhard	Mot-man
Fischer, Matthias	Cook
Tupy,Mario	Cooksmate
Martens, Michael	Cooksmate
Dinse, Petra	1.Stwdess
Hennig, Christina	Stwdss/KS
Streit, Christina	2.Steward
Hischke, Peggy	2.Stwdess
Wartenberg, Irina	2.Stwdess
Hu, Guo Yong	2.Steward
Chen, Quan Lun	2.Steward
Ruan, Hui Guang	Laundrym.
Seibel, Sebastian	Apprent.
Strauß, Erik	Apprent.

ANT-XXVIII/2

3 December 2011 – 5 January 1012

Cape Town - Cape Town

Chief scientist

Gerhard Kattner

Contents

1. ÜBERBLICK UND FAHRTVERLAUF

Gerhard Kattner
Alfred-Wegener-Institut

Der Fahrtabschnitt ANT-XXVIII/2 beginnt am 3. Dezember 2011 in Kapstadt und endet am 5. Januar 2012 wieder in Kapstadt. Ein Schwerpunkt dieser Expedition ist die Versorgung der deutschen Neumayer-Station auf dem antarktischen Schelfeis. Die Station soll am 19./20. Dezember erreicht werden, und die Versorgung wird dann 2 bis 3 Tage in Anspruch nehmen. Das Untersuchungsgebiet für die wissenschaftlichen Arbeiten wird daher entlang der Fahrtroute von Kapstadt zur Neumayer-Station liegen (Abb. 1). Ozeanographische, biologische und chemische Arbeiten bilden die Schwerpunkte dieses Fahrtabschnitts.

Die ozeanographischen Arbeiten werden entlang des Greenwich Meridians durchgeführt und ergänzen damit langfristige Datensätze zur Untersuchung der antarktischen Wassermassen. Es werden mit einer CTD-Sonde die physikalischen Größen, Salzgehalt, Temperatur und Tiefe bestimmt sowie Wasserproben für biologische und chemische Untersuchungen genommen. Gleichzeitig werden kontinuierlich physikalische Messungen während der gesamten Fahrt durchgeführt. Drei Messsysteme, die am Meeresboden verankert sind, werden aufgenommen bzw. ausgebracht. Sie dienen zur Untersuchung des Strömungssystems des Antarktischen Zirkumpolarstroms. Eine weitere Verankerung wird aufgenommen, die bereits seit 2008 akustische Aufzeichnungen macht, um Bewegungs- und Verteilungsmuster von marinen Säugern, insbesondere von Walen, festzustellen zu können. Diese Arbeiten stehen in engem Zusammenhang mit dem MAPS Projekt, in dem die kontinuierliche Erhebung von thermographischen Bilddaten entwickelt wird, um Mustererkennungsalgorithmen zur automatischen Detektion von Walen zu erstellen. Um die Effizienz der Algorithmen bei verschiedenen Umweltbedingungen (Wassertemperatur, Eisbedeckung, Sichtweite) bestimmen zu können, werden die Autodetektionsdaten mit Walsichtungen verglichen. Die Walbeobachtungen und -zählungen werden vom Krähennest des Schiffs und während Helikopterflügen durchgeführt. Die Daten sollen dazu dienen, um Maßnahmen zum Schutz der Wale zu unterstützen. Desweiteren werden Seevögel beobachtet und gezählt.

Die biologisch-chemischen Projekte befassen sich mit dem Bakterio-, Phyto- und Zooplankton. Der *Roseobacter* Stamm spielt eine wichtige Rolle in der globalen Verteilung der marinen Bakterien. Die Verteilung und das Wachstum der Bakterien werden untersucht, sowie deren Einfluss auf das gelöste organische Material (DOM). Das DOM wird chemisch möglichst weitgehend charakterisiert, um Zusammenhänge zwischen Bakterioplankton und DOM aufzeigen zu können. Die Phytoplanktonarbeiten konzentrieren sich auf das Auftreten von Diatomeen in der Wassersäule und im Meereis. Im Meereis soll darüber hinaus die Rolle des Ikaits, einer Form das Calciumkarbonats, im Kohlenstoffkreislauf untersucht werden. Die Zooplanktonarbeiten werden sich mit den Überwinterungsstrategien von Copepoden befassen. Die Copepoden steigen während des Frühjahrs und Sommers aus der Tiefe, in der sie in einer Art Diapause überwintern, in die oberen Wasserschichten auf, um in die aktive Lebensphase überzugehen. Ein weiterer Schwerpunkt ist die Untersuchung der Auftriebsregulierung der Copepoden, die praktisch bewegungslos in der Tiefe mit stark reduziertem Stoffwechsel überwintern. Es soll die Frage geklärt werden, inwieweit die Ammoniumkonzentration in der Hämolymphe der Copepoden zum Einen für die Diapause und zum Anderen für die Bestimmung der Tiefe für die Überwinterung verantwortlich ist und welche Rolle die Lipide bei diesen Prozessen spielen.

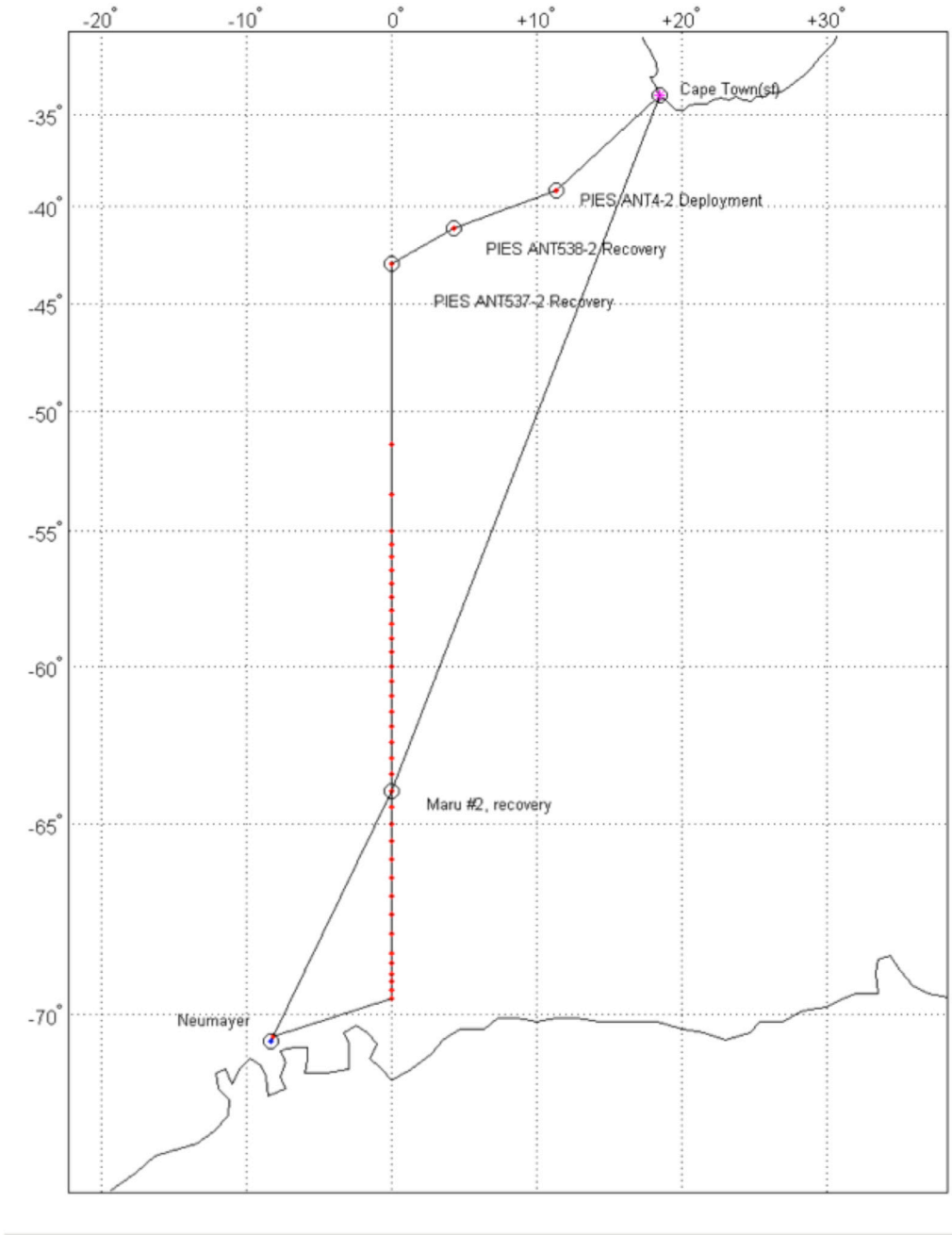

Abb. 1: Geplante Fahrtroute während ANT-XXVIII/2. Kreise markieren die Verankerungsaufnahmen und -auslegungen, Punkte die geplanten Stationen

Fig. 1: Planned cruise track during ANT-XXVIII/2. Circles mark mooring recoveries and deployment,. dots indicate planned stations

ITINERARY AND SUMMARY

The cruise leg ANT-XXVIII/2 starts in Cape Town on 3 December 2011 and ends again in Cape Town on 5 January 2012. The main topic of this expedition is the supply of the German Neumayer Station on the Antarctic self ice. We plan to reach the station at 19 or 20 December and expect to need 2 to 3 days for the supply. The main working sites are thus located along the route from Cape Town to the Neumayer station (Fig. 1). Oceanographic, biological and chemical investigations are the main scientific objectives during this leg.

The oceanographic program will be performed along the Greenwich meridian and prolongs the time series of regular hydrographic surveys studying the Antarctic water masses. With a CTD probe combined with a rosette water sampler salinity (conductivity), temperature and depth will be determined, and water samples will be taken for the biological and chemical investigations. During the entire cruise physical measurements will be continuously performed. Three moorings (PIES, Pressure inverted echo sounder), which are located at the sea floor, will be recovered or deployed. The aims of this PIES array were to determine the properties of the Antarctic Circumpolar Current. Another mooring, which was deployed already in 2008, will be recovered. This mooring is an underwater acoustic recorder and aims to gain insights into movement and distribution patterns of marine mammals, especially whales. These studies are in connection with the MAPS project, an automatic whale blow detection system on the basis of thermographic images from a 360° scanning IR sensor. Thermographic images will be collected continuously throughout the cruise. To test the efficiency of detection algorithms for various species and under varying environmental conditions, auto-detections will be compared with sightings of whales. Whale observation and counting of sightings will be performed from the ship's crow nest and helicopters. Data on cetacean occurrence and abundance are important to decision makers for management and protection of whales. In addition, during the entire cruise sea birds will be observed and counted.

The biological and chemical projects address bacterio-, phyto- and zooplankton studies. Within the bacterioplankton the *Roseobacter* clade plays a prominent role in the Southern Ocean. Abundance and growth of the bacteria will be studied as well as its influence on the dissolved organic matter (DOM). DOM will be chemically characterized with modern analytical methods to detect relations between bacterioplankton and DOM. The phytoplankton studies focus on the abundance of diatoms in the water column and in sea ice. In sea ice the role of ikaite, a form of calcium carboante, in the carbon cycle will be studied. The zooplankton studies focus on overwintering strategies of copepods. During spring and early summer copepods ascent to the surface layer from depth where they overwintered in a diapause. In the surface layer they start feeding and reproduction. Another topic is to study the buoyancy regulation of copepods which overwinter almost motionless at depth with a strongly reduced metabolism. The hypothesis will be tested whether the ammonium concentration in the haemolymph of copepods triggers at the same time the induction of the diapause and determines the actual overwintering depths via buoyancy regulation and how far lipids are involved in these processes.

2. HAFOS: CLIMATE OF THE ANTARCTIC AND THE SOUTHERN OCEAN

Andreas Macrander, Krissy Reeve, Hiroshi Yoshinari, Xu Zhang, (AWI),
Hendrik Kienert (PIK),
not on board Olaf Boebel, Eberhard Fahrbach, Gert Rohardt (AWI)

Objectives

The densest bottom waters of the global oceans originate in the Southern Ocean. Production and export of these dense waters constitute a vital component of the global climate system. The influence of Southern Ocean waters can be traced far into the northern hemisphere. As deep and bottom waters, they represent the deepest layer of the global overturning circulation. The conditions in the Southern Ocean are largely controlled by the Antarctic Circumpolar Current (ACC), the world´s most powerful current system, which transports about 140 Sv (106 m^3 s^{-1}) of water at all depths. It connects the three ocean basins and forms an isolating water ring around the Antarctic continent.

South of the ACC, in the subpolar region, warm and salty water masses are carried in the subpolar gyres to the continental margins of Antarctica. Water sinking near the continental margins spreads to the adjacent ocean basins. These dense waters are produced at several sites near the continental margins of Antarctica. Quantitatively the most important region for dense water formation may well be the Weddell Sea, however, other areas provide significant contributions as well. The properties and volume of the newly formed bottom water underlies significant variability on a wide range of time scales, which are only poorly explored due to the large efforts needed to obtain measurements in ice covered ocean areas.

The Polarstern cruise ANT-XXVIII/2 will extend the time series of water mass observations along the Greenwich meridian in the eastern part of the Weddell gyre. Circulation and water mass properties will be measured by autonomous profiling floats to be deployed. Further to the north, the PIES (Pressure Inverted Echo Sounder) array across the Antarctic Circumpolar Current which monitors both barotropic and baroclinic transport variations, will be fully operational after a last gap will be closed by a PIES deployment during ANT-XXVIII/2.

The Hybrid Antarctic/Arctic Float Observing System (HAFOS) aims to establish a contribution to the Southern Ocean Observing System (SOOS) in international cooperation in the context of the PACES programme of the Hermann von Helmholtz Association of German Research Centres (HGF). The observations occur jointly with the IBONUS-GOODHOPE project which covers the northern part of the Atlantic sector of the Southern Ocean. The pressure inverted echo sounder (PIES) array is part of the SAMOC programme (South Atlantic Meridional Overturning Circulation).

Work at sea

The focus of this cruise is the Greenwich meridian section, where the decades-long time series of regular hydrographic surveys will be prolonged. Additionally to hydrographic survey with CTD, thermosalinograph and vmADCP, 3 PIES and 1 acoustic recorder mooring are serviced. 8 profiling floats will be deployed to extend the global Argo float network.

A CTD (Conductivity / Temperature / Depth) and rosette water sampler will be lowered on ca. 20 to 50 stations along the Greenwich meridian (Fig. 1) to obtain profiles of water mass properties. Water samples will be taken by the other work groups on board (see other chapters in this booklet). Further CTD casts are planned at the PIES mooring positions to calibrate the PIES's acoustic travel time measurements with a profile of temperature, salinity and sound speed, and for comparison with the CTD of the underwater PALAOA observatory near

Neumayer station. Polarstern will sail along the Greenwich meridian between 43°S and the Antarctic coast; the main CTD survey will focus on the Weddell gyre south of 55°S, where the section will be sampled along the same positions as during past cruises, extending this decades-long timeseries of water mass properties. The actual number of CTD stations will be adapted to weather and ice conditions and available ship time.

Thermosalinograph and vmADPC: Underway measurements of surface water temperature, salinity, and a number of other parameters are made by the ship's thermosalinograph. Current velocity and direction of the upper approx. 300 m are measured continuously by the vessel-mounted Acoustic Doppler Current Profiler (vmADCP). The vmADCP data can be linked with geostrophic current anomalies derived from CTD profiles, thus allowing to obtain full-depth current estimates.

Moorings: Most of the long-term moorings have been served in 2010/11 during ANT-XXVII/2. There are, however, four moorings to be served by this cruise. PIES (Pressure inverted echo sounder) are operated by AWI on the GoodHope/Greenwich section across the Antarctic Circumpolar Current (ACC) and on a north-western extension. The aims of this PIES array operational since 2006 are (a) observation of large-scale ocean bottom pressure (OBP) variability and (b) observation of barotropic and baroclinic transport variability of the ACC. The PIES are attached to a fixed steel frame at the bottom, measuring OBP (with a resolution of 0.001 dbar) and acoustic travel time of a sound signal from bottom to surface and back. With OBP measurements across the ACC, barotropic transport variability can be assessed. Also, the in-situ OBP time series are critical for validation of gravity measurements obtained from the GRACE satellite mission which assesses mass redistribution on a global scale. Acoustic travel times primarily depend on sound speed and hence temperature. By assigning OBP/travel time to the known range of temperature/salinity profiles across the ACC (Gravest Empirical Mode), the location of oceanic fronts, and baroclinic transport variability of the ACC are assessed.

Three PIES will be serviced: PIES ANT4-2 will be deployed in the north of the GoodHope section (Fig. 1, Table 2.1), filling the gap caused by a failed deployment (broken PIES release, see cruise report ANT-XXVII/2) in December 2010. Scheduled for deployment is a C-PIES measuring acoustic travel time and bottom pressure. Additionally the C-PIES includes an Aanderaa DCS Current meter to determine local near-bottom current velocity. Two PopUp buoys (made by Optimare Sensorsysteme AG) receive the PIES data via an IrDA link. The PopUps release automatically, and allow data transmission before recovery of the PIES itself. An IXSEA ET861 transponder aids relocation of the mooring via the ship's Posidonia device during future recovery. The mooring assembly is designed for a free-falling deployment. By this redeployment, the PIES array is fully operational, covering the entire ACC with acoustic travel time and bottom pressure measurements, to obtain both barotropic and baroclinic transport variability.

PIES ANT537-2 and ANT538-2 (Fig. 1, Table 2.2) were both deployed from R/V G.O. Sars in January 2008 for validation of coherent large scale ocean bottom pressure signals detected by the GRACE satellite mission. After 3 years, they need to be recovered (their mission would otherwise terminate with an automatic release in February 2012). The PIES will be acoustically released by hydrophone. After surfacing, they are located visually (if necessary by flashlight), and by VHF direction finder (Channel 77). These two PIES are not equipped with a Posidonia transponder.

Table 2.1: Pressure inverted echo sounder (PIES) to be deployed on the GoodHope section

Mooring	Planned deployment position [GPS]	Depth [m]	Planned instruments	Remarks
ANT 4-2	39° 12.75' S 11° 20.07' E	4709	C-PIES Aanderaa DCS IXSEA ET361	Re-Deployment at Topex/Jason crossover.

Table 2.2: Pressure inverted echo sounders (PIES) to be recovered on the transect from South Africa to Antarctica. Both PIES have been deployed from R/V G.O. Sars during AKES Leg 2 cruise in Feb. 2008

Mooring	Deployment position [GPS]	Depth [m]	Deployment date Time [UTC]	Instrument	Autorelease date Time [UTC]
ANT 538-2	42° 58.80' S 00° 00.08' E	~4359	08 Feb 2008 23:55	PIES #012	21 Feb 2012 12:00
ANT 537-2	41° 10.85' S 04° 15.51' E	~4867	09 Feb 2008 21:50	PIES #005	20 Feb 2012 12:00

MARU (Marine Autonomous Recording Unit): Long-term acoustic recordings are an important tool to gain insights into the movement and distribution patterns of marine mammals, which are poorly known so far. The deployment of two MARUs along the Greenwich meridian in 2008 aimed at obtaining >1 year long acoustic recordings, providing a tool to learn about behaviour of marine mammals, including large baleen whales (unbiased by the presence of a vessel), and their abundance, distribution and migration patterns. MARU #2 is a passive underwater acoustic recorder detecting vocalizations of marine mammals, deployed from Cornell University during ANT-XXV/2 in December 2008 (Fig. 1, Table 2.3). It is adapted to long-term recording with an extra battery pack. In 2010/11 (ANT-XXVII/2) its recovery was cancelled due to dense sea ice coverage.

Table 2.3: Mooring to be recovered on the Greenwich meridian

Mooring	Latitude Longitude	Water depth (m)	Date time 1. Record	Instrument type	Serial number	Instrument depth (m)
MARU#2	64° 05.07' S	5194	14.12.2008	PAM	2	5144
	00° 05.24' W		10:00			

Abbreviations: PAM: Passive Acoustic Monitor (Type: MARU, Marine Autonomous Recording Unit)

Profiling floats: The international Argo programme aims at observing global ocean upper temperature and circulation by means of free floating Argo floats. Globally, approximately 3150 of such regularly undulating platforms are in operation. During ANT-XXVIII/2, 8 profiling NEMO

floats (Navigating European Marine Observer) will be deployed. These ice-adapted floats complement the global Argo float network in the South, obtaining year-round temperature, salinity, and current velocity data from ice-covered and open regions of the Weddell Sea and Southern Ocean. The floats are drifting in a depth of ca. 800 m. Every 10 days, they carry out a vertical profile between 2000 m and the surface. The resulting temperature/salinity profile is transmitted via satellite. The NEMO floats, developed by AWI and Optimare Sensorsysteme AG with support of the EU project MERSEA, and German Argo, are specifically adapted to the conditions of ice-covered regions: When sea ice prevents surfacing of the float, all profile data are stored internally. Once the float detects an ice-free surface (e.g. in next summer, or when the float has drifted to more northerly regions), the sub-ice profiles are transmitted. Position information for the sub-ice trajectory can be obtained from the stored arrival times of acoustic signals from an array of sound sources, which have been deployed in the Weddell Sea.

3. THE *ROSEOBACTER* CLADE AND THE DISSOLVED ORGANIC MATTER (DOM) COMPOSITION IN THE ATLANTIC SECTOR OF THE SOUTHERN OCEAN

Helge A. Giebel, Christine Beardsley, Birgit Kuerzel, Helena Osterholz, Siri Rackebrandt, Thomas Remke, Maren Seibt, Matthias Wietz, Mascha Wurst (ICBM), Martin Engelhaupt, John Vollmers (Uni GÖ),
not on board: Rolf Daniel (Uni GÖ), Thorsten Dittmar, Meinhard Simon (ICBM)

Objectives

The goal of this project is a comprehensive assessment of the *Roseobacter* clade and its major bacterioplankton subclusters in the Atlantic sector of the Southern Ocean. This project is part of a key work package of the Transregional Collaborative Research Center Ecology, Physiology and Molecular Biology of the *Roseobacter* clade: Towards a Systems Biology Understanding of a Globally Important Clade of Marine Bacteria (TRR 51). The work includes investigations of the biogeography, growth and population dynamics, the genomic potential and the impact on the DOM decomposition and cycling by the *Roseobacter* clade. A special focus will be on the *Roseobacter* clade affiliated (RCA) cluster whose prominent role in Southern Ocean bacterioplankton dynamics has already been shown. Samples in the entire water column will be analysed by culture-independent and culture-dependent approaches for the phylogenetic and functional diversity and abundance of the *Roseobacter* clade and various subclusters. Samples for metagenomic, metatranscriptomic and metaproteomic analyses will be collected as well in order to assess the full and actively expressed genomic potential of this clade in the Southern Ocean. DOM samples will be analyzed for dissolved organic carbon (DOC) and nitrogen (DON) concentrations, but also for its molecular characterization by ultra high resolution mass spectrometry (FT-ICR-MS). We intend to correlate the DOM composition to the composition of the bacterioplankton and in particular to its subcommunity, consisting of members of the *Roseobacter* clade.

Work at sea

The analysis will be mainly based on concerted sampling of the water column at approx. 30 stations covering the entire transect from the subtropics to the Antarctic Coastal Current and all water masses in between. Samples will be collected mainly from near-surface waters (<200 m) but in each water mass also the entire depth profile to the bottom will be sampled. A few samples will also be collected from sea ice to assess the biodiversity and significance

of the *Roseobacter* clade in sea ice microbial communities. Further, mesocosms of 20-50 liters will be set up and subsampled to manipulate the substrate conditions to examine how the *Roseobacter* clade will respond to a changed substrate environment.

The following parameters will be analysed: Particulate organic carbon (POC; analysis in the home lab), chlorophyll, bacterial abundance (flow cytometry), bacterial biomass production (leucine and thymidine incorporation), substrate turnover (glucose, amino acids), concentrations of dissolved amino acids (analysis in the home lab), DOC (analysis in the home lab), DOM (FT-ICR-MS, solid phase extraction on board, analysis in the home lab), Fluorescence in situ hybridization by probes of various specificity (CARD-FISH, MAR-FISH), BrdU-FISH. Samples will also be collected and concentrated on filters of various sizes and pore size, stored at -80°C for later analysis in the home lab: Denaturing gradient gel electrophoresis (DGGE) of PCR-amplified 16S rRNA gene fragments amplified with primers of various specificity, expression of functional genes by qPCR, metagenomics, metatranscriptomics, proteomics. For the omics analyses, large volumes (50-100 L) will be needed but sampling will be less frequently than for the other parameters.

4. PELAGIC DIATOM STUDY, SEA ICE MOLECULAR BIOLOGY AND BIOGEOCHEMISTRY

Bánk Beszteri, Christiane Uhlig, Anique Stecher, Yubin Hu (AWI),
not on board: Gerhard Dieckmann (AWI)

Objectives

The aim of our work (in collaboration with other groups) is to sample planktonic diatoms for cultivation as well as for extending the diatom collection and biogeographic records of the Hustedt Diatom Study Centre in the ice-free parts of the cruise. In the ice covered segments and during Neumayer supply, the team will collect ice cores for biological and physico-chemical characterization. The pelagic and ice samples to be collected will be used by a number of ongoing research projects at the Polar Biological Oceanography department of the AWI, all contributing to the overarching aim of better understanding the role of these habitats in biogeochemical cycling of elements, and the ecology and evolution of primary producers inhabiting them.

The projects include: Sea ice molecular ecology (Sea ice working group), the biogeochemical role of ikaite in sea ice (Sea ice working group and the Biogeochemistry department at AWI), and the planktonic diatom biogeography and molecular systematics (Hustedt Diatom Study Centre).

Work at Sea

Plankton samples will be collected in Niskin bottles mounted on the rosette sampler and using multinet tows at discrete depths throughout the water column, as well as using smaller plankton nets, the sea water supply system and the moon pool from the surface on several stations along transects. Brine samples will be collected from sack holes in sea ice. Sea ice will be sampled by taking cores with a standard corer. Cores will be returned to the vessel where they will be sectioned and melted at 4°C. After melting, samples will be available for various analyses. In addition, we will record supplementary sea ice parameters such as temperature, salinity and texture as well as other parameters in brine. We will preserve or freeze samples to be returned to the home laboratory for further analyses.

5. LIFE-CYCLE STRATEGIES OF ANTARCTIC COPEPODS: PHYSIOLOGICAL REGULATION OF OVERWINTERING AND LIPID METABOLISM IN THE WEDDELL SEA

Holger Auel, Wilhelm Hagen, Sabine Schründer, Carolin Hauer (MarZoo), Franz Sartoris, Sigrid Schiel, Richie Steinmetz (AWI), Hans Verheye, Jenny Huggett, Keshnee Pillay (DEA)

Objectives

Within the DFG project „Overwintering strategies in polar copepods: Physiological mechanisms and buoyancy regulation by ammonium" (Auel, Sartoris, Schiel, Schründer), the physiological regulation mechanisms of seasonal vertical migrations in dominant copepod species are studied. Based on field data, ecophysiological measurements on board and biochemical analyses in the home lab, we will test the hypothesis that the ammonium concentration in the haemolymph of copepods at the same time triggers the induction of diapause by metabolic depression and determines the actual overwintering depths via buoyancy regulation. The research cruise ANT XXVIII/2 in austral spring/summer will allow us to study the critical transition from overwintering at depths to the active phase in the surface layer. Zooplankton will be collected by stratified hauls in order to monitor the vertical distribution of dominant copepods and to collect individuals for respiration, grazing and reproduction measurements on board.

Mesozooplankton biomass in both polar oceans is strongly dominated by large calanoid copepods. In the Southern Ocean, *Calanoides acutus* and *Calanus propinquus* contribute between 10 and 50% to the total mesozooplankton biomass. The distinct seasonality in polar environments is probably the most important factor influencing life cycles and adaptations of herbivorous copepods. Ontogenetic and seasonal vertical migrations associated with a diapause are known as an adaptation to escape temporarily from unfavourable conditions and food scarcity during the unproductive winter season. Many species of polar copepods migrate mainly as late copepodite stages to greater depths where they reside for several months in diapause characterized by low swimming activity, cessation of feeding, arrested development and reduced metabolic rates. These copepods accumulate large amounts of depot lipids during spring and summer, almost exclusively composed of wax esters, to fuel diapause and reproduction in the following spring partly independent of food intake.

Although ontogenetic vertical migrations (OVM) have been known for many years, the triggers inducing OVM and diapause in polar copepods are still unknown and it is not clear how diapausing copepods with a reduced swimming activity regulate their buoyancy to remain at a certain depth over a long period of time. Whether an organism floats or sinks depends on the density difference between the animal and the surrounding seawater. Thus, a neutrally buoyant animal must have the same density as the surrounding seawater. It is widely believed that lipids play a role in buoyancy control. However, body lipids of copepods are generally more compressible and have a larger thermal expansion than seawater. Therefore, the buoyancy of copepods is extremely sensitive to their biochemical composition and the relative fractions of lipids, proteins and chitin, which makes lipid-regulated neutral buoyancy unstable. Moreover, the seasonal pattern in lipid accumulation is out of phase with OVMs. Copepods descend to overwintering depth at the end of summer, when their lipid content is at its maximum and, hence, lipid-regulated buoyancy is very high. Only a small percentage of the stored lipids are consumed during overwintering, but lipid deposits fuel the re-start of development, maturation and fertilisation at the end of winter, when the copepods are still at depth. Thus, copepods must ascend again in spring with severely reduced lipid levels and, therefore, low buoyancy. It follows that maintenance of neutral buoyancy requires additional regulation mechanisms

besides lipid storage. Ion replacement, i.e. the selective exclusion of heavier ions (Na^+, Mg^{2+}, SO_4^{2-}) and replacement by lighter ions (e.g. NH_3/NH_4^+, Cl^-), can help marine organisms to reduce their aggregate density, while still remaining isoosmotic with the surrounding seawater.

This mechanism has been reported for deep-water shrimps and for pelagic deep-water cephalopods. Our preliminary studies show that diapausing copepods also contain high concentrations of ammonia. Compared to the extra cost of swimming or the accumulation of low-density organic compounds such as lipids, the energetic costs involved in the production of large amounts of ammonia are low, as it is a waste product of protein/nitrogen metabolism. Dependent on the pH, ammonia exists in solutions as both, NH_3 and NH_4^+. The pK of the reaction is about 9.5 resulting in a shift to form NH_4^+ with decreasing pH. In addition, NH_3 is more toxic than NH_4^+ and in contrast to NH_4^+ it easily penetrates cell membranes. Ammonia concentrations as high as those found in the haemolymph of the Antarctic copepods *Calanoides acutus* and *Rhincalanus gigas* would impair nervous function in cephalopods. In cephalopods and in deep-water shrimp, the low-density fluid is therefore stored in specialized compartments at low pH to cope with the potentially toxic levels of ammonia. Due to the toxicity and the higher diffusibility of NH_3, we predict a low haemolymph pH in diapausing copepods to favour the formation of ammonium (NH_4^+), which is more resistant to loss by passive diffusion and is less toxic. On the other hand, as it is only slightly lighter than sodium, the dominant ion with which it is typically exchanged, large quantities must be accumulated in order to achieve neutral buoyancy.

