Expeditionsprogramm Nr. 74

FS POLARSTERN

ANT XXIII/1

ANT XXIII/2

ANT XXIII/3

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ANT XXIII/1
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...NG ALFRED-WEGENER-INSTITUT
...OLAR- UND MEERESFORSCHUNG

OKTOBER 2005

EXPEDITIONPROGRAM No 74

RV POLARSTERN

ANT XXIII/1
13 October 2005 - 17 November 2005
Bremerhaven - Cape Town

ANT XXIII/2
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Cape Town - Punta Arenas

ANT XXIII/3
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Punta Arenas - Punta Arenas

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FÜR POLAR- UND MEERESFORSCHUNG

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ANT XXIII/1

1. ÜBERBLICK UND FAHRTVERLAUF

M. Rutgers van der Loeff (AWI)

Am 13. Oktober wird FS POLARSTERN aus Bremerhaven auslaufen. Die Anreise Bremerhaven-Kapstadt dient als Pilotstudie für das internationale Programm GEOTRACES, das zur Zeit im Aufbau ist. Spezialisten für eine breite Palette von Spurenstoffen werden hier zusammenarbeiten. Weitere Programme beschäftigen sich mit akustischen Messmethoden, mit der Zusammensetzung der Atmosphäre und mit optischen Messungen zum „Ground-Truthing" von Satellitenbeobachtungen. In Vigo wird ein offizieller Besuch zum Ausbau der wissenschaftlichen Zusammenarbeit stattfinden, zu dem auch die ehemaligen spanischen Besatzungsmitglieder des FS POLARSTERN, die aus der Region stammen, eingeladen werden.

Biscaya
Die Fahrt geht zunächst in die Biscaya. Vier Tage werden dazu benutzt, neue akustische Techniken auszutesten, um mögliche Einwirkungen von akustischen Messmethoden auf marine Säugetiere zu minimieren. Schnitte, die bei früheren Fahrten mit dem HYDROSWEEP-System vermessen wurden, sollen mit reduzierter Schallintensität wiederholt werden, um zu prüfen, ob die Signalstärke ohne Qualitätsverlust der Daten reduziert werden kann. Neben diesen Studien soll auch ein neues SONAR System getestet werden, mit dem Wale möglicherweise geortet werden können.
In der Biscaya sind außerdem eine Teststation und eine geochemische Station geplant.

Vigo: 23.-24. Oktober
In den frühen Morgenstunden des 23. Oktobers wird FS POLARSTERN in Vigo/Spanien einlaufen und im Rahmen eines Besuchsprogramms zur Besichtigung geöffnet sein. Mit der Stadt Vigo ist FS POLARSTERN durch eine Vielzahl ehemaliger Besatzungsmitglieder aus Galizien verbunden, die sich inzwischen im Ruhestand befinden. Abends wird zu ihren Ehren ein Grillabend veranstaltet, bei dem sie ihren Familien ihren früheren Arbeitsplatz vorführen können. Am 24. Oktober findet eine Pressekonferenz statt, an der der SCAR-Präsident und Direktor des Alfred-Wegener-Instituts für Polar- und Meeresforschung, Prof. Jörn Thiede und der Präsident der spanischen SCAR-Delegation, Prof. Jerónimo López, teilnehmen werden. Im Anschluss an die Pressekonferenz beginnt ein wissenschaftliches Seminar mit dem Thema: „Spanisch-Deutsche Zusammenarbeit in der Polarforschung: Vergangenheit, Gegenwart, Zukunft". das mit einem Empfang abgeschlossen wird. Anschließend läuft FS POLARSTERN zur Fortsetzung der Reise aus.

Fahrtroute

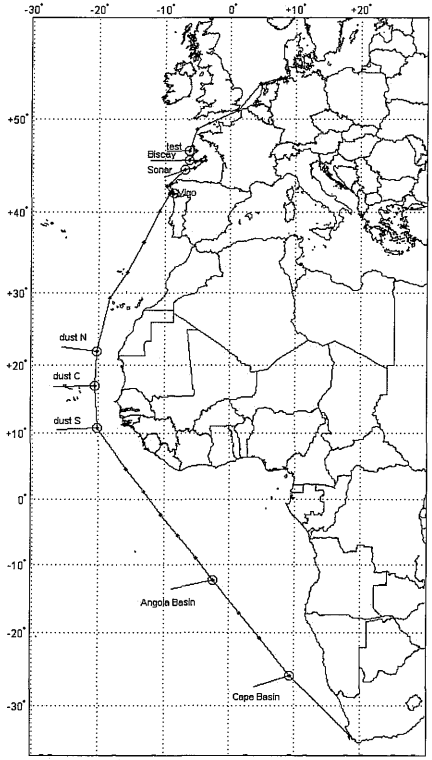

Fig. 1. Fahrtroute mit den geschätzten Positionen der Stationen für optische Messungen (kleine Punkte) und der großen Spurenstoffstationen.
Fig. 1. Cruise track with approximate position of optical (small dots) and major tracer/hydrographic stations.

Messungen während der Fahrt
Gleich nach Verlassen des Weserästuars werden kontinuierliche Messungen zur Chemie der Atmosphäre, zur Spurenstoffverteilung im Oberflächenwasser und zur Überprüfung der akustischen Systeme gestartet. Während der ganzen Expedition werden Spurenstoffproben des Oberflächenwassers genommen und analysiert, um die Verteilung dieser Stoffe zu bestimmen. Ferner sollen neue Beprobungs- und analytischen Verfahren weiterentwickelt und bestehende Methoden verglichen (interkalibriert) werden. Für die Beprobung des Oberflächenwassers werden gleichzeitig mehrere Techniken angewendet, die sich in der Vermeidung von Verunreinigungen durch das Schiff unterscheiden. Die Probennahme erfolgt durch:

- die im Schiff eingebaute Seewasserleitung
- einen Fisch, der neben dem Schiff am Schiebebalken geschleppt wird, und mit dem Wasser direkt unter der Oberfläche durch einen Kunststoffschlauch angesaugt wird
- den "Schnorchel", der im Brunnenschacht eingebaut wird, und der es erlaubt, Wasser von unter dem Kiel des Schiffs zu beproben
- die „Klaus" Membranpumpe, die ebenfalls Wasser von unter dem Kiel des Schiffs ansaugt, und es erlaubt große Wasservolumina durch Edelstahlleitungen zu beproben.

Schwebstoffe im Oberflächenwasser werden durch Filtration und mit Hilfe einer Durchlaufzentrifuge gesammelt. Atmosphärenchemiker und –physiker werden Luft- und Aerosolproben auf dem Peildeck sammeln und optische Messungen in der Atmosphäre durchführen.
Während des ersten Teils des Fahrtabschnitts bis Vigo werden außerhalb der 12-Meilen-Zone die akustischen Systeme Parasound und Hydrosweep zu Testzwecken eingeschaltet werden.

Tägliche Stationen
Entsprechend der verfügbaren Zeit, wird gegen Mttag eine Station zur Beprobung der oberen Wassersäule mit der Rosette und zur Messung von optischen Parametern bis in 200 m Tiefe ausgeführt werden. Die erste Station wird im Englischen Kanal stattfinden.

Hauptstationen
Eine geochemische Station beinhaltet außer dem Programm der täglichen Stationen verschiedene flache und tiefe Probennahmen mit der CTD/Rosette sowie solche mit Kunststoffflaschen an einem Kevlarseil bis in eine Tiefe von 200 m. Eine Hauptstation wird in der Biscaya durchgeführt, fünf weitere sind nach Vigo geplant: drei in dem von Auftrieb und Staubeintrag gekennzeichneten Gebiet vor Westafrika, eine im Angolabecken und eine im Kapbecken. Die endgültige Zahl der Stationen muss dem Ablauf der Arbeiten angepasst werden.

Die Fahrt geht am 17. November in Kapstadt zu Ende

ITINARY AND SUMMARY

M. Rutgers van der Loeff (AWI)

RV POLARSTERN will leave Bremerhaven on 13 October 2005. The transit Bremerhaven-Cape Town will serve as a pilot study for the international programme GEOTRACES which is currently developed and will bring together specialists engaged in the studies of a variety of trace elements. Besides GEOTRACES, a range of programmes will be carried out dealing with ocean acoustics, atmospheric chemistry, and optical studies as ground-truth for satellite observations. In Vigo there will be an official meeting to foster the Spanish-German cooperation in polar research and to honour former Spanish crewmembers on RV POLARSTERN who have been so instrumental in handling the sampling equipment from the very beginning and are retired now

Bay of Biscay

The expedition will first head to the Bay of Biscay. Four days will be spent to test new acoustic techniques that aim at reducing potential impacts of acoustic studies on marine mammals. Sections that have been measured with the HYDROSWEEP system on previous expeditions will now be repeated with lower acoustical energy levels in order to investigate to what extent the signal power can be reduced while still obtaining sufficiently accurate information. Along with these studies, a new SONAR system will be tested that may be used for the detection of whales.

In the Bay of Biscay we will also perform a test station and a major hydrographical/tracer station.

Vigo: 23-24 October

In the early morning of 23 October POLARSTERN will enter the harbour of Vigo/Spain. Then the ship will be open for visits. Vigo enjoys strong ties with RV POLARSTERN because of many former and now retired crewmembers from Galicia. In the evening a party in honour of the former crewmembers will be organized on board of RV POLARSTERN. This occasion will give them the opportunity to show their families their past working environment

The next day, a press conference will take place with the president of SCAR, the AWI director Prof. Jörn Thiede and the president of the Spanish SCAR delegation, Prof. Jerónimo López.

The press conference will be followed by a scientific seminar on "Spanish-German Cooperation in Polar Research: past, present and future" and a reception. Afterwards, RV POLARSTERN will leave Vigo.

Underway measurements

Immediately after leaving the Weser estuary, underway studies will start on atmospheric chemistry, tracer distribution and the performance of the acoustic systems. Throughout the expedition the tracer team will collect surface water for their studies: both for measuring the distribution of tracers in surface waters and for implementing new sampling methods and intercalibration of sampling and analytical techniques. Surface water will be simultaneously collected by various techniques all demonstrating their respectivequalities in respect to avoiding contamination by the ship.

Samples will be taken by:

- the ship's seawater supply
- a fish towed aside the ship for clean water collection
- a snorkel mounted in the moon pool to collect water from under the ship
- the "Klaus" membrane pump to collect large volume water samples from below the ship through stainless steel pipes

Particulate material in surface waters will be collected by filtration and by continuous centrifugation.
Atmospheric scientists will take air samples on the upper deck and will perform optical measurements in the atmosphere
During the first part up to Vigo and as long as we are outside the 12 nm zone the acoustic systems Parasound and Hydrosweep will be switched on.

Daily stations
As often as time permits, we will stop around local noon for a shallow station where water will be sampled (with the Rosette) and optical measurements will be carried out in the upper 200 m. These stations will not start before we arrive in the British Channel.

Major stations
A full hydrographical/tracer station comprises several shallow and deep casts with the CTD/Rosette and casts with GoFlo bottles on a Kevlar line to a maximum of 200 m. The programme of the daily stations will also be included in these major stations. One major station is planned in the Biscay, while five more are scheduled after Vigo: three in the area influenced by upwelling and dust inputs from West Africa, one in the Angola Basin and one in the Cape Basin. The actual number of stations that can be sampled will depend on the progress of work.

The expedition will end on 17 November in Cape Town.

2. ACOUSTICS

2.1 STUDIES TO MINIMIZE THE ACOUSTIC IMPACT OF THE ATLAS HYDROSWEEP AND PARASOUND ECHOSOUNDERS ON THE MARINE ENVIRONMENT IN THE BAY OF BISCAY

Breitzke, El Naggar, Graffe, Kuhn, Niederjasper (AWI)
NN (Atlas Hydrographic)

Objectives
To minimize the acoustic impact of RV POLARSTERN's hull-mounted scientific sonars on the marine environment ATLAS Hydrographic GmbH developed various options to reduce the source levels of its Hydrosweep multibeam and Parasound sediment echosounder systems. The currently installed Hydrosweep DS-2 system includes an upgrade which allows (1) to use 241 "soft" beams (HDBE Mode = High Definiton Bearing Estimation Mode) instead of the conventional 59 "hard" beams for bathymetric surveys and (2) to reduce the source level manually and automatically (ASLC mode = Automatic Source Level Control Mode). A correctly working HDBE mode is mandatory for an application of the ASLC mode. The

current Parasound DS-2 system includes options (1) to swivel the emitting/receiving cone so that signal penetration is always perpendicular to the sea floor, and (2) to reduce the source level manually within certain limits using a completely renewed software to operate the system. An automatic source level control comparable to the ASLC mode of the Hydrosweep DS-2 system will be included in the future Parasound DS-3 system scheduled for installation in RV POLARSTERN in 2007. In the Bay of Biscay both echosounder systems will be applied to pursue the following objectives:

(1) Comparison of the data quality of the new high-resolution Hydrosweep bathymetric data (241 "soft" beams) including manually and automatically (ASLC mode) reduced source levels with formerly recorded conventional Hydrosweep data (59 "hard" beams, no source level reduction) at already established test sites.

(2) Recording of a digital Parasound reference data set without and with manually reduced source levels which allows to compare the data quality of future Parasound system versions and upgrades (e.g. DS-3 in 2007) with that of the preceding system. Such a reference data set does not exist up to now.

Work at Sea

The Hydrosweep and Parasound surveys will be conducted simultaneously at test sites in the Bay of Biscay already used for former tests of the Hydrosweep DS-1 and other versions of the DS-2 system during RV POLARSTERN cruises ANT VIII/1, ANT XV/1 and ANT XXI/1 (Fig. 2). Two of these sites - one in the deep sea (Loc. 1) and one on the continental slope covering a small ridge and with sediment and sea floor properties different to the deep sea site (Loc. 2b) - will be selected and surveyed again by several profile lines without and with the high-resolution HDBE mode and with several different manually selected source level and ASLC mode settings for the Hydrosweep system. Simultaneously, several different manually selected source level settings will be used for the Parasound system in combination with the standard setting of 4 kHz/2 sine wave period signal length for the parametric signal.

Expected Results

As results we intend to verify (1) if the high-resolution HDBE mode of the Hydrosweep system provides an improved bathymetry compared to the conventional data recorded up to now, (2) if and how much the source level of the Hydrosweep and Parasound system can be reduced manually without loss of data quality, (3) if and with which predefined S/N ratio the ASLC mode can be used for the Hydrosweep system without loss of data quality, all at least for the environmental conditions during these studies. Additionally, as mentioned above, we intend to record a digital Parasound reference data set for comparisons with recordings of future system versions, which is not available up to now.

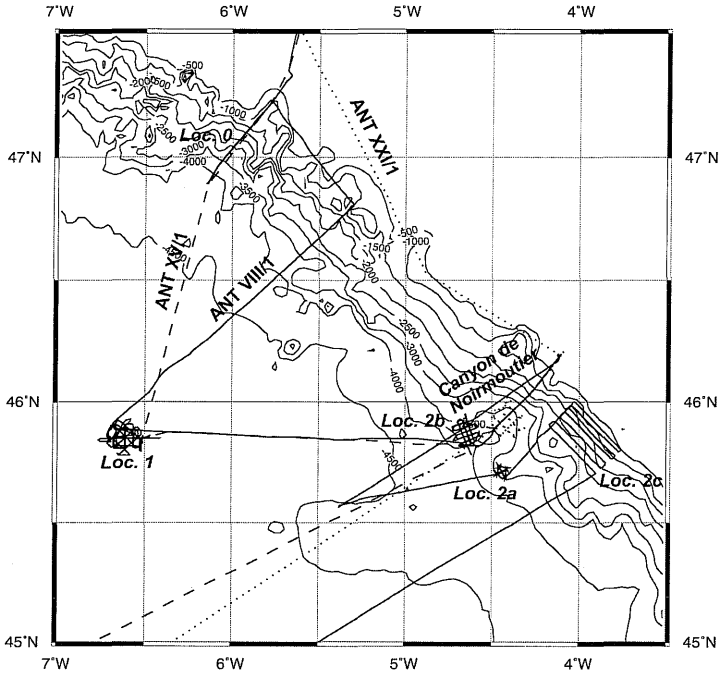

Fig. 2: Tracks of former RV POLARSTERN cruises (ANT VIII/1, ANT XV/1, ANT XXI/1) and test sites in the Bay of Biscay used to test earlier versions the Hydrosweep multibeam system.

2.2 TEST OF THE ELAC NDS3070 COLLISION AVOIDANCE SONAR IN THE BAY OF BISCAY

Breitzke, El Naggar, Graffe, Kuhn, Niederjasper (AWI);
Schönwetter (ELAC Nautic)

Objectives

To mitigate the acoustic impact of seismic surveys on the marine environment tools are under development which allow to monitor safety radii around and beneath RV POLARSTERN within which at least some species of marine mammals are potentially subject to behavioural disturbance and/or physical damage due to the received sound pressure levels (e.g. temporary or permanent threshold shifts). According to the regulations defined by the National Marine Fisheries Service, USA the 180 dBRMS sound pressure level

is presently considered to be the threshold above which marine mammals might possibly experience temporary threshold shifts.
Internationally, three methods for monitoring the safety radii are applied: (1) Visual monitoring, (2) passive acoustic monitoring, (3) active acoustic monitoring. For RV POLARSTERN visual monitoring is realized by binoculars and, for spatially limited sectors, by infrared cameras. For passive acoustic monitoring a 600 m long streamer consisting of three 10 m long sections with 5 hydrophones has been developed. This test study is intended to be a first step towards the development of an active acoustic monitoring system, which has the advantage that marine mammals neither have to be visible at the sea surface nor have to vocalize to be detected, as is necessary for visual or passive monitoring systems.
The ELAC NDS3070 collision avoidance sonar has been selected as a potential first prototype for an active whale detection sonar for RV POLARSTERN. In its active panorama mode the ELAC NDS3070 collision avoidance sonar operates with 30 kHz and allows to monitor a spherical sector of 360° horizontal and 26° vertical angle (from sea surface) around the ship. Assuming a detection probability of 90% and a false alarm rate of 0.5%, theoretical computations show that an object with a target strength of -6 dB can be detected up to 1500 m distance (under ideal sea and velocity conditions). A value of -6 dB was chosen because it is approximately the minimum target strength of a small whale hit at its head or tail by sound waves. To test this active sonar under "real" conditions the sonar head will be installed in the moon pool and sonar signals will be generated and received by mobile transmission and receiving cabinets brought onboard RV POLARSTERN for this study. Objectives are:

(1) to test if such sonar systems can generally be used for marine mammal detection in the presence of the rather loud background noise of RV POLARSTERN,
(2) to determine the detection ranges for an object of known target strength under the "real" environmental conditions prevailing during the test study in the Bay of Biscay.

Work at Sea
Work at sea starts with the deployment of a CTD and recording of a sound velocity profile down to minimum 500 m water depth. This sound velocity profile is then used for the theoretical computation of detection ranges under the actual environmental conditions. Subsequently, an object (triple mirror) with a calibrated target strength of -6 dB is deployed and positioned in a certain water depth by appropriate buoys and weights. RV POLARSTERN is approaching this target from various angles and with decreasing distances using a spiral-shaped course so that its detectability can be verified as function of angle and range (Fig. 3). This experiment will be repeated with different propeller revolutions, i.e. different background noise of RV POLARSTERN and with the triple mirror placed in different water depths.

Expected Results
As result we intend to derive curves which indicate the detectability of a triple mirror of -6 dB target strength under the "real" environmental conditions during the test study in the Bay of Biscay as function of range and angle, for different propeller revolutions (background noise) of RV POLARSTERN, and for the triple mirror placed in different water depths.

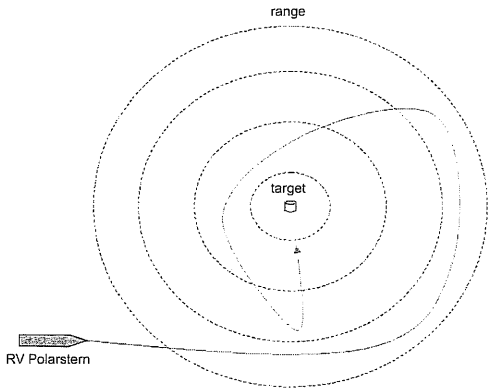

Fig. 3:Course track for RV POLARSTERN approaching the calibration target (triple mirror) from various angles and decreasing distances to verify its detectability as function of range and angle.

3. TRACER STUDIES

3.1 GEOTRACES PILOT STUDY

Dissard, Geibert, Hans, van der Loeff, Vöge (AWI); Croot, Frank, Schlosser, Steigenberger (IFM-GEOMAR); Rickli (ETH Zürich); Gastaud, Scholten (MEL-IAEA); Hennings (IOW); Daberkow, Harms (IAP)

The GEOTRACES programme

Our knowledge of ocean circulation and global biogeochemical cycles has a strong basis in the GEOSECS programme, conducted in the 1970s. The ensuing development of analytical techniques now allows studies of trace elements and their isotopes (TEIs) at concentration levels and at space and time resolution that were inconceivable during the GEOSECS era. These developments include clean sampling, sensitivity, miniaturisation, automation, in-situ techniques or entirely new detection principles. This means that detailed mapping can be obtained of far more tracers including their isotopic composition with the potential to provide unique insights into a wide range of oceanic processes. This opportunity was the stimulus of the recently inaugurated GEOTRACES programme. This programme is endorsed by SCOR, which has recently also approved the GEOTRACES science plan (http://www.ldeo.columbia.edu/res/pi/geotraces/)

The two primary objectives for the GEOTRACES programme are:

- To determine global distributions of selected TEIs in the ocean; and
- To evaluate the oceanic sources, sinks, and internal cycling of these TEIs and thereby characterize more completely their global biogeochemical cycles.

The central point in the concept of GEOTRACES is to measure a wide set of tracers in parallel. Only if the tracers are measured in the same water masses can we be confident to use them as mutual support in the interpretation. The radionuclides can help to explain the history of particle flux of the water mass, the trace metals can track the history of dust inputs and the REE and soluble radionuclides trace the origin of the water masses. This integrating concept, as it can now be applied due to methodological advances, has not been fully used in previous studies.

The present Atlantic transit will serve as a pilot study for such an integrated approach. While this will not yet fulfill the GEOTRACES objective to obtain full-depth multi-tracer transects across ocean basins, we can already learn a great deal from surface transects with a limited number of deep casts. Surface waters are, by nature, the part of the water column that is expected to experience the greatest temporal variability. We will pass water masses characterized by very different inputs: the upwelling area off West Africa, dust inputs off Sahara and the very low inputs in the South Atlantic gyre, and we can now measure the effect of these variable inputs on a wider range of tracers than was previously before.

3.2 THE MEASUREMENT, DISTRIBUTION AND BEHAVIOUR OF NATURAL THORIUM ISOTOPES IN SEAWATER

Geibert, van der Loeff, Vöge (AWI)

Objectives

Thorium isotopes are used in the marine geosciences for the understanding and quantification of a considerable variety of processes, ranging from the aggregation and disaggregation of particles, the export of organic substances from the surface layer of the ocean, the circulation of water masses, to the quantification of particle fluxes to the deep sea and the sea floor. The precise measurement of thorium and the understanding of its chemical behaviour are therefore important for many investigations in marine biogeochemical cycles. Our studies target on both the measurement and the behaviour aspect.

Work at sea

Continuous sampling of ^{234}Th in surface waters.

A newly developed automatic sampling device for ^{234}Th in surface waters will be tested. It will allow to measure continuous transects of the distribution of ^{234}Th between particulate and dissolved form in dependence of a variety of controlling environmental factors in an unprecedented spatial and temporal resolution. The measurements will be compared to traditional sampling and measurement techniques. In addition, we will collect samples for the analysis of $^{210}Po/^{210}Pb$ in surface water and shallow CTD casts.

Enrichment of inorganic colloids by means of a large volume centrifuge

The colloidal size fraction of seawater, filling the gap between particulate (e.g. algae) and truly dissolved substances (e.g. salt), has been a target of marine geochemistry for many years. A focus of the investigations has been placed on organic components of the colloidal fraction. Inorganic colloidal substances were not considered to represent an important component of sea water. In order to screen seawater for potential inorganic colloids, we will try to enrich the smallest possible size fractions from large volumes of sea water in order to obtain a sufficient amount of material for analysis. A continuous flow centrifuge will be used

to separate small particles from seawater samples. The centrifuge will be connected to the ship's seawater supply, and will collect particles and colloids from one m^3 of seawater at a flow rate of ~200 l/hour at about 16000 x g. The sample collection is suitable for trace element analysis, as the inlet system and the collecting surface is made from titanium or teflon® only.
The given acceleration should be sufficient to efficiently collect particles much smaller than 2 µm in diameter, dependent on their density. This size fraction is expected to contain clay minerals, which would be overlooked in conventional analytic techniques. In order to identify these clay minerals (if present), analysis will include electron microscopy and the measurement of specific elements (Ti, ^{232}Th, Si)

Experimental study of Th adsorption onto particles
In an experimental study, the adsorption of thorium onto particles will be compared in filtered surface water, in filtered deep sea water, and in artificial seawater. A clay mineral standard will be added to these water types to test the hypothesis whether the natural colloidal composition of seawater will affect the sorption kinetics of Th. The results will be compared to the same water types with no particles added.

Expected results
The distribution of ^{234}Th depletion will give an indication of the latitudinal distribution of export production. We expect that the first results of the binding of thorium on natural colloids will become available on board.

3.3 INTERCOMPARISON OF TECHNIQUES FOR THE ANALYSIS OF TH-230, RARE EARTH ELEMENTS AND THE ISOTOPIC COMPOSITION OF ND

Geibert, van der Loeff, Vöge, (AWI); Frank (IFM-GEOMAR); Rickli (ETH Zürich), Scholten (MEL-IAEA)

Objectives
The measurement of ^{230}Th and particularly ^{231}Pa in the water column is still challenging because the concentrations of these isotopes in sea water are very low (down to fg/l). Within the last few years, a dramatic change in measurement techniques has taken place, from radiometrical determination towards mass spectrometry. As a consequence, the main problems in measurement have shifted. Whereas radiometric determinations were requiring large volume samples (several hundreds of liters), typically obtained by in-situ pumps, the mass spectrometric approach only requires about 5 L (^{230}Th) to 20 L (^{231}Pa), obtained from Niskin bottles. Radiometric data were in most cases not affected much by blank contributions. This has changed with the low volumes that are used for mass spectrometry - clean sample processing is now crucial for reliable mass-spectrometric ^{230}Th and ^{231}Pa data.
The quick development in measurement techniques within the last years has led to a number of individual approaches in the analysis, typically determined by the requirements of the different groups (e.g. which other isotopes are to be analysed), and by individual experience. We will compare the effects of different treatments during sampling, storage, and purification of Th when analysing a single deep water sample for ^{230}Th by means of mass spectrometry.
Rare earth elements (REE) and especially the isotopic composition of Nd are important water mass tracers, and we will also perform an intercomparison of techniques for these tracers.

Work at sea
Clean surface water samples will be taken and two special CTD/Rosette casts to approximately 1000 m will be made to collect water for this intercomparison exercise. Samples will be pretreated on board and filled into the precleaned sample bottles supplied by the various participants.

Expected results:
Analysis will follow in the respective labs. Results will help to make the data obtained by the different labs comparable, a prerequisite for future GEOTRACES studies.

3.4 DISTRIBUTION OF ANTHORPOGENIC AND NATURAL RADIONUCLIDES IN SURFACE WATERS OF THE EAST ATLANTIC

Gastaud, Scholten (MEL-IAEA)

Objective
Full oceanographic transects of natural and anthropogenic radionuclides through the Atlantic Ocean are sparse. The investigations of MEL during the RV POLARSTERN cruise aim at a better understanding of the distribution of natural isotopes (^{230}Th, ^{232}Th, ^{231}Pa,) and anthropogenic radionuclides (such as ^{90}Sr, ^{137}Cs, plutonium isotopes and others) in surface waters on the transect between Vigo and Cape Town. The specific objectives are:

a) distribution of ^{232}Th in surface waters and its potential as a tracer for aeolian dust/nutrient supply;
b) mechanisms of scavenging and the role of surface water mass mixing on the ^{230}Th and ^{231}Pa distribution;
c) gradients of anthropogenic radionuclides between the North and South Atlantic
d) aeolian deposition of natural and anthropogenic radionuclides
e) intercalibration of analytical procedures for the determination of radionuclides;

Work at sea
During the transect continuous sampling for anthropogenic (^{90}Sr, ^{99}Tc, ^{137}Cs, ^{129}I, Pu isotopes, and ^{241}Am) and natural radionuclides ^{230}Th, ^{232}Th ^{210}Po/^{210}Pb and ^{231}Pa will be conducted using the ship's seawater pump and the towed fish. In addition to surface waters, certain (6-8) deep hydrocast stations will be conducted using a rosette system with Niskin bottles. Selected water samples will be filtered in various size fractions (0.45µm, 0.2µm, 0.2-10 kDa). Samples for the determination of anthropogenic radionuclides will be pre-concentrated on-board the ship. Aerosol sampling will be conducted for determination of anthropogenic radionuclides, ^{232}Th and ^{210}Pb.

Expected results
The results obtained during RV POLARSTERN ANT XXIII-1 are expected to provide a baseline for radionuclide distributions in the East Atlantic and new insights about the behaviour of radionuclides along gradients of bioproductivity and atmospheric deposition.

3.5 HF-ND-ISOTOPES

Frank (IFM-GEOMAR); Rickli (ETH Zürich)

Objectives

The isotopic signatures of Hf and Nd vary largely between continental lithologies. They are transferred into the ocean via processes such as riverine inputs, dust inputs, or leaching of shelf sediments. Dissolved Hf and Nd isotopes in seawater thus can serve as tracers for weathering inputs and ocean circulation because their residence times is seawater are on the order of 500-2000 years, which prevents complete homogenisation of the isotopic signatures but at the same time allows for a long distance transport within particular water masses. Both isotopic systems have been applied as paleotracers for ocean circulation and continental weathering regimes. There are, however, still large uncertainties as to the importance of dust inputs versus riverine supply, which have prevented full exploitation of the potential of these isotope systems. While there is some information available on Nd isotopes from previous studies, there is essentially no information on Hf isotopes. This is mainly due to the extremely low concentrations in seawater between 0.1 and 1 pmol/l, which have until recently prevented isotopic measurements of seawater.

Work at sea

At ETH Zurich we have developed a method to extract and measure the Nd and Hf isotope composition simultaneously from filtered 120 L seawater samples. These samples will be acidified for homogenization and Hf and Nd will be co-precipitated with Fe on board of the ship. The precipitates will be shipped to Zurich, where they will be further chemically separated and analysed by mass-spectrometry (Multi-collector ICPMS) in the clean laboratories at ETH. In addition, we will extract cosmogenic ^{10}Be and lithogenic ^{9}Be from the same water samples in the laboratory, which will provide complementary information on inputs and water mass sources.

Expected results

Comparison with the isotopic composition of dust and the lithologies of the Saharan and Namibian continental source areas will allow an estimation of the contribution of dust to the dissolved signatures in the surface waters. In the equatorial upwelling area the Nd and Hf isotopes will provide information on the sources of the deep waters and other trace metals supplied by these waters.

3.6 CATION INCORPORATION INTO FORAMINIFERAL SHELLS

Dissard (AWI)

The biogeosciences section of the AWI participates in this GEOTRACES pilot cruise to determine the cation incorporation into foraminiferal shells as a function of temperature, salinity and sea water carbonate chemistry. Surface water will be sampled continuously (order of 1L/sec) to collect planktonic foraminifera (6 hr intervals) along with data on temperature and salinity. After each sampling-interval water samples will be collected for later analysis of alkalinity and total CO_2 to determine the carbonate chemistry of seawater. Together with culture experiments and numerical modelling (carried out on biological stations and at the AWI, respectively) we hope to improve existing proxy relationships and develop new ones.

3.7 CONTINUOUS SHIPBOARD MEASUREMENTS OF DISSOLVED FE, AL AND TI

Croot, Schlosser (IFM-GEOMAR); Steigenberger (AWI)

Work at sea
During the cruise leg, the trace metal group from IFM-GEOMAR in collaboration with co-workers from IOW, AWI and University Bremen will undertake continuous near surface sampling for the dust derived elements Fe, Al and Ti, using a towed fish and trace metal clean pumping system. This sampling system will allow discrete surface samples to be taken along the cruise track from Bremerhaven to Vigo and from Vigo to Cape Town.

Expected results
Samples will be analysed using a combination of online flow injection analysis (FIA) systems: Fe(III) via luminol/H_2O_2 chemiluminescence, Al(III) via a fluorescence technique and Ti(IV) via a new voltametric method pioneered at IFM-GEOMAR. By comparison of the concentrations of these 3 strongly hydrolysed elements in the soluble, dissolved and particulate phases we hope to be able to better understand the processes affecting dust dissolution and particle scavenging in the surface ocean. The cruise track from Vigo to Cape Town allows comparison between high dust load regions affected by the Saharan and Namibian deserts, low dust regions in between and a zone of high biological productivity at the equator.

This work is part of the German contribution for GEOTRACES and is also a continuation of similar earlier work performed on the RV POLARSTERN (ANTXVIII-1) and the RV METEOR (M55) in the central Atlantic looking at the effect of Saharan dust deposition on surface seawater iron concentrations. This work is funded through the DFG and IFM-GEOMAR.