Work at sea

Diapausing copepod species will be sampled by different opening and closing nets (Hydro-Bios Multinet Maxi and Midi) from the overwintering depth (max. 2000 m) to the surface. Additional nets (Bongo and RMT) may be used to supply sufficient quantities of individuals for experiments and analyses. A total of 25 sampling stations are required. Depending on the type of the sampling gear (e.g. only 5 discrete sampling strata with the Multinet Midi), stations may have to be sampled with two successive hauls immediately one after the other to provide a reasonable vertical resolution of 9 depth strata. A typical sampling profile would therefore combine one deep haul (2000-1500-1000-500-200-0 m) with a shallow haul (200-150-100-50-20-0 m). In addition, some stations will have to be sampled several times in order to provide sufficient individuals for experiments and biochemical analyses.

Copepods will be sorted from the different depth layers, identified to species, sex and developmental stages and counted. The rest of the samples will be preserved in 4% buffered formalin for later studies on the abundance, population structure, vertical distribution and maturity of gonads and gut contents.

Under a dissecting microscope, haemolymph will be extracted manually from individual animals by use of glass capillaries, prepared beforehand with an electrode puller in order to provide ultra-fine tips, which easily penetrate the copepods exoskeleton. The haemolymph is sucked by capillary forces into the glass tip and then transferred into a plastic cap filled with 40 µL of distilled water, before freezing. Haemolymph samples will be analysed by ion chromatography. The measurements will include inorganic ions, especially NH_4^+, Mg^{++}, K^+, Ca^+, Na^+, Cl^-, and SO_4^{--}. The ion chromatograph Dionex IC 2000 allows for the measurement of small volumes of haemolymph (minimum volume >10 nL) as obtained from copepods and will deliver the relative percentages of the different ions. The content of ammonium (and other ions) will therefore be given as a percentage of the overall cation/anion content, which is a good measure for the ammonia content since ammonia is exchanged for other cations such as sodium, magnesium and calcium. In a second approach, haemolymph samples will be collected on board to measure extracellular pH.

We will determine respiration rates of copepods in different life-cycle phases and from different

depth layers under simulated in situ conditions in temperature-controlled labs on board as a measure of metabolic activity. 10 to 20 individuals will be incubated in gas-tight bottles filled with filtered and oxygenated seawater and fixed to a plankton circulation wheel for several hours. The decrease in oxygen concentration will be monitored in comparison to animal-free controls either by oxygen optodes or Winkler titration. At the end of the experiments, samples of the incubation water will be collected and deep-frozen for the determination of the ammonium concentration in the home lab. This approach will allow us to measure in parallel respiration and excretion rates of copepods. Respiration measurements will be supplemented by grazing experiments in order to determine ingestion rates as another proxy for copepod activity.

Deep-frozen (-80°C) samples of the different copepod species and stages from different depth layers and seasons will be collected for biochemical analyses. Lipid content and lipid-class composition will be measured in order to provide data for buoyancy calculations. Protein content and C/N ratios will be determined to trace seasonal trends in protein catabolism as a potential source of ammonia. Digestive enzyme and electron transfer system (ETS) activity will be measured as additional proxies for metabolic activity.

In addition, South African partners will deploy a Continuous Plankton Recorder (CPR) for underway zooplankton sampling along the cruise track from Cape Town to Antarctica. The CPR will be towed behind the vessel. Actually, CPRs have been developed to use commercial ships-of-opportunity for scientific purpose. Zooplankton is continuously filtered and preserved on a gaze stored in 4% formaldehyde solution. In regular intervals the gaze cartridges will be replaced. The CPR survey will provide data on zooplankton distribution in higher spatial resolution than point measurements by conventional net hauls.

6. MAPS: MARINE MAMMAL PERIMETER SURVEILLANCE

Sebastian Richter (AWI),
not on board: Olaf Boebel, Lars Kindermann, Daniel Zitterbart (AWI)

Objectives

Both, non-governmental organizations and governmental agencies increasingly criticize the use of air-guns for marine geophysical research due to the enhanced noise levels these instruments introduce to the aquatic environment. To remedy possible detrimental effects to the marine fauna, mitigation measures are commonly requested, which in most cases imply visual observation of the ship's perimeter and shut down of seismic operations when whales are sighted within a predefined exclusion zone around the airguns. To facilitate such observations, the MAPS project aims at developing an automatic whale blow detection system on the basis of a 360° thermal imaging sensor, FIRST Navy.

Data collected with this system during two recent Polarstern cruises resulted in numerous detections during retrospective human visual screening, even in relatively warm waters of up to 6°C. These encouraging results however only represent a first step, as now a robust computer based image recognition algorithm needs to be developed and tested, which automatically processes the video stream for the occurrence of whale blows, resulting in issuing a real-time alert to the marine mammal observers and ship's crew. This very expedition's goal is to collect additional data for further efficiency tests of automated detection algorithms as developed on the basis of data collected during the expedition ANT-XXVI/3 and ANT XXVII/2. This requires considering two questions:

1) What is the number of missed events (i.e. whales present which are not detected by the automated algorithm).

2) What is the number of false positives (i.e. events such as breaking waves that the automated algorithm mistakenly identifies as whale blows).

Last but not least, the add-on PiP system, which shall automatically collect high-resolution visual photo footage of autodetected events, shall be further developed. The system requires a predictive compensation of the ship's pitch and roll, which is yet not fully developed.

Work at sea

During the cruise, two data sets will to be collected independently: a) an IR video stream and b) protocols of visual whale sightings by human observers. Visual whale sightings will be collected under the auspices of independent whale observer groups and the ship's nautical officers. The IR video stream will be saved continuously for retrospective analysis. To this end, the exact time (to the second), direction and preferably distance of any visual sighting need to be recorded along with information on the species sighted. In addition the image stabilization of the PiP system shall be improved during this cruise. The development and testing of this system can only be conducted in-situ on the ship, with direct connection to the FIRST-Navy gimbal data.

Expected results

This effort is expect to result in the collection of a comprehensive dataset for further system development and validation, behavioral analysis and a marine mammal sighting database. Behavioral analysis will provide high resolution tracks of marine mammals in the vicinity of the ship, including the distribution of concurrent ice-floes. System validation will lead to improved algorithms, with the aim to minimize the amount of false alerts. Furthermore, we expect to have optimized the PiP System with regard to compensation of pitch and roll.

7. MARINE MAMMAL SURVEY

Linn Sophia Lehnert, Ian Gray, Stephanie Plön, Conny Schmidt (ITAW), Kristina Lehnert (HZG), Hans Verdaat, Steve Geelhoed (IMARES), not on board: Ursula Siebert (ITAW)

Objectives

Knowledge on distribution, density and abundance of cetaceans in the Southern Ocean is rather limited. Especially in pack-ice regions, little research has been conducted, as only few vessels can penetrate into the ice. By means of a dedicated cetacean sighting survey following standard line-transect distance sampling methodology, our project aims to contribute to solid base line data on cetacean occurrence and abundance, needed by decision makers for management and protection. In addition, behavioural observations shall investigate response behaviour of cetaceans towards vessels in Antarctic waters.

Work at sea

We will conduct shipboard and aerial cetacean sighting surveys whenever sighting and weather conditions permit (e.g. we need relatively calm seas in order to spot cetaceans). For the shipboard survey our observation platform will be the crow's nest, and we will survey along the cruise track of Polarstern. During any shift 2 observers will collect sighting data according to distance sampling methodology and a third person will enter these data directly into a computer connected to a GPS. The same method will be followed during the aerial surveys which will be conducted by helicopter, to survey areas away from the ship. In addition to the distance sampling survey, we will conduct some tracking from the crow's nest, i.e. following

detected (groups of) animals with powerful binoculars („Big Eyes“), noting down their track as long as possible. This is a means to evaluate cetacean behaviour, for example in response to the ship.

Our data will be used for population assessment of cetaceans in Antarctic waters. Along with distributional analyses of species occurrence, distance sampling evaluation will contribute to abundance estimation of species, e.g. the Antarctic minke whale (*Balaenoptera bonaerensis)*, which is still being hunted. Our tracking data will be used for behavioural studies.

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

Claude R. Joiris, Dominique Verbelen, Jan Haelters (PolE)

In the frame of our long-term study of the at-sea distribution of seabirds and marine mammals, concerning mainly the mechanisms explaining this distribution: water masses and fronts and bottom structures such as slope influencing the localization of fronts (upwellings), special attention is to be paid to less studied Antarctic zones such as the eastern and western parts of the Weddell Sea. In comparison with previous expeditions between South Africa and Antarctica, basic mechanisms are expected to be confirmed and possible changes in density and/ or geographical distribution could be detected. Work at sea consists in continuous transect counts from the bridge.

9. BETEILIGTE INSTITUTE / PARTICIPATING INSTITUTES

	Adresse **Address**
AWI	Alfred-Wegener-Institut für Polar- und Meeresforschung in der Helmholtz-Gemeinschaft Postfach 120161 27515 Bremerhaven/Germany
DEA	Department of Environmental Affairs: Oceans and Coasts Research P.O. Box 52126, Victoria & Alfred Waterfront Cape Town/South Africa
DWD	Deutscher Wetterdienst Bernhard-Nocht Str. 76 20359 Hamburg/Germany
HeliService	HeliService International GmbH, Deutschland Am Luneort 15 27572 Bremerhaven/Germany
HZG	Helmholtz Zentrum Geesthacht, Institut für Küstenforschung Werftstraße 6 25761 Büsum/Germany
ITAW	Institut für Terrestrische und Aquatische Wildtierforschung Stiftung Tierärztliche Hochschule Hannover Werftstraße 6 25761 Büsum/Germany
ICBM	Institute for Chemistry and Biology of the Marine Environment University of Oldenburg 26131 Oldenburg/Germany
IMARES	IMARES Wageningen UR 1790 AD Den Burg (Texel)/The Netherlands
Laeisz	Reederei F. Laeisz (Bremerhaven) GmbH Brückenstraße 25 27568 Bremerhaven/Germany
MarZoo	Marine Zoologie Universität Bremen P.O. Box 330 440 28334 Bremen/Germany

	Adresse **Address**
PIK	Potsdam-Institut für Klimafolgenforschung Telegraphenberg A 31 14473 Potsdam/Germany
PolE	Laboratory for Ecotoxicology and Polar Ecology Free University of Brussels Pleinlaan 2 B-1050 Brussels/Belgium
UBA	Umweltbundesamt Wörlitzer Platz 1 06844 Dessau-Roßlau/Germany
Uni GÖ	Institute of Microbiology and Genetics Georg-August-Universität Göttingen Grisebachstr. 8 37077 Göttingen/Germany

10. FAHRTTEILNEHMER / PARTICIPANTS

Name/ Last name	Vorname/ First name	Institut/ Institute	Beruf/ Profession
Auel	Holger	MarZoo	Biologist
Beardsley	Christine	ICBM	Microbiologist
Beszteri	Bánk	AWI	Biologist
Engelhaupt	Martin	Uni GÖ	Student, biology
Geelhoed	Steve	IMARES	Biologist
Giebel	Helge A.	ICBM	Microbiologist
Gray	Ian	ITAW	Biologist
Haelters	Jan	PolE	Biologist
Hagen	Wilhelm	MarZoo	Biologist
Hauer	Carolin	MarZoo	Student, biology
Hirsekorn	Marius	AWI	Logistic (to Neumayer)
Hu	Yubin	AWI	PhD student, chemistry
Huggett	Jenny	DEA	Biologist
Joiris	Claude R.	PolE	Biologist
Kattner	Gerhard	AWI	Chemist
Kallfelz	Monika	Coole Klassen	Teacher
Kienert	Hendrik	PIK	PhD Student, oceanography
Kuerzel	Birgit	ICBM	Technician
Lehnert	Kristina	HZG	Biologist
Lehnert	Linn Sophia	ITAW	Biologist
Osterholz	Helena	ICBM	PhD student, geochemistry
Macrander	Andreas	AWI	Oceanographer
Miller	Max	DWD	Meteorologist
Müller	Miriam	UBA	Logistic
Pillay	Keshnee	DEA	PhD student, biology
Plön	Stephanie	ITAW	Biologist
Pluder	Andreas	Laeisz	Logistic (to Neumayer)
Rackebrandt	Siri	ICBM	Student, marine sciences
Reeve	Krissy	AWI	PhD student, oceanography
Remke	Thomas	ICBM	Student, marine sciences
Richter	Sebastian	AWI	Physicist
Satoris	Franz Josef	AWI	Biologist
Schiel	Sigrid	AWI	Biologist
Schmidt	Conny	ITAW	Technician
Schründer	Sabine	MarZoo	PhD student, biology
Seibt	Maren	ICBM	PhD student, geochemistry
Sonnabend	Hartmut	DWD	Technician
Stecher	Anique	AWI	PhD student, biology

Name/ Last name	Vorname/ First name	Institut/ Institute	Beruf/ Profession
Steinmetz	Richard	AWI	Technician
Uhlig	Christiane	AWI	PhD student, biology
Wietz	Matthias	ICBM	PhD student, microbiology
Wurst	Mascha	ICBM	PhD student, microbiology
Verbelen	Dominique	PolE	Biologist
Verdaat	Hans	IMARES	Biologist
Verheye	Hans M.	DEA	Biologist
Vollmers	John	UniGÖ	PhD student, microbiology
Yoshinari	Hiroshi	AWI	Oceanographer
Zhang	Xu	AWI	PhD student, oceanography
NN		AWI	Technician
NN		HeliService	Pilot
NN		HeliService	Pilot
NN		HeliService	Technician
NN		HeliService	Technician

11. SCHIFFSBESATZUNG / SHIP'S CREW

Name	Rank
Wunderlich, Thomas	Master
Spielke, Steffen	1.Offc.
Ziemann, Olaf	Ch.Eng.
Lauber, Felix	2.Offc.
Peine, Lutz	2.Offc.
Hering, Igor	2.Offc.
Lambrecht, Wolfgang	Doctor
Koch, Georg	R.Offc.
Kotnik, Herbert	2.Eng.
Schnürch, Helmut	2.Eng.
Westphal, Henning	2.Eng.
Brehme, Andreas	Elec.Tech.
Fröb, Martin	Electron.
Muhle, Helmut	Electron.
Winter, Andreas	Electron.
Feiertag, Thomas	Electron.
Clasen, Burkhard	Boatsw.
Neisner,Winfried	Carpenter
Schultz, Ottomar	A.B.
Burzan, G.-Ekkehard	A.B.
Schröder, Norbert	A.B.
Moser, Siegfried	A.B.
Hartwig-L., Andreas	A.B.
Kretzschmar, Uwe	A.B.
Kreis, Reinhard	A.B.
Schröter, Rene	A.B.
Beth, Detlef	Storekeep
NN	Mot-man
Fritz, Günter	Mot-man
Krösche, Eckard	Mot-man
Dinse, Horst	Mot-man
Watzel, Bernhard	Mot-man
Fischer, Matthias	Cook
Tupy,Mario	Cooksmat
Völske, Thomasl	Cooksmat
Dinse, Petra	1.Stwdess
Hennig, Christina	Stwdss/KS
Streit, Christina	2.Steward
Hischke, Peggy	2.Stwdess
Wartenberg, Irina	2.Stwdess
Hu, Guo Yong	2.Steward
Chen, Quan Lun	2.Steward
Ruan, Hui Guang	Laundrym.
Seibel, Sebastian	Apprent.
Strauß, Erik	Apprent.

ANT-XXVIII/3

7 January 2012 – 11 March 2012

Cape Town – Punta Arenas

Chief Scientist

Dieter Wolf-Gladrow

Contents

1. ÜBERBLICK UND FAHRTVERLAUF

Dieter Wolf-Gladrow, Volker Strass(AWI), Angelika Brandt
(Uni Hamburg/Zoo. Mus)

Das Forschungsschiff *Polarstern* wird am 7. Januar 2012 den Hafen von Kapstadt verlassen und die Expedition ANT-XXVIII/3 beginnen. Die Fahrroute führt zunächst südostwärts bis etwa 55°S 30°O, dann im Breitenbereich 50-60°S westwärts bis nach Südamerika, wo die Expedition am 11. März 2012 im Hafen von Punta Arenas (Chile) enden wird (Abb. 1). Während der Reise werden zwei große Forschungsprojekte durchgeführt:

1. „Eddy Pump“, eine interdisziplinäre Untersuchung der physikalischen, chemischen und biologischen Prozesse, die die Kohlenstoffpumpen im Südlichen Ozean und insbesondere in den zahlreich eingebetteten mesoskaligen Wirbeln antreiben.

2. SYSTCO II (SYSTem COupling in the deep Southern Ocean II), eine Untersuchung der (a) Diversität, Verteilung und Häufigkeit von benthischen Tiefseeorganismen und deren Beziehung zur biologischen Produktivität in und zum Export von organischem Material aus der euphotischen Zone (b) Ökologie der Tiefseefauna und (c) der Erhaltung von DNS in der Wassersäule und in Tiefseesedimenten und das Potential von DNS zur Rekonstruktion der eukaryotischen Diversität heute und in der geologischen Vergangenheit.

Die beiden Forschungsprojekte ergänzen sich und daher werden Probennahmen an zahlreichen gemeinsamen Stationen entlang der Fahrtroute stattfinden. Einen Schwerpunkt werden detaillierte Untersuchungen in mehreren mesoskaligen Wirbeln darstellen, die so ausgewählt werden, dass sie verschiedene ozeanographische und biogeochemische/ biogeographische Regime abdecken, insbesondere: (1) Die Region mit verstärkter kinetischer Wirbelenergie im Bereich südlich von 50°S bei etwa 30°O, verbunden mit einer südwärtigen Verlagerung der Polarfront am östlichen Ausläufer des Weddellwirbels, die entgegen der erwarteten Eisenzufuhr durch häufigen mesoskaligen Auftrieb vermutlich von *F. kerguelensis* dominiert wird. (2) Den zentralen Antarktischen Zirkumpolarstrom entlang der Polarfront bei 0°O, der durch kurzlebige Phytoplanktonblüten mit wechselnder Dominanz von *Chaetoceros* und *F. kerguelensis* gekennzeichnet ist. Getrieben werden die Blüten vermutlich durch sporadische Eisenzufuhr durch mesoskalige Auftriebsereignisse in Bereichen mit geringer oder mäßiger kinetischer Wirbelenergie. (3) Die `*Chaetoceros*-Provinz’ im ‘Kielwasser’ von South Georgia und der Antarktischen Halbinsel, die von hohen langfristigen mittleren Chlorophyll-Konzentrationen an der Meeresoberfläche gekennzeichnet ist, vermutlich gefördert von lateraler Eisenzufuhr vom Schelf oder von schmelzenden Eisbergen freigesetztem Eisen. Unterwegs wird zwischen den Hauptuntersuchungsgebieten die übliche hydrographische und biogeochemische Stationsarbeit durchgeführt, insbesondere quer durch die Drake Passage, die einen starken Süd-Nord Gradienten der kinetischen Wirbelenergie, aber einen insgesamt sehr niedrigen Chlorophyllgehalt an der Meeresoberfläche aufweist.

Hintergrund und Ziele von „Eddy Pump”

Während die wichtige Rolle des Südlichen Ozeans im globalen Kohlenstoffkreislauf unbestritten ist, gibt es kontroverse Debatten darüber, ob er sich aufgrund des Klimawandels von einer CO_2 Senke zu einer CO_2 Quelle ändern wird. Die Größenordnung und sogar die Richtung einer solchen Änderung hängt ab von Verschiebungen des empfindlichen Gleichgewichts zwischen der physikalischen Kohlenstoffpumpe, verbunden mit der Aufwärtsströmung von kaltem, mit CO_2 angereichertem Tiefenwasser und der biologischen Kohlenstoffpumpe, die angetrieben wird von der CO_2-Aufnahme durch Photosynthese nahe der Meeresoberfläche und der anschließenden Sedimentation der organischen Partikel. Ein komplexes Zusammenspiel von physikalischen, chemischen und biologischen Prozessen bestimmt also, ob der Südliche

Ozean die durch Treibhausgas angetriebenen Klimaveränderungen abschwächen oder verstärken wird. Um diese Prozesse und deren Kopplungen zu identifizieren, werden wir uns auf den Breitenbereich zwischen 50°S und 60°S konzentrieren, wo die aufwärts strömenden Tiefenwassermassen mit der Atmosphäre interagieren, bevor sie an der Subantarktischen Front abtauchen. Um den Einfluss verschiedener Prozesse auf die Kohlstoffpumpen während eines bedeutenden Teils der Wachstumssaison aufzuklären, werden die Prozessuntersuchungen innerhalb von Wirbeln wiederholt durchgeführt. Die Wirbel werden so ausgesucht, dass sie die verschiedenen ozeangraphischen und biogeochemischen Systeme im Atlantischen Sektor des Südlichen Ozeans repräsentieren.

Die Komplexität der marinen Klima- und Ökosysteme des Südlichen Ozeans und ihrer Wechselwirkungen erfordert einen interdisziplinären Einsatz. Die Kampagne „Eddy Pump" wird die verschiedenen maßgeblichen Disziplinen zusammenführen und ihr Synergiepotenzial ausschöpfen, indem sie sie auf ein gemeinsames Ziel hin bündelt. Das breite Spektrum der beteiligten Disziplinen und Ansätze umfasst:

- Physikalische Ozeanographie: Standortsuche mit Hilfe von Satelliten- und vor Ort Daten; atmosphärischer Antrieb; Schichtung; vertikale Vermischung und ihr Einfluss auf die kritische Lichttiefe für Phytoplanktonwachstum; mesoskalige Dynamik von frontalen Mäandern und Wirbeln, Aufwärtsströmung und Subduktion; Advektion von Wassermassen und von gelösten und partikulären Substanzen.

- Marine Chemie: Luft-Wasser CO_2-Gasaustausch; gelöster anorganischer und organischer Kohlenstoff; Sauerstoff; Makronährstoffe und Mikronährstoffe wie Fe.

- Biologische Ozeanographie: Phytoplankton: räumliche und zeitliche Änderungen in der Konzentration, Artenzusammensetzung, Primärproduktion von partikulärem organischem Kohlenstoff; Wachstumsreaktion auf Änderungen bei den Mikro- und Makro-Nährstoffen; Zooplankton: räumliche und zeitliche Änderungen in der Konzentration, Artenzusammensetzung, Fraßraten und Bedarf an organischem Kohlenstoff, trophische Wechselwirkungen und Nahrungsnetzstrukturen.

- Marine Geochemie: Indikator-basierte Abschätzung der Export-Produktion, Quantifizierung von Stoffflüssen oder partikulärer organischer Substanz.

- Satellitenfernerkundung der Farbe des Ozeans: Phytoplankton-Pigmentkonzentrationen; Verbesserung von diagnostischen Modellen zur Primärproduktion.

Hintergrund und Ziele von SYSTCO II

Der wissenschaftliche Ansatz von SYSTCO II wird auf dem ersten Projekt und den internationalen und interdisziplinären Untersuchungen des Meeresboden aufbauen, die während ANDEEP-SYSTCO I im Jahre 2007/2008 in der Tiefsee des Südlichen Ozeans begannen (ANDEEP = Antarctic benthic deep-sea biodiversity: colonization history and recent community patterns). Wenn möglich sollte das Untersuchungsgebiet die Stationen, die während des Projektes „Eddy Pump" werden, mit einschließen.

SYSTCO II baut auf die enge Zusammenarbeit von Wissenschaftlern aus verschiedenen Disziplinen, wie physikalischer Ozeanographie, Planktologie, Biogeochemie, Sedimentologie und Bathymetrie mit Benthologen, die sich auf verschiedene Aspekte konzentrieren, um Licht in die atmosphärisch-pelagisch-benthischen Kopplungsprozesse zu bringen.

Unser Beitrag zu SYSTCO II wird folgende drei Aspekte umfassen:

- Diversität, Verteilung und Häufigkeit von Tiefsee-Organismen von Meiofauna bis zu Megafauna-Organismen in Bezug zu Oberflächenwasserproduktivität und Sedimentation

von organischem Material zum Meeresboden.

- Ökologie der Tiefsee-Fauna im Hinblick auf Kopplungsprozesse mit unterschiedlichen Ansätzen, wie herkömmliche und molekulare Analyse des Mageninhalts sowie biogeochemische Untersuchungen (Fettsäuren-Profile und Verhältnissen von stabilen C und N Isotopen).
- DNA-Konservierung in der Wassersäule und den Tiefsee-Sedimenten und ihr möglicher Gebrauch für Untersuchungen zur Diversität der Eukaryoten in Gegenwart und Vergangenheit.

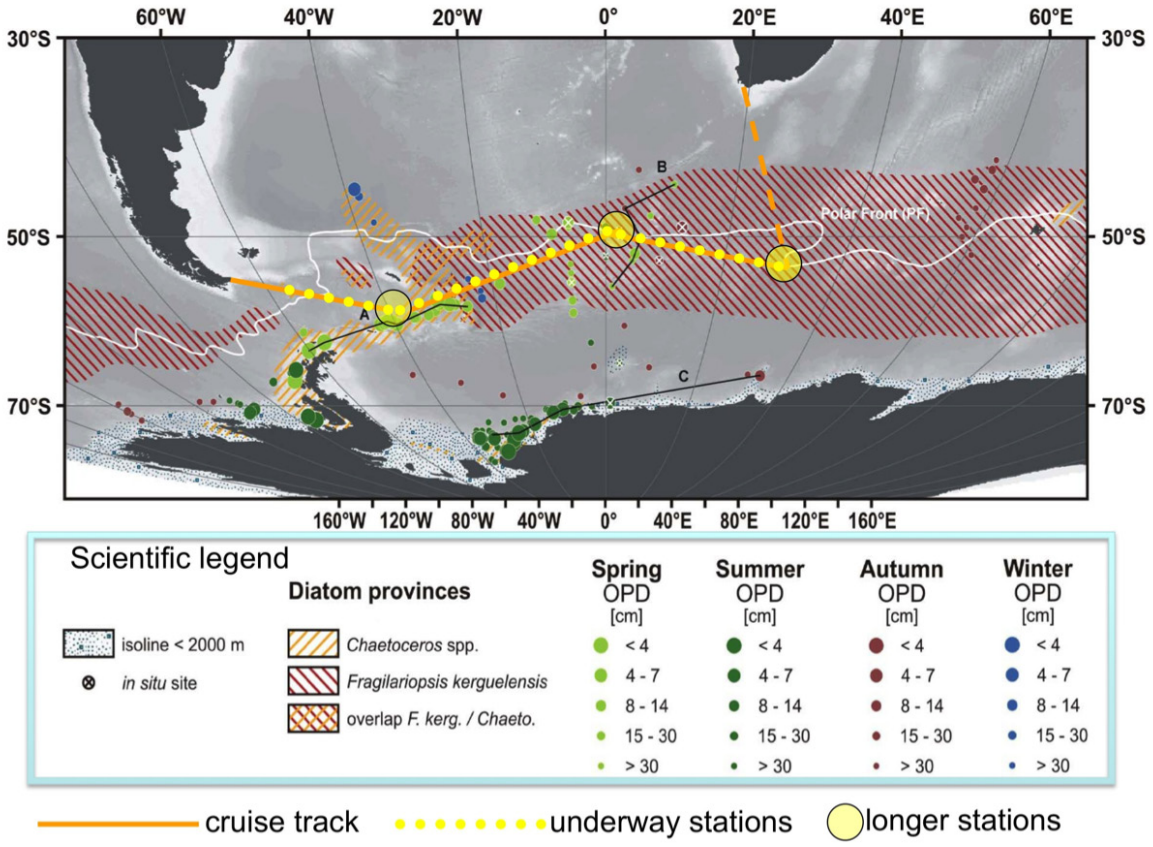

Abb. 1: Fahrtroute und geplante Stationsverteilung während ANT-XXVIII/3
Fig. 1: Cruise track and planned stations during ANT-XXVIII/3

SUMMARY AND ITINERARY

On 7 January 2012 the research vessel *Polarstern* will leave Cape Town to start its expedition ANT-XXVIII/3. Initially the route leads southeastwards until 55°S, 30°E, then turning westwards to South America within the latitudinal region of 50-60°S where the expedition will come to an end on 11 March 2011 in Punta Arenas (Chile) (Fig. 1). During the cruise two large research projects will be carried out:

1. “Eddy pump“, an interdisciplinary study of the physical, chemical and biological

processes driving the carbon pumps in the Southern Ocean, in particular within the numerous embedded mesoscale eddies.

2. SYSTCO II (SYSTem COupling in the deep Southern Ocean II), a study on a) diversity, distribution and abundance of deep-sea organisms in relation to surface water productivity and sedimentation of organic material to the seafloor; b) ecology of deep-sea fauna, and c) DNA preservation in the water column and the deep-sea sediments and its possible use to study the eukaryotes diversity in the present and the past.

Both research projects complement each other and thus sampling will take place at numerous joint stations along the trip route.

A focus will be on studies in several mesoscale eddies, chosen to cover various oceanographic and biogeochemical/biogeographical regimes, especially: (1) The region with enhanced eddy kinetic energy in the area south of 50°S at approx. 30°E, associated with a southward veering of the Polar Front at the eastern extent of the Weddell Gyre, which despite presumed enhanced iron supply from upwelling is assumed to be dominated by *F. kerguelensis*. (2) The central Antarctic Circumpolar Current along the Polar Front at 0°E marked by transient phytoplankton blooms, presumably driven by pulses of iron supply through mesoscale upwelling events associated with a low to moderate level of eddy kinetic energy (EKE), and alternating between *Chaetoceros* and *F. kerguelensis* dominance. (3) The `*Chaetoceros* Province' in the wake of South Georgia and the Antarctic Peninsula marked by high long-term mean sea surface chlorophyll concentration, presumably fostered by lateral advection of iron from the shelf or by iron released from melting icebergs). En route between the main investigation sites, conventional hydrographic and biogeochemical station work will be performed, in particular across Drake Passage which features a strong south-north gradient of EKE but overall very low sea surface chlorophyll.

Background and objectives of "Eddy Pump"

While the important role of the Southern Ocean in the global carbon cycle is undisputed, controversially debated is whether it will change from a CO_2 sink to a source with changing climate. The magnitude and even the direction of such change depends on shifts of the delicate balance between the physical carbon pump, associated with the upwelling of cold deep water enriched with CO_2 and plant nutrients in the Antarctic Divergence, and the biological pump, fuelled by the uptake of CO_2 through photosynthesis near the sea surface and the subsequent sedimentation of organic particles. A complex interaction of physical, chemical and biological processes thus regulates, whether the Southern Ocean will attenuate or amplify greenhouse-gas driven changes of climate. In order to identify those processes and their coupling we will concentrate on the band of latitudes between 50°S and 60°S where the upwelled deep-water masses interact with the atmosphere before they are subducted at the Sub-Antarctic Front. To enable the effect on the carbon pumps during a significant part of the growth season to be revealed, the process studies will be repeatedly conducted within vertically coherent eddies, which will be chosen so that they represent presumed different oceanographic and biogeochemical regimes in the Atlantic Sector of the Southern Ocean.

The complexity of the Southern Ocean marine climate and ecosystem and of their interactions calls for an interdisciplinary effort. "Eddy Pump" will integrate the different relevant disciplines and exploit their synergy potential by focussing on a common goal. The wide spectrum of disciplines and approaches involved includes:

- Physical Oceanography: site selection using remote and *in-situ* data; atmospheric forcing, stratification, vertical mixing and their influence on the critical light depth for phytoplankton growth; mesoscale dynamics of frontal meanders and eddies, upwelling and subduction; advection of water masses and of dissolved and particulate substances.