3.8 DEPOSITION OF TRACE METALS TO ATLANTIC SURFACE WATERS

Croot, Schlosser (IFM-GEOMAR); Steigenberger (AWI)

Transport of airborne dust from the continents provides a route by which Fe can enter remote surface ocean waters. This transport can be of particular importance for supplying iron to HNLC regions where Fe is the limiting nutrient. The episodic nature of dust transport makes many aspects of this deposition uncertain – how much is soluble, what is the redox speciation and how much is deposited in rainfall?

During ANTXXIII-1 aerosol samples will be collected using a Graseby-Anderson high-volume sampler. Samples collected during the transect past West Africa will be of particular interest, as the Sahara is the major source of dust to the atmosphere. Daily samples for aerosol dust collected during the cruise will be analysed in the laboratory upon return for dust derived elements.

3.9 HYDROGEN PEROXIDE (H_2O_2) IN ATLANTIC SURFACE WATERS

Croot, Schlosser (IFM-GEOMAR); Steigenberger (AWI)

Discrete surface measurements of H_2O_2 will be made along the cruise transect from Vigo to Cape Town during ANTXXIII-1. Complementary vertical profiles will be obtained where possible along with some on-deck incubations to examine the diel cycle of this reactive oxygen species. Information on H_2O_2 concentrations in seawater can potentially be used in tropical regions to determine recent rain events and/or the extent of vertical mixing through the euphotic zone. Hydrogen peroxide is also an important oxidant involved in trace metal redox cycling and information on its concentrations can determine turnover times for these cycles.

3.10 DISSOLVED GERMANIUM IN THE ATLANTIC OCEAN: A GERMANE ELEMENT FOR GERMAN GEOTRACES

Croot, Schlosser (IFM-GEOMAR); Steigenberger (AWI)

Germanium (Ge) is a metalloid and exists in seawater primarily as $Ge(OH)_4$, in a dissolved form analogous to nutrient silicon, $Si(OH)_4$ (silicic acid). Ge has a similar nutrient-type profile to Si in the ocean as organisms which use silicon in their skeletons (Diatoms etc.) have only a small discrimination between Ge and Si. Similarly to Si, Ge shows similar inter-ocean differences in concentrations. Even though the bulk of oceanic Ge follows the silicon cycle, small differences exist that are useful to oceanographers. Thus the Ge:Si ratio in seawater can provide useful information on processes affecting the Ge and Si cycles. In the present work we will examine the deep water distribution of Ge at a number of stations along a transect in the Atlantic Ocean. This work is an international co-operation between Dr Michael Ellwood (NIWA, New Zealand) and Dr Peter Croot (IfM-Geomar).

3.11 MERCURY DISTRIBUTION IN EASTERN ATLANTIC SURFACE WATERS AND THE CALIBRATION OF METHODS IN THE FRAMEWORK OF GEOTRACES (IOW)

Hennings (IOW)

Objectives

- To calibrate our sample handling and analytical methods for trace elements like Cd, Pb, Cu, Zn, Ni, Co, Mn, Fe with the sample handling and analytical methods of colleagues from the national and international GEOTRACES community.
- To determine the distribution of mercury (Hg) in the surface waters of the eastern Atlantic Ocean at high frequency, under consideration of the main oceanic regimes, and meteorological systems, including an oceanic region which is affected by high Saharan dust deposition.

The determination of mercury in oceanic regions is highly ambitious. For that reason only data from 3 stations exist on the distribution of mercury in the eastern Atlantic Ocean. The transect from Bremerhaven to Cape Town will cross different oceanic and meteorological

regimes. Between 65°N-10°N the surface water body (0-500 m) of the "Eastern North Atlantic Central Water" dominates, while between 10°N – 40°S "South Atlantic Central Water" will be met. Furthermore, the dust input from the African deserts by the trade winds and their influence on the mercury distribution in surface waters are of main interest. In this connection it will be a unique chance to carry out a baseline study for mercury with new sampling equipment and methods.

Work at sea
Sampling will be carried out by the use of a "Clean Water Sampling Fish" provided by IFM-GEOMAR. Mercury concentrations will be directly analysed on board of RV POLARSTERN by using cold vapour technique with mercury amalgamation on a gold net and the determination by fluorescence detection. For total mercury the expected concentrations in the ocean surface waters will range between 2-5 pmol in dependence of the atmospheric input.
For the determination of the other metals, samples will be divided in filtered and unfiltered samples, acidified and stored. Analyses will be carried out in the home laboratory.

3.12 SCAVENGED-TYPE TRACE METALS IN SOLUTION, COLLOIDS AND PARTICLES OF AN ATLANTIC OCEAN SURFACE SECTION (GEOTRACES)

Daberkow, Harms (IAP)

Objectives
Particle-water interaction is a key process in the biogeochemical cycling of chemical elements in the ocean. Uptake into/onto particulate matter and subsequent sinking (scavenging) exerts major control on the chemical composition of seawater. This process maintains the rather low concentrations of many elements in seawater. Marine particles can be classified into different size fractions: (i) there are relatively large/heavy, fast sinking particles, which are responsible for the vertical transport towards the sediment; most of the mass resides in (ii) small, almost unsinkable suspended particulate matter (SPM) of biogenic and terrestrial origin; and (iii) the colloidal fraction which passes the filter membranes (< 0.4 µm) which are typically used to separate the SPM from the dissolved fraction. Thus, the fraction classically regarded as dissolved, needs to be divided into the colloidal fraction(s) and the "truly" dissolved fraction. The role of this colloidal fraction in the interactions between dissolved and particulate matter in the ocean and its trace element composition is still widely unknown. Although being part of the operationally defined dissolved fraction, the colloidal size fraction including the elements adsorbed on the colloids may have biogeochemical properties different from those of "truly" dissolved elements.
The comparison of trace element composition of the different fractions in seawater (SPM, dissolved, colloidal and "truly" dissolved) and the additional comparison to the composition of aerosol particles and rainwater samples are expected to provide important clues on the transport and sorption mechanisms (sorption of trace elements onto colloids and sorption on suspended particles) as well as on the general biogeochemical behavior of the analysed trace elements (e.g. Fe, Co, Ni, Cu, Zn, Cd, Pb) in the ocean.
With Fe being a prominent example, many of the trace element studied here are essential for marine life, and thus also for the biogenically induced particle flux within the water column. These trace elements cover a broad range of chemical properties, enabling the study of relevant biogeochemical processes in greater detail.

Work at sea
During the cruise surface water samples will be collected for the analysis of trace elements in the mentioned fractions. Dissolved samples will be separated into "truly" dissolved and colloidal sample material using cross-flow ultra filtration (CFUF, with a nominal mass cut-off at 5000 daltons).
The atmosphere, amongst other sources, provides significant inputs of dissolved and particulate elements to the ocean and this source is variable in time and space. Therefore, in addition to the surface water sampling, aerosol particles and, whenever possible, also rainwater samples will be collected. To have another indicator for the input of particles/dust from the atmosphere, the concentration of total dissolvable aluminium (TD-Al) will be analyzed using the lumogallion fluorescence method.
Sampling will be conducted over the whole transact, covering different regions of input and production and will also include a few water column profiles in the major basins.

3.13 INTERNATIONAL STUDY OF SELECTED PERSISTENT ORGANIC POLLUTANTS (POPS) IN AIR AND WATER

Caba, Jahnke (GKSS); Gioia (University Lancaster); Nizzetto (University Insubria)

Objectives
Several leading groups of Environmental Chemistry are joining the RV POLARSTERN during ANT-XXIII/1 to determine trace organic contaminants in moderate latitudes of the Northern and Southern hemisphere in order to further investigate the circulation, fate and behaviour of these global key contaminants. The measurement programme concentrates on the determination of selected POPs in air and water, which can be subdivided into two major groups:

1) the „classical" POPs like polychlorinated dibenzodioxins/-furans (PCDD/Fs) and polycyclic aromatic hydrocarbons (PAHs) formed during combustion processes, polychlorinated biphenyls (PCBs) used in transformers, and selected organochlorine pesticides,
2) „new" and emerging POPs like the polybrominated diphenylether (PBDE) flame retardants and polyfluorinated compounds (PFCs) used primarily for surface treatment.

Work at sea
During ANT-XXIII/1, water samples will be taken from the ship´s seawater system (Klaus-pump), while air samples will be taken on the upper deck (Peildeck). Extraction and analysis of the samples will be done in the clean laboratories at GKSS research centre and University of Lancaster subsequent to the cruise.

Expected results
Two hypotheses have been postulated to explain the occurrence of PFCs in remote regions: a) transport via the atmosphere by means of volatile, neutral precursors or b) transport by sea currents. The investigation of the long-range distribution of PFCs in waters from the North Sea and the Atlantic is therefore an ideal complementation of the air sampling taking place in parallel. The cruise plot is especially appropriate for this study as it ranges from the

probable sources (European continent) to remote locations where direct inputs are lacking. This project is supposed to indicate the relative importance of both hypotheses.
Concerning "classical" POPs, the sampling and analysis of PCB and PBDE concentrations in air and water should enable the determination of partition coefficients between ocean and atmosphere. This study will aid to clarify if the transport and the deposition of different organic contaminants are dominated by atmospheric transport and / or transport via the water phase. This project should help to answer the question if the Atlantic still represents a sink for POPs or if the water- and airborne concentrations have come to an equilibrium. Finally, one significant topic is also to what extent POP concentrations in the Northern and Southern hemisphere are converging.

3.14 LONG-TERM TRENDS AND SEASONAL VARIABLITY OF THE ^{13}C SIGNATURE OF DISSOLVED INORGANIC CARBON (DIC) IN SURFACE WATERS OF THE ATLANTIC OCEAN

Dissard (AWI)

The project is a continuation of a long-term observation study from Arne Körtzinger IFM-GEOMAR of the ^{13}C signature of dissolved inorganic carbon (DIC) in surface waters of the Atlantic Ocean, which commenced in 2003. The biannual sampling based on transits of RV POLARSTERN to/from the Southern Ocean will provide insight into the seasonality and interannual variability of the $\lambda^{13}C$-DIC in contrasting climatic and biogeochemical regimes (subtropical vs. subpolar, oligotrophic vs. mesotrophic, thermally vs. biologically controlled CO_2 system). It may also permit quantification of the Suess effect on $\lambda^{13}C$-DIC if maintained as a long-term project.

A similar scientific question has been addressed successfully at the oceanic time-series stations such as the Bermuda Atlantic Time Series Study (BATS) and the Hawaii Ocean Time Series. In addition, sampling programmes have been mounted on „Volunteer Observing Ships" in the North Pacific and North Atlantic. Within the EU-funded project CARBOOCEAN, the IFM-GEOMAR since 2005 measures $\lambda^{13}C$-DIC along a trans-Atlantic VOS line. The present long-term sampling programme based on POLARSTERN transits represents a significant extension of the CARBOOCEAN study.

4. SATELLITE GROUND-TRUTH AND ATMOSPHERIC STUDIES

4.1 BIO-OPTICAL REMOTE SENSING; DEVELOPMENT OF AN ALGORITHM FOR ESTIMATING PARTICULATE ORGANIC CARBON IN THE OCEAN FROM SATELLITE OBSERVATIONS

Reynolds, Stramski (UCSD-Scripps); Stramska (UCSD-Hancock); Kaczmarek (IOPAS); Heymann, Röttgers, (GKSS); Ruser (FTZ-Westküste)

Objectives
An important goal of Earth and climate research is to develop an understanding of processes that regulate change in atmospheric CO_2. Uncertainties about various carbon reservoirs and fluxes lead to difficulties in balancing the contemporary carbon budget at global scale. Therefore, improving measurement capabilities and accuracy of carbon estimates for various

compartments of the Earth system is essential. Particulate organic carbon (POC) in the surface ocean is one such compartment of substantial interest. Satellite sensors provide a unique tool for long-term synoptic observations of the surface ocean with the global extent of coverage. The capability to estimate chlorophyll-a concentration from remotely-sensed ocean colour has long been established and utilized. Development of a similar capability for estimating POC is still in its infancy. However, our recent work in the Southern Ocean and the north polar Atlantic demonstrated the feasibility of estimating POC from satellite observations of ocean colour (Stramski et al., Science, 285, 239-242, 1999; Stramska and Stramski, J. Geophys. Res., 2005, in press).

During this cruise we wish to make advancement toward developing a capability for global monitoring of POC from satellites. For achieving this goal, it is necessary to conduct a specially designed set of bio-optical measurements over a range of biogeochemical provinces of the world's ocean. Simultaneous measurements of POC and other properties of suspended particulate matter, spectral ocean reflectance, spectral optical backscattering, angular distribution of light scattering, and spectral absorption properties have not been made in the past. Our research objective on the cruise will be to explore an approach for estimating POC from optical backscattering and ocean colour on basin-scales in the Atlantic Ocean. To address this objective we will carry out a unique set of bio-optical measurements as described below.

Work at sea

In Situ Optical Measurements - In-water optical profiles will be made around the local noon throughout the photic zone within the upper ocean (down to ~ 100 - 250 m) with two instruments. We will use a freefall, hand-operated spectroradiometer (SPMR, Satlantic profiler) for underwater measurements of spectral downwelling irradiance (Ed) and upwelling radiance (Lu). We will also use a Multisensor Datalogger System (MDS) for measuring the physical and inherent optical properties of ocean water. This system is equipped with SeaBird Sealogger 25 with temperature, conductivity, and pressure sensors, with two single-wavelength (488 and 660 nm) beam transmissometers (c-Star, WetLabs), a chlorophyll fluorometer (WetStar, WetLabs), a Hydroscat-6 and two a-beta instruments, allowing determination of backscattering coefficient at eight wavelengths (HobiLabs), and a LISST-100 (Sequoia) for measuring the volume scattering function in forward directions and determining the particle size distribution. In addition: water samples will be taken from the general CTD-rosette between 0 and 200 m, and a flow-through system will be run with water pumped from the moon pool to measure photosynthetic parameter with a FRRF FastTracka fluorometer (Chelsea).

Laboratory Measurements- the discrete water samples taken from ship's CTD/rosette system as well as surface water samples taken frequently when ship is underway will be subject to various analyses. Samples for particulate, detrital and Gelbstoff absorption spectra, $a_p(\lambda)$, $a_d(\lambda)$, and $a_{cdom}(\lambda)$, will be taken. Phytoplankton absorption $a_{ph}(\lambda)$ will be estimated as a difference between $a_p(\lambda)$ and $a_d(\lambda)$. Standard procedures will include samples for POC, PIC, photosynthetic pigments, elemental composition of particulate matter, and total suspended matter (TSM). One set of pigment samples will already be analyzed onboard by HPLC, the optical absorption properties directly measured with a newly designed integrating cavity absorption meter and a spectrophotometer.
Further on-deck measurements of the light scattering function (i.e., scattered intensity as a function of scattering angle) will be made on seawater samples with a Dawn EOS (Enhanced Optical System) scattering meter operating at 532 nm (Wyatt Tech.). The multi-angle

measurements will provide unique information for quantifying the backscattering coefficient and the roles played by POC and PIC (particulate inorganic carbon) in optical scattering.
We also plan to perform particle analysis (particle identification, size, and concentration) of discrete water samples on board the ship. We will use a FlowCam system (Fluid Imaging) and a flow-cytometer (Cytosence). The FlowCam images, counts, and measures and the flow-cytometer counts, measures and analyses particles in fluids.

4.2 MEASUREMENT OF OZONE DISTRIBUTION, UV RADIATION AND OPTICAL DEPTH

Bluszcz, El Naggar, Wuttke (AWI)

Objectives
Objectives of these investigations are the study of stratospheric ozone depletion and the resulting enhanced UV-B radiation, the radiation transfer in the atmosphere and effects to be expected in the biosphere. In order to obtain meaningful data sets measurements over longer time periods are necessary. The transects with RV POLARSTERN offer the unique opportunity to obtain data from the northern and southern hemisphere.

Work at sea
During the cruise ozone sondes will be launched daily, which will provide information about the vertical distribution of ozone up to about 30 km altitude. With these measurements an existing series of measurements will be complemented with respect to the observation of long-term trends. Special attention will be paid to processes which take place in the UTLS region (UT = upper troposphere, LS = lower stratosphere). The ozone measurements as well as the UV measurements provide important data for model studies.

The UV measurements will be performed with an UV (A+B) spectral radiometer throughout the entire cruise. Our UV spectral radiometer allows the simultaneous measurement of the UV spectral range from 280 nm to 400 nm. This permits the determination of the total ozone column on the basis of the ratio of a suitable wavelength pair according the standard Dobson procedure independent of the weather conditions. Modelling will be conducted on the basis of a numerical solution of the radiation transfer equation using adequate simplifications. In particular, anomalies observed earlier in the region of the intertropical convergence zone will be characterized more accurately. In addition the aerosol optical depth, which will be required for the analysis of the UV data, will be measured with a sun photometer. Furthermore, measurements of the global UV-B dose will be performed with the electronic UV-B dosimeter ELUV-14. The erythem-weighted daily dose will be determined as well by using the biometer Solar Light 501. The calculation of the daily dose will be performed by taking the solar angle and ozone concentration into account. In the long-run the maximum dose to be expected at sea level and their variations can be determined in this way.