- Marine Chemistry: air-sea fluxes of CO_2; dissolved inorganic and organic carbon; oxygen; macro and micro nutrients such as Fe.
- Biological Oceanography: phytoplankton: spatial and temporal changes in concentration, species composition, primary production, particulate organic carbon; growth response to variations in micro and macro nutrients, ambient CO_2 and acidity; zooplankton: spatial and temporal changes in concentration, species composition, feeding rates and organic carbon demand, trophic interaction and food-web structures.
- Marine Geochemistry: tracer-based estimates of export production, quantification of fluxes or particulate organic matter (POM).
- Satellite Remote Sensing of Ocean Colour: phytoplankton pigment concentrations; improvement of diagnostic models of primary production.

Background and objectives of SYSTCO II

The scientific approach of SYSTCO II will build on the first venture and aims to build on the international and interdisciplinary investigations of the seafloor which started during ANDEEP-SYSTCO I in 2007/2008 in the Southern Ocean deep sea. The research area should include those stations which will be sampled during the “Eddy Pump” project.

SYSTCO builds on the close cooperation of scientists from different disciplines, such as physical oceanography, planktology, biogeochemistry, sedimentology, and bathymetry with benthologist concentrating on various aspects to shed light on atmospheric-pelagic-benthic coupling processes. This has already been performed with remarkable success on the SYSTCO I cruise.

Our contribution to SYSTCO II will concern three aspects:

- Diversity, distribution and abundance of deep-sea organisms from meiofaunal foraminifera to megafaunal organisms in relation to surface water productivity and sedimentation of organic material to the seafloor.
- Ecology of deep-sea fauna with regard to coupling processes utilizing different approaches, like traditional and molecular gut content analyses as well as biochemical investigations (fatty acid profiles and stable isotope C and N ratios).
- DNA preservation in the water column and the deep-sea sediments and its possible use to study the eukaryotes diversity in the present and the past.

2. PHYSICAL OCEANOGRAPHY

Volker Strass (AWI), Mathew Donnelly, Harry Leach (SoES), Rainer Graupner, Hendrik Sander (OPTIMARE), Matthias Krüger (IfM-GEOMAR), Hartmut Prandke (ISW Wassermesstechnik)

Rationale and objectives

“Eddy Pump” is an ambitious programme designed to study the coupling of processes that exert a control on the physical and biological pumps of carbon in different hydrographic and biogeochemical regimes of the Atlantic Sector of the Southern Ocean. In order to document the effects exerted by those processes, measurements have to be repeated in the same volume of water at a time interval of several weeks. Within the swift and variable flow of the ACC only mesoscale eddies, which form here and there from growing instabilities of frontal meanders

and then usually persist for weeks to months, can provide sufficiently stable and comparatively confined as well as vertically coherent bodies of water needed for budgeting the carbon flux.

Those eddies likewise exert a strong control on the three-dimensional flow field, on the transports of dissolved and particulate matter, interact with the mixed layer dynamics and thus influence the underwater light regime in which the plankton grows as well as the diffusive fluxes and exchanges between the ocean and atmosphere.

Work at sea

The search for suitable eddy-like structures will start in advance of the cruise on the basis of sea surface height variability maps derived from satellite altimetry that are made publicly available. Satellite maps of sea surface chlorophyll will be used as auxiliary information. That a priori information obtained from remote sensing needs verification by in situ measurements, which will be made by employing an instrument package that combines the vessel-mounted acoustic Doppler current profiler (VM-ADCP; RDI *Ocean Surveyor* 150 kHz) and a CTD (SBE 911*plus*). Upon successful verification of the existence of a suitable eddy, a surface buoy (MetOcean SVP-Iridium drifter) drogued at mid-depth of the mixed layer will be deployed close to its centre. The GPS positions obtained and transmitted by the buoy will then be used as a reference for conducting the further measurements in a Lagrangian manner, following the same body of water. After finishing our measurements in the one eddy and before heading for the next, the buoy will be recovered and relocated.

The VM-ADCP/CTD instrument package will also be used for describing the physical environmental conditions of phytoplankton and zooplankton during our process studies. Among the variables describing the physical conditions are the three-dimensional velocity field and its temporal variations, the variables of state, temperature, salinity and density. The ship's CTD will also support auxiliary instruments such as an oxygen sensor, a fluorometer for measuring the chlorophyll concentration, and a transmissometer for measuring the light attenuation, which can be calibrated to give the particulate organic carbon (POC) concentration and for indicating the particle load in the water column. An indication of the zooplankton abundance, its mesoscale distribution and vertical migration will be derived from the ADCP backscatter signal. The ship's CTD will be integrated with a rosette frame (SBE 32 Carousel) holding 22 12-l-bottles, helping to supply various scientific disciplines with sea water samples from selected depths. Also attached to the rosette frame will be an upward/downward looking pair of L-ADCPs (RDI *Workhorse Sentinel* 300 kHz) allowing to record current velocities over the full water column from the sea surface to the ocean floor. By use of a free-falling probe, MSS, we will record microstructure turbulence profiles that allow for discriminating between fossil mixed layers and actively mixing layers as well as for estimating Thorpe scales of vertical overturns and for estimating the critical light depth for phytoplankton growth, and for determining the vertical diffusivity. The so-determined vertical diffusivity is essential for calculation of the diffusive fluxes of dissolved substances, needed to estimate the budgets of nutrients and carbon.

In total, we plan to perform 72 deep CTD casts to full ocean depth, about 200 CTD casts to 500 m in order to obtain regular grid surveys needed to reveal the eddy structure, and 72 MSS burst casts. Several other floats will be deployed *en route* as a service to other scientists not involved and participating in "Eddy Pump".

3. SAMOC: SOUTH ATLANTIC MERIDIONAL OVERTURNING CIRCULATION AND CLIMATE

Sabrina Speich (LPO, not on board), Nathanaële Lebreton (SHOM, not on board), Volker Strass (AWI)

Objectives

SAMOC aims at the role of the Atlantic Ocean Meridional Overturning Circulation (MOC) for climate variability and change. A particular focus is to develop a monitoring array in the South Atlantic, within a broad international partnership, to continue a time series started in 2004 in the South Atlantic and Southern Ocean. The main goals of SAMOC are: (1) to characterize the time-mean and time-varying components of the MOC, as well as the heat and salt carried by the MOC in the South Atlantic; (2) to observe the changes in the ventilation characteristics and relative contributions of different water masses to the MOC, and (3) to contribute with regional studies in the assessment of the sensitivity of the South American and African climate conditions to the SAMOC variability and changes.

The continuous implementation of Argo profiling floats is an essential element of SAMOC. Indeed, beyond the importance of these floats in the global coverage goal of the Argo programme we would like to keep-on the effort to improve the knowledge on regional processes and their impact on the global scale ocean circulation and climate.

Work at sea

Within ANT-XXVIII we want to continue the implementation of Argo profiling float observations in the turbulent regions of the eastern Atlantic and Atlantic sector of the Southern Ocean. In 2010/11, we will deploy 15 PROVOR and 15 ARVOR Argo floats. Additionally to temperature / conductivity / pressure, 3 of the PROVOR floats will be instrumented with a dissolved oxygen sensor.

The deployment strategy is the following:

- 6 ARVOR floats during ANT-XXVIII/1 on the transit from Bremerhaven to Cape Town.
- 15 PROVOR and 5 ARVOR floats are deployed by *S.A. Agulhas* along the GoodHope section and during a transit from South Africa to South Georgia between December 2011 and February 2012.
- 4 ARVOR floats in the Antarctic Circumpolar Current during ANT-XXVIII/3 at approximately 50°S, 55°S, 57°S, 59°S.

All floats will be drifting at 1000 dbar, and will be obtaining profiles from 2000 dbar to surface in regular intervals. By increasing the number of profiling floats in the turbulent regions of the Atlantic and Southern Ocean we will be able to improve quantitatively the knowledge on regional mesoscale dynamics and better estimate the zonal and meridional exchanges of mass, heat and freshwater. The real-time data will be made available through the Coriolis Data Assembly Centre (DAC). Delayed mode data will be available on the same DAC within a 6-month period. We will integrate the SAMOC Argo data on the SAMOC observing platform.

4. CARBON DIOXIDE, NUTRIENTS, DISSOLVED OXYGEN AND TRANSIENT TRACERS DYNAMICS DURING "EDDY PUMP"

Mario Hoppema (AWI; not on board), Toste Tanhua (IFM-GEOMAR; not on board), Judith Hauck, Felix Müller (AWI), Nicola Clargo, Sharyn Crayford (NIOZ), 1 NN

Rationale

The oceans and the climate system appear to be changing in many different aspects. The increasing westerlies in the Southern Ocean are recent exponents of this phenomenon. This may have consequences for the uptake of CO_2 by the ocean. In the Southern Ocean, a decrease of the CO_2 sink was suggested due to enhanced upwelling of deep waters. Northward eddy transport across the Antarctic Circumpolar Current may or may not be counteracting this. We propose to investigate the carbon budget of eddies and the role of eddies in the equatorward transport of carbon. CO_2 measurements within and across different eddies will be conducted, as well as transient tracers, which will be utilized to describe the physical characteristics of the eddies, and to calculate anthropogenic CO_2.

Transient tracers, i.e., chlorofluorocarbons (CFCs) and SF_6 are powerful tools in oceanographic studies, where they are used to deduce transport times, estimate mixing between water masses, and study formation rates of water masses. Measurements of CFCs and SF_6 are considered routine components of hydrographic investigations, and are, for instance, recommended by the GO-SHIP group. The tracer pair SF_6 and CFC-12 is especially useful to determine mixing in the upper ocean dominated by "young" (i.e., recently ventilated) water masses.

Objectives

Specific objectives of the proposed research include: (1) Investigate the role of eddies in the transport of inorganic carbon in two or three different biogeochemical regimes of the ACC. (2) Describe the chemical characteristics (CO_2, nutrients, oxygen, CFCs) of the wider region. (3) Determine the air-sea exchange of CO_2 in eddies as compared to that in the regions surrounding them and estimate the role of eddies in the source/sink function of the Southern Ocean; exact CO_2 fluxes will be calculated using detailed results of the mixed layer and mixing layer depths as determined using CFC-12 and SF_6 data and by the physical oceanography group. (4) Compute vertical transport of carbon using results from the transient tracers and the physical oceanographers (vertical diffusivity), but also using the chemical (CO_2, oxygen, nutrients) balance of the surface layer. (5) Determine a carbon budget of the eddies based on inorganic carbon data, but also compare this with results from other investigators concentrating on specific carbon fluxes (e.g., export production with Thorium-234 depletion). (6) Calculate anthropogenic CO_2 in and around eddies using transient tracers ratio.

Work at sea

In all eddies and on hydrographic transects, water samples will be drawn from the rosette sampler at depths all through the water column, but with a bias towards the upper layers. We will determine Total CO_2 (TCO_2; also known as DIC), Total Alkalinity, CFCs and SF_6 in discrete water samples taken from the rosette sampler on board ship. TCO_2 is analyzed by a precise state-of-the-art coulometric method. The accuracy is set by internationally recognized and widely used certified reference material for TCO_2 and alkalinity measurements, to be obtained from Prof. A. Dickson at Scripps (U.S.A.). In addition, online data of surface water pCO_2 and pH will be collected off the ship's pumping system. pCO_2 is obtained with a General Oceanics system with an infra-red analyzer (Li-cor), both for seawater using an water-air equilibrator

and for the atmosphere, the air being pumped from the crow's nest. SF_6 and CFCs will be determined using purge-and-trap gas chromatography with electron capture detection.

Other variables that are essential to biogeochemical studies involving the CO_2 system are the major nutrients and oxygen. We will determine nutrients (phosphate, nitrate, nitrite, silicate) with a Technicon TRAACS 800 Auto-analyzer using standard colorimetric techniques. This system of the Royal Netherlands Institute for Sea has been used frequently in the Southern Ocean and is able to produce precise and accurate results. Oxygen will be measured with a standard automated Winkler technique.

5. PRIMARY PRODUCTIVITY AND IMPACT OF CO_2 AND DUST ON PHYTOPLANKTON GROWTH

Clara Hoppe, Tina Brenneis, Scarlet Trimborn (AWI), Louisa Norman (CAWCR/UTS), Björn Rost (AWI, not on board)

Objectives

The Southern Ocean accounts for ~20 % of the global annual phytoplankton production and is considered to exert a large influence on the marine carbon cycle and to have the greatest potential in affecting atmospheric CO_2 concentrations. *In-situ* fertilization experiments have revealed that iron availability is the key factor controlling phytoplankton growth in the Southern Ocean. Dust deposition, ice melting or iron input from land run-off and contact with sediments are important processes through which in particular coastal regions of the Southern Ocean are naturally enriched with iron. In open ocean regions, atmospheric dust input is one of the major sources of iron. Only a few studies have investigated the impact of dust addition on open ocean phytoplankton productivity. Aside from this crucial factor, other environmental factors like changing atmospheric CO_2 concentrations due to ongoing ocean acidification as well as to seasonal changes in CO_2 were also found to exert control on both phytoplankton structure and growth. Unfortunately, its effects on the physiological ecology of the phytoplankton community have thus far received very little attention, even though large seasonal changes in CO_2 can be observed over the course of the growing season. Until now, research so far has focussed on the investigation of one of these two factors, while attention has not yet been paid to the assessment of dust deposition in conjunction with CO_2, even though the combination of both factors may be crucial in controlling the phytoplankton species composition in the Southern Ocean.

Work at sea

It is planned to characterize phytoplankton populations of cyclonic and anticyclonic eddies using fluorescence induction relaxation fluorometry (FIRe) and various ^{14}C-based assays. One main focus will be the determination of primary production rates of marine phytoplankton by the commonly used ^{14}C technique at *in-situ* light intensities. Further, we will characterize the mode of carbon acquisition using the ^{14}C disequilibrium and the ^{14}C kinetic techniques on roder to determine how sensitive phytoplankton responds to changes in CO_2.

In addition, shipboard CO_2/dust pertubation experiments with natural phytoplankton communities will be performed to address the important question of how CO_2-related changes in carbonate chemistry (e.g. ocean acidification) in combination with different iron availabilities (through dust addition) will directly affect primary productivity and phytoplankton species composition. Therefore, incubations of natural assemblages will be exposed to CO_2 levels representing values of the last glacial maximum (~180 **µ**atm), present-day (~380 **µ**atm), and those projected for the year 2100 (~1,000 **µ**atm).

Expected results

The physiological characterization of phytoplankton populations of cyclonic and anticyclonic eddies will help to provide a better ecophysiological explanation for the spatial distribution of Southern Ocean phytoplankton. Especially, the performance of shipboard CO_2-/dust manipulation experiments will enable us to gain a process-based understanding of how dust deposition and CO_2 shape the Southern Ocean phytoplankton community structure, alter productivity and phytoplankton growth.

6. IRON DURING "EDDY PUMP"

Luis M. Laglera (UIB), Juan Santos-Echeandía (IIM-CSIC), Louisa Norman (CAWCR/UTS)

Objectives

Iron bioavailability is the key factor limiting primary production in vast areas of the Southern Ocean and could rule the patchy distribution of phytoplanktonic species in the area. Therefore, the determination of its concentration and speciation coupled to incubation experiments is essential to understand the local biological processes.

Work at sea

Samples corresponding to the first 300 m of the water column will be collected and sampled by means of GoFlo bottles at selected stations. The iron concentration will be determined by Flow Injection Analysis with detection by chemiluminescence in the unfiltered and filtered fractions (0.22 and 0.05 mm) after 1 day acidification to pH 1.9. Immediately after sampling, Fe(II), the most bioavailable form, will be analyzed by chemiluminescence to obtain the redox speciation. Some samples will be taken back to the lab for determination of iron organic speciation by polarography and determination of other key metals if possible. For a few selected samples, desorption kinetics will be conducted by ligand exchange with detection by polarography.

Expected results

Determine if the different regions under study present significant differences in iron concentration and speciation.

7. IMPACT OF GRAZERS ON IRON BIOAVAILABILITY

Louisa Norman (CAWCR/UTS), Scarlet Trimborn (AWI), Luis Laglera (UIB), Juan Santos-Echeandía (IIM-CSIC), Clara Hoppe (AWI), Brian Hunt (UBC), Christine Klaas (AWI), Evgeny Pakhomov (UBC)

Objectives

Most of the iron is present under organic forms, likely produced by the biota and controlling iron bioavailability to support the growth of phytoplankton. However, the nature of these organic compounds defining iron marine chemistry and bioavailability remains largely unknown. Biological interactions between phytoplankton and zooplankton are known to recycle iron, therefore re-supplying bioavailable iron forms. Grazers affect iron chemistry by lysing and digesting phytoplankton and also by producing fecal pellets. Perturbation experiments will be

carried to investigate how these two processes affect iron chemistry, the nature of organic material present and the bioavailability of iron to endemic phytoplankton community. For this purpose endemic grazing products (from large copepods exposed to natural phytoplankton) and fecal pellets will be collected and analysed. Because iron photochemistry is believed to be important in defining the chemical reactivity of iron and light affect iron biological recycling, exposure to dark and light will be used.

Work at sea

Perturbation experiments will be carried out with grazers, most probably copepods, grazing on marine phytoplankton. The effect of grazing on iron chemistry, the nature of organic material present and its effect on iron bioavailability to phytoplankton will be investigated. Grazing products and fecal pellets will be collected and analysed. In addition experiments on the effect of fecal pellets are planned.

Expected results

The planned experiments will shed light on the role of grazing on iron chemistry and bioavailability to phytoplankton.

8. NATURAL RADIONUCLIDES

Viena Puigcorbé & Montserrat Roca (UAB/ICTA)

8.1 ^{234}Th as tracer of export production of POC

Objectives

The carbon flux exportation from the surface to the deep waters is an important parameter if we want to estimate the efficiency of the carbon pump. We will quantify this flux by measuring the depletion of ^{234}Th with respect to ^{238}U in the upper water column. Repeated measurements of the integrated ^{234}Th depletion will allow the calculation of the downward flux of particulate ^{234}Th out of the surface water. In order to convert this flux to a carbon flux we will need to determine the POC/^{234}Th ratio of suspended and sinking particles, separated in different size fractions.

Work at sea

^{234}Th and POC samples will be collected and processed during the cruise. Ideally one profile of ^{234}Th at approximated 10 depths down to 500 m will be sampled per station. Occasionally, we will analyse deeper samples for calibration purposes. All the samples collected will be analyzed on board. They will also be measured on board by beta counting using RISO beta counters. At selected stations, 2 L water samples will be also obtained from the Niskin bottles at the same depths for SPM, POC and PON determinations. At selected stations, large particles will be collected at 100 m by deployment of *in-situ* pumps using size-fractionated filtration for ^{234}Th direct measurement in the beta counters and POC determinations.

8.2 Radium isotopes

Objectives

Four radium isotopes are supplied to the ocean by contact with the continent or (deep-sea)-sediments: ^{223}Ra, (half-life 11.4 d); ^{224}Ra (3.7 d), ^{226}Ra (1620 y) and ^{228}Ra (5.8 y). The

distribution of these isotopes in seawater has been shown to be most helpful to evaluate shelf-basin exchange and water residence times. They can therefore help us to determine whether the water masses have been influenced by natural iron enrichments by contact with shelf sediments in preceding months (^{228}Ra), weeks (^{223}Ra) or days (^{224}Ra).

Work at sea

Large volume (100-300 L) surface water samples will be collected for Ra isotopes using the *Polarstern*'s seawater intake and they will be passed over MnO_2-impregnated acrylic fiber to scavenge Ra isotopes. Fibers are partly dried using compressed air, and short-lived ^{223}Ra and ^{224}Ra measured at-sea using RaDeCC detectors. Longer-lived ^{226}Ra and ^{228}Ra will be measured on the fibers by gamma counting in the shore-based lab. For occasional deeper (i.e. below surface) sampling, large-volume samples require multiple (2-3) CTD casts and filling barrels. This study will be concentrated on stations in the vicinity of the shelf of South Georgia and the Antarctic Peninsula.

9. BIO-OPTICAL MEASUREMENTS FOR SATELLITE VALIDATION AND RETRIEVAL

Mariana A. Soppa (AWI), Wee Cheah (IMAS), Astrid Bracher (AWI/IUP; not on board)

Objectives

Ocean colour satellite data is especially useful to investigate polar oceans, due to remoteness of these locations, providing a cost effective solution for a good coverage of the Polar Regions. However, the uncertainty of the ocean colour products is still significant in polar regions and is a result of several factors including the lack of in-situ measurements for ground truthing. Field measurements of phytoplankton pigment composition, optical characteristics of phytoplankton and other water constituents, reflectance and underwater light availability are highly precise input parameters for the satellite retrievals and modelling. Nevertheless, the variation of phytoplankton absorption in ocean waters affects the retrieval of chlorophyll a concentration (a measure of phytoplankton biomass) derived from satellite sensors, which is important input variable for modelling ocean primary production.

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.

During the cruise, we will conduct several bio-optical measurements encompassing a wide range of oceanic regions and ecosystems encountered during the expedition. Specifically, we will examine relationships between hyperspectral remote sensing reflectance (R_{rs} (λ)), inherent optical properties (IOPs) such as the spectral absorption and scattering coefficients, and phytoplankton taxa-specific pigment composition in order to investigate the different phytoplankton communities. We will also examine how other inorganic and organic seawater constituents co-existing with phytoplankton communities, affect R_{rs}(λ). Similar analysis will be conducted at the level of hyperspectral IOPs (e.g., the spectral backscattering coefficient, b_b(λ), and absorption coefficient, a(λ)), which are primary determinants of R_{rs}(λ). In particular, data collected during this cruise will help to improve our understanding on the ocean variability in terms of optical properties, to examine the dynamics of phytoplankton composition and primary production and to improve/develop remote sensing algorithms for the Southern Ocean.

Work at sea

Water samples

Discrete surface water samples will be taken from the ship's underway system and at multiple depths from the CTD/Rosette at the stations. Several analyses will be performed on board and post-cruise as follows: (1) filtration of water samples onto GF/F filters for HPLC pigment analysis and particulate absorption measurements; (2) water samples will be preserved for flow cytometric measurements and microscopy for later analysis in the laboratory in Bremerhaven; (3) water samples will be filtered and preserved for measurements of coloured dissolved organic matter (CDOM) fluorescence.

Online and in-situ optical measurements

(1) a FastTracka Fast Repetition Rate Fluorimeter (FRRF) will be used in a flow-through system to provide online data of chlorophyll fluorescence during the cruise, (2) a second FRRF will take measurements in the water column during stations for fluorescence vertical profiles; (3) in-water downwelling spectral irradiance and upwelling spectral irradiance and radiance will be measured at the stations with a set of three radiometers (Ramses TRIOS) (vertical profiles down to 150 m maximum), while a fourth sensor is mounted on deck and measures downwelling irradiance at the sea surface.

10. CHLOROPHYLL *A*, PARTICULATE AND DISSOLVED CARBON, NITROGEN, PHOSPHORUS AND STABLE SILICON ISOTOPES DETERMINATION

Dieter Wolf-Gladrow, V. Schourup-Kristensen, Dorothee Kottmeier (AWI),
Christina De La Rocha (UBO; not on board)

Objectives

The purpose of this study is to follow the development and composition of biomass during the end phase of natural blooms dominated by different plankton assemblages in two major productive areas of the Southern Ocean. The measurements of bulk organic matter standing stocks and composition will allow estimating the influence of community composition on elemental cycling and export. The isotopic composition $\delta^{30}Si$ of diatom frustules archived in marine sediments is used as a proxy for the relative utilization of silicic acid in the geological past. The interpretation of sediment data depends on the value of the isotopic fractionation factor $^{30}\varepsilon$ between silicic acid and biogenic silica and on the isotopic composition $\delta^{30}Si$ of the silicic acid in the source water. The goal is to determine the evolution of the isotopic composition, $\delta^{30}Si$, of silicic acid and of particulate material (dominated by diatoms) during the course of diatom blooms in the Southern Ocean.

Work at sea

Measurements of Chlorophyll *a* (Chl *a*) and sampling for particulate organic carbon (POC), nitrogen (PON), phosphorus (POP) and Biogenic silica (BSi) as well as dissolved organic carbon (DOC), nitrogen (DON) and phosphorus (DOP) determination will carried out at discrete depths ranging from 5 to 250 m at stations inside mesoscale eddies. In addition, the fate (export and remineralization) of particulate organic matter and biominerals will be determined by following the time evolution of deep profiles (100 m to 3000 m depth) of POC, PON, biogenic silica (BSi).

Water samples collected from Niskin bottles attached to a CTD-rosette will be filtered onto 25 mm diameter GF/F filters at pressures not exceeding 200 mbar and processed for analysis of Chl *a* (on board), POC and PON and dissolved organics matter. Filters for Chl *a* analysis will be immediately transferred to centrifuge tubes with 10 ml 90 % acetone and 1 ccm of glass beads. The sealed tubes will be stored at –20°C for at least 30 min and up to 24 hours. Chl*a* will be extracted by placing the centrifuge tubes in a grinder for 3 min followed by centrifugation at 0°C. The supernatant is poured in quartz tubes and measured for Chl*a* content in a Turner 10-AU fluorometer. 1 to 2 L seawater samples for POC and PON analysis will be filtered onto pre-combusted 25 mm diameter GFF filters and stored in pre-combusted glass Petri dishes for further analysis on land. 1 to 2 L seawater samples will be filtered onto 25 mm diameter polycarbonate filters for BSi and $CaCO_3$ analysis. After filtration filters will be dried overnight at 50°C and stored into HCL-cleaned plastic (PP) Eppendorf tubes stored for further analysis on land. At selected stations, additional water samples will be collected in order to obtain > 10 μmol Si in filtered water (typically 1/2 L) and > 30 μmol Si in particulate organic material (requires filtration of up to 30 L of seawater) for analysis of the Si isotopic composition in source waters and in BSi. 1 to 2 L seawater samples for POP analysis will be filtered onto 25 mm diameter GFF filters and stored in plastic (PE) Petri dishes. About 100 ml samples for DOC, DON and DOP analysis will be filtered onto 25 mm diameter pre-combusted GFF filters using a HCL-cleaned glass filtration unit. The filtrate will be collected directly into plastic vials for DOC, DON and DOP determination. Samples will be stored frozen (-20°C) for further analysis on land.

11. MICROPHYTO- AND PROTOZOOPLANKTON

Christine Klaas, Fabian Altvater, Theresa Rueger (AWI), Morten H. Iversen (MARUM), Katja Metfies (AWI, not on board).

Objectives

Our aim is to improve our understanding of the distribution patterns and the wax and wane of key plankton species and the relationship between unicellular plankton dynamics and sedimentation through quantitative in-situ observations in the water column. This study will combine microscopy and molecular methods for the qualitative and quantitative assessment of plankton assemblages and determination of key species *in-situ* growth rates and physiological status. Further, we will also establish clonal cultures of Antarctic phytoplankton species to provide support for species identification and evaluation of molecular studies results.

Work at sea

Quantitative assessment of phyto- and protozooplankton assemblage

Duplicate 200 ml water samples for microscopic analysis of protist assemblages will be obtained from Niskin bottles attached to a Conductivity Temperature Depth (CTD) rosette from 8 discrete depths in between 10 and 200 m depth at each station. One set of samples will be preserved with hexamine-buffered formalin solution and one with acidic Lugol's iodine at a final concentration of 2 % and 10 % respectively. During the eddy studies, large volume samples will be collected to assess distribution and composition of the less abundant larger particles (faecal pellets, small aggregates) that contribute most to vertical fluxes: the whole content of two Niskin bottles (24 L) will be sampled at 12 depths, between 10 and 1000 m and concentrated down to 50 ml by pouring the water gently through a 20 µm mesh net and fixed with 2 % buffered formalin. Fixed samples will be stored at 4°C in the dark until counting back in the home laboratory.

Sampling for molecular analysis

Samples for 454-pyrosequencing will be collected to characterise assemblage diversity and composition for protists that cannot be identified using light microscopy. For the analysis of eukaryotic diversity, water samples taken in parallel to the sampling for microscopic analysis will be pre-screened (100 µm mesh net, to eliminate small metazoans), size fractionated (two size fractions, 0.2-20 µm and 20-100 µm) and filtered on board. Filter samples will be stored at –80°C for later analysis. Processing and analysis of these samples will be carried out on land.

In-situ growth rates and physiological status

Estimates of species-specific growth rates of key diatoms will be obtained through incubation of undisturbed water samples under natural light and temperature conditions for 24 hours after staining with the fluorochrome PDMPO that binds to the newly deposited silica during cell division. The difference between *in-situ* growth rates determined with the PDMPO technique and the actual accumulation rates of individual species populations during the eddy studies will allow a quantitative estimate of the loss rates (mortality and sinking) acting on individual species populations. At selected stations plankton samples will be stained with DAPI and SYTOX Green in order to determine the fraction of dead cells, whether through viral infection or programmed cell death, within natural populations. Further, a fluorescent marker for apoptotic cells will be applied to infer whether programmed cell death is involved in the demise of individual species population. All stained samples will be preserved with 2 % hexamine-buffered formalin and stored at 4°C until counting.

Clonal cultures

Hand net (20 and 55 µm mesh size) and water samples will be used to collect plankton cells for single cell isolation and establishment of clonal cultures of phytoplankton species that can significantly contribute to phytoplankton biomass but are not easily identifiable using light microscopy.

12. ZOOPLANKTON COMPOSITION AND GRAZING

Evgeny Pakhomov (UBC) and Brian Hunt (UBC)

Background and objectives

Recently, much effort has been directed to understand factors controlling the transformation of organic matter in the ocean. Zooplankton is well known to be a cornerstone of the biological pump occupying an important intermediate position between primary producers and secondary consumers. Its role in the ocean is multifaceted as it may act as a “gatekeeper” for the carbon leaving the euphotic zone into the mesopelagic realm. Aggregation of particles, grazing by zooplankton, its active vertical migrations, nutrient and iron release during feeding are all critically important in the dynamics of the organic matter vertical flux in the ocean. Overall, the length of the individual food chains will determine the productivity at the upper trophic levels as well as the degree of retention and/or sedimentation of the organic matter out of the euphotic zone of the ocean. The “Eddy Pump” cruise will provide a unique opportunity to study the zooplankton dynamics, including effects of the mesoscale eddies, in various oceanographic provinces.

Our main objectives are to characterize the composition and biomass of zooplankton and micronekton and estimate the zooplankton grazing impact. We aim to: (1) collect samples inside and outside eddies to characterize zooplankton composition, abundance and biomass, as well as the zooplankton biomass size spectrum within the top 1,000 m using nets and

possibly LOPC (laser optical plankton counter); (2) measure size-fractionated and individual (for selected species) grazing rates using the gut fluorescent technique to provide the total zooplankton community grazing impact; (3) collect epi- and mesopelagic meso- and macrozooplankton samples for the food web characterization using stable isotope; and (4) conduct (time permitting) size-fractionated and individual (for selected large metazonas) fecal pellet production experiments to assess the role of the zooplankton community fecal production (potential carbon flux) and iron recycling/removal.

Work at sea

According to the preliminary sampling schedule: 1.5-2 days of initial sampling, 1.5-2 days of benthic sampling and 1-1.5 days of concluding sampling (re-sampling), we would like to concentrate on aims 1 and 2 during the initial 2 days of sampling and possibly on the aim 4 during the re-sampling period. Aim 3 will be accomplished on ad-hoc basis using multi-net and RMT-samples.

For grazing studies, a 24-h cycle coverage (at least 5 tows over that cycle) would be required. This ideally should be collected during the course of first 48 hours, sampling top 300 m layer using Bongo. If there will be sufficient plankton concentration gut pigment evacuation rates will have to be estimated at least twice a day, during daytime and nighttime. This also could be done during the re-sampling period. These samples will also be used for biomass spectra estimates.

The large ring net will be used for the biomass spectra measurements (+LOPC), stable isotope data collection and obtaining large metazoans for experimental (grazing and iron) work. A minimum of three-four 0-600 m tows should be performed per individual sampling area. This could be done either during the initial or/and re-sampling phase of sampling.

RMT8+1 should be used twice during the entire individual sampling in the 0-600 m preferably during darkness.

Expected results

Taxonomically resolved zooplankton biomass spectrum would indicate the overall state (“retentive” or “loss”) of the pelagic system. The experimental work will provide an *in-situ* magnitude of the zooplankton grazing and fecal pellet production in the epipelagic layer. Stable isotopes would provide an overall pelagic food web structure.

13. SINKING FLUXES

Morten H. Iversen (MARUM), Christine Klaas (AWI), Gerhard Fischer (MARUM; not on board)

Objectives

Our goal is to investigate processes determining the efficiency of the biological pump in the Southern Ocean, in particular, - the link between plankton community composition in the euphotic zone and export fluxes of carbon and silica in the *F. kerguelensis* and *Chaetoceros* provinces - determine elemental and structural composition of sinking material at the base of the mixed layer and in deeper layers to provide quantitative and qualitative information on the origin of sinking particles and transformation processes leading to the export of organic matter and biogenic silica at depth.

Work at sea

Surface drifting traps will be deployed at selected locations during the eddy studies to simultaneously determine elemental and structural composition of sinking material at the base of the mixed layer and at 300 m depth.

Two types of deployments will be carried out in parallel:

1) Standard deployments will be carried out to estimate biogeochemical fluxes of carbon, nitrogen, biogenic silica, CaCO3 and lithogenic material. Sample aliquots from these deployments, will be analysed using epifluorescence microscopy as described for water-column samples used in the analysis of microphyto- and protozooplankton assemblages. Trap collection located at the base of the mixed layer will also be stained with DAPI, SYTOX Green in order to investigate the physiological status of sinking assemblages. Filtration for DNA extraction and 454-pyrosequencing will be carried out in order to compare assemblage composition in sinking material with those from the water column.

2) Trap deployments with viscous (polyacrylamide, cryogels) gels at the bottom of the trap tubes: this new technique allows preservation of sinking material in its original shape. Particles from different origins (faecal pellet, aggregates, single organisms) will be enumerated and measured in gels using stereomicroscopy and digital imaging software. The gel deployments have to be of short duration (1 day) in order to minimise overlaying of particles potentially complicating microscope analysis.

Small-scale O_2-fluxes to individual particles (fecal pellets and marine snow aggregates) will be measured using an O_2-microelectrode at the aggregate-water interface. This will enable direct measurements of carbon-specific respiration rates of the microbial community associated with the particles, and, thus, provides carbon-specific degradation rates. Fecal pellets will be collected directly from water samples and marine snow will be re-aggregates from non-treated water samples in roller tank incubations. Size-specific sinking speed will be measured on individual aggregates using either a settling column or a vertical flow chamber for fecal pellets and marine snow aggregates, respectively. Dry weight and elemental composition of the particles will be determined from collection of several aggregates on pre-weighed combusted GF/F filter on a microscale and C/N-analyzed.

14. ANTARCTIC DEEP SEA BENTHOS: A PICTURE IS WORTH A 1000 WORDS

Sandor Mulsow (LEET-UACh)

Background and objectives

Changes at the water-sediment interface can leave a distinctive biogeochemical signature (biogeochemical shifts) if the change has a certain magnitude (intensity) and lasts a sufficiently long time. In shallow waters and at high sedimentation rates these processes have been clearly characterized using a suite of methodologies such as Sediment Profile Imagine Cameras and biogeochemical proxies (benthos, metabolites micro-profiles, nutrients and sedimentology). However, in bathyal and abyssal sediment interfaces, the processes (sedimentation rates and water column processes) do not seem to leave a signature on those sediments. There are reports that Antarctic benthos does not respond/react to apparently strong seasonal water column production rates, at least at the Foodbanc study sites in Antarctica. Our working hypothesis is that 1) there is a distinctive biogeochemical signature (geological, chemical and

biological) recorded in Antarctic soft-bottom sediments and 2) that a biogeochemical signature shift may be present at the sediment column at small spatial scales.

Work at sea

Visualization

We will use an SPI camera (Sediment Profile Imagine; 10 images per station) to visualize the top 12 to 15 cm including the sediment water interface. This sediment column accounts for geological records up to 10000 years ago. Each one of the images will be analyzed for biological, chemical and sedimentological recorded features.

Biogeochemistry

At each one of the sites sampled with SPI, at least 2 sediment cores (MUC) will be used for measuring micro-profiles of O_2, pH, Eh and sulfur micro-electrodes to derived concentration of H_2S. Immediately upon measurements of micro-profiles, one of the sediment cores will be sectioned every 5 mm down to 1 cm and thereafter every 10 mm until 10 cm deep and then sectioned every 2 cm until the bottom of the sediment core is reached. All the sections from 0.0 to 10 cm will be sampled for pore water (sediment water squeezer). Each one of the porewater volumes will be collected and frozen until arrival to UACh-Valdivia, Chile for nutrient and microbial analyses. The solid fraction of the sectioned cores will be wet weighed, salt corrected, and dry wt determined (UACh-Valdivia-Chile) to be used for chemical analyses (CP-MS: Li, Ti, V, Cr, Cd, Cu, Zn, Mn, Fe, As, Se, Mo) and geochronology (^{210}Pb method). The resulting ^{210}Pb profiles will be treated as time keepers (sedimentation rates derivation) as well as the result of biological benthic mixing rates of the visited benthic communities. All the parameters will be analyzed jointly with the biological benthic ecology variables collected during the sampling cruise as well.

15. FORAMINIFERA OF THE DEEP SOUTHERN OCEAN: BENTHO-PELAGIC DISTRIBUTION AND PAST AND PRESENT METAGENETICS

Tomas Cehagen (University of Aarhus) & Franck Lejzerowicz (DGE)

Background and objectives

In high latitude systems, Foraminifera represents the most diversified and abundant group of protistan meiofauna thriving on the deep-sea floor. Given highly variable morphologies and patchiness across samples, accurate species identification and distribution surveys are challenging, especially for minute and inconspicuous monothalamous (single-chambered) species hidden within sediment particles. The non-fossilized monothalamous foraminifera and their bentho-pelagic distribution patterns are often overlooked in biodiversity studies, despite increasing evidence that they form a major driver of deep-sea benthic dynamics.

The main objective of this project is to target foraminifera in deep-sea Antarctic sediments to conduct a comprehensive metagenetic study across the bentho-pelagic deposition system. Using sorted specimens as well as bulk sediment material collected during this cruise, the following questions will be addressed: (1) Which and how many deep Southern Ocean species display small and large scale cosmopolitanism patterns? (2) Is there an unexplored pelagic group of monothalamous foraminifera restricted to the water column? (3) Is deposited and sediment-borne extracellular DNA a good proxy for seasonal variation diversity studies?

and (4) Are ancient foraminiferal DNA sequences preserved in Antarctic downcore sediment recoverable and diverse? Moreover, we will participate in the identification of foraminiferal components of isopods diet, based on DNA analysis of their gut content. We will also complete our taxonomic survey of Southern Ocean deep-sea foraminifera, with particular emphasis given to monothalamous species.

Work at sea

We will collect surface sediment samples from a wide range of water depths and sites using the multicorer and box corer. For species sorting, multicores and subsamples of box cores will be sieved immediately after sediment retrieval and living foraminifera hand picked under a binocular microscope, photographed and their DNA extracted to complete our reference database. Other sediment samples will be deep-frozen for further DNA/RNA-based diversity analyses. Some sediment cores will be chosen for paleogenetic analysis in order to recover ancient foraminiferal DNA diversity. Additionally, surface- and deep-water DNA samples will be taken to search for monothalamous foraminiferal species living in the water column and dispersal forms (propagules) stemming from the benthos.

16. THE LINK BETWEEN STRUCTURAL AND FUNCTIONAL BIODIVERSITY OF THE MEIOBENTHOS IN THE ANTARCTIC DEEP SEA: FOCUS ON NEMATODES

Freija Hauquier & Ann Vanreusel (Ghent University)

Background and objectives

Nematodes are the most abundant metazoan meiobenthic taxon in many areas of the world's ocean. Also in the deep sea they tend to be dominant and densities can be high, which makes them important players in the benthic food web. However, knowledge on the biodiversity and functioning of nematode communities is still scarce, especially in the deep realms of the oceans. In continuation of the SYSTCO I expedition we therefore aim to further elucidate on the role of meiofauna, and especially nematodes, in the C flow through benthic deep-sea sediments of the Antarctic in relation to their biodiversity. In order to unravel the link between nematode biodiversity and function, it is essential to reveal the interactions in the benthic food web and their trophic position at locations with contrasting food input. This contrasting food input might be generated, for example, by sampling stations before and after the phytoplankton blooms in the area. As for many systems, a relation between biodiversity and productivity of the system has been hypothesized but correlation with water depth and other associated environmental factors often hampers to unravel the link between biodiversity and food input. Sampling at similar water depths between 40°S and 70°S, along the Polar Front, would therefore allow us to estimate the variation in local biodiversity in relation to changing productivity levels.

Work at sea

Benthic samples will be collected at all stations with a multicorer device to recover virtually undisturbed water-sediment interface samples. Preferably two cores of each deployment will be used for community analysis, to gain more knowledge on meiofauna, and more specifically nematode diversity at different regions of the Southern Ocean. One core will be sliced per cm till 5 cm sediment depth and stored at 4 % buffered formalin for further identification and counting in the lab. The second core will also be sliced per cm but stored in ethanol or

DESS for molecular analysis (i.e. pyrosequencing of the mitochondrial COI gene). To unravel the importance of meiofauna taxa in the C turnover in deep-sea sediments, one core will be sliced per cm and stored at -20°C for the analysis of different natural biomarkers (stable isotopes and fatty acid profiles). Despite their high numerical dominance and potential high reproductive turnover rates there is little evidence that nematodes are strong agents in the carbon mineralization but indirectly they may interact with microbiological activities (by grazing on bacteria populations). Characterization of the nematode stable isotope composition and fatty acid profiles will allow us to determine the preferential food source (fresh phytodetritus or bacterial) of the dominant nematode genera and to assess their trophic position in the food web. Finally, one core will be used for the quantification of some environmental factors known to influence nematode abundance and diversity. These include pigment concentrations (as a measure of phytodetritus input), grain size distribution, total organic matter content and C/N content. The sediment will therefore be sliced per cm and stored at -20°C until further analysis in the lab.

17. BENTHIC AND PLANKTONIC OSTRACODA OF THE SOUTHERN OCEAN: BIODIVERSITY AND BIOGEOGRAPHY

Simone Nunes Brandão (Senckenberg/DZMB)

Background and objectives

Biodiversity

The class Ostracoda is taxonomically and ecologically very diverse, Their representatives live in varied aquatic ecosystems as benthos as well as plankton. This Class has one of the most extensive fossil records, and thus represent important proxies in palaeoenvironmental reconstructions. Several studies investigate the local diversity changes through geological time. However, comparisons between regions, i.e. the study of β- and γ-diversities are still limited by the differences in the sampling. Therefore, the first objective of the present project is to measure the biodiversity of the Southern Ocean deep sea, and compare it with other deep-sea regions sampled by other projects. With such a comparison, it will be possible to test prevailing theories on bathymetrical and latitudinal gradients of diversity.

Paleo-climatic and Paleo-environmental reconstructions

Additionally, the geochemical measurements taken during ANDEEP-SYSTCO will enable the testing of the ecological preferences of selected ostracod taxa, widely used in paleo-climatic and paleo-environmental reconstructions. The Platycopida have long been considered typical for environments with low oxygen content, and its abundance to the relative remaining ostracods (mostly podocopids) in single fossil samples were long used to reconstruct oxygen concentrations. The methodology developed by Whatley and colleagues was used by many authors to reconstruct palaeoenvironments from the Palaeozoic to the Quaternary. However, all modern data available on this topic was re-evaluated by Brandão and Horne, who concluded that “previously published and widely applied calibrations of platycopid abundance against dissolved oxygen levels are inadequately justified by the available data“. Still, we also acknowledged that while the modern data do not support Whatley’s methodology, it also did not disprove it. The biological samples collected during ANDEEP-SYSTCO II, together with the oxygen measurements, will provide for the first time an experimental basis to test the methodology described above.

Further tests of ecological preferences of ostracod taxa will include the Polycopidae, which are considered to prefer food-rich environments. Moreover, the habitat of the genera *Krithe* and *Henryhowella* are considered as infaunal and epifaunal, respectively. Nevertheless, only a few studies investigated the depth distribution of ostracods in the sediment, and these studies involved a few species and geographic localities. The ANDEEP-SYSTCO II samples will enable to test if the depth distribution and the ecological preferences of the above mentioned taxa, which form(ed) the base for several paleo-climatic and paleo-environmental reconstructions.

Work at sea

We will collect benthic samples with the EpiBenthic Sledge (EBS), the multicorer and the box corer. For the biodiversity estimates and comparisons, ostracods collected by the EBS will be identified to the lowest taxonomic level as possible (but at least to family level). Distinct depth horizons of multicores and subsamples of box cores will be sieved and living ostracods from the selected taxa (*Krithe*, *Henryhowella*, Polycopidae and Platycopida) will be picked. The limbs will be mounted on a glass slide, while the empty valves will be kept in micropalaeontological slides.

18. ON THE FUNCTIONAL BIODIVERSITY AND ECOLOGY OF MACROBENTHIC ABYSSAL KEY SPECIES WITH FOCUS ON THE ISOPODA AND POLYCHAETA

Angelika Brandt Laura Würzberg, Anna Meyer-Löbbecke (Uni Hamburg Zoo Mus.), Sarah Schnurr, Martina Vortkamp (Senckenberg/DZMB) Myriam Schüller (Uni Bochum), Ann Christine Zinkann (ZSM)

Background and objectives

Very little is known about the ecology and role of deep-sea fauna in the trophodynamic coupling and nutrient cycling in oceanic ecosystems. This project examines the trophic structure and functioning of the abyssal macrobenthic community of the Southern Atlantic Ocean, focusing specifically on the role of the Isopoda and Polychaeta including 1) systematics, 2) general feeding biology, 3) bentho-pelagic coupling, and 4) the reproduction of certain key species. Epibenthic sledge samples from four previous *Polarstern* expeditions (ANDEEP I-III and ANDEEP-SYSTCO) and new epibenthic sledge and sediment core samples taken during ANT-XXVIII/3 will be analysed. A variety of methods will be used including gut content analysis, functional morphology of target species as well as biochemical measurements. The latter include analyses of biomarkers, and examination of stable isotopic signatures of epifaunal animals. The results will be compared and combined with the findings of research groups examining other aspects of the Southern Ocean food web or biogeochemistry of the sediment. Combining the comprehensive datasets concerning diversity and colonisation patterns available from ANDEEP I-III, ANDEEP-SYSTCO I and this planned study focusing on food-web dynamics allows us to better understand the trophodynamics including the role of deep-sea fauna in the ecology of the Southern Atlantic Ocean.

Work at sea

The identification of key species from the above mentioned Southern Ocean material prior to the expedition will allow us to more quickly identify and collect them from the new SYSTCO samples in the cool room.

In order to save as much steaming time as possible, our sampling stations will be the same

stations that will be visited during “Eddy pump”. It is planned to work for a longer period of time at these three stations and if possible take one additional station on a seamount. We do not know the exact depth of the stations at this stage because the positions of the stations will depend on the atmospheric processes (i.e. primary productivity) during the expedition. However, usually the mean depth of any abyssal station lies between 4000-5000 m.

As soon as the samples will be on board, they will be sorted in a cool room or container by the most important taxa and key abyssal species of these groups, in order to freeze it immediately for the further described treatment in the laboratories in Hamburg (ZIM and IHF). At each station we will also take sediment samples (see section 13, Mulsow) which will be worked up either directly by a sedimentologist on board or – if this is not possible – later in Germany in close collaboration with the Alfred Wegener Institute for Polar and Marine Research.

Those isopod specimens which will not be used for biochemical analyses, will be studied with regard to the functional morphology of the mouthparts, gut contents or they will be available for other projects dealing with systematic or phylogenetic investigations. For molecular genetic studies concerning phylogenetic relationships or population genetics of selected key species, we will dissect specimens for later DNA extraction after precooling of the samples at -20°C for at least 48 hours. These results will be compared with those obtained from the isopod material from the previous ANDEEP and ANDEEP-SYSTCO expeditions.

Our data and those which will be obtained on primary production and abundances and biomasses of important pelagic species (in cooperation with planktologists and other colleagues on board of *Polarstern*) will help to identify potential links between these two ocean realms and possibly document the processes critical to bentho-pelagic-coupling.

19. INVESTIGATIONS ON THE SYSTEMATICS AND ZOOGEOGRAPHY OF DEEP-SEA ISOPODA (CRUSTACEA, MALACOSTRACA) IN THE POLAR FRONT

Angelika Brandt & Anna Meyer-Löbbecke (Uni Hamburg/Zoo. Mus.)

Background and objectives

As supposed, in Pliocene and Pleistocene the Antarctic ice shelf never completely eradicated the Antarctic benthic shelf fauna. The disintegration of the Gondwana continents and the subsequent isolation of Antarctica accompanied by climatic changes with intermittent periods of global warming and global sea-level changes have determined faunal zoogeographic ranges, migration processes in and out of the Antarctic, and limits. Extensions of the ice sheet may have enhanced speciation processes (as demonstrated for several isopod and amphipod families such as the Serolidae and Arcturidae or Epimeriidae and Iphimediidae) on the Antarctic continental shelf, suitably named the Antarctic “diversity pump“.

The most appropriate tool for studies of zoogeography is systematics. The Antarctic shelf is well isolated and the zoogeographic distribution of the 371 isopod species, which show a degree of endemism of 88 %, is well documented. The three ANDEEP expeditions yielded 13046 specimens of Isopoda. During ANDEEP I – II 5525 specimens and 317 species of Isopoda were sampled and 7521 specimens and 496 species were discriminated from the ANDEEP III material. Overall, Isopoda comprised 35 % of all Peracarida sampled and we identified 674 isopod species from the 40 deep SO stations. 89 of these species (13 %) were

known, the others (585 species) were new to the area, and most of these were new to science and 43 genera being recorded for the first time. Asellota comprised 97 % of all ANDEEP Isopoda and Munnopsidae were the most dominant family, followed by the Desmosomatidae, Haploniscidae and Ischnomesidae. To our present knowledge 87 % of the SO deep-sea Isopoda are apparently “endemic”. Most species did not occur frequently in the samples.

Will we find a similar composition of asellote families in the polar front during SYSTCO II? Are the deep-sea Isopoda in the polar front widely distributed or patchy? Is there a northern limit of the SO deep-sea isopod fauna in the Weddell Sea?

Some specific aims are:

- To expand and deepen insights into biodiversity of Antarctic deep-sea benthic Isopoda, collected during ANDEEP I –III.
- To continue the systematics and zoogeographic analyses of Southern Ocean deep-sea Isopoda.
- To analyse whether the deep sea of the polar front also serves as a reservoir of high species diversity within some isopod taxa like the Weddell Sea.
- To investigate whether the Antarctic deep-sea fauna of the polar front differs from that of the south Atlantic.

Work at sea

Samples will primarily be taken with an epibenthic sledge, however, also isopods from box-corer and multiple-box-corer samples will be used. The samples will be immediately fixed in 80 % precooled ethanol in order to allow also future molecular studies. Large and well preserved animals will be photographed alive to document the colour patterns.

20. BARCODING DEEP-SEA ISOPODA

Sarah Schnurr, Anna Meyer-Löbbecke (Uni Hamburg/Zoo Mus., Senckenberg/DZMB), Saskia Brix Senckenberg/DZMB)

Asellote Isopoda (Crustacea) are one of the most important and abundant macrofaunal groups in the deep sea. A high number of undescribed species (more than 80 % of collected species are new) and low numbers of specimens per species is typical for abyssal plains. This makes taxonomic work very time consuming and global biodiversity comparisons a difficult task. DNA barcoding is a standardized approach to identify species by comparing small sequences of DNA. Our project is attempting DNA barcoding in deep-sea isopods as a baseline study combining the classical taxonomic approach with including DNA barcodes in species descriptions or analysing species complexes. We use the Folmer primer set (HCO and LCO) which usually amplifies a 658 bp fragment of the CO I gene. Datasets for this marker are already available (although small for deep-sea isopods, about 50 published sequences in GenBank). Other mitochondrial genes are discussed as useful for barcoding in the literature. Thus, we want to test if a better solution is possible with other mitochondrial genes like 16 S or 12S. During SYSTCO II we will enlarge the database we started during ANDEEP-SYSTCO in 2007/2008.

Specific questions that will be addressed are: How reliably can barcode data assign unknown specimens to known species? What pitfalls limit this practice? How does barcoding resolve cryptic speciation or ongoing radiation? How do the levels of abyssal intraspecific variability

compare to shallow water species? What are the character-based patterns of nucleotide variation within the sequenced region, and can these patterns be used instead of percent of sequence similarity?

Work at sea

Samples will primarily be taken with an epibenthic sledge. Isopods will be sorted on species level and individually numbered for managing all available information in the project database system. One or two pereopods will be taken from each specimen and put into 96well plates together with a drop of undenatured 96 % Ethanol. These plates will be stored frozen at -20°C. Extractions and further steps like PCR and sequencing will be done in the laboratory of the Smithsonian Institution, Washington, D.C. or the home laboratory in Hamburg.

21. PHYLOGENY AND PHYLOGEOGRAPHY OF DEEP SEA AMPHIPODS: CONNECTIVITY WITHIN AND BETWEEN ANTARCTIC, SUB-ANTARCTIC AND ATLANTIC REGIONS

Charlotte Havermans, Cédric d'Udekem d'Acoz (not on board), Patrick Martin (IRSNB,not on board)

Background and objectives

With over 600 described species, amphipods are the most speciose animal group in Antarctic shelf regions, with a high percentage of endemic species. Even if Antarctic shelf species have been extensively investigated, recent studies showed that many species are inadequately described and several morphospecies are composed of genetically heterogeneous species complexes. In contrast, the Antarctic deep sea remained virtually unknown until the ANDEEP and SYSTCO I cruises. These expeditions revealed an overwhelming abundance and diversity of amphipods.

By molecular analyses, we investigate for several amphipod species the link between (1) Antarctic and sub-Antarctic regions and (2) Antarctic regions and Atlantic abyssal basins. We will test how phylogeographic patterns differ between shelf and deep-sea species and whether deep-sea species are genetically less variable than shallow water species. By phylogenetic analyses, the relationships between Antarctic shelf and deep-sea fauna (submergence vs. emergence hypothesis) will be examined as well as the relationships between Antarctic and Atlantic species. Former analyses on lysianassoid species demonstrated the presence of identical haplotypes between Atlantic abyssal basins and the Antarctic Peninsula which can be explained by the existence of the Antarctic bottom water, connecting these basins. Furthermore, there are indications for several independent colonizations of these Atlantic abyssal basins from the Antarctic deep sea. More deep-sea samples are needed to confirm these hypotheses.

Specific topics to investigate include: (1) To document faunistical and zoogeographical of amphipod taxocoenoses from different abyssal areas; (2) To contribute to the description of the Antarctic amphipod biodiversity, with a special focus on the Lysianassoidea; (3) To use fast evolving genetic markers to measure the intra- and interpopulation genetic variability and to compare the phylogeography of target taxa; (4) To use more slowly evolving genetic markers to identify colonization patterns between different abyssal basins; (5) To contribute to the SCAR-MarBIN database (www.scarmarbin.be) in bringing a new dataset of distributional, ecological and photographic information on Antarctic amphipods.

Work at sea

Sampling will be performed at each station by different collecting methods: Agassiz trawl, Epibenthic sledge and Rauschert dredge. The sorting, preparation of samples, photographing and preliminary identification, as well as DNA extractions, will be carried out onboard. Most of the samples will be fixed in absolute ethanol at –20°C, for further DNA analyses.

22. BIOGEOGRAPHY AND PHYLOGENY OF SOUTHERN ATLANTIC DEEP-SEA MOLLUSCA

Michael Schrödl, Katharina Jörger & Enrico Schwabe (ZSM)

Background and objectives

Within the framework of an inventory of Atlantic cold water and deep-sea molluscs, we observed a generally high species richness and local abundance of molluscs in the Southern Ocean. Many Antarctic gastropods appear eurybathic, however, traditional shell-based taxonomic remains to be confirmed by molecular approaches. Surprisingly, just a single benthic Antarctic deep-sea gastropod species was found to extend slightly north of the boundary of the Southern Ocean yet. In lower latitudes of the southern Atlantic, gastropod faunas were poor in species and abundance. Comparisons along a transect from the Equator to the Weddell Sea thus showed increasing gastropod diversity from lower to higher latitudes, opposing a previous paradigm. During SYSTCO II we will collect molluscs from stations along the Antarctic convergence, a thus far under-sampled area that is crucial for addressing apparent biogeographic boundaries between the strictly Antarctic fauna and the Southern deep-sea basins previously investigated. Species limits as revealed by morphology will be assessed by molecular markers.

In the era of molecular systematics the phylogeny of basal molluscs and of several subgroups (e.g. Heterobranchia) is in a state of revolution and Antarctic/deep-sea taxa such as monoplacophorans have played a key role. Further members of basal taxa and more adequately preserved specimens are needed for molecular and, ultimately, phylogenomic research. Transcriptome analyses will give further insights into functional aspects and adaptations to these special ecological conditions. Collecting environmental DNA may reveal first data on interstitial molluscan deep-sea fauna on a global scale and other hard-to-obtain members of the meiofauna. Comparative research on fatty acids and isotopes will explore the trophic ecology of molluscs in benthic deep-sea communities.

Work at sea

We plan to collect benthic and meiofaunal deep-sea molluscs with a variety of different gears, including EBS, AGT, MUC and box corers. In particular, we are interested in poorly known micromolluscs (e.g. Monoplacophora and Heterobranchia). On board, specimens will be thoroughly observed and documented and subsequently fixed for morphological, histological and ultrastructural investigations, and deep frozen for fatty acid and stable isotope analyses. Molecular samples for DNA will be taken of individual samples to reveal putative cryptic diversity. Of target taxa such as monoplacophorans, chitons, aplacophorans, and special deep-sea gastropods total RNA will be stabilized for transcriptome analyses.

23. CHARACTERIZATION OF THE POLYCHAETE FAUNA AT THE POLAR FRONT WITH REGARD TO WIDELY DISTRIBUTED SPECIES

Ann Christine Zinkann (ZMS) & Myriam Schüller (University of Bochum, not on board)

Background and objectives

Many polychaetes are considered to be widely distributed or even cosmopolitan. However, particularly the large-scale studies under the auspices of the Census of Marine Life have casted some doubt on the presence of cosmopolitan species as for the first time sufficient material was collected worldwide. Molecular genetic methods further challenge the concept of very wide distributions, at least among the macrobenthos.

The Polar Front may or may not be a barrier to dispersal of polychaetes, and it may even be a zone of a particular assemblage. According to the literature based on classical taxonomy, about 100 species of polychaetes were recorded both south and north of the Front (e.g., Hartman). Genetic evidence may prove some of these records wrong. The objective is therefore to cooperate with the NSF-funded project WormNet II and preserve any species that are found in sufficient quantities, but not needed for gut content analysis (see section 17, Brandt et al.), in several ways to identify both morphospecies and haplotypes. Material from the south Atlantic Ocean is available for comparison (e.g., DIVA III, Argentine Basin) and ANDEEP. As data on many abiotic parameters will be collected as well (see section 13, Mulsow), we hope to match haplotypes with certain environmental conditions such as sedimentary characteristics. Different reactions of haplotypes to increased amounts of available food after a plankton bloom are also possible.

Work at sea

Polychaetes from Agassitz trawl and Epibenthic sled samples will be sorted alive and, if found in sufficient quantities, be fixed in cold 90 % Ethanol, RNAlater, or deep frozen at 20°C (posterior ends) and, for morphological identification, in Formalin (anterior ends), according to the standardized procedures used for the barcoding in WormNet II. Polychaetes from box core samples will be picked and sorted in the laboratory on land after the end of the expedition and identified morphologically to species to cover the quantitative aspect of the project and to give a more complete picture of the infaunal community structure.

24. SPONGES - SESSILE SUSPENSION FEEDERS, A BIOLOGICAL NUTRIENTS PUMP IN THE PELAGO-BENTHIC COUPLING SYSTEM

Dorte Janussen (Senckenberg/Frankfurt)

Background and objectives

Sessile suspension feeders play an essential role in the pelagic-benthic coupling processes, as they transfer considerable amounts of nutrients from the water column to the benthic ecosystem. In the deep-sea this role is mainly played by the Porifera and as second by the ascidians. It is known that a large hexactinellid sponge pumps several 100 l water per day retaining ca. 90 % of the picoplankton, such as bacteria, and a major part of the dissolved Silica.

According to our preliminary results from stable isotopes in organisms collected during SYSTCO I, sponges exhibit extraordinary high δ^{15}N-values, higher than all other animals. So far, only few isotope-based food-web studies included the sponges, but those publications indicate that uptake of recycled POM is responsible for high δ^{15}N-values for suspension feeders, especially sponges, in deep water, and also the highly diverse, symbiotic microbial community probably play a major role. A first study of the feeding behaviour of Antarctic demosponges (from shallow water) has proven that niche partition between different sponge species with different microbial food sources can be revealed by stable isotopes and lipid analysis.

Recent data indicate that sponges including their symbionts constitute a nutrient cycle which is partly separated from the “general” food web, but on the other hand serves as a link between the pelagic and the benthic ecosystems.

Purpose of this project is to investigate the feeding niches of common, Antarctic, deep-water sponge species, including their microbial symbionts, to gain a better understanding of their significance for the pelago-benthic coupling.

Work at sea

Collection and documentation of sponges from different depth intervals (bathyal and abyssal) and locations in and around the Antarctic Weddell Sea. With special focus on the more common Antarctic deep-sea taxa (e. g. *Bathydorus spinosa*, *Caulophacus* spp., *Polymastia invaginata*, *Tentorium semisuberites*, *Tedania tantula*, *Myxilla mollis*, *Isodictya setifer*), sponges will be subsampled for stable isotopes, lipids and natural products analysis (for - 20°C, respectively – 80°C freezer), furthermore RNALater and Glutaraldehyde fixation (for TEM and FISH) in sterile filtered sea water will be performed. Furthermore, collection of bottom sediment samples and bottom water and their freezing for isotopes etc., (bacteria and nutrients analysis) is needed. The bottom water samples will be processed immediately upon collection through 0.2 µm Millipore filters and frozen at –80°C for later bacteria DNA-screening.

Separate selection of the possibly or evidently spongiovore epifauna sitting on, or in small caves within, the sponge walls will be performed and specimens shall be frozen for later isotope analysis and comparison with sponge data. Washing of parts of the larger sponges should be done as soon as possible upon collection through a 40 µm sieve under running sea water, to isolate a major part of the meio-infauna.