References
C. Groß, H. Tüg, O. Schrems, Three Years Spectral Resolved UV-Measurements at Koldewey-Station (1997-1999), Memoirs of National Institute of Polar Research, Special Issue No. 54, 113-123, 2001
S. El Naggar, H. Gernandt, N. Spelten, A. Klaas, Personal ultraviolett-B dosimetry at Koldewey-Station by using an electronic dosimeter ELUV-14., Memoirs of National Institute of Polar Research, Special Issue, No.54, 429-436, 2001

4.3 LIDAR MEASUREMENTS OF AEROSOLS AND CIRRUS CLOUDS

Immler, Terli (AWI); Ruhe (impres)

Objectives

Objectives of our investigations are the observations of aerosols and cirrus clouds in extended regions of the northern and southern hemisphere (50°N to 30°S) which will complete the data sets obtained during previous cruises of RV POLARSTERN (see references below). The lidar method offers the opportunity to detect atmospheric aerosols and cirrus clouds over a wide range of optical depths and with high vertical and high time resolution. The backscatter data of our lidar will provide a detailed picture of the vertical structure of the clouds. With the help of radiosondes which will be launched twice a day from RV POLARSTERN the temperature of the cirrus clouds as well as the structure of the tropopause can be characterized.

Work at sea

For the measurements aboard RV POLARSTERN our new lidar system (ComCAL) which uses a Nd:YAG laser with 20 Hz repetition rate and 200 mJ pulse energy at 1064 nm, 532 nm and 355 nm will be deployed. The backscattered light is collected by means of a 40 cm telescope. The whole system is mounted in a 20 feet laboratory container which will be placed either on the observation or helicopter deck. Measurements are planned to be performed continuously throughout the cruise as far as the meteorological conditions allow to do so. The lidar measurements will contribute to the EU project SCOUT-O3 and to the virtual institute PEP (Pole – Equator – Pole).

Expected results

We expect to observe tropospheric aerosols and in particular Saharan dust layers in the region of 7°N to 35°N and in altitude ranges up to about 6 km. Concerning the observation of cirrus clouds special attention will be paid to high-altitude tropical cirrus. Here the backscatter signals will provide a detailed picture of the vertical structure of the cirrus clouds, which frequently extend to more than 1000 km horizontally and which can persist for several days. On the basis of the obtained data certain cloud properties will be derived.

References

F. Immler and O. Schrems, Determination of tropical cirrus properties by simultaneous lidar and radiosonde measurements, Geophys. Res. Lett. Vol. 29, NO.23, 2090, doi:10.1029/200GL015076, 2002

F. Immler and O. Schrems, Vertical profiles, optical and microphysical properties of Saharan dust layers determined by a ship-borne lidar, Atmos. Chem. Phys. 3, 1353-1364, 2003

4.4 ATMOSPHERIC TRACE GAS MEASUREMENTS USING THE SOLAR ABSORPTION SPECTROMETRY IN THE INFRARED SPECTRAL REGION, FTIR-MEASUREMENTS

Weinzierl, Mengistu Tsidu (IUP Bremen);

Objectives

The FTIR spectroscopy using the sun or moon as light sources has been established throughout the last decades as a suitable tool to study the composition of the atmosphere. Feeding the solar light on the entrance aperture of a spectrometer allows to record

absorption spectra in the whole spectral range from the infrared up to the UV. The solar light is received using a solar tracker with two movable mirrors following the course of the sun and correcting for the ships movements. If the spectra are recorded in high resolution the spectral features are well separated. For such observations, measuring a broad spectral range with high resolution, Michelson interferometers have been found to be the most suitable ones. After the interferograms are recorded they are Fourier transformed yielding the requested spectra, which can be analysed. This measurements technique is now known as FTIR-(Fourier Transform InfraRed) spectrometry.

Since the solar spectrum is well known the absorption lines can be assigned either to the solar system or to the earth atmosphere. The position of the spectral lines can in most cases unambiguously be assigned to specific atmospheric gases and the absorption depth is related to the total atmospheric gas amount. Overall, about 20 atmospheric trace gases from the stratosphere and troposphere can be measured. Furthermore, for a few trace gases the concentration profiles can be retrieved up to approximately 30 km, by analysing the width and shape of isolated spectral lines. The physics behind this is the dependency of the spectral line width on the atmospheric pressure, which decreases with altitude.

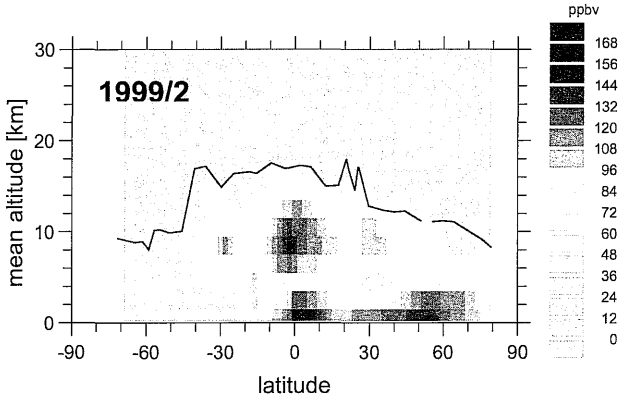

Fig. 4: Latitudinal variability of CO (concentration colour coded), as measured in 1999/2000 on board RV POLARSTERN as an example of the use of solar absorption FTIR-spectrometry. The black line gives the altitude of the thermal tropopause. (Notholt et al., 2003).

The aim of this cruise is twofold.
(i) Since air from the troposphere enters the stratosphere in the tropics the composition of the tropical upper troposphere later on determines the composition of the stratosphere. The aim of the cruise is to study the impact of the tropical biomass burning emissions and emissions from the northern hemisphere on the composition of the upper tropical troposphere.
(ii) The ENVISAT satellite instrument has been launched on March 1, 2002. The instruments on board require a long-term validation.

Work at Sea

Measurement of the altitudinal and latitudinal variability of the trace gases will be carried out. Of special interest are the short lived compounds CO, C_2H_6, OCS, HCN and CH_2O and the long lived ones CO_2, N_2O and CH_4. Since our last cruises the measurement and analysis techniques has been expanded, which now allows to study CO_2 and CH_4 with a precision of < 0.5 %, necessary to detect the small atmospheric variability of these trace gases.

The second aim of the cruise is to measure the latitudinal variability of several trace gases, like O_3, CH_4, CH_2O or CO, and use the resulting concentrations for the validation of the SCIAMACHY and MIPAS instrument on board ENVISAT. One big advantage of these observations is that the concentrations at different latitudes are recorded with the same instrument within a relatively short campaign. This minimises potential systematic uncertainties.

The remote sensing measurements will be complemented by in-situ flask samples, filled onboard during the cruise. It is planned that samples are taken twice per day in the morning and afternoon to get a rough information on diurnal variation of the trace gases. The flask samples will be analysed for CO, H_2, CO_2, CH_4, N_2O, SF_6, and the isotopes $^{13}CO_2$ and $C^{18}O_2$.

References

J. Notholt, Z. Kuang, C.P. Rinsland, G.C. Toon, M. Rex, N. Jones, T. Albrecht,H. Deckelmann, J. Krieg, C. Weinzierl, H. Bingemer, R. Weller, O. Schrems, Enhanced upper tropical tropospheric COS: Impact on the stratospheric aerosol layer, Science, 300, 307-310, 2003.

4.5 MAX-DOAS-MEASUREMENTS OF ATMOSPHERIC TRACE GASES FOR SCIAMACHY-VALIDATION

Wagner (University Heidelberg)

Objectives

An important aspect of environmental sciences is the knowledge on trace gases and their concentration and distribution in the atmosphere. Especially interesting are tropospheric trace gases like NO_2, H_2O, HCHO, IO, BrO, O_4 and SO_2 as well as stratospheric ones like O_3, NO_2, BrO, OClO, H_2O, HCHO, and IO. According spectroscopic measurements can be performed on different platforms for instance by satellites, such as the instrument SCIAMACHY onboard the European ENVISAT, which was launched into a polar orbit in March 2002. To validate satellite data, however, ground-based control-measurements done at locations beneath the satellite's orbit are necessary. In case of SCIAMACHY, measurements onboard of RV POLARSTERN seem to be best suited for that purpose, because the ship follows a polar course relevant to ENVISAT's orbit when it is going on its way to and from the Antarctica.

Work at sea

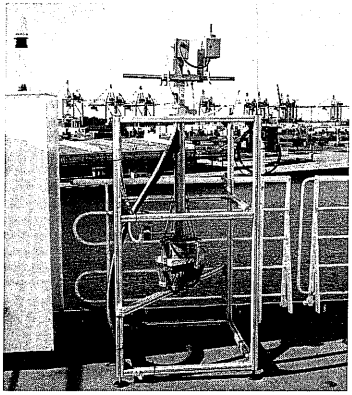

Fig. 5: The on-deck instrumentation of the MAX-DOAS instrument. The telescope unit is mounted on a cardanic system whereby the brush is used for reducing the motion influenced by the ship's movement.

DOAS instrumentation: The method used by the satellite's instrument is the approved Differential Optical Absorption Spectroscopy (DOAS). For this principle, the fact is used that solar light passing through the atmosphere is not only scattered but also absorbed by gas molecules and will thereby yield characteristic absorption lines for each trace gas within the collected spectra. From these lines, identity and amount of atmospheric trace gases can be obtained. For ground-based measurements, it is even possible to derive height profiles of the trace gases: stray light spectra from zenith sky measurements are mainly dominated by stratospheric absorption, whereas measurements from lower telescope elevation angle become more sensitive to tropospheric absorption due to the enhanced light paths in lower atmospheric layers. This is the so-called Multi-Axis-DOAS principle.

The validation instrument onboard RV POLARSTERN also applies the (MAX-)DOAS measurement principle of the satellite's apparatus. Thereby a moveable telescope which is able to point sequentially to different directions in the vertical plane is mounted on a cardanic system to reduce the effect of the ship's movements (see Fig. 5). The incoming light is conducted to a cooled miniature Czerny-Turner spectrograph/CCD-detector unit (OceanOptics USB2000) by glass fibres. The wavelength range of about 290 to 430 nm allows for example the retrieval of NO_2, BrO, SO_2 and HCHO. Last, the gained spectra are stored in PC hard disk for the later DOAS analysis. The instrument is working mostly automated.

Expected results

E. g. measurements performed during the cruise ANT XIX of RV POLARSTERN from Bremerhaven to Cape Town using a precursor of the nowadays instrumentation (same instruments, but another configuration of telescope units) show the concentration of BrO and NO_2: The maxima were reached when the ship passed the English Channel with 3.1 ± 1.1 parts per trillion for BrO and 0.36 ± 0.13 parts per billion for NO_2. This was to be expected from the high air pollution in Europe. Furthermore an anti-correlation of BrO and NO_2 could be observed indicating a reservoir substance formed by the two gases (Diploma thesis J. Boßmeyer). On further cruises the ship-based DOAS instrumentation should gather data to investigate such events including other trace gases in combination with the satellite results. Besides the fact that these measurements are mainly done for validation purposes, gathering data in Antarctic seas is important for further atmospheric and climate research.
Ship-based DOAS measurements have been carried out before in the years 1990, 1993 and from 2001 through 2005 with good success from the Heidelberg Institute of Environmental Physics.

References

Kreher, K.; Messung der Breitenverteilung (50°N – 70°S) von stratosphärischem Ozon mittels optischer Absorptionsspekroskopie, Diplomarbeit, Universität Heidelberg, 1991

Platt, U.; Differential optical absorption spectroscopy (DOAS), in Air Monitoring by Spectroscopic Techniques,M. W. Sigrist (Ed.), Ch. Analysis Series Vol. 127, John Wiley, New York, 1994

Senne, T.; Stutz. J.; Platt, U.; Measurement of the latitudinal distribution of NO2 column densities and layer heights in Oct./Nov. 1993, Geophys. Res. Let., 23, 805-808, 1996.

Boßmeyer, J.; Ship-Based Multi-Axis Differential Optical Absorption Spectroscopy Measurements of Tropospheric Trace Gases over the Atlantic Ocean, Diploma thesis, University of Heidelberg, 2002.

Halasia, Magdalini-Anastasia, SMAX-DOAS observation of atmospheric trace gases on the POLARSTERN ANT/XX-expedition from October 2002 until February 2003, Diploma thesis, University of Heidelberg, 2004.

4.6 VALIDATION OF SCIAMACHY MESOPAUSE TEMPERATURES WITH SHIP-BASED MEASUREMENTS

Bittner, Höppner (DLR)

Objectives

Located between approx. 60-120 km above the Earth's surface, the mesosphere and lower thermosphere (MLT) region is a gateway between Earth's environment and space, where the atmosphere is sensitive to external influences from the sun above and atmospheric layers below it. Measurements of temperature in the MLT are, however, difficult. Aircrafts and balloons, for example, cannot reach this altitude. Therefore the use of satellite-based measurements for the continuous observation of the MLT - particularly the mesopause region - in global coverage becomes more and more important. Thereby it depends on a routine observation with controlled quality of the measurements. The SCIAMACHY instrument for the first time provides such satellite-based measurements. Analyses of satellite-based data of these heights are, however, delicate. Continuous validation of the satellite data is therefore essential.

Work at sea

A first comparison between a stationary OH-spectrometer at Hohenpeissenberg (47.5°N / 11.1°E) (designed very similar to the mobile GRIPS-instrument of DLR, GRIPS 4) with OH rotational temperatures from the ENVISAT-SCIAMACHY satellite instrument yielded a good agreement. The mean difference was found to be about 2 K which is excellent [von Savigny et al., 2004], particularly when considering the different observation geometries, field-of-views and retrieval techniques. In order to study if this agreement also holds at other sites, the mobile GRIPS 4 instrument will be put on the RV POLARSTERN during the expedition ANT XXIII/1 from Bremerhaven to Cape Town. The temperature in the mesopause region will thus be measured continuously throughout an extended latitude interval: SCIAMACHY will therefore be validated over a wide latitude range. On the other hand a data series will be generated during the expedition which inherently is of scientific interest concerning the investigation of the dynamics of the atmosphere (i.e. gravity waves) [Bittner et al., 2002]. The

expedition with the RV POLARSTERN is part of the ESA project "SCIAMACHY Long Term Validation (SciLoV)".

On board the RV POLARSTERN the instrument continuously measures the temperature around the mesopause (~87 km) with high temporal resolution (3 minutes). The measuring technique is described by Bittner et al. [2000, 2002]. It is briefly summarized in the following. In the upper mesosphere atomic hydrogen reacts with ozone to form excited hydroxyl molecules (OH*) in a layer of ~8 km thickness and a peak altitude of ~87 km. Chemically excited OH molecules emit near-infrared radiation from several rotational-vibrational transitions. These emissions can be measured by ground-based instruments during nighttime (OH* concentrations during daytime are negligible). The measuring technique also allows measurements even if light clouds or haze are present. The instrument is equipped with a Germanium detector that is cooled with liquid nitrogen. The measuring system works nearly automatically, but with permanent support.

References

Bittner, M., D. Offermann, and H.-H. Graef, Mesopause temperature variability above a midlatitude station in Europe, J. Geophys. Res., 105(D2), 2045-2058, 2000.

Bittner, M., D. Offermann, H.-H. Graef, M. Donner, and K. Hamilton, An 18-year time series of OH rotational temperatures and middle atmosphere decadal variations, J. Atmos. Sol. Terr. Phys., 64, 1147-1166, 2002.

von Savigny, C., K.-U. Eichmann, E. J. Llewellyn, H. Bovensmann, J. P. Burrows, M. Bittner, K. Höppner, D. Offermann, M. J. Taylor, Y. Zhao, W. Steinbrecht, and P. Winkler, First near-global retrievals of OH rotational temperatures from satellite-based Meinel band emission measurements, Geophys. Res. Lett., 31, L15111, doi: 10.1029/2004GL020410, 2004.

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Bremerhaven- Cape Town

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Weinzierl	Thomas	University Bremen	Student
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7. SCHIFFSBESATZUNG / SHIP'S CREW

Reederei F.Laeisz G.m.b.H — Reise/Leg ANT XXIII/1
Name of Ship : — RV POLARSTERN
Nationality : — GERMAN — Bremerhaven - Cape Town

No.	Name	Rank
01.	Pahl, Uwe	Master
02.	Spielke, Steffen	1.Offc.
03.	Schulz, Volker	Ch.Eng.
04.	Bratz, Herbert	2.Offc.
05.	Wunderlich, Thomas	2.Offc.
06.	Niehusen, Frank	2.Offc.
07.	Uhlig, Heinz-Jürgen	Doctor
08.	Koch, Georg	R.Offc.
09.	Ziemann, Olaf	2.Eng.
10.	Simon, Wolfgang	2.Eng.
11.	Westphal, Henning	3.Eng.
12.	Holtz, Hartmut	Elec.Tech.
13.	Dimmler, Werner	Electron.
14.	Riess, Felix	Electron.
15.	Fröb, Martin	Electron.
16.	Feiertag, Thomas	Electron.
17.	Clasen, Burkhard	Boatsw.
18.	Neisner,Winfried	Carpenter
19.	Kreis, Reinhard	A.B.
20.	Schultz, Ottomar	A.B.
21.	Burzan, G.-Ekkehard	A.B.
22.	Schröder, Norbert	A.B.
23.	Moser, Siegfried	A.B.
24.	Pousada Martinez, S.	A.B.
25.	Hartwig-L., Andreas	A.B.
26.	Lamm, Gerd	A.B.
27.	Beth, Detlef	Storekeep.
28.	Hoppe, Kurt	Mot-man
29.	Fritz, Günter	Mot-man
30.	Krösche, Eckard	Mot-man
31.	Dinse, Horst	Mot-man
32.	Toeltl, Siegfried	Mot-man
33.	Fischer, Matthias	Cook
34.	Tupy, Mario	Cooksmate
35.	Martens, Michael	Cooksmate
36.	Dinse, Petra	1.Stwdess
37.	Tillmann, Barbara	Stwdss/KS
38.	Streit, Christina	2.Stwdess
39.	Schmidt,Maria	2.Stwdess
40.	Deuß, Stefanie	2.Stwdess
41.	Tu, Jian Min	2.Steward
42.	Sun, Yong Sheng	2.Steward
43.	Yu, Chung Leung	Laundrym.

ANT XXIII/2

19.11.2005 - 12.01.2006

Cape Town - Punta Arenas

Fahrtleiter/Chief Scientist:

ANT XXIII/2

Volker Strass

ANT XXIII/2

1. ÜBERBLICK UND FAHRTVERLAUF

Volker Strass (AWI)

Am 19. November 2005 wird FS POLARSTERN von Kapstadt aus zum zweiten Fahrtabschnitt ihrer 23. Antarktis-Expedition auslaufen. Während des Fahrtabschnittes wird sie als Basis für die Durchführung eines umfangreichen marinen Forschungsprogramms dienen und, als logistische Aufgabe, die Neumayer-Station sowie Landexpeditionen auf dem antarktischen Kontinent versorgen. Enden wird der Fahrtabschnitt am 12. Januar 2006 in Punta Arenas.

Um die Station und die Landexpeditionen so früh wie möglich in der antarktischen Sommer-Saison zu versorgen, wird FS POLARSTERN nach Auslaufen von Kapstadt direkten Kurs zur Neumayer-Station nehmen. Nur einige wenige marine Forschungsarbeiten, die an Positionen geplant sind, an denen FS POLARSTERN nur auf ihrem Weg nach Süden vorbeikommt, sollen unterwegs vor Erreichen der Neumayer-Station durchgeführt werden. Insgesamt sollen solche vorgezogenen marinen Arbeiten aber nicht mehr als einige wenige Tage Schiffszeit in Anspruch nehmen.

In die obige Kategorie fallen beispielsweise Probennahmen mit Planktonnetzen im Kapbecken und im Frontenbereich des Antarktischen Zirkumpolarstroms, die im Rahmen eines Projekts zur Untersuchung des Auftretens und der Verteilung bathy-pelagischen Planktons, insbesondere von Mysiden und Polychaeten, benötigt werden. Die Probennahme für dieses Projekt wird im späteren Verlauf des Fahrtabschnittes mit Netzhols vor der Neumayer-Station, nahe der Maud-Kuppe und bei den Süd-Sandwich-Inseln fortgesetzt.

Die Anreise von Kapstadt zur Neumayer-Station wird außerdem für einen Tag bei der Bouvet-Insel unterbrochen werden, um dort zu versuchen, mit köderbestückten Fischfallen und dem Agassiz-Schleppnetz Aalmuttern (Zoarcidae und Notothenoidae) zu fangen. Die so gefangenen lebenden Tiere werden für Aquarienexperimente zur Untersuchung der adaptiven Kompetenz kalt-stenothermer Teleostei benötigt. Das Projekt wird nach der Versorgung der Neumayer-Station mit Einsatz der gleichen Methoden in der hocharktischen Atka-Bucht fortgesetzt.

Ein weiteres Vorhaben, das abhängig von der Eislage eventuell noch vor dem Anlaufen der Neumayer-Station durchgeführt werden wird, besteht in dem Aussetzen eines Meeresbodenobservatoriums, MABEL genannt. MABEL ist geschaffen für die automatisierte Erfassung langfristiger (ein Jahr und länger) multidisziplinärer Messreihen in polarer Umgebung. An Instrumenten ist MABEL bestückt mit einem Breitband-Seismometer, einem Strömungsvektor-Rekorder, einem CTD zur Messung von Leitfähigkeit (Salzgehalt), Temperatur und Druck, einem Transmissiometer, Elektroden zur Messung von pH und Redox-Potential sowie einem Wasserprobensammler.

Außerdem können auf dem Weg nach Süden zur Neumayer-Station natürlich solche Messungen durchgeführt werden, die keine zusätzliche Schiffszeit kosten. Dazu gehört das Sammeln von oberflächennahem Zooplankton mittels eines hinter dem Schiff geschleppten Plankton-Rekorders (Continuous Plankton Recorder, CPR) ebenso wie das visuelle Beobachten von Warmblütern. Zählungen von Walen und Robben sowie von Seevögeln

einschließlich Pinguinen werden von zwei von der Internationalen Walfang-Kommission (International Whaling Commission, IWC) gestellten Beobachtern vorgenommen werden. Die IWC-Beobachter werden zudem diverse Parameter zur Charakterisierung der Meereisbedeckung aufzeichnen. Parallel zu den visuellen Beobachtungen mariner Säuger werden auf der Anreise nach der Neumayer-Station zwei verschiedenartige automatisierte Überwachungssysteme getestet. Das eine System basiert auf speziellen passiven Hydrophon-Ketten, die vom Schiff geschleppt werden. Das Andere nutzt Infrarot-Kameras, die im Krähennest montiert mit einer Bildverarbeitungs-Software betrieben werden und es erlauben, den warmen Wal-Blas auch bei Dunkelheit und schlechten Sichtverhältnissen zu erkennen.

Das marine Hauptmessprogramm der Reise wird erst nach der Versorgung der Neumayer-Station und der Landexpeditionen in Angriff genommen werden. Es widmet sich der vom BMBF geförderten LAzarev-See KRIII Studie (LAKRIS), einem deutschen Beitrag zu SO-GLOBEC.
SO-GLOBEC (Southern Ocean Global Ocean Ecosystems Dynamics) ist ein internationales und multi-disziplinäres Wissenschaftsprogramm, das ein besseres Verständnis der physikalischen und biologischen Faktoren, die Wachstum und Reproduktion und den Überwinterungserfolg von antarktischem Krill (Euphausia superba) beeinflussen, anstrebt. LAKRIS zielt darauf ab, Prozesse der saisonalen Populationsdynamik und die physiologische Kondition von Krill in einem interdisziplinären Ansatz zu quantifizieren, und zwar in einer Region, die bisher nur wenig beprobt und hinsichtlich ihrer Bedeutung für die Krillbestände fast unbekannt ist.
Im Wesentlichen stammt unser Wissen über den antarktischen Krill aus nur wenigen Gebieten, insbesondere dem um die Antarktischen Halbinsel. Es verdichten sich aber die Hinweise, dass die saisonalen Überlebensmechanismen variabel sind, dass weder die lokalen Umweltfaktoren noch die Reaktion von Krill darauf auf ein größeres umgebendes Gebiet extrapoliert werden dürfen. Mit dem LAKRIS-Projekt sollen Messungen, die im Rahmen von SO-GLOBEC und von CCAMLR (Convention for the Conservation of Antarctic Marine Living Resources) auf der Westseite der Antarktischen Halbinsel, im Südantillenmeer und im Indischen Sektor des Südpolarmeeres vorgesehen sind, durch detaillierte Untersuchungen in der Lazarev-See ergänzt werden.

Innerhalb des Wasserringes um die Antarktis gibt es unter anderem zwischen der Antarktischen Halbinsel und dem Nullgrad-Meridian, bzw. der Lazarev-See, ein Gebiet mit anscheinend erhöhten Konzentrationen von Krill. Ob diese offenbare Krillansammlung einem einzigen Krillbestand oder mehreren verschiedenen Beständen zuzuordnen ist, ist unklar. Strittig debattiert wird gegenwärtig auch, wie und ob dieser Bestand bzw. diese Bestände mit denen in anderen Abschnitten des Südpolarmeeres in Verbindung stehen. Untersuchungen in der Lazarev-See könnten zur Klärung dieser Fragen entscheidend beitragen.

Wenn Krill mit Meeresströmungen in das Weddellmeer eingetragen wird, dann am wahrscheinlichsten im Bereich der Lazarev-See, wo, zusammenfallend mit der Ostflanke des Weddell-Wirbels, südwärtige Strömungen angetroffen werden. Entlang des Nullgrad-Meridians kommt Krill zwischen dem 50. südlichen Breitengrad und der antarktischen Küste bei 70°S vor. Dies stellt die weiteste Nord-Süd-Verteilung von Krill im gesamten zirkumpolaren Südpolarmeer dar. Nördlich von 60°S ist Krill dem ostwärts versetzenden Zirkumpolarstrom unterworfen; Krill, der hier angetroffen wird, befindet sich also stromab der bekanntermaßen großen Bestände des Südantillenmeeres. Aus dem Bereich weiter südlich in Nähe des Kontinents, wo in der Lazarev-See westwärtige Strömungen vorherrschen, gibt es kaum Informationen über das Vorkommen von Krill-Larven. Diese müssten hier aber

vorkommen, wenn eine Rezirkulation von Krill mit dem Weddell-Wirbel in das Südantillenmeeres postuliert wird.

Das im Rahmen von LAKRIS vorgesehene Messprogramm verteilt sich auf drei Forschungsfahrten zu verschiedenen Jahreszeiten, von denen diese hier die erste ist - abgesehen von einer Pilotstudie, die bereits mit der FS POLARSTERN-Reise ANT-XXI/4 erfolgreich absolviert wurde. Thematisch gliedert sich LAKRIS in drei Teilprojekte:

SAISONALE UND ZWISCHENJÄHRLICHE VARIABILITÄT IN DER DEMOGRAPHISCHEN STRUKTUR DER KRILL-BESTÄNDE IN DER LAZAREV-SEE. Ein standardisiertes Beprobungsprogramm mit RMT(Rectangular Midwater Trawl)-Netzhols wird im Rahmen von LAKRIS durchgeführt, um biologische Daten über die Krill-Population in der Lazarev-See zu gewinnen. Das Hauptaugenmerk wird auf die Schätzung der mittleren Bestandsstärke und die Stärke der Jahresklassen in Relation zu Umweltvariablen gerichtet. Der Reproduktionserfolg des Laicherbestandes wird ebenso untersucht wie die Larvenverteilung und die Überlebensrate während des Winters.

HORIZONTALE UND VERTIKALE VERTEILUNG VON KRILL UND ZOOPLANKTON. Die täglichen vertikalen Wanderungsbewegungen und geographischen Verteilungen von Schlüsselorganismen wie Krill (Euphausia superba, E. crystallorophias), Copepoden (Calanus propinquus, Rhincalanus gigas, Oithona spp.) und anderem Zooplankton (Salpen, Pteropoden, Chaetognathen, Amphipoden) sowie Fischen (Myctophiden) sollen mittels eines Mehrfrequenz-Echolotes (38, 72, 120, 200 kHz) aufgezeichnet werden. Anhand der aufgezeichneten Verteilungen sollen vor allem folgende Fragen bearbeitet werden: Wandern die Organismen täglich in Relation zum Lichtfeld, zu den Nahrungsbedingungen und/oder zu den Fressfeinden? Trennen sich Populationen unterschiedlicher Arten und/oder unterschiedlicher Entwicklungsstadien der gleichen Art unter bestimmten Umweltbedingungen oder zu bestimmten Jahreszeiten? Ist die geographische Verteilung bestimmter Arten Schwankungen unterworfen und was sind gegebenenfalls die Ursachen dafür?

AUSWIRKUNGEN DER WASSERMASSENZIRKULATION UND DER SAISONALEN MEEREISBEDECKUNG AUF DAS ZOOPLANKTON. Das Projekt ist ausgerichtet auf die Identifikation von Beziehungen zwischen dem physikalischen Umfeld und dem Vorkommen von Zooplankton in der Lazarev-See. Besonderes Gewicht wird auf die mögliche Rolle des Weddell-Wirbels für die Schließung des Lebenszyklus' von Krill gelegt. Die Datenbasis für diese Untersuchung wird geschaffen durch Aufzeichnung multi-disziplinärer Zeitreihen mit verankerten Instrumenten und durch schiffsgestützte räumliche Messaufnahmen.

SAISONALE DYNAMIK DER PHYSIOLOGISCHEN KONDITION VON KRILL MIT SCHWERPUNKT AUF DEN LARVENSTADIEN. Es sollen verschiedene Fitness-Indikatoren, die eine Vorhersage des Rekrutierungserfolges und der Überlebensrate der Nachfolge-Generation erlauben, quantifiziert werden. Bei Arbeiten mit erwachsenen Tieren wird der Schwerpunkt auf die Suche nach den wahrscheinlichen Ursachen für die Reduktion des Metabolismus am Anfang des Winters gelegt, der aber offensichtlich nicht durch Nahrungsmangel ausgelöst ist.

SAISONALE LIPID-DYNAMIK UND ENERGETISCHE ANPASSUNGEN VON *EUPHAUSIA SUPERBA* UNTER BESONDERER BERÜCKSICHTIGUNG DER JUGEND- UND ERWACHSENEN-STADIEN. Die Untersuchungen konzentrieren sich auf die saisonale Dynamik der Lipid-Anreicherung und deren Nutzung. Der Energiebedarf bei verschiedenen

Überwinterungsstrategien und für die Reproduktion soll durch Laborexperimente und mittels Feldmessungen festgestellt werden.

Die umfassenden, dem Krill gewidmeten Forschungsarbeiten werden ergänzt durch zusätzliche Projekte, die andere Zooplankton-Gruppen wie pelagische Tunicate (Salpen), Chaetognathen (Pfeilwürmer) und Pteropoden (Flügelschnecken) in den Mittelpunkt ihrer jeweiligen Untersuchungen stellen. Zentrale Frage bei all diesen Untersuchungen ist, welchen Fraßdruck diese verschiedenen Zooplankton-Gruppen ausüben und welchen Fluss von Materie und Energie durch das Nahrungsnetz und durch die vertikale Wassersäule sie bewirken. Eine weitere Studie widmet sich den verschiedenen benthischen Suspensionsfressern, die zur pelago-benthischen Kopplung auf dem antarktischen Kontinentalschelf beitragen.

Die Reise wird durch eine Journalistin begleitet, die Unterstützung bei der Information der Öffentlichkeit leisten wird. Sowohl das Internet als auch herkömmlichen Medien sollen genutzt werden, um die Ziele, die wichtigsten zu klärenden Fragen, benutzte Methoden und erste Ergebnisse bekannt zu machen.

Fahrtroute

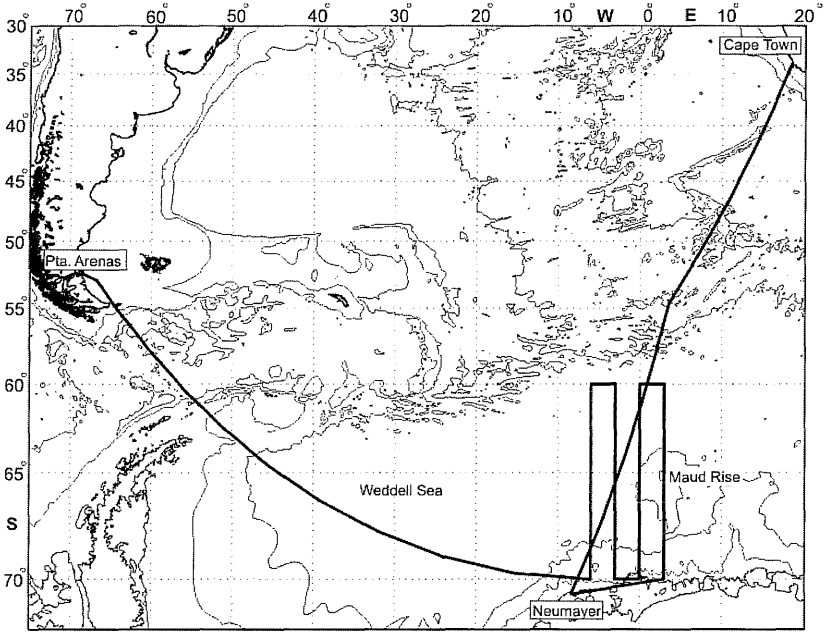

Abb.1 Übersichtskarte des Untersuchungsgebietes und der geplanten Fahrroute der FS POLARSTERN-Reise ANT-XXIII/2. Die Reise wird am 19. November 2005 in Kapstadt beginnen und am 12. Januar 2006 in Punta Arenas enden.