25. BETEILIGTE INSTITUTE / PARTICIPATING INSTITUTES

	Adress/Adresse
Aarhus University	Aarhus University Department of Biological Sciences, Section of Marine Ecology, Building 1135, Ole Worms allé 1, DK-8000 Aarhus C, Denmark
AWI	Alfred-Wegener-Institut für Polar- und Meeresforschung in der Helmholtz-Gemeinschaft Am Handelshafen 12 D-27570 Bremerhaven, Germany
CAWCR/UTS	Centre for Australian Weather and Climate Research (CAWCR), a partnership between CSIRO and the Bureau of Meteorology, Castray Esplanade, Hobart, TAS, Australia
DWD	Deutscher Wetterdienst Geschäftsbereich Wettervorhersage Seeschifffahrtsberatung Bernhard-Nocht-Strasse 76 D-20359 Hamburg, Germany
DGE	Department of Genetics and Evolution, University of Geneva, Sciences III , 30, Quai Ernest Ansermet CH 1211 Genève 4, Switzerland
FMK	Zoologisches Forschungsmuseum Alexander Koenig Museumsmeile Bonn Adenauerallee 160 D-53113 Bonn, Germany
Ghent Univ.	Ghent University Marine Biology Section Krijgslaan 281 Sterrecomplex S8 B-9000 Ghent, Belgium
IFM-GEOMAR	Leibniz-Institut für Meereswissenschaften IFM-GEOMAR Düsternbrooker Weg 20 D-24105 Kiel, Germany
IIM-CSIC	Marine Research Institute (IIM-CSIC) Marine Biogeochemistry Department C/Eduardo Cabello, 6. 36208 Vigo, Spain

	Adress/Adresse
IMAS	Institute for Marine and Antarctic Studies University of Tasmania, Australia
IRSNB	Institut royal des Sciences naturelles de Belgique Departement of Freshwater Biology Rue Vautier, 29, B-1000 Brussels, Belgium
ISW Wassermesstech.	ISW Wassermesstechnik Gartenweg 1, D-17213 Fünfseen, OT Petersdorf, Germany
LEET-UACh	Universidad Austral de Chile, Independencia 641 Casa Central, Valdivia, Chile
LOP	Laboratoire de Physique des Oceans UMR6523 CNRS/IFREMER/IRD/UBO Universite de Bretagne Occidentale - UFR Sciences 6, av Le Gorgeu C.S. 93837 29238 Brest Cedex 3, France
MARUM	MARUM GEO II, R 1050 Klagenfurter Strasse Universität Bremen D-28359 Bremen, Germany
NIOZ	NIOZ Koninklijk Nederlands Instituut voor Zeeonderzoek Landsdiep 4 1797 SZ ’t Horntje (Texel), The Netherlands
OPTIMARE	OPTIMARE Sensorsysteme GmbH & Co. KG Am Luneort 15a D – 27572 Bremerhaven, Germany
Senckenberg/DZMB	Senckenberg am Meer Deutsches Zentrum für marine Biodiversitätsforschung,(DZMB) c/o Biocentrum Grindel Martin-Luther-King Platz 3 D-20146 Hamburg, Germany
Senckenberg/Frankfurt	Sektion Marine Evertebraten I, Forschungsinstitut und Naturmuseum Senckenberg, Senckenberganlage 25, D- 61350 Frankfurt am Main, Germany

	Adress/Adresse
SHOM	Service hydrographique et océanographique de la marine, DMGS/DIES/DISE Responsable de la cellule CORIO- LIS De-ploiement, Centre militaire d'océanographie SHOM - BP 30316 - 29603 BREST CEDEX, France
SoES	School of Environmental Sciences Nicholson and Thornley Buildings University of Liverpool, 4 Brownlow Street, Liverpool, L69 3GP, UK
UAB/ICTA	Institut de Ciència i Tecnologia Ambiental (ICTA) Grup de Física de les Radiacions Facultat de Ciències, C3-348 Universitat Autònoma de Barcelona (UAB) 08193-Cerdanyola del Vallès, Spain
UBC	Department of Earth and Ocean Sciences, University of British Columbia, 6339 Stores Road, Vancouver, BC, V6T1Z4, Canada
UBO	Université de Bretagne Occidentale Laboratoire des sciences de l'Environnement Marin (LEMAR) Institut Universitaire Européen de la Mer (IUEM) Technopôle Brest-Iroise Place Nicolas Copernic F-29280 Plouzane, France
Uni Bochum	Lehrstuhl für Evolutionsökologie und Biodiversität der Tiere Ruhr-Universität Bochum Universitätsstr. 150 D-44801 Bochum, Germany
Uni Hamburg/Zoo. Mus	Biozentrum Grindel and Zoological Museum University of Hamburg Martin-Luther-King-Platz 3 D-20146 Hamburg

	Adress/Adresse
UTS	University of Technology Sydney Faculty of Science, Plant Functional Biology and Climate Change Cluster, City campus PO Box 123, 2007 Broadway, NSW Sydney, Australia
ZSM	Bavarian State Collection of Zoology Dep. Mollusca Münchhausenstrasse 21 D-81247 München, Germany

26. FAHRTTEILNEHMER / PARTICIPANTS

Name	Vorname/First Name	Institut/Institute	Beruf/Profession
Altenburg Soppa	Mariana	AWI	Phys. Oceanographer
Altvater	Fabian	AWI	Student (Biology)
Bogner	Boie	IFM-GEOMAR	Technician
Brandão	Simone	Senckenberg/DZMB	Biologist
Brandt	Angelika	Uni Hamburg/Zoo. Mus.	Biologist
Brenneis	Tina	AWI	Technician
Cedhagen	Tomas	Aarhus University	Marine Ecologist
Cheah	Wee	AWI	Biological Oceangr.
Clargo	Nicola	NIOZ	Chem. Oceanographer
Crayford	Sharyn	NIOZ	Chemical Laboratory Analyst
Donnelly	Matthew	SoES	Phys. Oceanographer
Graupner	Rainer	OPTIMARE	Technician
Hauck	Judith	AWI	Biol. Oceanographer
Hauquier	Freija	Ghent Univ.	Biologist
Havermans	Charlotte	IRSNB	Biologist
Hoppe	Clara	AWI	Biologist
Hunt	Brian	UBC	Biological Oceanogr.
Iversen	Morten Hvitfeldt	MARUM	Biologist
Janussen	Dorte	Senckenberg	Biologist
Jörger	Katharina	ZSM	Biologist
Klaas, Christine	Klaas, Christine	AWI	Biologist
Kottmeier	Dorothee	AWI	Student (Biology)
Krüger	Matthias	IFM-GEOMAR	Student (Physics)
Laglera Baquer	Luis Miguel	UIB	Chemist
Leach	Harry	SoES	Phys. Oceanographer
Lejzerowicz	Franck	DGE Geneva	Biologist
Meyer-Löbbecke	Anna	Uni HH/Zool. Museum	Student (Biology)
Müller	Felix	AWI	Student (Biotechnol.)
Mulsow	Sandor	LEET-UACH	Biologist (Biogeochem.)
Norman	Louisa	UTS	Chem. Oceanogr. (PhD student)
Pakhomov	Evgeny	UBC	Biological Oceanogr.
Prandke	Hartmut	ISW Wassermesstech.	Physicist
Puigcorbé Lacueva	Viena	UAB/ICTA	Environm. Scientist
Roca Martí	Montserrat	UAB/ICTA	Environm. Scientist

Name	Vorname/First Name	Institut/Institute	Beruf/Profession
Rueger	Theresa	AWI	Student (Biology)
Sander	Hendrik	OPTIMARE	Physical Engineer
Santos-Echeandía	Juan	IIM-CSIC	Chemist
Schourup-Kristensen	Vibe	AWI	Biologist
Schnurr	Sarah	Senckenberg/DZMB	Biologist
Schwabe	Enrico	ZSM	Biologist
NN			Journalist
Stöven	Tim	IFM-GEOMAR	Chemist (PhD student)
Strass	Volker	AWI	Phys. Oceanographer
Trimborn	Scarlett	AWI	Biologist
Vortkamp	Martina	Senckenberg/DZMB	Technician
Wolf-Gladrow	Dieter	AWI	Physicist
Würzberg	Laura	Uni HH/Zool. Museum	Benthic Ecologist
Zinkann	Ann Christine	ZSM	Student (Biology)
NN			Chemist
NN			Biologist

27. SCHIFFSBESATZUNG / SHIP'S CREW

Name	Rank
Pahl, Uwe	Master
Grundmann, Uwel	1.Offc.
Krohn, Günter	Ch. Eng.
Fallei, Holger	2. Offc.
Gumtow, Philipp	2.Offc.
Rackete, Carola	2.Offc.
Leichtle, Marion	Doctor
Hecht, Andreas	R.Offc.
Sümnicht, Stefan	2.Eng.
Minzlaff, Hans-Ulrich	2.Eng.
Holst, Wolfgang	3. Eng.
Scholz, Manfred	Elec.Tech.
Dimmler, Werner	Electron.
Stronzek, David	Electron.
Nasis, Ilias	Electron.
Himmel,Frank	Electron
Loidl, Reiner	Boatsw.
Reise, Lutz	Carpenter
Scheel, Sebastian	A.B.
Brickmann, Peter	A.B.
Winkler, Michael	A.B.
Hagemann, Manfred	A.B.
Schmidt, Uwe	A.B.
Guse, Hartmut	A.B.
Wende, Uwe	A.B.
Bäcker, Andreas	A.B.
NN	A.B.
Preußner, Jörg	Storek.
Teichert, Uwe	Mot-man
Voy, Bernd	Mot-man
Elsner, Klaus	Mot-man
Schütt, Norbert	Mot-man
Pinske, Lutz	Mot-man
Müller-Homburg, Ralf-Dieter	Cook
Silinski, Frank	Cooksmate
Völske, Thomas	Cooksmate
Czyborra, Bärbel	1.Stwdess
Wöckener, Martina	Stwdss/KS
Streit, Christina	2.Steward
Silinski, Carmen	2.Stwdess
Kraft, Henry	2.Steward
Möller, Wolfgang	2.Steward
Sun, Yong Shen	2.Steward
Yu, Kwok Yuen	Laundrym.

ANT-XXVIII/4

13 March 2012 – 09 April 2012

Punta Arenas –Punta Arenas

Chief scientist

Magnus Lucassen

Contents

1. ÜBERBLICK UND FAHRTVERLAUF

Magnus Lucassen (AWI)

Mit der Öffnung der Drake-Passage und der Etablierung des Antarktischen Zirkumpolarstromes (ACC) hat sich das antarktische Meeres-Ökosystem bis zu seiner heutigen Form entwickelt, das durch stabil niedrige Wassertemperaturen nahe dem Gefrierpunkt von Meerwasser, eine pulsierende Primärproduktion auf Grund der starken Saisonalität und dem Wechsel von offenem Wasser und Meereis gekennzeichnet ist. Trotz der kalten Temperaturen hat sich ein produktives marines Ökosystem entwickeln können, auf das große Säuger- und Vogelpopulationen zurückgreifen, die sich intensiv von Fischen und Krill ernähren. Innerhalb dieser Umgebung entstand auf dem antarktischen Schelf und den angrenzenden Inseln eine einzigartige Fischfauna mit vergleichsweise geringer Artendiversität und einem hohen Maß an endemischen Arten. Es scheint gesichert, dass die Anpassung an diese extreme Kälte sich auf Kosten einer hohen thermischen Sensitivität entwickelt hat. Neben neuen physiologischen Attributen, z. B. Frostschutzproteinen, die für ein Überleben bei niedrigen Temperaturen notwendig sind, haben einige antarktische Arten auch funktionelle Eigenschaften verloren, wie beispielsweise die Expression von Globinen und eine induzierbare Hitzeschockantwort, was zu einer limitierten Anpassungsfähigkeit dieser Arten gegenüber Umwelteinflüssen beitragen mag.

Das Protokoll zum Schutz der Umwelt innerhalb des Antarktis-Vertrags stellt den Schutz der antarktischen Umwelt als Interesse für die Menschheit als Ganzes heraus. Allerdings hält der Einfluss menschlicher Aktivität nicht an den Grenzen der Antarktis an. Die fortdauernde Freisetzung des Treibhausgases CO_2 aus fossilen Brennstoffen in die Atmosphäre wird für eine globale Temperaturerhöhung und eine Versauerung der Weltmeere verantwortlich gemacht. Die Veränderungen unterscheiden sich lokal beträchtlich, und die Region um die Antarktische Halbinsel wurde weltweit als eine von drei Regionen identifiziert, in der zur Zeit die stärksten Erwärmungen nachgewiesen wurden. Da die Löslichkeit von CO_2 in kaltem Wasser und Körperflüssigkeiten zudem verstärkt ist, muss von Auswirkungen des Klimawandels auf die hochspezialisierten Arten dieser Region ausgegangen werden. Zunehmende Kontaminationen von persistenten, bioakkumulierenden Substanzen wurden zudem in den marinen Ökosystemen der Antarktis nachgewiesen, was eine zusätzliche Gefährdung dieses empfindlichen Ökosystems darstellt. Insgesamt scheint es naheliegend, dass die Summe der sich ändernden Umweltfaktoren und abiotischen Stressoren kumulativ das Leistungsfenster einzelner Arten einschränkt, was sich letztendlich bis hin zu Lebensgemeinschaften und dem Ökosystem auswirkt.

Menschliche Aktivitäten haben aber schon wesentlich offensichtlicher in das antarktische Ökosystem eingegriffen. Die Fischbestände in der Region Elephant Island – South Shetland Island – Antarktische Halbinsel wurden kommerziell zwischen dem Ende der Siebziger und 1989/90 ausgebeutet. Die Fischerei war lediglich in den ersten Jahren profitabel, danach gingen die Fänge drastisch zurück. Daher wurde 1990 die Fischerei durch die “Commission of Antarctic Marine Living Resources” (CCAMLR) solange verboten, bis eine Erholung der Fischbestände von der Überfischung nachgewiesen worden ist.

Im Rahmen von ANT-XXVIII/4 sind daher Untersuchungen zur Auswirkung dieser menschlichen Aktivitäten und des Klimawandels auf das empfindliche antarktische Ökosystem, mit besonderem Fokus auf die heterotrophen, benthischen Lebensgemeinschaften im Umfeld der Antarktischen Halbinsel, geplant. Den Ausgangspunkt für diesen Fahrtabschnitt stellen die Untersuchungen zur Verbreitung, Abundanz und Zustand der Fischbestände mit Hilfe der Grundschleppfischerei im Rahmen von CCAMLR im Bereich von Elephant Island, South Shetland Island und der Antarktischen Halbinsel als Fortsetzung früherer Erhebungen dar. Die Proben von allen Netzfängen werden zudem von einer Vielzahl von übergreifenden Projekten

weiter verarbeitet: Mit Hilfe genetischer Marker soll die Populationsstruktur ausgewählter notothenioider Arten untersucht werden und mit Wachstums- und Reproduktionsparametern, Lebensstrategien, der Dauer der (pelagischen) Larvalentwicklung und den vorherrschenden Meeresströmungen verknüpft werden. Diese Projekte sind zudem Teil von genetischen Langzeitreihen in dieser sich stark ändernden antarktischen Region. Die Verfassung des Reproduktionssystems und des Lebenszyklus von *Pleuragramma antarcticum*, einer Schlüsselart des antarktischen Nahrungsnetzes, wird im Vergleich zu anderen antarktischen Regionen untersucht.

Um den Zustand des Ökosystems zu bestimmen, sollen empfindliche Indikatorarten entsprechend ihrer sensitiven physiologischen Anpassungsfähigkeit und ihrer vorangegangenen Exposition gegenüber Xenobiotika ausgewählt werden. Darüber hinaus sollen allgemeingültige molekulare Mechanismen, die die physiologische Ansprechbarkeit und Anpassungsfähigkeit gegenüber Klimaschwankungen definieren, in einem vergleichenden Ansatz verschiedener Fischgruppen herausgearbeitet werden. Dazu werden neben den Grundschleppnetzen auch Köderfallen eingesetzt, um unverletzte Fische für physiologische Experimente an lebenden Tieren, die an Bord oder nach Transport ans AWI durchgeführt werden sollen, zu fangen.

Die Belastbarkeit von Fischpopulationen hängt zudem vom Befall mit Parasiten ab. Die Biodiversität und Evolution von parasitischem Leben soll daher in ausgewählten Fischarten in Hinblick auf Ökosystemänderungen untersucht werden. Informationen zur Biologie des Lebenszyklus und den Übertragungsstrategien von Fisch-, Vogel- und Säugerparasiten entlang der Antarktischen Halbinsel soll zur Erfassung der Wechselwirkungen zwischen den Wirtspopulationen beitragen.

Sämtliche Fänge werden mit Blick auf Evertebraten untersucht. Evertebrate Indikator Taxa sollen während des Fahrtabschnittes erfasst werden, um sogenannte „vulnerable marine ecosystems" (VME) nachzuweisen. Die Abundanz und trophische Ökologie von Cephalopoden wird in einem weiteren Projekt untersucht.

Das antarktische Tiefenwasser gilt als eine der größten marinen Senken von atmosphärischen CO_2 während der letzten Eiszeit. Tiefsee-Sedimente sollen daher mit Hilfe eines Multicorer beprobt werden, um Foraminiferen in Hochdruckaquarien zu kultivieren, die eine Kalibrierung von Spurenelementverhältnissen (Mg/Ca, B/Ca, U/Ca), wie sie in kalzifizierten Foraminiferengehäusen zur Abschätzung des Paleoklimas verwendet werden, zu ermöglichen.

Ein weiterer Schwerpunkt dieses Fahrtabschnittes liegt in der umfassenden Charakterisierung des *Roseobacter*-Stamms, einer bedeutenden Komponente des antarktischen Bakterioplanktons, entlang der Drake-Passage und der Antarktischen Halbinsel. Als Teil von Aktivitäten während weiterer Fahrtabschnitte sollen Proben der gesamten Wassersäule und Sedimente mit Hilfe von kulturabhängigen und –unabhängigen Methoden hinsichtlich phylogenetischer und funktioneller Diversität und Abundanz des *Roseobacter*-Stamms und seiner verschiedenen Untergruppen untersucht werden. Proben für metagenomische, metatranscriptomische und metaproteomische Analysen sollen gesammelt werden, um zu einem umfassenden Verständnis des aktiv exprimierbaren, genomischen Potentials dieser Bakteriengruppe im Südlichen Ozean zugelangen.

Das Programm wird vervollständigt durch Projekte zur Erfassung von Walen und Seevögeln: Gegenstand des MAPS-Projektes ist die kontinuierliche Erhebung von thermographischen Bilddaten, um Mustererkennungsalgorithmen zur automatischen Detektion von Walen entwickeln zu können. Um die Effizienz der Algorithmen bei verschiedenen Umweltbedingungen bestimmen zu können, sollen die Daten mit Walsichtungen eines unabhängigen Beobachterteams verglichen werden.

Der Fahrtabschnitt startet am 13. März 2012 in Punta Arenas, Chile. Der Rahmen des

Programms wird durch die Fischerei vorgegeben, um eine Vergleichbarkeit mit früheren Erhebungen zu gewährleisten. Etwa 3,5 Tage werden bis zum Erreichen der ersten Fischerei-Station in der Nähe von Elephant Island benötigt. Auf dem Weg dorthin sind drei CTD-Stationen (Beprobung bis 500 Metern) vor und nach dem Passieren der Polarfront entlang des Kurses geplant. Zwischen dem 17. Und dem 26. März sind etwa 50 Fänge mit dem Grundschleppnetz um Elephant Island herum geplant. Anschließend bewegt sich *Polarstern* entlang der South Shetland Islands, nördlich von King George Island bis hin zu Snow Island. Entlang dieses Kurses sind etwa 20 Hols geplant. Anschließend wird *Polarstern* durch die Bransfield Strait zur Spitze der Antarktischen Halbinsel verlegt, wo weitere 20 Hols geplant sind (sofern Zeit verbleibt). Die Grundschleppfischerei wird bei Tageslicht durchgeführt. Danach werden bei Gelegenheit Fischfallen entlang des Kurses ausgesetzt bzw. eingeholt. Während des Abends und in der Nacht verlässt *Polarstern* jeweils den Schelf in Richtung Tiefsee, wo CTD und Multicorer-Stationen der Roseobacter- und Foraminiferen-Projekte bearbeitet werden. Etwa 3,5 Tage sind für die Rückkehr nach Punta Arenas, wo die Reise am 9. April 2012 endet, eingeplant.

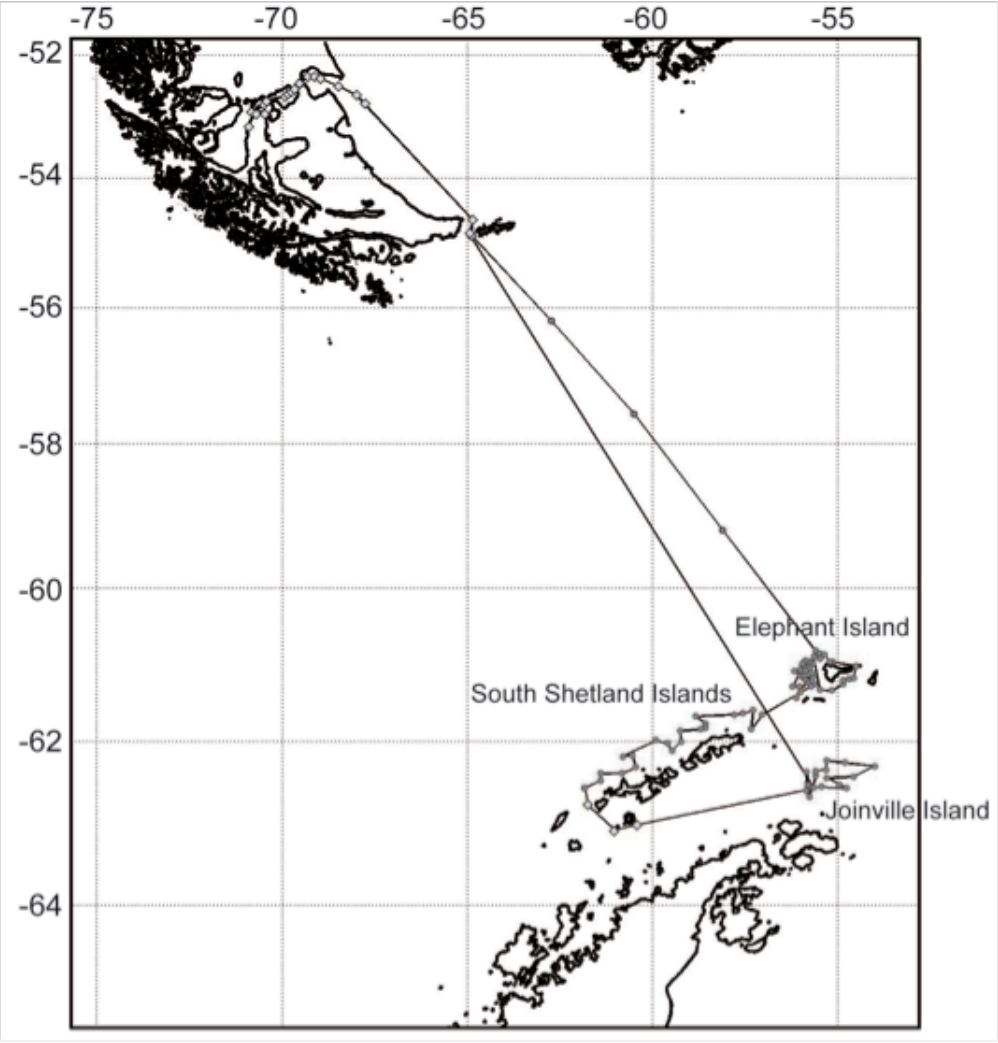

Abb 1: Geplante Fahrtroute während ANT-XXVIII/4
Stationen sind als Kreise, Wegpunkte als Rauten markiert.
Fig. 1: Planned cruise track during ANT-XXVIII/4
Stations are marked as circle, waypoints as rhombi.

SUMMARY AND ITINERARY

Since the opening of the Drake Passage and the establishment of the Antarctic Circumpolar Current (ACC), the Antarctic marine ecosystem developed to its present form with stable low temperatures close to the freezing point of seawater, pulses of primary production due to high seasonality and alterations between open water and sea ice. Despite the frigid temperature, the Antarctic marine ecosystem is quite productive and supports large populations of mammals and birds that feed extensively on fish and krill. Within this environment a unique ichthyofauna developed on the shelves of the Antarctic continent and adjacent islands is showing low species diversity and high levels of endemism. Adaptations to the extreme cold appear to be evolved at the expense of high thermal sensitivity. Besides novel physiological characters for coping with low temperatures, e.g. antifreeze proteins, some Antarctic fish have lost functional traits like globin expression and an inducible heat shock response that may contribute to the limited adaptability of these species upon environmental change.

The Protocol on Environmental Protection to the Antarctic treaty emphasizes that the protection of the Antarctic environment is in the interest of mankind as a whole. Despite, human impact does not stop at the borderline of Antarctica. The ongoing release of the greenhouse gas CO_2 from fossil fuels into the atmosphere is believed to cause both, global warming and ocean acidification. The changes largely differ between regions, and the Antarctic Peninsula is one of the three areas of the globe that are currently experiencing rapid warming. Moreover, as CO_2 solubility is enhanced in cold waters and body fluids, climate change is expected to affect the highly specialised species in this area. Increasing contamination with persistent bio accumulating compounds is reported for the aquatic ecosystems of Antarctica, which add another threat to the sensitive ecosystem. Thus, the sum of changing environmental factors and abiotic stressors is thought to cumulatively narrow the performance windows of individual species, thereby ultimately exerting their effects to the community and ecosystem levels.

Human activities have already affected the Antarctic ecosystem even more obviously. The finfish stocks in the area of Elephant Island – South Shetland Islands – Antarctic Peninsula have been commercially exploited from the late seventies until 1989/90. Fishery was only profitable in the very beginning, and catches declined rapidly thereafter. Fishing was closed in 1990 by the “Commission of Antarctic Marine Living Resources” (CCAMLR), until the recovery of the fish stocks from overexploitation had been demonstrated.

Thus, the present cruise ANT-XXVIII/4 aims to investigate the consequences of human activities and climate change for the sensitive Antarctic ecosystem, focusing on the benthic heterotrophic community in vicinity of the Antarctic Peninsula. The initial point of the cruise leg will be the investigation on the distribution, abundance and state of fish stocks by means of bottom trawls in the framework of CCAMLR at Elephant Island, the South Shetland Islands and the Antarctic Peninsula in continuation of earlier surveys. The samples from all bottom trawls are going to be processed further by a number of comprehensive projects:

The population structure of selected notothenioid species will be studied by means of genetic markers and linked to growth and reproduction parameters, life-history strategies, (pelagic) larval durations and prevailing current systems. These projects are part of long-term genetic monitoring of the selected species in this rapidly changing Antarctic region. The reproductive condition and life cycle of *Pleuragramma antarcticum*, a key species in the Antarctic food web, will be compared to other Antarctic sectors.

To evaluate the health of the ecosystem sensitive indicator species are going to be selected according to their physiological capabilities to respond sensitively and to their prior exposure to xenobiotics. More generally, common molecular mechanisms defining physiological

responsiveness and climate adaptability will be studied in a comparable approach of different fish species. Baited bottom traps will be used beside the bottom trawls to catch uninjured fish for physiological approaches on live animals on board and after transportation alive to the AWI.

The resilience of fish populations is furthermore influenced by parasitism. Biodiversity and evolution of parasitic life in selected fish species will be studied in response to ecosystem change. Information on the life cycle biology and transmission strategies of fish, bird and mammal parasites along the Antarctic Peninsula will contribute to the assessment of relationship between the host populations.

All catches will be further processed for invertebrate species. Invertebrate indicator taxa will be assessed during the cruise to detect vulnerable marine ecosystems (VME), and the abundance and trophic ecology of cephalopods will be investigated.

The Antarctic deep water has been described as the largest marine sink of atmospheric CO_2 during the last glacial. Sediments from deep waters will be sampled by multi corer to cultivate foraminifera as environmental controls of trace metal ratios (Mg/Ca, B/Ca, U/Ca) recorded in calcareous tests of Antarctic deep-sea benthic foraminifera.

Another focus of the cruise leg will be the comprehensive assessment of the *Roseobacter* clade, a prominent component of the Antarctic bacterioplankton, in the Drake Passage and the Antarctic Peninsula region. As part of activities on further cruise legs samples in the entire water column and in sediments will be analysed by culture-independent and culture-dependent approaches for the phylogenetic and functional diversity and abundance of the *Roseobacter* clade and various subclusters. Samples for metagenomic, metatranscriptomic and metaproteomic analyses will be collected in order to assess the full and actively expressed genomic potential of this clade in the Southern Ocean.

The programme will be completed by whale and bird observation projects: The MAPS project aims at developing an automatic whale blow detection system on the basis of thermographic images from a 360° scanning IR sensor. The efficiency of detection algorithms for various species and under varying environmental conditions will be tested in comparison to sightings from an independent observer team.

The cruise leg will start 13 March 2012 in Punta Arenas, Chile. The framework of the cruise leg is given by the fishing programme due to comparability to earlier surveys. About 3.5 days are required to arrive at the first fishing station off Elephant Island. On the way about three CTD stations (sampling down to 500 metres water depths) along the track are planned before reaching and after passing the Polar Front. Between 17 and 26 March about 50 bottom trawls will be performed around Elephant Island. After 26 March until about 31 March *Polarstern* will move along the South Shetland Island, North of King George Island to Snow Island. Along this track about 20 hauls with bottom trawl will be done. Thereafter, *Polarstern* will transfer through the Bransfield Strait to the tip of the Antarctic Peninsula (Joinville Island), where another 20 hauls will be performed (time permitting). The bottom trawls will be performed during the day. Thereafter fish traps will be deployed or recovered on occasion along the station plot. During evening and night *Polarstern* will move from the shelf to deeper waters for the CTD and multi corer stations of the *Roseobacter* and foraminifera projects. About 3.5 days are needed for the way back to Punta Arenas. The end of the leg will be in Punta Arenas on 9 April 2012.