Fig.1 Map of the area of observations and of the planned cruise track of RV POLARSTERN expedition ANT-XXIII/2. The cruise will begin on the 19th of November 2005 in Cape Town and will end on the 12th of January 2006 in Punta Arenas

ITINARY AND SUMMARY

On the 19th of November 2005 RV POLARSTERN will leave from Cape Town for the 2nd leg of her 23rd Antarctic Expedition. During this cruise, which will end on the 12th of January 2006 in Punta Arenas, RV POLARSTERN will support an extensive marine research programme and will supply the Neumayer base as well as scientific expeditions on the Antarctic continent with personnel and material.

In order to supply the base and continental expeditions as early as possible in the Antarctic summer season, RV POLARSTERN will head almost straight towards Neumayer base after departure from Cape Town. On the way to the Antarctic continent and prior to supplying Neumayer station ship time for scientific activities is limited. Marine research is focussed on locations which lie en route the initial way south but will not be visited again later during the cruise.

One project planned to be performed on this route will be the research of the occurrence and distribution of bathypelagic plankton, in particular pelagic species of Mysidacea and Polychaeta. Samples for this project shall be collected with plankton nets in the Cape Basin and in the vicinity of the sub-Antarctic as well as Antarctic frontal systems. Sampling for this project will be continued later during the cruise with net hols near Maud Rise, off Neumayer station, and off the South Sandwich Islands.

En route the way from Cape Town to Neumayer we will also stop at Bouvet Island, where we aim to catch sub-Antarctic eelpouts (zoarcids, supposedly more cold eurythermal) and Notothenioidei by means of baited bottom traps and Agassiz trawls. The so-caught animals will be used in a study of the adaptive competence and ecology of cold-stenothermal Teleostei. After the supply stop at Neumayer station the project will be continued with the same methods in the high Antarctic waters of the Atka Bay.

Depending on sea ice conditions the deployment of a seafloor observatory named MABEL, which is designed for multidisciplinary, long-term missions in the polar environment is planned prior to our visit of Neumayer station.
The primary objective of this project is the complete development and the first operative use of MABEL in Antarctica. MABEL is designed to autonomously and automatically register data for a minimum of one year with the following instruments: a three component broad band seismometer, a vector current meter, a CTD, a transmissometer, a chemical electrode analyser presently equipped with pH and redox electrodes, and a water sampler.

On the southward route from Cape Town another project scheduled and not requiring any ship time is the sampling of the near-surface zooplankton by use of the so-called Continuous Plankton Recorder (CPR), and observations on the highest trophic level. Cetacean sightings and records of other wildlife such as seals, penguins and seabirds will be contributed by observers sent by the International Whaling Commission (IWC) to participate in the cruise. The IWC observers will also record a comprehensive suite of sea ice data. In addition to the visual observations of marine mammals, two different automated monitoring systems will be tested during transit to Neumayer station. The one is a passive acoustic system consisting of towed hydrophone streamers that are custom-tailored to the detection of marine mammals. The other system is based on two infrared cameras, which are mounted at the crow's nest

and are operated with image processing software that will continuously monitor the regions next to the ship for infrared signatures of whale spouts even at night and poor visibility.

The major marine research programme of this cruise will commence after the supply of the Neumayer base and the continental expeditions. It is devoted to the BMBF-funded LAzarev Sea KRIII Study (LAKRIS), a German contribution to SO-GLOBEC.

The Southern Ocean Global Ocean Ecosystems Dynamics (SO-GLOBEC) programme is an international, multidisciplinary effort to understand the physical and biological factors that influence the growth, reproduction, recruitment, and survival of Antarctic krill (Euphausia superba) with special emphasis on its overwintering mechanisms. As part of SO-GLOBEC, the LAzarev Sea KRIII Study (LAKRIS) aims to quantify seasonal population dynamics and physiological condition of krill in an interdisciplinary approach and in a region of the Antarctic that is poorly sampled and understood.

Much of our knowledge of Antarctic krill comes from a few regions, such as the much-studied Antarctic Peninsula. But it is becoming increasingly clear that the seasonal survival mechanisms of krill are variable, so neither the local environment, (e.g. those along the Antarctic Peninsula) nor the response of krill to it, can be extrapolated easily to a wider area. The LAKRIS project will complement the existing international research activities within SO-GLOBEC and CCAMLR (Convention for the Conservation of Antarctic Marine Living resources) along the west Antarctic Peninsula, Scotia Sea and in the Southwest Indian Ocean Sector.

Within the great current systems encircling Antarctica, there is a hotspot of krill density within a sector defined roughly by the Greenwich Meridian (i.e the Lazarev Sea) and the west of the Antarctic Peninsula. Whether this hotspot itself contains one or several "stocks" of krill and whether these are connected with those in the rest of the Southern Ocean are currently topics of intense debate. Understanding krill survival at the seldom-studied eastern extremity of this hotspot may provide some clues in this puzzle.

The Lazarev Sea has been suggested to be the gateway through which the krill population enters the Weddell Gyre. At the 0° meridian krill distribution ranges from approximately 50°S to the Antarctic continent at 70°S - the widest latitudinal range throughout their entire circumpolar distribution. North of 60°S, krill are under the influence of the eastward-flowing Antarctic Circumpolar Current. They are thus downstream of the extensive Scotia Sea populations and reflect spawning success there. But south of 60°S, within the westwards flowing counter currents of the Lazarev Sea, there is little information on krill spawning and larval occurrence. If, however, the Weddell Gyre is the source of high krill densities in the Scotia Sea, then the westward moving water masses of the Lazarev Sea should seed substantial amounts of krill larvae into the system to sustain the large population observed at the northern outflow of the Weddell Gyre.

Field work for LAKRIS will be distributed over three cruises in different seasons, of which this one is the first, apart of a pilot study already conducted during RV POLARSTERN cruise ANT-XXI/4. The LAKRIS-project is divided in 5 subprojects with the following topics:

SEASONAL AND INTERANNUAL VARIABILITY IN KRILL DEMOGRAPHY OF HIGH LATITUDE KRILL STOCKS IN THE LAZAREV SEA. A standardized RMT (Rectangular Midwater Trawl) net sampling programme will be carried out during the LAKRIS study to collect biological data on the krill population in the southern Lazarev Sea. The main focus will

be the estimation of average spatial krill density and the determination of year-class strength in relation to key environmental variables. Reproductive success of the spawning stock will be studied as well as larval distribution and survival during the winter period.

HORIZONTAL AND VERTICAL DISTRIBUTION OF KRILL AND ZOOPLANKTON. Diel vertical migration and geographical distribution of target organisms like krill (Euphausia superba, E. crystallorophias), copepods (Calanus propinquus, Rhincalanus gigas, Oithona spp.), other zooplankter (salps, pteropods, chaetognaths, amphipods) and fish (Myctophiden) will be detected by means of a four-split beam acoustic array (38, 72, 120, 200 kHz). Some major questions are: Do organisms migrate daily in relation to the light field, feeding conditions and/or to the predator field? Do populations of different species and/or different developmental stages of one species segregate in certain environmental conditions or different times of the year? Is the geographical distribution of species subject to change and if so, what are the possible causes?

EFFECTS OF WATER MASS CIRCULATION AND SEA ICE ON THE ABUNDANCE OF ZOOPLANKTON. The project is aimed at identifying relationships between the physical environment and the abundance of zooplankton in the Lazarev Sea. Special emphasis will be put on the possible role of the Weddell Gyre circulation in closing the life cycle of krill. The data base for this study will be collected by moored instruments to reveal temporal variations, by shipboard observations to map spatial distributions, and will also encompass the analysis of historical ADCP (Acoustical Doppler Current Profiler) data from the region.

SEASONAL DYNAMICS OF PHYSIOLOGICAL CONDITION OF KRILL WITH EMPHASIS ON THE LARVAE STAGES. The subproject will quantify various fitness indicators, which will permit the prediction of recruitment success and mortality rates of the following generation and how these factors will be influenced. In adult krill the work will investigate the likely reasons for a metabolic reduction that start at the onset of winter which do not seem to be caused by food limitation at this time of the year.

SEASONAL LIPID DYNAMICS AND ENERGETIC ADAPTATIONS OF EUPHAUSIA SUPERBA, WITH EMPHASIS ON JUVENILE AND ADULT STAGES. The subproject will focus on seasonal dynamics of lipid accumulation and utilization of juvenile and adult stages of krill. Energetic requirements with regard to overwintering strategies and reproductive effort will be quantified using experiments and field data.

Our extensive study of krill will be complemented by further projects, which focus on other zooplankton genera such as pelagic tunicates (salps), chaetognaths (arrow worms) and pteropods. The central question addressed by these projects is the grazing impact exerted and the flow of biogenic matter through the food chain and water column accomplished by those groups of zooplankton. A further study is dedicated to the various benthic suspension feeders, which contribute to the pelago-benthic coupling on the Antarctic shelf.

The cruise will be accompanied by a journalist in order to assist in the information of the general public. Through the internet and the media, we will inform about aims, background, methods and results of the various participating scientific programmes.

2. BATHYPELAGIC PLANKTON OF THE SOUTHERN OCEAN (POLYCHAETA, MYSIDACEA)

Mühlenhardt-Siegel, Hilbig (DZMB)

Objectives
Pelagic species of Mysidacea and Polychaeta shall be captured, identified and enumerated. Due to the scarcity of research activities, very little is known about occurrence and distribution of these groups. Samples are to be taken in the Cape Basin, in the vicinity of the sub-Antarctic and Antarctic frontal systems, between 60° and 65°S, near Maud Rise, off Neumayer station, and east and west of the South Sandwich Islands. The investigation is an addition to the expeditions I - III of the project ANDEEP, during which, among other gear, an epibenthic sledge was used to collect benthic and hyperbenthic fauna. The project is also planned as a pilot study to a more detailed investigation under the umbrella of CeDAMar (Census of the Biodiversity of Abyssal Marine Life).

Work at sea
Mysids are fast swimmers and therefore difficult to obtain with commonly employed nets such as the relatively small and fine-meshed multinet. On the other hand, most projects involving the use of large plankton nets, such as the RMT 8, are designed for the investigation of the biology of the Antarctic krill, and samples are taken in the upper 200 m of the water column. Only a single investigation of nektonic communities of the Southern Ocean has been carried out so far in depths between 200 and 1,000 m. The mysids known to date from depths below 1,000 m are included in material from the large expeditions around the turn of the 20th century, including the "Challenger", "Discovery", "German Deep-Sea", "Scottish National Antarctic", "Swedish Antarctic" and "German Antarctic" expeditions.

Pelagic polychaetes of the Southern Ocean have not been investigated since the middle of the 20th century, and most of the records are from the same expeditions as the mysids mentioned above. Additionally, the problem of pelagic larvae of polychaetes has not been solved. Even though distributional patterns strongly suggest that at least some polychaetes have planktic larval stages, they have never been caught in meaningful numbers, most likely because of inadequate sampling techniques.

The present project is hoped to close gaps in our knowledge of the deep Southern Ocean left open by the project ANDEEP by employing additional sampling gear in an innovative way.

3. ADAPTIVE COMPETENCE AND ECOLOGY OF COLD-STENOTHERMAL TELEOSTEI IN THE EASTERN WEDDELL SEA AND AT THE ANTARCTIC PENINSULA IN COMPARISON TO SUB-ANTARCTIC SPECIES

Lucassen, Koschnick, Wittmann (AWI)

Objectives:
Temperature is one of the main abiotic factors determining the biogeography of poikilothermal fish. Latitudinal distribution of fish populations is thus mainly defined by their tolerance towards temperature, i.e. eurythermal fish inhabit wider latitudinal ranges than

stenothermal species. In polar Teleostei, temperature adaptability differs between high-Antarctic and sub-Antarctic animals. Zoarcidae, which inhabit temperate, subpolar and polar waters, represent a model system for the study of temperature adaptation versus acclimatisation. Our resent studies suggest that Antarctic Zoarcidae avoid the extreme cold high-Antarctic waters, thereby possessing higher tolerance against warm temperature. On the other hand Notothenioidei represent the most important and most specialized fish group in the Southern oceans, occupying all available habitats. Comparative physiological, biochemical and molecular studies of sub-polar species from Bouvet Island and species from the Eastern Weddell Sea as well as from the Antarctic Peninsula from both fish groups should give an insight into universal principles of thermal adaptation strategies at higher phylogenetic levels. Collecting live animals for the continuous work at the AWI is one major aim of the cruise. During the cruise we intend to take a close look on the major cellular energy demanding and providing processes. Ion and pH regulation as a result of active and passive processes across the membrane are very sensitive to temperature changes. Different strategies in the relation of active and passive fractions are discussed for cold-adapted and temperate species. In gills, a close relationship between ion regulation and energy demand becomes visible, as the main ion pump, the Na+/K+-ATPase, is located in the mitochondrial-rich chloride cells. Therefore, the capacities of key enzymes for ion regulation should be linked to aerobic capacities in different species along the latitudinal cline. The second approach will focus on genomic techniques to identify differentially expressed genes within the latitudinal cline and new candidate genes with so far unknown functions, which contribute to thermal plasticity. Therefore, samples from freshly captured as well as acclimated fish will be taken for further analyses at the AWI. DNA extraction and later analyses shall give further insight into phylogenetic relationships of high- and sub-Antarctic fauna, and catch composition of the sub-Antarctic Agassiz trawls will be compared with high Antarctic catches from the eastern Weddell Sea.

Work at sea:
The programme will be performed during ANTXXIII/2 and ANTXXIII/3. By means of baited bottom traps and Agassiz trawls we aim to catch sub-Antarctic eelpouts (zoarcids, supposedly more cold eurythermal) and Notothenioidei off Bouvet Island during the first days of the cruise. In high Antarctic waters (Atka Bay) we expect to catch further, more stenothermal eelpouts and cold-adapted Notothenioidei (ANTXXIII/2). Since the last attempts on ANTXXI/2 to catch eelpouts in these extreme cold waters of the shelf failed, we will use new traps especially designed for deeper waters on this cruise. During ANTXXIII/3, we aim to catch fish at the Antarctic Peninsula near King George Island and/or Elephant Island. 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 on board and at the AWI. For ecological studies the fish composition of all catches will be examined and whole specimens will be preserved for further analyses at the AWI.

Live specimens of sub-Antarctic and high-Antarctic 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 RV POLARSTERN at environmental temperature conditions, and will be sent alive to the AWI at the end of each leg.

On board RV POLARSTERN we intend to investigate the capacity and temperature sensitivity of a number of key enzymes of the respiratory chain, the Krebs cycle and ion regulation in tissue homogenates, membrane preparations and mitochondrial suspensions.

In parallel, serum osmolality will be determined for the respective specimens. The data will be completed by specific mRNA expression studies and protein quantification by means of antibodies at the AWI. The mRNA samples will be further analysed for differentially expressed genes at the institute. Thereby, we hope to identify various strategies of energetic and thermal adaptations in these species along a latitudinal cline and the underlying molecular mechanisms.

4. MABEL OBSERVATORY WEDDELL SEA MISSION.

Calcara, Capua, Lo Bue (INGV)

Introduction

The ocean is a sort of conservative environment, allowing to face different scientific fields like and even more than on land. The study of the oceans is growing always more in importance to evaluate the Global Change. Therefore researches and climate forecasting cannot leave out of consideration of observations, of continuous and of long-term measurements taken through permanent monitoring network on the seafloor. Such observations are necessary to elaborate descriptive and evolutive models of studied phenomena. The Antarctic continent is of fundamental importance to study the past and the present being an area of uncontaminated environment. Antarctica is therefore the most suitable place to study the man induced environmental changes on a global scale. The use of benthic observatories in an innovative approach is complementary to traditional surveys that are sparse in time and in space. The development of a benthic observatory is also a high technological challenge, with few examples in the world of which none in Antarctica. The realisation of a polar observatory is the first step for the installation of a wide variety of scientific instrument in extreme environment, opening a new point of view for scientific research. MABEL project has realised a deep sea polar observatory, and it will be installed on the seafloor of Weddell Sea, on a plateau located north from Neumayer station: 69°23'S/5°20°W. It will register autonomously and automatically for minimum a year data with the following instruments: three component broad band seismometer (100 Hz per channel); Vectorial current meter (2 Hz); CDT (1 sample hour); transmissometer (1 data/hour); chemical electrode analyser presently equipped with pH and redox electrodes (1 data every two days); water sampler (1 sample/week).