2. INVESTIGATIONS ON ANTARCTIC FISH

Karl-Hermann Kock, Volker Siegel, Annika Elsheimer, Julia Wolske (vTI),
Christopher D. Jones (NOAA)

Objectives

Germany is a member of the “Convention on the Conservation of Antarctic Marine Living Resources” (CCAMLR) since CCAMLR came into force in 1982. One of the requirements of the Convention is to conduct research related to the resources of the Southern Ocean managed by CCAMLR. Germany has substantially contributed to fish research in the Scotia Arc region since CCAMLR came into force in 1982. Since 1998, Germany is closely cooperating with the Antarctic Marine Living Resources Program of the Southwest Fisheries Science Centre (SWFSC) of the National Marine Fisheries Service (NMFS) in La Jolla, California (USA). The present survey is one in a series of surveys conducted since 1996:

Table 1: Surveys in the framework of the present cruise since 1996

Month/year	Research vessel	Area of investigation
Dec 1996	Polarstern	Elephant Island
Mar/Apr 1998	Yuzhmorgeologiya	Elephant Island, South Shetland Islands
Mar/Apr 1999	Yuzhmorgeologiya	South Orkney Island
Mar/Apr 2001	Yuzhmorgeologiya	Elephant Island, South Shetland Islands
Jan/Febr 2002	Polarstern	Elephant Island, South Shetland Islands, Joinville – D’Urville Islands
Mar/Apr 2003	Yuzhmorgeologiya	Elephant Island, South Shetland Islands
Febr/Mar 2006	Yuzhmorgeologiya	West of the Antarctic Peninsula
Dec/Jan 2006/07	Polarstern	Elephant Island, South Shetland Islands, Joinville – D’Urville Islands
Feb/Mar 2009	Yuzhmorgeologiya	South Orkney Islands
Mar/Apr 2012	Polarstern	Elephant Island, South Shetland Islands, Joinville – D’Urville Islands

Work at sea

The core part of the cruise will be a bottom trawl survey around Elephant Island, the South Shetland Island and Joinville/D’Urville Islands using a stratified random survey design (as during previous surveys). The shelf of Elephant Island and the South Shetland Islands down to 500 m will be covered by about 70-75 hauls. Another 15-20 hauls will be conducted on the shelf north of Joinville Island – D’Urville Island off the northern tip of the Antarctic Peninsula. The trawl used will be a commercially–sized 140’ bottom trawl. Trawling time will be 30 minutes on the bottom. It is envisaged that depending on the bottom depth up to 4–5 hauls will be conducted in the course of a day. The fish catch will be processed according to standard methods used on previous surveys. Parasitologists, geneticists, cephalopod researchers, and benthologists will participate in the fish samples. Results from the survey will be present to CCAMLR at its meeting of the Fish Stock Assessment Working Group in October 2012.

3. FISH AS BIOINDICATOR: CONDITION AND HEALTH OF GROUND FISH SPECIES AROUND ELEPHANT ISLAND, THE SOUTH SHETLAND ISLANDS AND AT THE TIP OF THE ANTARCTIC PENINSULA

Patricia Burkhardt-Holm (UniBasel), Helmut Segner (UniBern); not on board: Peter Schmid (EMPA)

Objectives

Increasing contamination with persistent bioaccumulating compounds is reported for the aquatic ecosystems of Antarctica. These substances mainly originating from distant sources are transported via the atmosphere at a global scale and are re-distributed in the aquatic environment by condensation and precipitation. These xenobiotics are accumulating in organisms (bioaccumulation), however, the effects on the various members of the food web are rarely investigated.

The Protocol on Environmental Protection to the Antarctic treaty emphasizes that the protection of the Antarctic environment is in the interest of mankind as a whole. Accordingly, the development and implementation of suitable procedures for environmental impact assessment in Antarctic areas affected by human settlement has to become a priority task.

To evaluate the health of the ecosystem it is one approach to study sensitive indicator species (= sentinel species). Sentinel species have been well established for various ecosystems. However, in Southern Ocean fishes, investigations on the suitability as sentinel species are still missing and a clear need for much more information on the response of polar marine species was addressed. Such species should be selected according to criteria of their role in the food web, their physiological capabilities to respond sensitively and to their prior exposure to chemicals. As a consequence, we focus on three ground fish species as they are representing different roles in the food web, e.g. the benthos feeding yellow notothenia (or bumphead notothenia *Gobionotothen gibberifrons)*, the fish feeder Scotia Sea icefish (or blackfin icefish, *Chaenocephalus aceratus)* and the krill feeding mackerel icefish (*Champsocephalus gunnari*).

As a consequence, this project aims at assessing the general potential of Antarctic groundfish species to cope with bioaccumulating organic toxicants and elucidate their potential as sentinel species. Therefore, we will study (1) if their physiological capability to accumulate and metabolise persistent organic pollutants is different from well-investigated sentinel species of boreal latitudes. With this, we attempt to raise first evidence whether one or more of the three Antarctic fish species are apt as sentinel species. (2) We will further study whether potential effects of preceding exposure to persistent bioaccumulating compounds affected health and selected biomarkers of these species. To raise these data, persistent organic pollutants will be measured in the fish muscle. Furthermore, endpoints will be studied such as condition factor, hepatosomatic index, spleenosomatic index, histopathology of liver and gill, as well as selected biomarkers.

Work at sea

Fish sampling will profit from the fishing program of the survey on the biology and ecology of Antarctic groundfish. This fishing will be conducted within the remit of CCAMLR and is thus due to specific research exemptions both under the Antarctic Treaty and CCAMLR. Accordingly, no additional fish has to be taken. From the provided three fish species, only male specimen of a specific maximum length (corresponding to age < 3 years) will be investigated to exclude sex differences, which are known to influence the bioaccumulation potency and the responsiveness of the biomarkers. At selected sampling sites, 20 fish fulfilling the mentioned criteria will be

sampled. Whole fish will be studied for biometric parameters. Muscle tissue will be dissected and preserved for further analysis of persistent organic pollutants (P. Schmid, EMPA). Liver, gill and muscle tissue will be sampled for biomarker analysis and PCR of selected enzymes of the detoxification metabolism.

4. MOLECULAR BASIS OF CLIMATE SENSITIVITY IN ANTARCTIC FISH: MITOCHONDRIAL FUNCTIONING AND ITS IMPLICATION FOR IONIC AND OSMOTIC REGULATION

Magnus Lucassen, Nils Koschnick, Tina Sandersfeld (AWI); not on board: Felix Mark, Cornelia Kreiss, Katharina Michael, Christian Bock, Hans-Otto Pörtner (AWI)

Objectives

Increasing CO_2 in the atmosphere causes both, ocean warming and acidification. Due to its pervasive impact on all biological processes, temperature is a crucial abiotic factor limiting geographical distribution of marine ectothermal animals on large scales. Additional environmental factors like increasing PCO_2 and the concomitant drop in water pH are thought to narrow the thermal window, as they are believed to act on the same physiological mechanisms. Thermal adaptation and phenotypic plasticity, which define the thermal niche and the responses to fluctuating environmental factors, are ultimately set by the genetic interior of the organisms. Adaptations to the extreme cold appear to be evolved at the expense of high thermal sensitivity. Mitochondrial functioning and maintenance resemble a key functional trait, as it is directly related to the aerobic performance windows of animals. Example studies on mitochondria from Antarctic fish suggest that mitochondrial functioning underwent significant adaptations upon evolution to extreme cold. Our findings of elevated capacities of respiratory chain components and uncoupling proteins in Antarctic eelpouts upon warm acclimation suggest the use of acclimation pathways different from those in temperate fish. Furthermore, we identified a molecular network, responding sensitively to warming beyond the realized ecological niche and mediating large rearrangements in energy metabolism.

The allocation of energy through mitochondria limits the main energy demanding processes like protein and RNA synthesis and ion and pH regulation. The interrelation of ion regulation and energy demand becomes obvious in branchial mitochondrial-rich cells, where the main ion pump, the Na^+/K^+-ATPase, is concentrated, too. Tight regulation of this process with a strong impact on whole animal energy budget has been shown both in response to temperature and CO_2. Ocean acidification is compensated for by an efficient ion regulatory system. With respect to temperature effects, different strategies in the use of active and passive strategies of pH regulation are discussed for cold-adapted and temperate species. As hemoglobin-less icefishes are characterized by larger blood volume and flow due to limited oxygen transport capacity, consequences for the passive transepithelial transport of ions may be postulated.

Here, we aim to characterise the branchial energy budget and ion regulatory system in gills in relation to the allocation of energy by mitochondria upon relevant environmental factors in an array of different Antarctic fish groups, to distinguish common principles and specific climate sensitivities in the light of the ongoing climate change.

Work at sea

The current cruise will provide access to a large number of fresh tissue samples from all Antarctic fish groups, which provides an excellent basis for comparative tissue and cellular

analyses. Fish from bottom trawls (Kock group) will be mainly processed directly by taking gills and other tissues after anaesthetizing and killing. All tissues will be frozen in liquid nitrogen for further analyses at AWI.

By use of baited traps we aim to catch animals of best quality for short-term thermal acclimation experiments (days to weeks) and physiological experiments at the institute. These fish will be maintained in an aquarium container for several days before experimentation. Depending on the number of specimens some fish will be acclimated to higher temperature for several days before sampling. All other fish will be kept on board *Polarstern* at environmental temperature conditions and will be sent alive to the AWI (ANT-XXVIII/5).

The capacity and temperature sensitivity of the ion regulatory system in response to further abiotic factors like CO_2 and O_2 will be characterised in isolated fish gills (at the AWI). In parallel samples for basic physiological parameters like ion composition, pHe, pHi, serum osmolality etc. will be taken for the respective specimens. Aliquots of gill tissue will be fixed for immunohistochemical and *in-situ* hybridisation analyses at the AWI. The data will be completed by the determination of functional capacities, specific mRNA expression studies and protein quantification by means of antibodies (in part during ANT-XXVIII/5 and at the AWI). The mRNA samples will be further analysed for differentially expressed genes at the institute.

In parallel, mitochondrial functioning will be characterised through oxygen consumption and membrane potential measurements in perfused tissue preparations and isolated mitochondria together with functional capacities of respective key enzymes. The data will be related to the isolated gill model.

Furthermore, during past cruises we have already collected a reasonable number of tissue samples from a broad set of fish species within the study area. Samples for molecular genetic and phylogenetic studies of various tissues will be taken from anaesthetized fish directly after catching and frozen instantaneously in liquid nitrogen. DNA and RNA will be extracted from selected tissues for further analyses later at the AWI. The new molecular analyses tools (in-depth pyrosequencing, etc.) present a quantum leap in analysing environmental samples from individual specimens. The continuous sampling of these samples will allow for holistic analyses of active genomes in a changing environment over time.

5. REPRODUCTIVE FEATURES OF ANTARCTIC SILVERFISH, *PLEURAGRAMMA ANTARCTICUM*, IN THE ATLANTIC SECTOR OF SOUTHERN OCEAN

Marino Vacchi (UniGenova)

Objectives

The Antarctic silverfish *Pleuragramma antarcticum*, is the dominant pelagic fish inhabiting both ice-free and pack ice waters over the Antarctic continental shelf. Despite its abundance and key role as a major item in the food web, knowledge about its reproductive biology is still lacking. Recently the first spawning sites have been identified in Terra Nova Bay where large amounts of fertilized eggs were found entangled in the platelet ice. This discovery indicates a life history linked to sea ice, with relevant biological and ecological implications. The reproductive features of *P. antarcticum* are presently part of extensive research carried out in the East Antarctic sectors, in collaboration among Italy, New Zealand and France, according to the experience accumulated over the past 15 years by the respective scientific teams.

The present project aims the enlargement of information on the life cycle of the Antarctic silverfish *P. antarcticum,* by the analysis of the reproductive condition of adult fish samples

collected in other Antarctic sectors. ANT-XXVIII/4 will provide in the Atlantic Antarctic Sector a very important opportunity to get adults of this key fish species in order to perform such analyses.

In the framework of the ongoing collaboration between scientists of Italy, France and New Zealand in order to study the life cycle of the Antarctic silverfish *P. antarcticum*, the *Polarstern* cruise will offer a very good opportunity to get adults and to acquire, for the first time, data on the reproduction cycle of this key fish species in the Atlantic sector of the Southern Ocean. The proposed activity aims also to extend the international cooperation on these topics to other scientists participating to the *Polarstern* cruise. The planned sampling activities should provide important information related either to geographical distribution of *P. antarcticum* and to its preferential bathymetric distribution within the water column (due to the use of different gears, such as pelagic and bottom trawls). The analyses of the gonadic condition of the various specimens coming from the survey will allow to reconstruct the reproduction cycle of the species and to get insights into its reproductive strategy. In fact the laboratory analysis will produce detailed information on the reproductive condition and the seasonal timing of spawning, thus adding information on the reproductive strategy of the silverfish and on its life cycle. The results will integrate the data coming from other Antarctic areas, in order to reconstruct the whole life cycle of the species.

The present proposal contributes to the *Polarstern* cruise general objectives by providing information on the cycle of Antarctic silverfish (*P. antarcticum*), with focus on reproductive features of this key fish species of the Antarctic coastal ecosystem.

Specific objectives are (1) to investigate the timing of the spawning events in *P. antarcticum* in the coastal region of Antarctic Atlantic sector, (2) to characterize sexual dimorphism and reproductive features in adult specimens of *P. antarcticum* in the Antarctic Atlantic sector.

Work at sea

Biological samples and cruise data will be used in laboratory activities and data analysis in order to improve our knowledge of life cycle of *P. antarcticum* in the Antarctic Atlantic sector of the Southern Ocean. International cooperation between Italy and Germany scientists will be developed on life cycle characteristics of *P. antarcticum*. Moreover the research will provide support on an ongoing collaboration with researchers of New Zealand and France on reproduction biology of the Antarctic silverfish.

6. POPULATION GENETICS AND PHYLOGENETICS OF NOTOTHENIOID FISH IN THE AREA OF ELEPHANT ISLAND – SOUTH SHETLAND ISLANDS AND THE ANTARCTIC PENINSULA: LONG TERM FOLLOW UP AND SAMPLING FOR GENE EXPRESSION PROFILING.

Chiara Papetti (UniPadova)

Objectives

We aim at extending our temporal sampling series of frozen and/or ethanol preserved muscle/fin tissues of notothenioid fish for population genetics analyses. Our studies have mainly targeted three species: *Chionodraco rastrospinous*, *Chaenocephalus aceratus*, *Pleuragramma antarcticum.* Previous samples of these three species were analyzed in published and under revision studies and belong to the Elephant Island - South Shetland Islands – Antarctic Peninsula area (CCAMLR Subarea 48.1). These samples were collected during two surveys

conducted by *Polarstern* in 2001/2002 (ANT-XIX/3) and 2006/07 (ANT-XXIII/8). A long-term genetic monitoring of these species in the West Antarctic Peninsula may help in verifying stability of differentiation pattern. Patterns of water circulation at small spatio-temporal scales may be modified by global warming leading to a strong impact inter-annual variability in the recruitment and growth of both pelagic and benthic organisms. While organisms are adapted to historical levels of such variability, they might not be able to cope with a significant increase in the frequency of years of low recruitment or slow growth, likely resulting in an alarming loss of genetic variability and decreases in effective and absolute population sizes.

More over the increasing impact of new approaches in conservation genomics including functional genomics, transcriptomics and gene expression methodologies, may give a major boost to our understanding of the evolution and population genetic structuring of Antarctic marine organism, especially in response to global climate change.

For this reason additional sampling will be aimed at collecting not only other fish species for future international sample exchange, but also different body tissues for future RNA extraction. In summary, the main target species for this project will be: *Chionodraco rastrospinous*, *C. myersi*, *Chaenocephalus aceratus*, *Pleuragramma antarcticum.* Additional species that will be sampled in small amount (6-8 individuals) are *Gobionotothen gibberifrons*, *Notothenia rossii*, *N. coriiceps*, *Champsocephalus gunnari*, *Lepidonotothen larseni*, *L. squamiforms*, *Pseudochaenichthys georgianus* and *Trematomus eulepidotus.*

Work at sea

Samples will be obtained from opportunistic sampling of fish tissues, made available by means of fishing efforts operated by other researchers. The working plan includes collection of adult and juvenile specimens, together with their total length, wet weight, sex, gonad index/ maturity state information, and otoliths. In particular, as during the ANT-XIX/3 and ANT-XXIII/8 cruises, a unique individual identifier will be assigned to a sub-sample of the fish collected, thus allowing to record ancillary information such as sex, length, maturity stage, and age of each fish for further use in following genetic analyses. This information will be recorded with the permission of scientific groups focused in collecting these data and in collaboration with Dr. E. Riginella (University of Padova). Possibly external appearance of few single fishes will be digitally recorded. Sampling entails dissection of a small amount of lateral muscle tissue and/or fin clips, under clean conditions, and storage of tissue samples in 2 ml RNA later (RNAlater™ Ambion) and 99% absolute ethanol (at 4°C). A replicated sampling of these tissues and possibly of additional organs (spleen, blood, brain, liver, heart) of interest will be frozen preserved (-80°C) or stored in RNA later at -20°C.

Finally we anticipate that population samples of *Euphausia sp.* will be occasionally collected as by-catch, and will be very useful for ongoing studies at Padova University. Tissues will be stored in RNA later for genetic analysis. The tissue will be stored in vials at -20°C. All the remaining experimental protocols will be carried out once back in the lab.

7. POPULATIONS STRUCTURE OF *CHAENOCEPHALUS ACERATUS* (CHANNICHTHYIDAE, TELEOSTEA) ACROSS THE SOUTHERN SCOTIA ARC BY MEANS OF LIFE HISTORY PARAMETERS LINKED TO GROWTH AND REPRODUCTION

Emilio Riginella (UniPadova); not on board: Carlotta Mazzoldi (UniPadova), Mario La Mesa, (UniPadova/ISMAR-CNR)

Objectives

The Atlantic sector of the Southern Ocean, encompassing the islands of the Southern Scotia Arc, has been one of the most harvested areas until ’90, when commercial finfish exploitation was banned by CCAMLR. One of the most important target species was the Scotia Sea icefish, *Chaenocephalus aceratus*, which is distributed along the Southern Scotia Arc including the tip of the Antarctic Peninsula, where it is among the most abundant fish species. Adults occur at depths of 200 to 400 m, although some individuals have been found beyond 700 m depth. The deep waters separating the shelves of the Scotia Arc Islands, which correspond to the areal of distribution of *C. aceratus*, may act as spatial boundaries, indicating the existence of discrete populations more or less isolated and, consequently, the need to manage them as separated stocks. Some biological features of *C. aceratus*, such as the sedentary habitus and negative buoyancy of adults and the deposition of demersal eggs on the bottom guarded by males for a long period, would support the aforementioned isolation among populations. On the other hand, the early life stages of *C. aceratus* are pelagic and remain in the water column for long time, increasing the possibility of gene flow and connectivity among populations through larval dispersal. Genetic analyses highlighted a complex pattern of differentiation of *C. aceratus*, with genetic differences occurring both at the temporal level at Elephant Island and at the geographic scale between southern South Shetland–Elephant Islands and South Orkney population samples. Studies on parasite infestation and growth parameters indicated the existence of at least three differentiated stocks off the shelves of South Georgia, South Orkney, and South Shetland Islands.

The management of Antarctic fish species harvesting made by CCAMLR is generally based on presumed stock units, considering populations of the same species which inhabit islands separated by deep waters as discrete, as *C. aceratus*. However, stocks identification is a fundamental prerequisite for the tasks of stock assessment and population dynamics. Indeed, failure to detect hidden stock units can lead to local over-fishing and in extreme cases to severe declines in species abundance. Differences in the life history parameters of different populations of the same species, including reproduction, spawning and maturity, as well as age and growth, have long been used as a basis for the identification of fish stocks. Estimates of these parameters are considered to be representative of individual fish within a putative stock, and can be used to distinguish among discrete stocks because they are phenotypic expression of the interaction between genotypic and environmental influences. Consequently, differences in life history parameters are assumed to evidence that populations of fish are geographically and/or reproductively isolated, and therefore considered as discrete stock units for management purposes.

Bearing in mind such statements, the present research aims to study the population structure of *C. aceratus* in their areal of distribution, and in particular from the South Shetlands and Antarctic Peninsula.

Work at sea

Samples of individuals of different sizes and sexes of *C. aceratus* will be collected and processed extracting gonads and otoliths. Each sample will be marked with species name, date and site of collection, sex (if visible) and size, and stored at room temperature. Gonads will be preserved in Formaldehyde 7% solution (ovaries, for fecundity estimation) or Dietrich solution (for histological analyses). Histological analyses and otolith reading will carried out in the laboratories of CNR and University of Padova (Italy) in order to:

1) analyse stock structure and estimate of growth parameters of the local populations by means of otolith readings;

2) validate of age estimates through radiometric analysis;

3) assess the spawning season, fecundity and size/age at sexual maturity of the local populations by means of macroscopic and histological analyses of gonads;

4) estimate the presence and extent of atretic phenomena in ovaries, that can be used as proxy of reproductive failure in a part of the population in relation to environmental factors.

Depending on availability, samples of gonads or whole body cavity or trunks of males and females will be removed from fish and fixed in Dietrich solution, for histological analyses, or Formaldehyde 7% solution, for fecundity estimation for a comparative analysis of male and female reproductive apparatus on Antarctic fish. Each sample will be marked with species name, date and site of collection, sex (if visible) and size, and stored at room temperature. In order to relate reproductive status (mature vs. immature) to size and age of fish, otoliths will be removed and preserved. For each species, a minimum of 30 individuals per sex should be preserved, although if individuals of different sizes are available, the collection of larger number of samples will allow the estimation of size/age at sexual maturity. Histological analyses and otolith readings will be carried out in the laboratories of CNR and University of Padova (Italy).

8. GENETIC POPULATION STRUCTURES OF NOTOTHENIOIDS ALONG THE SCOTIA ARC

Reinhold Hanel, Malte Damerau (vTI)

Objectives

Since the cooling of the Southern Ocean approximately 20 million years ago, a unique ichthyofauna evolved on the shelves of the Antarctic continent and adjacent islands showing low species diversity and high levels of endemism. The majority of fish are bottom dwelling and belong to the suborder Notothenioidei (Perciformes). Their larvae usually develop pelagically over an extended period of several months. During this time, larvae may be dispersed over large distances by strong current systems, including the Antarctic Circumpolar Current that surrounds Antarctica. Indeed, high genetic homogeneity and low differentiation among populations is often found even for species with circumantarctic distributions, highlighting the role of protracted larval phases for gene flow. On the other hand, larvae are often found to be retained in neritic waters by local gyres. Also, oceanic fronts and strong currents may act as barriers hindering gene flow by larval dispersal or migration.

In our planned study, we want to compare the genetic population structures along the Scotia Arc region of selected notothenioid species with differing life-history strategies and larval durations to elucidate the role of prolonged larval phases and prevailing current systems in population structuring and, moreover, the influence of ecology and gene flow on the ongoing adaptive radiation of notothenioids in the Southern Ocean.

Work at sea

Along the shelves of the Scotia Arc islands and the Antarctic Peninsula a bottom trawl will be used to sample demersal notothenioids. After each haul, muscle tissue will be collected for genetic analyses from all caught notothenioid species with a special focus on *Chaenocephalus aceratus, Champsocephalus gunnari* and *Lepidonotothen larseni*. In addition, biological data will be collected (sex, length, weight (total, eviscerated, stomach, gonad)). The combined data will allow us to thoroughly analyse the spatial and temporal demographic influence on genetic population structuring in these species. We will furthermore collect tissue samples of all caught fish species for phylogenetic investigations.

9. BIODIVERSITY AND EVOLUTION OF PARASITIC LIFE IN THE SOUTHERN OCEAN: RESPONSE TO ECOSYSTEM CHANGE

Sven Klimpel, Thomas Kuhn, Markus W. Busch, Sebastian Emde (BiK-F)

Objectives

Antarctica offers a unique natural laboratory for undertaking fundamental research on the relationship between the climate, evolutionary processes and species adaptation to extreme environmental conditions. Krill, cephalopods and Antarctic fish species are considered the key species of the marine food web in the Southern Ocean. Being a species rich but often well hidden component of the Antarctic fauna, fish parasites have been studied with a focus on single parasite species or taxa. Recent parasitological studies of some nototheniid and channichthyid fish from the Antarctic Peninsula and the eastern Weddell Sea revealed a highly diverse parasite fauna, with over 30 different species in the Antarctic rock cod *Notothenia coriiceps*. In general, Antarctic fish seems to be infected with a wide variety of endemic parasite species, most of them with less or little host specificity. Molecular techniques have been applied to utilize parasites as ”biological tags” to characterize the population structure of their hosts. The evaluation of their genetic variability might provide important information about the population biology and behaviour of their fish hosts.

The combination of parasitological, genetical and feeding ecological studies reveals information on the life cycle biology and transmission strategies (trophic interactions) of fish, bird and mammal parasites along the Antarctic Peninsula and contributes to the assessment of relationship between their host populations. The development of the fish parasite diversity within the region might have happened either in close co-evolution with the notothenioid fish or is a consequence of regularly occurring parasite invasions of formerly more northern species into the Antarctic. The results can be directly compared with two earlier studies during the Antarctic summer 1996/97 (ANT-XIV) and 2006/07 (ANT-XXIII/8), especially considering the fact that the Antarctic Peninsula is one of the three areas of the globe that are currently experienced rapid regional climate change.

Work at sea

Different Antarctic fish species will be collected off the South Shetland Islands and investigated for stomach content analyses and metazoan parasites. Special attention will be given at the occurrence of anisakid nematodes, such as Contracaecum osculatum, C. radiatum and Pseudoterranova decipiens. The isolated parasites will be preserved in 70% and 100% ethanol and frozen at -80°C for subsequent parasitological and molecular genetic studies. Tissue samples of various fish species will be collected and preserved for population genetics. In addition fish, squids and euphausiids or other crustaceans will be deep frozen for further examinations at our lab in Frankfurt/Main.

10. DETECTION OF VULNERABLE MARINE ECOSYSTEMS (VMES) IN THE AREA OF ELEPHANT ISLAND – SOUTH SHETLAND ISLANDS

Susanne Lockhart (NOAA), Eric A. Lazo-Wasem (Yale), Nerida Wilson (Austmus)

Background and objectives

Protection of vulnerable marine ecosystems (VMEs) is an important component within the management framework of bottom fisheries in high seas areas of the world's oceans. The Commission for the Conservation of Marine Living Resources (CCAMLR) has adopted conservation measures aimed at minimizing adverse impacts on VMEs in the Southern Ocean. These include measures which require a notification to be completed when evidence of VMEs are encountered during the course of fishery-independent research activities, such as a demersal finfish bottom trawl survey.

CCAMLR has interpreted a VME to be consistent with an area that includes the presence of benthic invertebrate taxa that significantly contribute to the creation of complex three-dimensional structure, cluster in high densities, change the structure of the substratum, provide substrata for other organisms, or populated by rare or unique benthic taxa. There are currently 27 taxonomic groups recognized by CCAMLR as VME indicator taxa. CCAMLR requires that the presence of these taxa should be monitored on research cruises, and presence of a certain density of VME indicator taxa in an area can lead to the designation of a VME, and inclusion into the CCAMLR VME registry.

Both Germany and the USA have been members of CCAMLR since CCAMLR came into force in 1982. The Seafisheries Institute of the Johann Heinrich von Thünen Institute conducts research in CCAMLR waters on behalf of the German Government as a contribution to this convention. Surveys for finfish were conducted at regular intervals starting prior to the establishment of CCAMLR in 1975/76, first with FRV *Walther Herwig* and later continued with *Polarstern* and in collaboration with scientists from Southwest Fisheries Science Centre in La Jolla, USA with the Russian research vessel *Yuzhmorgeologiya*. Information collected during the 2006 and 2009 bottom trawl surveys in Subareas 48.1 and 48.2 has led to the registrations of 29 VMEs in these areas. However, this analysis has not been completed for the South Shetland Islands region of Subarea 48.1.

The main purpose of the proposed study is to examine the benthic invertebrate VME indicator taxa bycatch taken during the course of the demersal finfish survey of the South Shetlands Islands scheduled as part of ANT-XXVIII/4. The by-catch will be analyzed to determine composition, density, and patterns of benthic communities around the South Shetland Islands. If there is sufficient evidence of the presence of a VME, this information will be used as justification toward submission of a VME notification to the CCAMLR Commission, which could potentially be included into the CCAMLR VME registry. This better allows CCAMLR the ability to manage and minimize risk to VMEs, in both present and potential future fisheries, in the Convention area.

Our project is part of the international effort of CCAMLR members to detect the presence of vulnerable marine ecosystems in the Southern Ocean, and is embedded in CCAMLR's ecosystem approach to managing Antarctic resources.

Work at sea

There will be no additional gear-deployment requirements beyond that which will be used for the demersal finfish bottom trawl survey. Upon the arrival of a trawl's haul at the Fish Lab,

members of both the fish and invertebrate teams will work to sort the former from the latter. The latter will then be subjected to further sorting for composition analyses. Depending on the size of material presented at each station, a subsample may need to be identified for this further analysis.

The composition of each sample will be analysed by sorting invertebrates into approx. 61 feasible taxonomic groupings or operational taxonomic units (OTUs) that incorporate the VME indicator taxa adopted by CCAMLR. Masses of each OTU will be recorded and individuals counted where appropriate. Any dead or unsortable organic matter will also be weighed, and for the latter, characterized (e.g. 60% demosponge, 30% irregular echinoid fragments, 10% organic matter).

Live specimens of each OTU, and of common species or species of particular interest, will be photographed for potential inclusion in general Antarctic, or specific VME, invertebrate field guides, or for use in institutional or international photographic databases.

In addition, samples of such specimens/species will be collected and preserved (for the most part in 95% ethanol) for potential inclusion in molecular phylogenetic or phylogeographic studies, and also for deposition at a number of museums worldwide.

11. CEPHALOPOD ABUNDANCE AND TROPHIC ECOLOGY OFF THE ANTARCTIC PENINSULA

Uwe Piatkowski (IFM-GEOMAR)

Objectives

Based on cephalopod collections of previous *Polarstern* cruises near the Antarctic Peninsula we have described twelve new octopods and documented that the cephalopod community in the area is much more diverse and richer in numbers than was suspected. Cephalopods occur sometimes in large numbers and dominate together with fishes the mobile demersal and benthopelagic fauna. Undoubtedly, they form a major faunal group in the Southern Ocean ecosystem.

Work at sea

During the cruise our research team will sample all cephalopods from the catches taken with the various sampling gears. The overall goal is to expand our previous observations to improve our understanding of diversity, biology, life cycles, distribution and abundance of this important animal group. Examination of freshly caught material will be particularly useful for further taxonomic and molecular biological studies. Tissue samples will be stored for more detailed histological and DNA studies. A major focus will be the intense on board investigation of stomach contents of cephalopods to identify their prey and to relate this to the various species of other faunal groups that are caught. This will inform us about direct links between the faunal groups. For further diet analysis we will take tissue samples of as many cephalopod species as possible and of their likely prey to analyse stable isoptopes, which will provide information on the cephalopods' long-term diet and an estimation of their trophic position.

12. THE *ROSEOBACTER* CLADE AND THE DOM COMPOSITION IN THE DRAKE PASSAGE AND THE ANTARCTIC PENINSULA REGION OF THE SOUTHERN OCEAN

Thomas Badewien, Thorsten Brinkhoff, Bert Engelen, Alexander Gavrilov, Judith Lucas , Swaantje Müllenmeister, Jutta Niggemann, Maren Seibt, Meinhard Simon, Mascha Wurst (ICBM), Maike Smits, Bernd Wemheuer (UniGÖ), Irene Wagner Döbler, Hui Wang (HZI); not on board: Rolf Daniel (UniGÖ), Thorsten Dittmar (ICBM)

Objectives

The goal of this project is a comprehensive assessment of the *Roseobacter* clade and its major bacterioplankton subclusters in the Drake Passage and the Antarctic Peninsula region of the Southern Ocean. This project is part of a key work package of the Transregional Collaborative Research Center Ecology, Physiology and Molecular Biology of the *Roseobacter* clade: Towards a Systems Biology Understanding of a Globally Important Clade of Marine Bacteria (TRR 51). The work includes investigations of the biogeography, growth and population dynamics, the genomic potential and the impact on the DOM decomposition and cycling by the *Roseobacter* clade in the water column and the sediment. A special focus will be on the *Roseobacter* clade affiliated (RCA) cluster, whose prominent role in Southern Ocean bacterioplankton dynamics has already been shown. Samples in the entire water column and in sediments will be analysed by culture-independent and culture-dependent approaches for the phylogenetic and functional diversity and abundance of the *Roseobacter* clade and various subclusters. Samples for metagenomic, metatranscriptomic and metaproteomic analyses will be collected as well in order to assess the full and actively expressed genomic potential of this clade in the Southern Ocean. DOM samples will be analyzed for DOC and DON concentrations, but also for its molecular characterization by ultra high-resolution mass spectrometry (FT-ICR-MS). We intend to correlate the DOM composition to the composition of the bacterioplankton and in particular to its subcommunity, consisting of members of the *Roseobacter* clade.