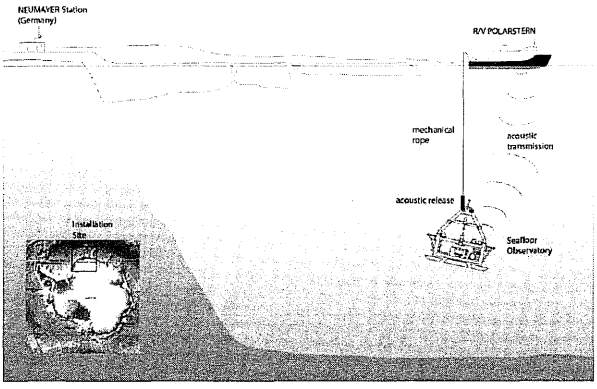

Fig 1: MABEL deposition outline

All these instruments and service packages are time referenced with a high precision rubidium clock. After MABEL deposition, a starting survey will be performed, with initially checks of registered data, recovering a copy through acoustic modem; moreover, in collaboration with other groups present during the ANTXXIII/2 RV POLARSTERN cruise, samples of seawater will be collected at different depths for on board analyses (for sure pH, Eh, HCO, NH, bivalent iron, and other reduced elements) and for on shore analyses, characterising the various seawater strata up to maximum depth, with major, minor and trace elements analyses.

MABEL Specifications

MABEL is a seafloor observatory designed for multidisciplinary, long-term missions in polar environment. It is a GEOSTAR-class observatory, compatible with the infrastructures already developed for the management of the existing observatories of this class, including the special ROV MODUS (capable to handle payload up to 30 kN at 4000 m). In deployment phase, when MODUS is used, it is possible to deploy the observatory in a controlled and accurate procedure, and subsequently recover it at the end of the mission. Once installed, the observatory is able to communicate to a ship of opportunity via a bi-directional acoustic modem.

Objectives

Project objective is the complete development and the first operative use in Antarctica of an innovative multidisciplinary benthic observatory.

The multidisciplinary approach, thanks to the peculiarity and plug and play observatory architecture, permits to acquire simultaneously data normally pertaining to different disciplines. Single data will analysed and confronted with others in order to have both comparison and validation.

The acquisition of one-year time series through the observatory with a unique time reference has the following goals. In seismology: to study the signal/noise ratio in comparison with that of other land-based Antarctic stations; to characterise the local seismicity; to provide at global scale a contribution to the study of high-energy events, Earth tides and Earth free

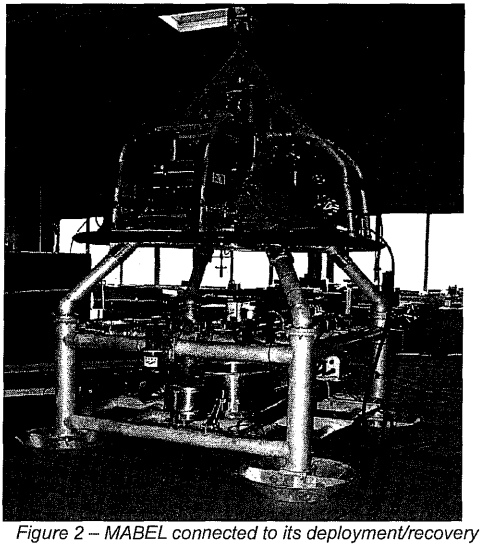

Figure 2 – MABEL connected to its deployment/recovery vehicle during tests at HSVA Hamburg

oscillations. In oceanography: to characterise the benthic stratum through the integration of physical parameters (temperature, salinity, sea current velocity along vertical profile and optical properties) and of geochemical ones. In geochemistry: to define temporal variations of chemical-physical parameters and geochemical parameters related to oceanographic, geophysical, geodynamic and environmental factors; samples collection (roughly one sample every week) for a posteriori aboratory chemical analyses is foreseen. Moreover the temperature data can provide a useful dataset for the evaluation of anthropogenic effects on climate

Work at sea

After the deposition of the station, and as site study, samples of waters pertaining to different depths will be collected in an area not far from deposition zone, for on board analyses (for sure pH, Eh,HCO^-_3, NH , bivalent iron, and other reduced elements) and for on shore analyses, characterising the various seawater strata over all column height, with major, minor and trace elements analyses. Chemical- physical characteristics of the different strata will be recorded as well, and the data will be compared and integrated with oceanographic parameters.

5. NEAR-SURFACE ZOOPLANKTON SAMPLING BY USE OF THE CONTINUOUS PLANKTON RECORDER, CPR

Herrmann (AWI); Hunt (University Vancouver)

General Purpose

The survey is using the sensitivity of plankton to environmental change as early warning indicators of the health of Southern Ocean, as well as serving as a reference on the general status of the Southern Ocean for other monitoring programs. The SO-CPR survey is an independent project, but together with CPR surveys in the northern hemisphere, it is a major survey and monitoring tool able to support GOOS. The SO-CPR Survey is not officially recognised as part of SO-GLOBEC, but contributes to GLOBEC internationally. The SO-CPR Survey is associated with the CPR Survey based at the Sir Alister Hardy Foundation for Ocean Science, Plymouth. Data acquired by partners in the SO-CPR survey are shared between partners.

The specific objectives are:

1. Map the biodiversity and distribution of zooplankton, including euphausiid (krill) life stages, in the Southern Ocean.
2. Assess the seasonal, annual and long term variability in abundance, species composition and distribution patterns of the Southern Ocean zooplankton communities
3. Similarly, assess the variability of abundance and development of krill larvae produced each year.

Methodology

The CPR can be towed from any vessel at speeds up to 23 knots and in conditions up to Force 12. They can be deployed and retrieved at normal ship's speed, although we often slow the ship to 3-5 knots for the final few metres of retrieval to prevent the CPR hit the stern. The CPR is towed 100 m aft of the ship, within the ship's wash, using wire of at least 12 mm diameter, and can be deployed from an A-frame, gantry, davit or similar. The unit cannot be towed in ice. The recorders can be towed continuously with no interruption to shipping schedules for 450 n miles before retrieval. They are purely mechanical, as they are driven by water passing over a propeller, and have no electronic components or power supplies that can fail. The mesh is advanced at a fixed rate of 1 cm per 1 nautical mile, regardless of ship's speed.

Ship time & deployments

No dedicated ship time is required. CPR can be deployed and retrieved at normal ship speed, although brief slowing to 3-5 knots is advisable for the final few metres of retrieval. No deviation is required from the scheduled cruise track. For the ANT-XXIII-2 cruise, tows will be conducted on the route south from Cape Town, commencing at 45°S and finishing at the krill survey area. Further tows are expected to be conducted on the return route to Cape Town commencing on departure from the krill survey area and finishing at 45°S.

6. INTERNATIONAL WHALING COMMISSION SOUTHERN OCEAN COLLABORATION WORKING GROUP (IWC SOC WG) PARTICIPATION ON GERMAN SO GLOBEC SURVEY ANTXXIII/2

Asmus, Glasgow (IWC)

Objectives

Two IWC SOC observers will participate in the second German SO GLOBEC multidisciplinary survey of the Lazarev Sea, Weddell Sea during the austral summer of 2005/06. Both observers are experienced in Antarctic cetacean surveys and sea ice classification. This survey will provide the opportunity to conduct cetacean survey work in the Lazarev Sea study area for a second time, thus providing repeat data for investigation of seasonal variability in cetacean distribution and sea ice. Our aim, in working with a range of international SO GLOBEC and other multidisciplinary programmes (Germany, UK, USA, Australia) is to collect data in each of the Antarctic regions (Weddell Sea, Scotia Sea, Western Antarctic Peninsula, Amundsen-Bellingshausen Sea, Ross Sea and East Antarctica) over a range of seasonal conditions to investigate connections between variability in cetacean distribution and other physical and biological processes for input to local,

regional and circumpolar scale models. Multidisciplinary programs, particularly those conducted under the auspices of SO GLOBEC, provide access to data across disciplines (hydrography, krill distribution, primary productivity) for collaborative analysis and modelling.

Work at sea
The observers will conduct visual survey along track in daylight hours throughout the cruise, dependent upon weather conditions. They will record cetacean sightings and records of other wildlife, using a methodology we have developed for use on SO GLOBEC multidisciplinary surveys. These data will provide distribution data for cetaceans and a biodiversity index for other marine wildlife (seals, penguins, seabirds). The IWC observers will record a comprehensive suite of sea ice data at 10-minute intervals during daylight hours. Digital images and the ASPeCt sea ice classification method will be used for all sea ice observations. Cetacean, marine wildlife and sea ice data will be entered on a laptop on the bridge (connected to live GPS feed from the vessel) using the 'Logger' program that allows real time entry of visual survey, sea ice and other related data fields.

7. MARINE MAMMAL AUTOMATED PERIMETER SURVEILLANCE (MAPS)

Klinck, Boebel (AWI)

Scientific Background
Ship based detection of marine mammals has a broad range of applications. Population ecologists with focus on whale distributions and migratory patterns are interested in effective methods for conducting a census of marine mammals. Users of hydroacoustic instruments are interested to most effectively implement reliable mitigation methods if adverse reactions of marine mammals to the ship's presence may be apprehended.

Objectives
Several methods for the detection, identification and localization of marine mammals will be evaluated. Whales and seals spend considerable periods of time both at the surface as well as submerged, necessitating the employment of multiple methods in parallel to ensure detection regardless of their location. Underwater, vocalizing mammals can be detected by passive sonar. Its usefulness is however currently compromised by intrinsic vessels noise, which will mask particularly low- to mid-frequency vocalizations of the mammals. We pursue the development of modern signal processing methods to optimally separate the sounds and provide the optimal sensitivity for the bioacoustic signals. Near the surface, whales might be recognized by their warm blow, which stands out against the cold Antarctic environment. Here, research will focus on establishing pattern recognition software, to automatically and reliably detect whale blows under varying environmental conditions.

Work at sea
A passive acoustic system custom tailored to the detection of marine mammals will be deployed while cruising. The system consists of three streamer segments, each containing five broad band hydrophones on a portable winch with 700 m tow cable and a signal processing unit.

In addition two infrared cameras mounted at the crow's nest with image processing software will continuously monitor the regions next to the ship for infrared signatures of whale spouts

even at night and poor visibility. The acoustic and infrared systems were tested for the first time during expedition ANT XXII/3 (January – April 2005). Based on these results several modifications are implemented in the current system design. During the ANT XXIII/2 expedition (polar summer) and the ANT XXIII/6 expedition (polar winter) the modified systems will be tested in detail.

Both at the summer and the winter expedition visual surveys will be executed by a group of experienced scientist. The number of visual whale sightings can be compared with the automated detections of the MAPS System. Thus the efficiency of the system can be evaluated. The results of both expeditions are important for improving the automated detection of marine mammals in the vicinity of RV POLARSTERN for future MAPS deployments.

8. BIOLOGICAL AND POPULATION DYNAMIC STUDIES ON KRILL AND ZOOPLANKTON IN THE LAZAREV SEA

Siegel, Haraldsson, Vortkamp (BFA Fisch)

Introduction

The Antarctic krill *Euphausia superba* is one of the few large marine resources currently not used to its maximum potential yield. Recent estimates show a possible biomass of up to 155 million tonnes for the Antarctic Ocean. This study did not include areas such as the Weddell Sea or the Lazarev Sea for which we have hardly any quantitative data on krill densities. New models are currently developed for a sustainable use of the krill resources for which we first need information on basic biological parameters to test the robustness of these models. Fortunately this scientific exercise is currently not under serious time pressure, because the total annual catches of approx. 100,000 t are far below the potential yield and the catch limit of 4 million tonnes for the Atlantic sector. Precautionary management procedures can be developed without the resource already being exploited to its maximum level.

Objectives

The work during the planned survey is centred around the data collection to describe krill population dynamics in the Lazarev Sea. Most programmes are currently concentrating their effort in the Antarctic Peninsula /Scotia Sea region, where the major krill fishery takes place and is managed by the Convention for the Conservation of Antarctic Marine Living resources (CCAMLR). However, estimates of stock size and changes in stock size and composition are essential for all sectors of the Antarctic Ocean, because first results indicate that regional differences do occur, but at the same time far ranging connections exist between large scale areas. Therefore, the planned activity in the Lazarev Sea is a valid extension and reference point outside the fished areas compared to the western Atlantic sector. The Lazarev Sea seems to play an important role as the gate way from the Indian Ocean into the Weddell Gyre, and may therefore have its influence on the water masses and krill stocks in the Scotia Sea. Confirmation is needed whether the Lazarev Sea population is a seeding stock for the Weddell Sea, which could make it an important upstream source population for the currently fished stocks in the Scotia Sea, or whether the Lazarev Sea obtains its krill via the northern route from the eastern Scotia Sea, thus representing simply downstream expatriates from the western Atlantic.

Current knowledge

Antarctic krill have a circumpolar distribution, however, some areas show distinctly higher krill densities than others, such as the Antarctic Peninsula, the Scotia Sea and Bellingshausen Sea. The krill habitat is the seasonal pack-ice zone, i.e. in summer krill live in large aggregations in the ice free areas, whereas during winter krill are almost exclusively found in the heavily ice-covered areas of the Southern Ocean.

In the Atlantic sector krill distribution shows a strong seasonal pattern. During summer spawning krill inhabits the offshore areas beyond the continental slope. At the end of the spawning season these areas are abandoned and krill aggregate in the coastal zone. At the same time large concentrations are still drifting through the eastern Scotia Sea to the east. Very little is known on the fate and destination of krill after passing this area in autumn. It is speculated that krill might drift eastwards beyond Bouvet Island and then turn south into the Lazarev Sea.

Krill stocks in the South Atlantic do not only show seasonal fluctuations, but also undergo interannual changes in distribution and abundance. During the late 1970ies and early 1980ies krill biomass was found to be on a relatively high level. From that time onwards krill biomass has decreased by almost one order of magnitude. If the Scotia Sea is connected with the Lazarev Sea and the Lazarev Sea with the Weddell Gyre, then the effect should also occur in the Lazarev Sea. This would effect the entire re-distribution of the krill stocks and also the krill fishery and the krill predators in the down stream areas.

Especially the sea-ice conditions during the austral winter affect the reproductive cycle and the recruitment success of krill. These effects become most obvious in those areas with narrow sea-ice belts such as the Antarctic Peninsula, because they are strongly affected by climate changes. The Lazarev Sea with its vast winter sea ice cover is probably buffered against rapid changes and may therefore still allow a successful spawning and recruitment of krill and serve as a source area for other areas during times of poor krill recruitment which are more rapidly and seriously affected by climate changes. These hypotheses have to be tested during the coming RV POLARSTERN cruises.

CCAMLR working groups have developed a krill yield model, which considers biological stock parameters to estimate potential yield. Among these parameters the most important ones are biomass, age composition, size and age at maturity, growth, mortality and recruitment. For most of these parameters necessary values are available from the Antarctic Peninsula region. However, preliminary studies indicate that conditions for population biology and dynamics may be different in other areas. Quantitative data on krill life-cycle are therefore needed from areas adjacent to the fishing grounds, and use those as reference points for the unexploited part of the population and to receive data on the natural variability of biological parameters.

Work at sea

Since 1976 the Seafisheries Institute in Hamburg is actively involved in studies of the krill stocks in the South Atlantic. Emphasis was placed on estimating biomass and recruitment indices in the South Shetland Island region as a reference area. With the gained knowledge in this highly productive and very dynamic area, we will establish a comparable data set from a high latitude area with different environmental conditions to look for congruence or differences in krill life cycle strategies. This study will be based on a regular standardized station grid in the southern Lazarev Sea similar to the establish Elephant Island survey grid. Direct comparisons will be possible for krill growth parameters, reproductive effort and recruitment success which finally determine krill stock size. Repetitive sampling during

different seasons will also allow us to gain information on seasonal aspects of the reproductive process, occurrence of larval stages, vertical and horizontal migration patterns as well as changes in the changes of zooplankton biomass and diversity.

The routine sampling gear will be the Rectangular Midwater Trawl (RMT 1+8) which has become the standard tool for quantitative sampling of Antarctic krill and thus allow direct comparisons with other data set collected in other areas around the continent. The RMT 8 (8 m^2 opening and 4.5 mm mesh size) will be used for krill and the macro-zooplankton fraction, while the RMT 1 (1 m^1 and 333 µm mesh size) samples will be analyzed for larval stages. The net will be equipped with depth sensor to monitor the track of the net and with a flow meter to allow the calculation of filtered water volume.
The work will be conducted along four meridional transects extending from the continental ice-shelves across the narrow shelf into the open ocean up to 60°S. Routine net sampling and CTD stations will be carried out each 30 miles. Additional time will be allowed for net samples to target for aggregations detected by acoustics. All krill will be immediately sorted from the sample for later measurement of length and identification of sex and maturity stages. Simultaneously salps will be removed from the samples and measured, because these organisms are important components in the carbon-cycle and possibly a strong competitor to krill for phytoplankton food resources. All other zooplankton species will have to be identified and counted at a later stage.