Work at sea

The analysis will be mainly based on concerted sampling of the water column at approx. 40 stations covering the transect across the Drake Passage and the Antarctic Peninsula region. Samples will be collected mainly from near-surface waters (<200 m) but in selected regions also the entire depth profile to the bottom will be sampled. Sediment samples will be collected by a multi corer at 6 stations. A few samples will also be collected from macroalgae to assess the biodiversity and potential for secondary metabolite production of the associated *Roseobacter spec*. Further, mesocosms of 20-50 liters will be set up and subsampled to manipulate the substrate conditions in order to examine how the *Roseobacter* clade will respond to a changed substrate environment.

The following parameters will be analysed: POC (analysis in the home lab), chlorophyll, bacterial abundance (flow cytometry), bacterial biomass production (leucine and thymidine incorporation), substrate turnover (glucose, amino acids), concentrations of dissolved amino acids (analysis in the home lab), DOC (analysis in the home lab), DOM (FT-ICR-MS, solid phase extraction on board, analysis in the home lab), Fluorescence *in-situ* hybridization by probes of various specificity (CARD-FISH, MAR-FISH). Samples will also be collected to isolate *Roseobacter* strains and to be concentrated on filters of various sizes and pore size, stored at -80°C for later analysis in the home lab: Denaturing gradient gel electrophoresis (DGGE) of PCR-amplified 16S rRNA gene fragments amplified with primers of various specificity,

expression of functional genes by qPCR, metagenomics, metatranscriptomics, proteomics. For the omics analyses, large volumes (50-100 liters) will be needed but sampling will be less frequently than for the other parameters.

Sediment samples in the oxic and anoxic layers will be analysed for the diversity of the *Roseobacter* clade by DGGE analyses and by isolating *Roseobacter* strains. The sediment will be characterized for the content of Corg, N, S, and P and the pore water for various organic and inorganic nutrients.

13. CULTURE EXPERIMENTS ON THE ENVIRONMENTAL CONTROLS OF TRACE METAL RATIOS (MG/CA, B/CA, U/CA) RECORDED IN CALCAREOUS TESTS OF ANTARCTIC DEEP-SEA BENTHIC FORAMINIFERA

Jutta Wollenburg (AWI)

Objectives

The Antarctic deep water during glacial time was, disputably still is, the largest marine sink of atmospheric CO_2. Employment of effective and fossilisable proxies on changes in the physical and geochemical properties is essential to assess glacial-interglacial variabilities, modern and future changes in Antarctic deep-waters. In this respect, analyses on trace metal (Mg/Ca, U/Ca, B/Ca) ratios recorded in tests of foraminifers to estimate calcification temperatures, alkalinity, carbonate ion saturation, and pH are common methods. However, for the Southern Ocean deep-sea benthic foraminifera calibration curves constrained by either core-top samples or culture experiments are lacking. Newly developed high-pressure aquaria have recently facilitated the first efficient cultivation (producing offspring) of our most trusted palaeodeep-water recorders *Fontbotia wuellerstorfi* and *Uvigerina peregrina*.

Work at sea

In different experimental set-ups the same facilities will be used to cultivate these foraminifera and associated species at different temperatures and in waters with different carbonate chemistries to establish the first species-specific trace metal calibration curves for the Antarctic Ocean. Five autoclaves are built and will be operated during the cruise. Sediments will be retrieved with a multiple corer and then immediately transferred into the autoclaves. Connected to high-pressure pumps the sediments will then be cultured at their original pressure. Additional sediment cores will be transferred in pressure-free mesocosms, treated in the same way than the autoclaves. The experimental results will be obtained approximately 6 months after the expedition.

14. MAPS: MARINE MAMMAL PERIMETER SURVEILLANCE

Elke Burkhardt, Sebastian Richter (AWI), Caterina Lanfredi (PolM); not on board: Daniel Zitterbart, Lars Kindermann and Olaf Boebel (AWI)

Objectives

To facilitate marine mammal observations for both mitigation and scientific applications, the MAPS project firstly aims at developing an automatic whale blow detection system on the basis of a 360° thermal imaging sensor, FIRST Navy. Data collected with this system during three recent *Polarstern* cruises resulted in numerous detections during retrospective human visual screening as well as autodetections through a custom developed autodetection algorithm.

However these cruises all occurred during periods of nearly continuous daylight, while it is of great interest to understand the systems performance at night. To this end, the IR system shall collect data both night and day to obtain sighting rates, which shall be compared with sightings rates obtained by concurrent visual sightings during dusk, day and dawn hours. Additionally, the add-on PiP system, which shall automatically collect high-resolution visual photo footage of autodetected events, shall be further developed. The system requires a predictive compensation of the ship's pitch and roll, which is yet not fully developed.

Secondly, MAPS aims at developing a better understanding of cetacean distributions using visual whale sighting data to develop habitat suitability models in conjunction with environmental proxy data.

Work at sea

The marine mammal observers will conduct visual observations along the track line and also collect exactly timed cue counts (blows) of individual whales. Observations will be conducted from the bridge from dusk till dawn in collaboration with the PolE team. The MAPS-IR thermal imaging system is planned to operate continuously throughout the cruise, particularly to collect whale blow images during night times. Raw data shall be saved for the entire cruise, with a preference for nighttime data and data concurrent with visual sightings, in case of unforeseen memory limitations. In addition the image stabilization of the PiP system shall be improved during this cruise. The development and testing of this system can only be conducted *in-situ* on the ship, with direct connection to the FIRST-Navy gimbal data.

Expected results

Firstly, visual sighting data and autodetections by the IR system shall be compared for further testing and validation of the performance of the infrared imager and the latest implementation of the automatic detection algorithm. With the latter being based on a learning algorithm, an expansion of the detectors applicability is expected, if including the cruise data of environmental conditions (night time, warmer waters) differing from those encountered during previous expeditions.

Secondly, visual sighting data will be merged with environmental parameters such as SST, water depth and sea ice coverage and be used in environmental habitat suitability models. System validation will lead in further improvement of algorithms with the main focus in minimizing false alert rates. IR footage will allow for behavioural analysis, which will provide high-resolution tracks of animals within the ship perimeter. Furthermore, we expect to have optimized the PiP System with regard to a predictive compensation of pitch and roll.

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

Claude R. Joiris, Christophe Gruwier (PolE)

Objectives

In the frame of our long-term study of the at-sea distribution of seabirds and marine mammals, concerning mainly the mechanisms explaining this distribution: water masses and fronts and bottom structures such as slope influencing the localization of fronts (upwellings), special attention is to be paid to less studied Antarctic zones such as the eastern and western parts of the Weddell Sea. Of special interest are the complementary studies of the main prey of seabirds and cetaceans: zooplankton and krill, nekton, and small fish.

Work at sea

Distribution of marine mammals and seabirds will be determined from continuous transect counts from the bridge.

16. BETEILIGTE INSTITUTE/ PARTICIPATING INSTITUTES

	Adresse/Address
AustMus	Australian Museum 6 College Street Sydney NSW 2010, Australia
AWI	Alfred-Wegener-Institut für Polar- und Meeresforschung Postfach 120161 27515 Bremerhaven, Germany
BIK-F	Biodiversität und Klima Forschungszentrum Medizinische Biodiversität und Parasitiologie Goethe-Universität Senckenberganlage 25 60325 Frankfurt, Germany
DWD	Deutscher Wetterdienst Geschäftsbereich Wettervorhersage Seeschifffahrtsberatung Bernhard-Nocht-Straße 76 20359 Hamburg, Germany
EMPA	Eidgenössische Materialprüfungs- und Forschungsanstalt Überlandstrasse 129 8600 Dübendorf, Switzerland
HZI	Helmholtzzentrum für Infektionsforschung Inhoffstraße 7 38124 Braunschweig, Germany
ICBM	Institut für Chemie und Biologie des Meeres Carl von Ossietzky Universität Oldenburg 26111 Oldenburg, Germany
ISMAR-CNR	Istituto di scienze marine-Consiglio Nazionale delle Ricerche Sede di Ancona Largo Fiera della Pesca 60125 Ancona, Italy
IFM-GEOMAR	IFM-GEOMAR Leibniz-Institut für Meereswissenschaften Düsternbrooker Weg 20 24105 Kiel, Germany
NOAA	Antarctic Ecosystem Research Division Southwest Fisheries Science Center NOAA National Marine Fisheries Service 3333 North Torrey Pines Court La Jolla, CA 92037, USA
PolE	Laboratory for Polar Ecology Rue du Fodia 18 1367 Ramillies, Belgium
PolM	Politecnico de Milano Leonardo da Vinci 32 20133 Milano, Italy

	Adresse/Address
UniBasel	Universität Basel Programm Mensch-Gesellschaft-Umwelt Departement Umweltwissenschaften Vesalgasse 1 4051 Basel, Switzerland
UniBern	Universität Bern Zentrum für Fisch- und Wildtiermedizin Länggassstrasse 122 3001 Bern; Switzerland
UniGenova	University of Genova Istituto Superiore per la Protezione e la Ricerca Ambientale c/o National Antarctic Museum Viale Benedetto XV 16132 Genova, Italy
UniGÖ	Georg-August-Universität Göttingen Institut für Mikrobiologie und Genetik 37077 Göttingen, Germany
UniPadova	University of Padova Department of Biology Via Ugo Bassi 58B 35131 Padova, Italy
vTI	Institut für Seefischerei, Johann Heinrich von Thünen Institut für ländliche Räume, Wald und Fischerei Palmaille 9 22767 Hamburg, Germany
Yale	Peabody Museum of Natural History Yale University 170 Whitney Avenue New Haven, CT 06520-8118, USA

17. FAHRTTEILNEHMER/ PARTICIPANTS

Name/Last name	Vorname/First name	Institut/Institute	Beruf/Profession
Badewien	Thomas	ICBM	Scientist, oceanography
Billerbeck	Sara	ICBM	PhD student, biology
Brinkhoff	Thorsten	ICBM	Scientist, microbiology
Burkhardt	Elke	AWI	Scientist, biology
Burkhardt-Holm	Patricia	UniBasel	Scientist, biology
Busch	Markus	BIK-F	Scientist, biology
Damerau	Malte	VTI	PhD student, biology
Elsheimer	Annika	vTI	Technician
Emde	Sebastian	BIK-F	PhD student, biology
Engelen	Bert	ICBM	Scientist, microbiology
Gavrilov	Alexander	ICBM	Student, marine environ. science
Gruvier	Christophe	PolE	Scientist, biology
Hanel	Reinhold	vTI	Scientist, biology
Joiris	Claude	PolE	Scientist, biology
Jones	Christopher D.	NOAA	Scientist, biology
Klimpel	Sven	BIK-F	Scientist, biology
Kock	Karl-Hermann	vTI	Scientist, fish biology
Koschnick	Nils	AWI	Engineer
Kuhn	Thomas	BIK-F	PhD student, biology
Lanfredi	Caterina	PolM	PhD student, biology
Lazo-Wasem	Eric A.	Yale	Senior collections manager
Lockhart	Susanne	NOAA	Scientist, biology
Lucas	Judith	ICBM	PhD student, biology
Lucassen	Magnus	AWI	Scientist, biology
Müllenmeister	Swaantje	ICBM	Student, marine environ. science
NN		IFM-Geomar	
NN		AWI	
Niggemann	Jutta	ICBM	Scientist, geochemistry
Papetti	Chiara	UniPadova	Scientist, biology
Piatkowski	Uwe	IFM-Geomar	Scientist, biology
Richter	Sebastian	AWI	Engineer
Riginella	Emilio	UniPadova	PhD student, biology
Sandersfeld	Tina	AWI	PhD student, biology
Segner	Helmut	UniBern	Scientist, zoology
Seibt	Maren	ICBM	PhD student, biology
Siegel	Volker	vTI	Scientist, biology
Simon	Meinhard	ICBM	Scientist, microbiology
Smits	Maike	UniGö	Student, biology
Vacchi	Marino	UniGenova	Scientist, biology
Wagner Döbler	Irene	HZI	Scientist, microbiology
Wang	Hui	HZI	PhD student, biology
Wemheuer	Bernd	UniGö	PhD student, biology
Wilson	Nerida	AustMus	Scientific officer
Wollenburg	Jutta	AWI	Scientist, geology
Wolske	Julia	vTI	Technician
Wurst	Mascha	ICBM	PhD student, biology
NN		HELISERVICE	Helicopter, pilot

NN		HELISERVICE	Helicopter, pilot
NN		HELISERVICE	Helicopter, technician
NN		DWD	Meteorologist
NN		DWD	Technician, meteorology

18. SCHIFFSBESATZUNG / SHIP'S CREW

Name	Rank
Wunderlich, Thomas	Master
Grundmann, Uwe	1.Offc.
Ziemann, Olaf	Ch.Eng.
Lauber, Felix	2.Offc.
Peine, Lutz	2.Offc.
Hering, Igor	2.Offc.
Reinmiedl, Judith	Doctor
Koch, Georg	R.Offc.
Kotnik, Herbert	2.Eng.
Schnürch, Helmut	2.Eng.
Westphal, Henning	2.Eng.
Brehme, Andreas	Elec.Tech.
Fröb, Martin	Electron.
Muhle, Helmut	Electron.
Winter, Andreas	Electron.
Feiertag, Thomas	Electron.
Clasen, Burkhard	Boatsw.
Neisner,Winfried	Carpenter
Schultz, Ottomar	A.B.
Burzan, G.-Ekkehard	A.B.
Schröder, Norbert	A.B.
Moser, Siegfried	A.B.
Hartwig-L., Andreas	A.B.
Kretzschmar, Uwe	A.B.
Kreis, Reinhard	A.B.
Schröter, Rene	A.B.
Guse, Hartmut	A.B.
Scheel, Sebastian	A.B.
Beth, Detlef	Storekeep.
NN	Mot-man
Fritz, Günter	Mot-man
Krösche, Eckard	Mot-man
Dinse, Horst	Mot-man
Watzel, Bernhard	Mot-man
Fischer, Matthias	Cook
Tupy,Mario	Cooksmate
Martens, Michael	Cooksmate
Dinse, Petra	1.Stwdess
Hennig, Christina	Stwdss/KS
Streit, Christina	2.Steward
Hischke, Peggy	2.Stwdess
Wartenberg, Irina	2.Stwdess
Hu, Guo Yong	2.Steward
Chen, Quan Lun	2.Steward
Ruan, Hui Guang	Laundrym.

ANT-XXVIII/5

11 April 2012 – 16 May 2012

Punta Arenas – Bremerhaven

Chief Scientist

Karl Bumke

Contents

1. ÜBERBLICK UND FAHRTVERLAUF

Karl Bumke, IFM-GEOMAR

Am 11. April 2012 wird FS *Polarstern* den Fahrtabschnitt ANT-XXVIII/5 von Punta Arenas (Chile) nach Bremerhaven antreten. Während Fahrt werden kontinuierlich atmosphärische wie ozeanische Eigenschaften und die Stoffflüsse zwischen Ozean und Atmosphäre gemessen sowie Wal- und Vogelbeobachtungen durchgeführt. Zusätzlich sind 32 Stationen geplant, an denen CTD- und Unterwasserlichtmessungen sowie Gerätetests stattfinden.

Die experimentelle Erfassung der Stoff- und Energieflüsse zwischen Atmosphäre und Ozean ist Teil des Projektes OCEANET, in dessen Rahmen autonome Messsysteme für den Einsatz auf Schiffen entwickelt werden. Im Zusammenhang mit umfangreichen Messungen des atmosphärischen Aerosols und seiner optischen Eigenschaften erlaubt dies detaillierte Analysen des atmosphärischen Zustands. Messungen zur Sauerstoffisotopenanomalie von Ozon und von Nitrat komplettieren die atmosphärischen Untersuchungen und erlauben Rückschlüsse auf atmosphärische Transporte.

An den CTD-Stationen werden jeweils Wasserproben aus verschiedenen Tiefen entnommen und im Hinblick auf verschiedene Parameter untersucht. Dazu zählen Untersuchungen von Bakterien der Roseobacter-Gruppe, die zu den häufigsten Prokaryoten in marinen Ökosystemen zählen. Diese Bakterien sind physiologisch äußerst vielseitig und spielen für die globalen Stoffkreisläufe der Meere eine wichtige Rolle. So ist die Entstehung von gelöstem organischen Material (dissolved organic matter, DOM) durch einen komplexen Kreislauf gekennzeichnet, in dem neben Phytoplankton und Viren Bakterien eine wichtige Rolle spielen. Dementsprechend werden die Wasserproben beispielsweise auch im Hinblick auf den DOM-Gehalt untersucht. Weitere Analysen der Wasserproben befassen sich mit Spurenmetallen im Rahmen eines Austauschprojektes des DAAD (Deutscher Akademischer Austausch Dienst) sowie CDOM und DOC (coloured dissolved organic matter und dissolved organic carbon) im Rahmen eines Eurofleets-Antrages. Unterwasserlichtmessungen ergänzen die Untersuchungen zu den gelösten organischen Stoffen.

Zwei CTD-Messungen im Bereich des Vema-Kanals wiederum sind Teil einer Langzeitstudie zu Untersuchungen der globalen thermohalinen Zirkulation. Informationen zur ozeanischen Strömung liefern auch die kontinuierlichen Messungen mit dem schiffseigenen Profilstrommesser ADCP (Acoustic Doppler Current Profiler).

Auf der gesamten Route werden Beobachtungen des Vorkommens von Seevögeln und Meeressäugern durchgeführt.

Die Reise wird zum Transport von Lebewesen und Sedimentproben, die auf den vorangegangenen Fahrtabschnitten gewonnen wurden, nach Bremerhaven genutzt. An den mitgebrachten Organismen werden während der Fahrt Untersuchungen an den Mitochondrien zum Beispiel hinsichtlich ihres Einflusses auf osmotische Prozesse durchgeführt.

Auf dem letzten Teil der Fahrt von Las Palmas nach Bremerhaven erfolgen Tests des weiterentwickelten Sonar Systems Hydrosweep 3 hinsichtlich seiner Eignung für Messungen in der Tiefsee.

FS *Polarstern* wird am 16. Mai 2012 in Bremerhaven einlaufen.

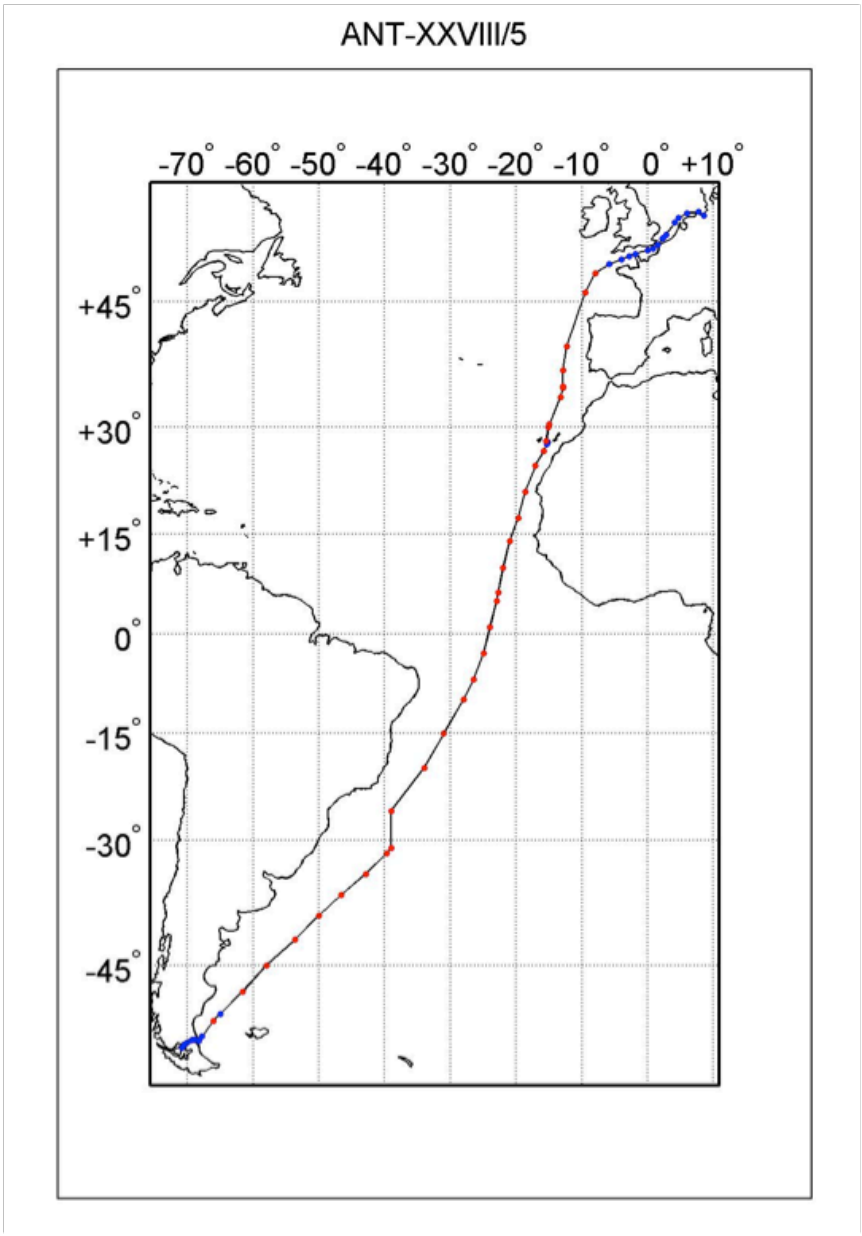

Abb. 1.1: Fahrtroute während ANT-XXVIII/5
Fig. 1.1: Route of ANT-XXVIII/5

SUMMARY AND ITINERARY

On 11 April 2012 *Polarstern* will start the cruise ANT-XXVIII/5 from Punta Arenas (Chile) to Bremerhaven. The cruise will be utilized for continuous measurements of atmospheric and marine properties as well as for energy and material fluxes between ocean and atmosphere. Instrument tests and observations of sea bird and marine mammals will be carried out, too. Additionally 32 stations are planned, where CTDs as well as underwater light measurements will take place.

The continuous measurements of atmospheric parameters and fluxes between ocean and atmosphere will be performed within the frame of the OCEANET project. Main subject of this

project is the development of autonomous measurement systems for operational use on ships. Together with comprehensive measurements of atmospheric aerosol and its optical properties this allows for a detailed analyzes of the atmospheric state. Measurements of the oxygen isotope anomalies of ozone and nitrate will complete the atmospheric observations. Therefore it is possible to investigate atmospheric transports.

At the CTD-stations water samples will be taken from different depths, which will be analyzed with respect to a number of parameters. This comprises the investigation of bacteria of the Roseobacter clade, which are one of the most frequent procariotes in the marine eco systems. These bacteria are physiologically versatile species and play an important role for the oceanic global cycle of matters. Thus, the building of DOM (dissolved organic matter) is part of a complex cyclus, where beside the phytoplankton and viruses bacteria are of importance. Therefore the dissolved organic matters will be analyzed, too. Within a project of the DAAD (Deutscher Akademischer Austausch Dienst) transition metals will be evaluated as well as CDOM and DOC (coloured dissolved organic matter and dissolved organic carbon) within the frame of an Eurofleet project. Under water light measurements complement the investigations of dissolved organic matters.

Two CTD stations at the Vema Channel are part of a long term study of the global thermohaline circulation. Additional information about oceanic currents will be gathered by the ship's acoustic Doppler current profiler (ADCP).

On route observations will take place about the occurrence of seabirds and marine mammals.

The cruise will be used to transport sediments and living creatures collected during previous legs to Bremerhaven. During the cruise investigations will be done of the mitochondrial functioning and its influence e.g. on osmotic regulation for Antarctic organism.

During the last part of the cruise from Las Palmas to Bremerhaven deep sea acceptance tests of the modified sonar system Hydrosweep 3 will be carried out.

Polarstern will arrive in Bremerhaven on the 16 May 2012.

2. AUTONOMOUS MEASUREMENT PLATFORMS FOR ENERGY AND MATERIAL EXCHANGE BETWEEN OCEAN AND ATMOSPHERE (OCEANET): ATMOSPHERE

Karl Bumke (IFM-GEOMAR), Jörg Walter, Michael Schäfer (LIM), Seethala Chellapan (MPI), Andreas Macke, D. Althausen (not on board), Marlen Brückner, Susanne Fuchs (IfT), NN (IAU)

Objectives

Radiation & microwave remote sensing

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 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 part of the “Meridional Ocean Radiation Experiment” MORE which uses Atlantic transfers of various research vessels for the combined measurements of the atmospheric state since 2004. The main project behind this cruise is the WGL-PAKT Initiative OCEANET.

A multichannel microwave radiometer will be applied to continuously retrieve temperature and humidity profiles as well as cloud liquid water path over the ocean. Time series of these profiles will show small scale atmospheric structures as well as the effects of the mean state of the atmosphere and its variability on the co-located measurements of the down-welling shortwave and longwave radiation. The atmospheric profiles will also be used to validate the satellite based profiles from the IASI instrument onboard the new European polar orbiting satellite MetOp. Atmospheric aerosol optical thickness will be measured by means of hand held sun photometer and spectral solar radiometer. Most instruments will be integrated in the new container-based atmosphere observatory.

Air-sea interaction and fluxes

Great emphasis has to be put on air-sea fluxes of momentum, sensible and latent heat to improve numerical models of weather forecast and climate simulations since oceans cover 71 % of the earth’s surface. The fluxes of sensible and latent heat are also of importance for the energy budget of the ocean and the atmosphere. Due to the steady increase of many trace gases in the atmosphere like CO_2, *in-situ* gas flux measurements are required to establish parameterizations that provide flux estimates in climate models.

To estimate the turbulent fluxes of momentum, sensible heat, latent heat, and CO_2 a sonic-anemometer and an open path LiCor will be mounted. Measurements are taken at a sampling rate of 10 Hz (LiCor) respectively 30 Hz (sonic-anemometer) allowing to derive the fluxes by applying the inertial dissipation method. This method relies on measurements at high frequencies, less distorted by the motion and the superstructure of the ship than the covariance technique. Additional measurements of the sea surface temperature (SST) in combination with observations of the standard meteorological parameters and measurements of the CO_2 content in ocean and atmosphere at a lower data rate performed by marine chemist (see section 2) flux parameterizations can be derived.

Aerosol measurements

The portfolio of the Aerosol Group at IfT includes the *in-situ* characterization of atmospheric aerosols in urban as well as remote background atmospheres, the characterization of regional and urban air quality, the examination of hygroscopic particle properties, the measurement and simulation of *in-situ* aerosol optical properties, the investigation of atmospheric transport processes, and the development of new and improved instruments for physical aerosol characterization. Onboard *Polarstern* all measurements will be conducted inside a temperature-controlled container laboratory, and focus on the particle characterization using high-end scientific instruments in order to study:

- physical aerosol properties using an Aerodynamic Sizer (APS) and Tandem Differential Mobility Analyzer (TDMPS) for particle number size distributions from 3 nm to 10 µm, and a Humidifying Differential Mobility Particle Sizer (HDMPS) for the hygroscopic growth of the particles;
- optical properties using a nephelometer and an absorption photometer to measure the particle light scattering and absorption coefficients, respectively; and
- particle chemical composition using a High Resolution Time of Flight Aerosol Mass Spectrometer (HR-ToFAMS) for the non-refractory PM1.

Sea surface chemistry

The main objective of the chemical analysis is to characterize the chemical composition of the ocean surface film in parallel to the chemical and physical characterization of the marine aerosol in order to identify the particle-based exchange of organic compound and hence carbon.

Work at sea

Upon departure both container based atmosphere observatories will be installed at the observation deck of *Polarstern*. Most measurements will be performed underway and continuously. The following individual instruments are combined:

1) Multichannel microwave radiometer HATRPO. The instruments require occasional calibrations with liquid nitrogen as well as tipp-calibrations under calm sea and homogeneous atmospheric conditions.

2) Whole sky imager for cloud structure measurements

3) Handheld sun photometer (Microtops) for aerosol and cloud optical thickness

4) Sonic anemometer USA-1 to measure the wind components and temperature

5) LiCor to measure water vapor and CO_2

6) M-100 absorption hygrometer to measure water vapor

7) *in-situ* aerosol measurements

Marine aerosol particles will be sampled and chemically analyzed in detail in parallel to physical particle characterization. During ship stops the ocean surface film will be sampled and chemically analyzed according to the current state-of-the-art.

Expected results

1) Two-dimensional structure of the clear sky atmosphere and corresponding net radiation budget.

2) Horizontal structure of the cloud water path and its effect on the down-welling shortwave and longwave radiation

3) Vertical structure of temperature and humidity as well as its variability for validation of satellite products

4) Vertical profiles of tropospheric aerosols and their effect on radiation

5) Turbulent fluxes of momentum, sensible, and latent heat

6) Flux of CO_2 between ocean and atmosphere

7) Near-surface aerosol size distributions and their physical and chemical compositions

8) Chemical composition of surface films and relation to evaporated organic materials and their aggregation in aerosols.

3. THE ROSEOBACTER CLADE AND THE DOM COMPOSITION IN THE ATLANTIC OCEAN

Soeren Ahmerkamp, Sara Billerbeck, Alexander Gavrilov, Helge A. Giebel, Katrin Klapproth, Thomas Remke, Maren Seibt, Meinhard Simon, René Ungermann, Mascha Wurst (ICBM), Rolf Daniel, John Vollmers (Uni GÖ), Irene Wagner-Döbler, Hui Wang (HZI)
Thorsten Dittmar (ICBM, not on board)

Objectives

The goal of this project is a comprehensive assessment of the Roseobacter clade and its major bacterioplankton subclusters in the Atlantic Ocean covering its major water masses in the southern and northern hemisphere. This project is part of a key work package of the Transregional Collaborative Research Center Ecology, Physiology and Molecular Biology of the Roseobacter clade: Towards a Systems Biology Understanding of a Globally Important Clade of Marine Bacteria (TRR 51). The work includes investigations of the biogeography, growth and population dynamics, the genomic potential and the impact on the DOM decomposition and cycling by the Roseobacter clade. Samples in the entire water column will be analyzed by culture-independent approaches for the phylogenetic and functional diversity and abundance of the Roseobacter clade and various subclusters. Samples for metagenomic, metatranscriptomic, and metaproteomic analyses will be collected as well in order to assess the full and actively expressed genomic potential of this clade in the Atlantic Ocean. DOM samples will be analyzed for DOC and DON concentrations, but also for its molecular characterization by ultrahigh resolution mass spectrometry (FT-ICR-MS). We intend to correlate the DOM composition to the composition of the bacterioplankton and in particular to its subcommunity, consisting of members of the Roseobacter clade.

Work at sea

The analysis will be mainly based on concerted sampling of the water column at 22 stations covering the entire Atlantic from the subantarctic region to the eastern North Atlantic and all water masses in between including the Mauretanian upwelling region. Samples will be collected mainly from near-surface waters (<200 m) but at 6 stations in the major water masses also the entire depth profile to the bottom will be sampled. Further, mesocosms of 20-50 liters will be set up and subsampled to manipulate the substrate conditions in order to examine how the Roseobacter clade will respond to a changed substrate environment.

The following parameters will be analyzed: POC (analysis in the home lab), chlorophyll, bacterial abundance (flow cytometry), bacterial biomass production (leucine and thymidine incorporation), substrate turnover (glucose, amino acids), concentrations of dissolved amino acids (analysis in the home lab), DOC (analysis in the home lab), DOM (FT-ICR-MS, solid phase extraction on board, analysis in the home lab), Fluorescence *in-situ* hybridization by probes of various specificity (CARD-FISH, MAR-FISH). Samples will also be collected and concentrated on filters of various sizes and pore size, stored at -80°C for later analysis in the home lab: Denaturing gradient gel electrophoresis (DGGE) of PCR-amplified 16S rRNA gene fragments amplified with primers of various specificity, expression of functional genes by qPCR, metagenomics, metatranscriptomics, proteomics. For the omics analyses, large volumes (50-100 liters) will be needed but sampling will be less frequently than for the other parameters.

Expected results

We expect to obtain a detailed insight into the significance, diversity and abundance of the Roseobacter clade and other components of the bacterioplankton across the various water

masses in the Atlantic Ocean and how the various populations of the Roseobacter clade associate with water masses. We hypothesize that the composition of the total, assessed by metagenomics, but presumably much more so of the active bacterioplankton, assessed by metatransc-riptomcs, correlates with the composition of the DOM.

4. ABYSSAL TEMPERATURE FLUCTUATIONS IN THE VEMA CHANNEL

Walter Zenk, Martin Visbeck (IFM-GEOMAR, not on board)

Objectives

The equator bound flow of Antarctic Bottom Water (AABW) represents a significant limb of the global thermal-haline circulation. In the South Atlantic the deep contour current along the continental rise carries large portions of AABW northward. The advected water masses originate from the Weddell Sea, where they are formed by deep reaching winter-time convection. At the latitude 32° S the abyssal flow encounters two topographical constrains in form of the zonally aligned Santos Plateau and the Rio Grande Rise. These combined submarine mountain chains separate the Argentine Basin in the south from the Brazil Basin farther to the north. AABW finds its equatorward pathway through this natural impedance via a long canyon called Vema Channel (Fig. 4.1). The meridionally directed conduit with water depths of over 4500 meters provides a choke point for observations of water mass property and transport fluctuations of abyssal waters. Monitoring such fluctuations is vital for a state-of-the-art modeling of the global climate system.

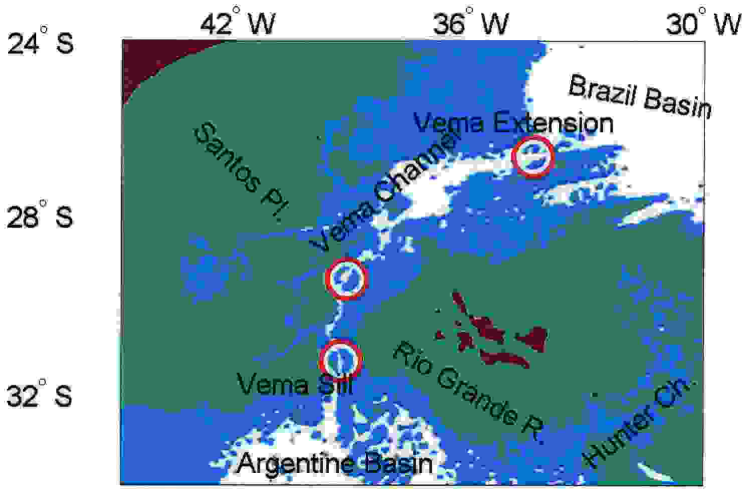

Fig 4.1: Vema Channel in the South Atlantic. This canyon enables dense Antarctic Bottom Water to leave the Argentine Basin on its equator bound drift towards the Brazil Basin. The revisits to the Vema Sill and the Vema Extension sites are planned during leg ANT-XXVIII/5.

A decade-scale record from the channel entrance (31° S, 39° W), obtained from repeated station work and from moored instruments indicates a clear increase of the lowest temperatures of the bottom water. Comparable observations from the exit region of the Vema Channel (26° S, 34° W) confirm the general abyssal temperature rise since 1991. The Vema Sill station at the entrance is internationally acknowledged as an ocean site observatory. *OceanSITES* is a worldwide system of long-term, deep water reference stations measuring regularly a number of physical, geochemical, and biological variables (http://www.oceansites.org).

Work at sea

Our prime objectives are revisits to the Vema Sill and Extension sites for additional high precision CTD (temperature, conductivity, depth) observations of the coldest AABW in the Vema Channel (see Fig. 4.1). It is desirable to repeat both stations on the return leg ANT-XXVIII/5. Work time for each station of about 3.5 hours appears adequate. The Vema Channel is situated en-route from the Strait of Magellan to the Canary Archipelago.

Expected results

After the last abyssal observation from Polarstern in the spring of 2010 we will append the latest status of the physical properties of Antarctic Bottom Water in the subtropics to our long-term time series from the Vema Channel.

5. MOLECULAR BASIS OF CLIMATE SENSITIVITY IN ANTARCTIC FISH: MITOCHONDRIAL FUNCTIONING AND ITS IMPLICATION FOR IONIC AND OSMOTIC REGULATION

Magnus Lucassen (AWI, not on board) Nils Koschnick (AWI), Tina Sandersfeld (AWI)

Objectives

Increasing CO_2 in the atmosphere causes both, ocean warming and acidification (IPCC, 2007). Due to its pervasive impact on all biological processes, temperature is a crucial abiotic factor limiting geographical distribution of marine ectothermal animals on large scales. Additional environmental factors like increasing PCO_2 and the concomitant drop in water pH are thought to narrow the thermal window as they act on the same physiological mechanisms.

Thermal adaptation and phenotypic plasticity, which define the thermal niche and the responses to fluctuating environmental factors, are ultimately set by the genetic interior of an organism. It is widely accepted that adaptation to the extreme cold has evolved at the expense of high thermal sensitivity. In the Antarctic realm studies focusing on the endemic fish suborder of Notothenioidei provide evidence of novel physiological characters for coping with low temperatures like antifreeze glycoproteins. Some Antarctic fish have lost functional traits during evolution to subzero temperatures. Many icefishes, for instance, lost the expression of hemoglobin and myoglobin; *Trematomus bernacchii* lost the ability to induce heat-shock protein expression. Although both examples may contribute to the high thermal sensitivity of these particular species, they do not represent general mechanisms in the majority of cold-adapted fishes and their limitations towards high temperature. Moreover, studying individual functions may not be sufficient. Thermal windows of the intact organism are usually much narrower than the temperature window of individual molecules. Studying the evolution of thermal sensitivity thus has to consider the integration of molecules into functional units and networks up to the whole organism level.

Mitochondrial functioning and its regulation resemble such a key functional trait, essential both in thermal acclimatization as well as evolutionary temperature adaptation as it is directly related to the aerobic performance windows of animals. Acclimation to seasonal cold usually causes a rise in aerobic capacity in temperate fish by increasing mitochondrial density or capacities. Cold adapted Antarctic fishes (Notothenioids) were shown to possess highest mitochondrial densities but at low capacities per mitochondrion. Our findings of elevated capacities of

respiratory chain components and uncoupling proteins in Antarctic eelpouts upon warm acclimation suggest the use of acclimation pathways different from those in temperate fish. Furthermore, we identified a molecular network, responding sensitively to warming beyond the realized ecological niche and mediating large rearrangements in energy metabolism. In other Antarctic fish mitochondrial functioning may be affected by the translocation of an essential subunit of the mitochondrial electron transport system (ETS). Beside this fundamental genetic difference we could demonstrate that the resulting ETS complex was fully functional in *Notothenia coriiceps* slightly more so than in *N. rossii*.. Together, these examples suggest that mitochondrial functioning underwent significant adaptations upon evolution to extreme cold.

Constraints on energy production by mitochondria limit main energy demanding processes like protein and RNA synthesis and ion and pH regulation. The interrelation of ion regulation and energy demand becomes obvious in branchial mitochondrial-rich cells, where the main ion pump, the Na+/K+-ATPase, is concentrated, too. Ion and pH regulation comprise thermally sensitive active and passive transfer processes across membranes. Ocean acidification is compensated for by an efficient ion regulatory system. With respect to temperature effects, different strategies in the use of active and passive strategies of pH regulation are discussed for cold-adapted and temperate species. As hemoglobin-less icefishes are characterized by larger blood volume and flow due to limited oxygen transport capacity, consequences for the passive transepithelial transport of ions may be postulated.

Only recently, we could demonstrate a strong responsiveness of the ion regulatory system in temperate as well as Antarctic species to CO_2 and temperature change. Using an isolated perfused gill model we characterized mechanisms shaping branchial energy turnover in two Antarctic Notothenioids (*Gobionotothen gibberifrons, Notothenia coriiceps*) in response to elevated CO_2 partial pressure. Elevated fractional costs of the main energy demanding processes under CO_2 at maintained overall rates of branchial energy turnover may indicate different degrees of mitochondrial coupling under stressed and steady state conditions, respectively. Studies on isolated mitochondria from Antarctic fish so far indicate high levels of coupling during ongoing ATP synthesis.

Thus, in continuation of the cruise ANT-XXVIII/4 we aim to characterize the branchial energy budget and ion regulatory system in isolated gill preparations in relation to the allocation of energy by mitochondria in an array of different Antarctic fish groups, to distinguish common principles and specific climate sensitivities.

Work at sea

Live animals, which have been caught during ANT-XXVIII/4 will be kept in the aquarium container (AWI 024) at 0°C water temperature and have to be transferred alive to Bremerhaven for the continuous physiological work. Another cooling container will serve for acclimation of fish to different abiotic factors and as backup system.

In parallel, the experiments on isolated gill preparations in relation to mitochondrial functioning started during ANT-XXVIII/4 will be continued during this cruise leg. Here, we will focus on the interrelation of functional capacities of respective key enzymes (Na+/K+ ATPase, NADH dehydrogenase, cytochrome c oxidase) and sample preparation for basic physiological parameters like ion composition, pHe, pHi, serum osmolality etc. Further analyses like immunohistochemical and in situ hybridisation, specific mRNA expression studies and protein quantification by means of antibodies will be performed at the institute.

6. EVALUATION OF THE TRANSITION METALS FROM SUBGROUPS IV, V AND VI IN THE ATLANTIC

Alexandre Batista Schneider, Andrea Koschinsky (Jacobs University, not on board)

Objectives

The project will focus on the trace elements titanium (Ti), zirconium (Zr), vanadium (V), niobium (Nb), tantalum (Ta) and molybdenum (Mo) in the marine water column, the marine biogeochemical behavior of which is not yet well understood. Nevertheless, they are important in the marine system, contributing for the deposit-formation of valuable minerals on the sea bottom, such as iron-manganese nodules and crusts. Besides, many of these elements and their isotopes serve either as proxies of elementary sources into the oceans, movements of aquatic masses, or tracers for paleo-redox conditions. Furthermore they are specified as high-tech elements and increasingly used e.g. at semiconductor applications and green technologies. As a consequence of this industrial use, they can nowadays also enter the oceans as contaminants. Due to many anthropogenically induced global changes the geochemical sources of the trace metals are changing, leading to modified distribution and behavior of these metals in the ocean. This urges a better understanding of their (bio)geochemical cycles in the marine system. A number of questions such as the distribution of Ti, Zr, V, Nb, Ta and Mo in the different layers of the water column and distribution between dissolved and colloidal phases cannot be fully answered yet and need further investigation. The analytical determination of Ti, Zr, V, Nb, Ta (and Mo) in seawater is difficult due to their extremely low concentration and the high ionic strength of the samples. In recent studies seawater samples had to be extensively pretreated.

Work at sea

The investigated elements are preconcentrated on resin-filled columns prior to analysis. Simultaneously, dissolved salts from seawater matrix are removed leading to lower background values. This intensive lab work including transfer and handling of the samples enhances the risk of contamination and increases the duration of the analysis. Our approach focuses on the direct determination of chemical species of Ti, Zr, V, Nb, Ta and Mo in seawater samples from different depths by application of electroanalytical techniques like voltammetry, which can be an efficient alternative. Using voltammetric methods the seawater samples can be measured directly in the saline matrix without any further preconcentration. Additionally, the simple applicability of the method onboard a research vessel and the low costs describe important advantages of voltammetry. On board a voltammetric device for trace analysis (693 VA PROCESSOR, 694 VA STAND, METROHM) combined with a computer will be used to analyse the samples collected by CTD. Further equipment includes nitrogen gas bottle, a UV-digestion-device (METROHM) and filtration-devices, plus some different chemicals necessary for carrying out the analyses directly after sampling. Further samples will be taken home after conservation of the samples with dilute acids and after freezing

Expected results

Estimates of the trace elements titanium (Ti), zirconium (Zr), vanadium (V), niobium (Nb), tantalum (Ta) and molybdenum (Mo) in the marine water column to improve the understanding of their (bio)geochemical cycles in the marine system.

7. SEA TRIALS AND VALIDATION OF THE MULTIBEAM HYDROSWEEP DS-3

Hans-Werner Schenke (not on board), Saad El Naggar, Ralf Krocker, Fred Niederjasper, Peter Gerchow (AWI), Rolf Alfke, Jörn Ewert (Atlas)

Objectives

The main objectives of the sea trials are to further test and validate the forward looking capability of the newly developed beam-former (SPM2 Module) of the upgraded sonar system HYDROSWEEP DS-3 from ATLAS Hydrographic, Germany, and to verify its deep sea performance after the hardware and software modification. The first version of the SPM2 Module was installed in October 2010 and tested during *Polarstern* cruises ANT-XXVII/1 and ANT-XXVII/4. The test results led to significant hardware and software modifications. Further technical development is required which must be followed by new tests in November 2011 during ANT-XXVIII/1 on the forward looking sonar using the SPM2 Module. The forward looking technology from flash mounted transducers was especially developed by ATLAS to determine online the mean sound velocity and to observe in advance the sea floor topography in order to provide support for navigation and for scientific purposes. New transducers will be installed in October 2011. Therefore calibrations and tests must be carried out during ANT-XXVIII/1.

Work at sea

The sea trials will be performed in the area of the Ampère Seamount (34° 57.4’ N, 12° 55.4’ W) by carrying out bathymetric surveys for about 12 hours. A sound velocity profile will be measured to about 2000 m water depth, using the VALEPORT SVP-Probe.

Supplementary trials and data validations are planned on route.

8. INVESTIGATION INTO THE OXYGEN ISOTOPE ANOMALY OF OZONE FROM 50°S TO 50°N IN THE ATLANTIC OCEAN

William Vicars, Joël Savarino (LGGE, not onboard)

Objectives

The oxygen isotope anomaly ($\Delta^{17}O$) of ozone (O_3) serves as a useful marker in studies of atmospheric oxidation pathways; however, due to the complexity of currently available analytical techniques, natural variations in $\Delta^{17}O(O_3)$ are not well constrained. We have developed a new method for the collection and subsequent isotopic characterization of ozone using a simple, active air sampler with a nitritecoated filter. This method involves simple technologies that can be implemented nearly anywhere; however, research into the method is just now moving beyond its preliminary stages and there is presently very little data for the ambient troposphere. Our participation in this cruise will represent a unique opportunity to investigate the seasonal, diurnal, and spatial features of the ozone isotope anomaly across a large part of the world. Data collected during this campaign will increase our understanding of the spatiotemporal variability of $\Delta^{17}O(O_3)$ and thus lead to a more robust theoretical framework for interpreting $\Delta^{17}O$ transfer processes in the atmosphere.

Work at Sea

We will sample tropospheric air continuously onboard the *Polarstern* during the ANT-XXVIII/5 cruise from Punta Arenas to Bremerhaven. Our ozone sampling apparatus is very light and simple, consisting of a low-volume pump connected to a filter holder with 1/4" PFA tubing. Ozone collection is achieved through the use of a glass fiber filter (Whatman™ GF/A) coated with a nitrite solution. In this technique, oxygen isotopes of ozone are trapped irreversibly in nitrate via the ozone/nitrite oxidation reaction within the filter matrix. Filters are then extracted with ultra-pure Milli-Q™ water and stored frozen until analysis. The mean flow rate for this sampling device is 0.003 m^3 min^{-1} and the expected sampling duration is 2-3 hours; however, we also expect to collect longer duration samples (6-12 hours) for day/night comparisons.

Additionally, we will also carry out high-volume sampling to investigate the link between the isotopic composition of ozone and that of nitrate, which is present in the marine boundary layer at a concentration much lower than that of ozone. This sampling program would be essentially identical to the one carried out by Samuel Morin in the spring of 2007 *Polarstern* cruise ANT-XXIII/10.This sampling basically consists of a high volume aerosol sampler equipped with a four-stage cascade impactor (slotted glass fiber filters) and a back-up filter for the fine size fraction. The mean flow rate for this sampling device is 1.2 m^3 min^{-1}. The expected sampling time will be 24 hours for this experiment, likely to be decreased in the event of highly polluted conditions.

Expected Results

We have developed a new method for the collection and subsequent isotopic characterization of ozone using a simple, active air sampler with a nitrite-coated filter in combination with the bacterial denitrifier method for the triple-oxygen isotope analysis of nitrate. This method is light, inexpensive, and easy to implement in nearly any sampling environment, providing researchers with the potential to monitor variations in ozone isotopes over a network of sites, even in remote or inaccessible areas (e.g., polar and alpine locations, stratosphere, etc.). Additionally, this method does not involve the complex, specialized sampling technology utilized in prior studies of atmospheric ozone isotopes and also precludes many of the measurement errors and uncertainties that are associated with these initial investigations. Preliminary results indicate that this method is sufficiently robust and reliable to be applied to the routine analysis of stable isotope ratios of atmospheric O_3. Initial investigations of collection efficiency and isotope transfer are promising and preliminary measurements in the ambient troposphere in Grenoble, France suggest that $\Delta^{17}O(O_3)$ exhibits a much greater degree of temporal and spatial variability then commonly hypothesized, exhibiting a diurnal range of nearly 10 per mil. This is an unexpected result and one with implications for the use of ozone isotope transfer processes to quantify and constrain the rates of natural processes. Most current approaches in the study of the oxygen isotope anomaly, both in the atmosphere and for geological materials, assume that $\Delta^{17}O(O_3)$ does not vary, either seasonally or diurnally. The large diurnal range observed in our initial studies would seem to suggest that atmospheric models used to simulate the propagation of $\Delta^{17}O$ throughout atmospheric chemical cycles must be modified to account for a naturally varying $\Delta^{17}O(O_3)$, particularly those models which seek to simulate the isotopic signature of day- and night-time nitrate production. However, research into the method is just now moving beyond its preliminary stages and there is presently very little data for the ambient troposphere. A better understanding of the nature and scale of spatiotemporal variations in tropospheric $\Delta^{17}O(O_3)$ will require a great number of observations in different contexts and environments, which a sampling campaign across the Atlantic Ocean, from Punta Arenas (53°S) to Bremerhaven (53°N), will provide. In combination with our studies in Dome C, Antarctica during 2011, and our ongoing field measurements in the French Alps, this transect represents a unique opportunity to extend dramatically the global representation of this variable.

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

René-Marie Lafontaine, Roselin Beudels, Oria Jamar (PolE), Claude Joiris (PolE, not on board)

Objectives

As a complement to our long-term study of at-sea distribution of marine mammals and seabirds in polar ecosystems - mainly in the Arctic - a large scale study will include the effects of water masses and fronts (and slope of the continental shelf). Very little is indeed known about seabirds, and much less even about cetaceans: this study is aimed at providing base-line information allowing to detect later possible changes in density and/ or geographical distribution.

Work at sea

Work at sea consists in continuous transect counts from the bridge.

Expected results

We expect to improve our knowledge about the at-sea distribution of seabirds and marine mammals and hydrological factors influencing their concentration patterns.

10. CULTURE EXPERIMENTS ON THE ENVIRONMENTAL CONTROLS OF TRACE METAL RATIOS (MG/CA, B/CA, U/CA) RECORDED IN CALCAREOUS TESTS OF ANTARCTIC DEEP-SEA BENTHIC FORAMINIFERA

Jutta Wollenburg (AWI)

Objectives

The Antarctic deep water during glacial time was, disputably still is, the largest marine sink of atmospheric CO_2. Employment of effective and fossilisable proxies on changes in the physical and geochemical properties is essential to assess glacial-interglacial variabilities, modern and future changes in Antarctic deep-waters. In this respect, analyses on trace metal (Mg/Ca, U/Ca, B/Ca) ratios recorded in tests of foraminifers to estimate calcification temperatures, alkalinity, carbonate ion saturation, and pH are common methods. However, for the Southern Ocean deep-sea benthic foraminifera calibration curves constrained by either core-top samples or culture experiments are lacking.

Work at sea

Newly developed high-pressure aquaria have recently facilitated the first efficient cultivation (producing offspring) of our most trusted palaeodeep-water recorders *Fontbotia wuellerstorfi* and *Uvigerina peregrina*. In different experimental set-ups the same facilities will be used to cultivate these foraminifera and associated species at different temperatures and in waters with different carbonate chemistries to establish the first species-specific trace metal calibration curves for the Antarctic Ocean. Five autoclaves were built and will be operated during this year's

cruise. Sediments will be retrieved with a multiple corer and then immediately transferred into the autoclaves. Connected to high-pressure pumps the sediments will then be cultured at their original pressure. Additional sediment cores will be transferred in pressure-free mesocosms, treated in the same way than the autoclaves.

Expected results

The experimental results will be obtained approximately 6 months after the expedition.

11. SOURCES AND TRANSFORMATION OF COLOURED DISSOLVED ORGANIC MATERIAL (CDOM) IN ATLANTIC OCEAN – ATLANTIC CDOM

Piotr Kowalczuk, Sławomir Sagan, Mirosław Darecki, Monika Zabłocka, Oskar Głowacki, Anna Raczkowska (IOPAS)

Objectives

The scientific objectives of the IOPAS project are:

1) identify individual CDOM components characterize them by spectral properties of excitation/emission fluorescence and absorption,

2) identify processes that control distribution of specific component in time and space and find those component, which distribution is controlled by physical conservative mixing of water masses with distinctly different optical and hydrological properties,

3) derive empirical relationships between specific CDOM components and inherent and apparent optical properties of marine waters and salinity,

4) derive empirical relationships between spectral properties of CDOM fluorescence and absorption with DOC concentration. Investigate the temporal and spatial variability of aCDOM/DOC and FDOM/DOC ,

5) establish the zonal variation of the depth integrated action spectra (the product of the CDOM absorption spectrum and spectral distribution of underwater irradiance at given depth) of the CDOM photodegradation.

Work at Sea

The work on sea will include taking water samples at each station on 6-7 depths from 500 m depth to the surface. Depths of water sampling will be decided on board during CTD cast and will depend on local biogoechemical and hydrological features such as: depth of the mixed layer, depth of the thermocline, depth of the deep chlorophyll a maximum and depth of the dissolved oxygen concentration. At each station there will be deployment of optical instruments: Integrated Optical-Hydrological Probe that consist with spectral in situ absorption and attenuation meter – ac-9, the CDOM fluorometer and CTD head; and profiling radiometers – the Compact Optical Profiling System, C-OPS. Optical instruments will be also deployed under way along the ship track to measure spatial changes of inherent and apparent optical properties of the Atlantic Ocean. The underway optical instruments consist with the Integrated Optical-Hydrological Probe coupled with the LISST laser particles meter and set of TRIOS hyperspectral radiometer for above water measurements of spectral remote sensing reflectance.

Water sample will be processed on board of *Polarstern*. The water will be filtered through the set of filters to collect samples of suspended material for estimation of following bio-optical parameters: chlorophyll a concentrations, assemblages of photosynthetic pigments established through HPLC methods, absorption of light by photosynthetic pigments and non-algal particles. Water samples will be also processed for estimation absorption and fluorescence by Chromophoric Dissolved Organic Matter and concentration of Dissolved Organic Carbon.

Expected results

We expect to collect set of optical bio-optical and biogeochemical data that enables us establish basin scale meridional variability of those parameter and compare data collected in different bio-geographical provinces of Atlantic Ocean, that includes both oligotrophic and highly productive water of Patagonian and Mauritanian Shelves. We also expect to recognize the basin scale meridional variability of distribution of CDOM, and DOC concentrations in the surface zone of Atlantic Ocean and its bio-geographical provinces. Collected the data should also enable us to establish the penetration depths of ultraviolet radiation into the different types of oceanic waters and recognize the variability in photo-degradation potential of the Dissolved Organic Matter by calculating the depth average CDOM photo-degradation action spectra over the entire meridional transect in the Atlantic Ocean.

12. BETEILIGTE INSTITUTE / PARTICIPATING INSTITUTES

	Adresse / Address
Atlas	ATLAS HYDROGRAPHIC GmbH Kurfürstenallee 130 28211 Bremen/Germany
AWI	Stiftung Alfred-Wegener-Institut für Polar- und Meeresforschung in der Helmholtz-Gemeinschaft Am Handelshafen 12 27570 Bremerhaven/Germany
DWD	Deutscher Wetterdienst Geschäftsbereich Wettervorhersage Schifffahrtsberatung Bernhard-Nocht-Str. 76 20359 Hamburg/Germany
HZI	Helmholtz-Zentrum für Infektionsforschung GmbH Inhoffenstraße 7 38124 Braunschweig/Germany
IAU	Institut für Atmosphäre und Umwelt Institute for Atmospheric and Environmental Sciences J.W.Goethe-Universität Altenhöferallee 1 60438 Frankfurt am Main
ICBM	Institut für Chemie und Biologie des Meeres Carl-von-Ossietzky-Str. 9-11 26111 Oldenburg/Germany
IFM-GEOMAR	Leibniz-Institute for Marine Sciences Düsternbrooker Weg 20 24105 Kiel/Germany
IfT	Institute for Tropospheric Research Permoserstr. 15 04318 Leipzig/Germany
IOPAS	Institute of Oceanology Polish Academy of Science Ul. Powstańców Warszawy 55 81-712 Sopot/Poland

	Adresse / Address
Jacobs University	Jacobs University Campus Ring 1 28759 Bremen/Germany
LGGE	Laboratoire de Glaciologie et Géophysique de l'Environnement (UMR 5183) 54 rue Molière 38402 - Saint Martin d'Hères cedex /France
LIM	Universität Leipzig Fakultät für Physik und Geowissenschaften Leipziger Institut für Meteorologie Stephanstr. 3 04103 Leipzig /Germany
MPI	Max-Planck-Institut für Meteorologie Bundesstr. 53 20146 Hamburg/Germany
PolE	Belgian Laboratory for Polar Ecology Rue du Fodia B-1367 Ramillies/Belgium
Uni GÖ	Georg-August-Universität Göttingen Wilhelmsplatz 1 37073 Göttingen/Germany

13. FAHRTTEILNEHMER / PARTICIPANTS

Name / Last Name	Vorname /First Name	Institut/ Institute	Beruf/Profession
Ahmerkamp	Soeren	ICBM	Student, marine environmental science
Alfke	Rolf	Atlas	Engineer
Billerbek	Sara	ICBM	PhD student, micro-biology
Beudels	Roselin	PolE	Biologist
Brückner	Marlen	IfT	Meteorologist
Bumke	Karl	IFM-GEOMAR	Meteorologist
Chellappan	Seethala	MPI	PhD Student, meteorology
Daniel	Rolf	Uni GÖ	Microbiologist
Darecki	Miroslaw	IOPAS	Physicist
El Naggar	Saad	AWI	Physicist
Ewert	Jörn	Atlas	Engineer
Fuchs	Susanne	IfT	Technican
Gerchow	Peter	AWI	Engineer
Giebel	Helge A.	ICBM	Microbiologist
Glowacki	Oskar	IOPAS	Student, oceanography
Gavrilov	Alexander	ICBM	Student assistant
Jamar	Oria	PolE	Geographer
Klapproth	Katrin	ICBM	Technican
Koschnik	Nils	AWI	Engineer
Kowalczuk	Piotr	IOPAS	Oceanographer
Krocker	Ralf	AWI	Engineer
Lafontaine	René-Marie	PolE	Biologist
Niederjasper	Fred	AWI	Geodesist
Raczkowska	Anna	IOPAS	Student, oceanography
Remke	Thomas	ICBM	Student, marine environmental science
Sagan	Slawomir	IOPAS	Oceanographer
Sandersfeld	Tina	AWI	Student, biology
Schäfer	Michael	LIM	Meteorologist
Schneider	Alexandre Batista	Jacobs Uni	PhD Student, chemistry
Seibt	Maren	ICBM	PhD Student, geochemistry
Simon	Meinhard	ICBM	Microbiologist
Ungermann	René	ICBM	PhD Student, geochemistry
Vicars	William	LGGE	PhD Student, environmental science
Vollmers	John	Uni GÖ	PhD Student, micro-biology
Wagner-Döbler	Irene	HZI	Microbiologist
Walter	Jörg	LIM	Meteorologist
Wang	Hui	HZI	PhD Student, micro-biology

Wollenburg	Jutta	AWI	Geologist
Wurst	Mascha	ICBM	PhD Student, micro-biology
Zablocka	Monika	IOPAS	Oceanographer
NN DWD		DWD	
NN DWD		DWD	
NN		IAU	

14. SCHIFFSBESATZUNG / SHIP'S CREW

Name	Rank
Pahl, Uwe	Master
Spielke, Steffen	1.Offc.
Ziemann, Olaf	Ch.Eng.
Peine, Lutz	2.Offc.
Hering, Igor	2.Offc.
Birkner, Thomas	Doctor
Koch, Georg	R.Offc.
Kotnik, Herbert	2.Eng.
Schnürch, Helmut	2.Eng.
Westphal, Henning	2.Eng.
Brehme, Andreas	Elec.Tech.
Fröb, Martin	Electron.
Muhle, Helmut	Electron.
Winter, Andreas	Electron.
Feiertag, Thomas	Electron.
Clasen, Burkhard	Boatsw.
Neisner,Winfried	Carpenter
Schultz, Ottomar	A.B.
Burzan, G.-Ekkehard	A.B.
Schröder, Norbert	A.B.
Moser, Siegfried	A.B.
Hartwig-L., Andreas	A.B.
Kretzschmar, Uwe	A.B.
Kreis, Reinhard	A.B.
Schröter, Rene	A.B.
Beth, Detlef	Storekeep
NN	Mot-man
Fritz, Günter	Mot-man
Krösche, Eckard	Mot-man
Dinse, Horst	Mot-man
Watzel, Bernhard	Mot-man
Fischer, Matthias	Cook
Tupy,Mario	Cooksmat
Martens, Michael	Cooksmat
Dinse, Petra	1.Stwdess
Hennig, Christina	Stwdss/KS
Streit, Christina	2.Steward
Hischke, Peggy	2.Stwdess
Wartenberg, Irina	2.Stwdess
Hu, Guo Yong	2.Steward
Chen, Quan Lun	2.Steward
Ruan, Hui Guang	Laundrym.