9. DISTRIBUTION AND BIOMASS OF KRILL AND ZOOPLANKTON: ACOUSTIC SURVEY

Herrmann, Hohn, Krägefsky, NN (AWI); Siegel (BFA Fisch); Giesecke (Universidad de Concepcion)

Objectives
Since the early assessments by the DISCOVERY expeditions between 1930 and 1960 we know about the spacious distribution of substantial stocks of Euphausia superba. Commencing with the BIOMASS program, the determination of krill catch quota by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) is based on acoustic stock assessments.
Compared with, for example, the Antarctic Peninsula area, there is only rare information about the development in krill stock in the Antarctic waters of the Eastern Weddell Sea and the Lazarev Sea during the last decades.

Work at sea
To survey the spatial distribution of *Euphausia surperba* and the zooplankton, including possible prey organism of krill multifrequency acoustic measurements will be made by a Simrad EK60 scientific echosounder with the frequencies 38, 70, 120 and 200 kHz. Sampling and processing of acoustic data will be carried out in accordance to the CCMLAR standard procedures. E.g. using different scattering models and discrimination methods, additional data analysis will be performed, to account for current difficulties in interpretation of acoustic measurements.

For comparison with and biological calibration of the acoustic survey data net samples of zooplankton will be taken with the multinet. Roughly 30 vertical nethols in the upper few hundred meters of the water column are planned using mesh sizes of 55 and 300 mm.

In addition, the Bongo Net will be employed to also catch larger zooplankton animals such as amphipods, which are able to swim fast enough to escape the multinet. Once on board, the net samples of zooplankton will be preserved using a 4% solution of Formol in sea water and then stored in Nalgene bottles. Gelatinous plankton like jelly fish will be sorted out before, with their biomass determined separately.
Beyond the purpose of calibration of the acoustic survey data the zooplankton net samples will be used for an investigation of the spatial distribution of different developmental stages of the various species.

10. EFFECTS OF WATER MASS CIRCULATION AND SEA ICE ON THE ABUNDANCE OF ZOOPLANKTON

Cisewski, Gerull, Poppe, Otto, Strass (AWI); Leach (University Liverpool);
Rohr (Optimare)

Objectives:
The project is aimed at identifying relationships between the physical environment and the abundance of zooplankton in the Lazarev Sea. The overarching goal is to reveal whether or not the Weddell Gyre circulation acts as a mechanism that supports krill by closing its life cycle. In particular we seek answers to the following questions:

- Does the distribution pattern of zooplankton, and especially of krill, correlate with the distribution of water masses?
- Are horizontal differences in the demographic structure of the krill population explicable by advection?
- Which patterns of diurnal vertical migration of zooplankton can be identified, and how do these change during the course of the year?
- Are there physical variables that can be used as predictors of the zooplankton vertical migration pattern?

Work at sea:
The data base for this study will be collected by moored instruments, employed to reveal temporal variations, and by shipboard observations, used to map spatial distributions.
In order to derive multi-annual time series of zooplankton abundance we will make use of backscatter measurements obtained from acoustically calibrated ADCPs (acoustic Doppler current profilers). Three of such instruments were deployed one year ago, and will be recovered and redeployed during the cruise. Time series of physical variables, recorded at the same mooring positions at various depths, include current vectors, temperature and salinity (and density), as well as sea ice thickness and sea ice coverage measured by upward looking sonars (ULSs).

The backscatter signal of the moored ADCPs will be compared with that measured by a similar instrument that is installed in the keel of the ship, which itself will be calibrated against zooplankton abundance data derived from net catches. The ship-based measurements of zooplankton abundance will be accompanied by vertical profiles of currents (from the very same instrument, the vessel-mounted ADCP) and of temperature, salinity and density, chlorophyll fluorescence and light transmissivity, taken with a CTD at hydrographic stations. The carousel water sampler attached to the CTD will be the main device used to provide water samples for the analysis of a variety of other variables. The hydrographic stations will be distributed between and around the mooring positions at a regular horizontal grid.

It is expected that, by combining physical oceanographic measurements made at a regular grid, which is fine enough to resolve mesoscale variations but large enough to cover the gyre-scale features, with Eulerian time series records, we will succeed to describe the circulation pattern of the eastern margin of the Weddell gyre more accurately than at present and accurately enough for a reliable study of advection of zooplankton.

11. SEASONAL DYNAMICS OF PHYSIOLOGICAL CONDITION OF ANTARCTIC KRILL EUPHAUSIA SUPERBA

Meyer, Fach, Fuentes, Hayden, Pape, Spahic (AWI); Auerswald (University Cape Town)

Objectives

The physiological mechanisms which enable krill to survive during winter when most of the Southern Ocean is covered by sea ice and the major summer food source phytoplankton is scarce, are still poorly understood. The following four overwintering mechanisms of adult krill are under debate; reduced metabolism, lipid utilisation, alternative food sources and body shrinkage but the importance of these different strategies for krill survival is not clearly known. However, the reduction in metabolic rate is regarded as one of the most important energy-saving mechanisms for adult krill during winter (Quetin and Ross 1991). Meyer et al. (2002) found a significant reduction in the metabolic key enzyme citrate synthase activity compared to summer values. Metabolic rate measurements and feeding experiments during a SW Lazarev Sea autumn study have shown that juveniles and adults have threefold reduced oxygen uptake rates compared to rates measured during summer. They also failed to respond with increased rates even after exposure to high food concentration for 11 days (Atkinson et al. 2002). These findings favour the theory of an adaptive seasonal strategy for juveniles and adults. The mechanisms that cause these reductions in metabolic rates are still unknown but very significant for our understanding of how krill survives the winter season and how this relates to their population development and recruitment success. Based on our previous findings we believe that internal physiological functions of krill may be influenced or induced by the annual photoperiod in the Antarctic. Changes in the photoperiod may be connected to differences of melatonin secretion in krill, which are expected to influence its physiology. To reach a better understanding of the different overwintering mechanisms and whether melatonin has an influence on physiological functions major krill functions have to be studied with the same experimental set up in different seasons and with different developmental stages. This includes filtration-, feeding-, respiration-, excretion rates, as well as krill growth. It is of great importance to monitor the development of these features over different seasons when environments change, as well as record interannually change. In addition the production of melatonin in different seasons and its influence on physiological mechanisms and behaviour has not yet been studied in Antarctic krill E. *superba*.

The project goal of the cruise is to characterise the physiological condition of krill by analysing their length, dry mass, elemental (carbon, nitrogen), and biochemical (protein, lipid, carbohydrates) composition, their melatonin concentration as well as their metabolic rates (respiration -, excretion, metabolic enzymes) and growth. Additional feeding experiments with possible food sources (natural seawater =NSW, NSW enriched with ice algae and zooplankton) will show the amount of food ingested. Starving experiments with juvenile and

adult krill will give us information's on changes in morphometric parameters, elemental and biochemical composition during starvation.

Work at sea

The planned investigations will be carried out in the Lazarev Sea. The plankton net RMT1+8 will be used as standard gear to collect krill samples from the upper 200 m surface layer at several LAKRIS grid stations. Part of the freshly caught krill will be frozen at -80°C or in liquid nitrogen for later analyses in the laboratory (length, dry mass, elemental- and biochemical composition, melatonin concentration, activity of metabolic enzymes). The remaining krill will be kept alive to measure their metabolic rates and to analyse the feeding activity of krill and their starvation tolerance. Krill will be fed with NSW obtained from CTD water samples taken from the chlorophyll maximum. For the feeding experiment enriched with zooplankton we will capture prey organisms from nighttime 0-150 m hauls from the krill collection area by use of the Bongo net and from 0-50 m catches with a hand-hauled Apstein net. The ice algae used in the feeding experiments will be obtained by scooping up brown discoulered chunks of sea ice with the ships's crane, slowly thawing lumps in seawater at 2°C, and sieving out large particles through 100µm gauze. Our investigation on this cruise is part of the LAKRIS-Project (Lazarev Sea Krill Study, subproject 4).

References

Atkinson A, Meyer B, Bathmann U, Stübing D, Hagen W, Schmidt K (2002) Feeding and energy budget of Antarctic krill *Euphausia superba* at the onset of winter. II. Juveniles and adults. Limnol Oceanogr 47: 953-966

Meyer B, Saborowski R, Atkinson A, Buchholz F, Bathmann U (2002) Seasonal differences in citrate synthase and digestive activity in larval and postlarval Antarctic krill, *Euphausia superba*. Mar Biol 141: 855-862

Quetin, L. B., and R. M. Ross. 1991. Behavioral and physiological characteristics of the Antarctic krill, *Euphausia superba*. Amer. Zool. 31: 49-63.

12. KRILL LIPIDS

Stübing, Schukat (University Bremen)

Objectives

This study aims at characterising the physiological condition and feeding behaviour of krill directly prior and during the energy demanding mating and spawning period by means of lipid analyses. Apparently, the reproductive costs are not just high for the females, but also – and maybe even higher – for the males. An unusual phenomenon in the life cycle of *Euphausia superba* is the high mortality rate of post-reproductive males. Previous studies have revealed that their lipid reserves were completely depleted. Unlike the other Antarctic euphausiids, *Euphausia superba* does not rely on internal reserves for fuelling reproduction but is dependent on external resources making use of the summer phytoplankton bloom. It is planned to comparatively study the energetic demands of reproductive males and females, to identify potential sexual differences in feeding behaviour (i.e. is there some kind of "resource management"), to elucidate the biochemical processes linked with reproduction and thus contribute to the understanding of the ecological significance of this phenomen.

Lipid content and lipid class composition indicate the amount and type of energy reserves and will be measured separately for each maturity stage available. The fatty acid composition reflects the animals' feeding histories integrated over several weeks and is thus an important supplement to the classical gut content analyses providing short-term trophic information.

Sampling will be carried out in parallel to the demographic studies of V. Siegel. The data may provide ecological information that help understand the observed distribution patterns. Furthermore, in comparison with the lipid data from previous summer expeditions a potential interannual and geographic variability of nutritive status and general fitness of the different development stages in the investigation area can be detected.

Work at sea

A characteristic feature of the life cycle of *Euphausia superba* and probably of some other Antarctic euphausiids (*Thysanoessa macrura, E. frigida*) is the so-called developmental ascent. The lipid composition of krill eggs and early larvae is only poorly studied so far. Hence, we plan to investigate the biochemical composition of krill eggs, nauplii, and calyptopes and to monitor potential changes in lipid composition and hence physical properties during embryonic and larval development and how this might influence the sinking versus rising behaviour of the eggs and larvae, respectively. Additionally, further light might be shed on the energetic and structural requirements for specific lipids during embryonic and early larval development which are entirely fuelled by the yolk reserves of the eggs.

Another central topic is the accumulation of lecithin, which may attain exceptionally high levels in polar euphausiids. The physiological significance of this unusual phenomen is still unknown. The identification of the position of the lecithin stores in the krill body (i.e. proximity to certain organs) and their ultrastructure, as well as a potential selctive utilisation or conservation of this reserve under controlled feeding or starvation conditions may provide information on the ecophysiological role of this membrane lipid. Accordingly, lipid-rich juvenile and adult krill specimens are to be specifically prepared for various histological analyses (cryo-sections, transmission electron microscopy).

13. PELAGIC TUNICATE (*SALPA THOMPSONI AND IHLEA RACOVITZAI*) ABUNDANCE, DISTRIBUTION, DEVELOPMENTAL AND ELEMENTAL COMPOSITION AS WELL AS FEEDING INTENSITY AND GRAZING IMPACT IN THE LAZAREV SEA

Schmidt (AWI); Gurney, Hunt, Pakhomov (University Vancouver)

Project goals

This project is a continuation of the salp biology project currently run at the AWI. The fall cruise ANT XXI-4 has been successful in obtaining novel information of the salp distribution patterns, their densities and feeding activity in the Lazarev Sea. One of the unexpected findings during this cruise was the presence of high concentrations of S. thompsoni in the near costal region, suggesting that this species could have been advected into the region recently or may have established viable population in the south most parts of the Lazarev Sea. The origin of this population is unknown. Since salps may insert dramatic grazing impact, it would be extremely valuable to obtain year round observations on salp biology as their complete life cycle in the high Antarctic under severe environmental conditions is still unknown. This in term would help to predict behaviour of this "warmer" water species in the region south of the Antarctic Polar Front under changing climatic conditions. During the present cruise, we will follow the salp population structure and distribution in the field as well as growth of salps *Euphausia superba* . Furthermore, we will carry out *Euphausia superba* feeding experiments to estimate their grazing impact in the different areas. In addition, the

gut content of salps of different regions will be analyzed to determine their in situ food ingestion and digestion over different depths.

Work at sea

1) Salps will be collected from RMT-8 samples according to the stations of the krill grid and will be counted, sexed, measured and developmental stage identified.

2) Bongo net samples in the top 200 m will be needed to sample animals for experiments. Essentially, three types of experiments will be carried out: a) grazing *Euphausia superba* (just salps and in combination with krill); (b) salp fecal pellet production rate experiments as short incubations just after sampling providing close to *in situ* ingestion rates; (c) growth rate experiments will involve keeping salps in large containers for 1-2 days and measure their growth over this short period of time.

3) To obtain an indication of salp feeding activity in the different regions, representative samples of salp guts will be collected with Bongo nets (~100 m), frozen and kept at –80°C for subsequent gut fluorescence measurements and HPLC analysis in the laboratory at home. Additionally, samples from different depths caught with the multinet (eventually in combination with sampling of mesopelagic micronekton by Svenja Kruse) at representative stations will allow to determine effects of digestion on the pigment composition. Water samples from according depths for later analysis of the Chl a concentration and pigment composition in the field will be taken.

4) Salps caught in nets for other use („bycatch") will be sampled whenever possible, frozen and kept at –80°C for further biometric analysis at home.

14. PTEROPOD TROPHODYNAMICS

Bernard, Jennings (Rhodes University)

Objectives

There are three aims to the research to be conducted in project during ANT XXIII/2:

1) to determine the spatial distribution of thecosome pteropods in the Lazarev Sea
2) to determine the grazing impact of dominant thecosome pteropods in the Lazarev Sea
3) to examine faecal pellet production of *Limacina helicina* in the Lazarev Sea

Work at sea

1) Spatial distribution

We aim to determine the summer time distribution, both vertical and horizontal, of thecosome pteropod species (including *Limacina helicina* and possibly *Clio* spp.) in the region of the Lazarev Sea. In addition to the general distribution trends, the spatial distribution of the size classes of the pteropod, *L. helicina*, will be assessed. Four size classes have been identified, namely veliger, juvenile, sub-adult and adult. A multinet sampler with a mesh size of 200 µm will be used to collect samples at selected depths. Thecosomes will be removed and stored in 6 % buffered formalin for analysis in the laboratory. Individuals will be separated by size class and counted.

2) Grazing impact

In addition to spatial distribution patterns of thecosome pteropods in the Lazarev Sea, our research aims to provide an estimate of the grazing impact of the four selected size classes of *Limacina helicina* as well as the grazing impact of any additional thecosome pteropods collected during the cruise (e.g. Clio spp.). Grazing impact will be determined using the gut fluorescence technique. Three types of experiments will be conducted to obtain the following variables used in the calculation of individual grazing rate (I, ng(chl)ind^{-1}day^{-1}):

1) integrated gut pigment content over a 24 hour period (G, ng(pigm)ind^{-1}day^{-1});
2) gut evacuation rate (k, h^{-1});
3) gut pigment destruction rate (b^1, non-dimensional).

$$I = kG /(1- b^1)$$

In order to obtain integrated gut pigment content (G), the diel variability in gut pigment contents of the selected size classes of *Limacina helicina* and *Clio* spp. will be assessed. Pteropods will be collected at approximately 4-hour intervals over a 24-hour period. Samples will be immediately anaesthetized in carbonated sea-water (by adding bicarbonate powder). The pteropods will then be sorted according to size class and/or species under low light conditions using a dissecting microscope. Once a sufficient number of individuals for each size class and/or species are collected they will be placed into plastic test tubes (10 mL) with 8 mL of 90 % acetone and stored at – 20°C for 24 hours. After centrifugation (5000 rpm), pigment content of the acetone extract will be measured fluorometrically, before and after acidification. Gut pigment content will be integrated by trapezoidal integration.

In order to calculate the gut evacuation rate (k, h^{-1}), freshly caught pteropods will be gently placed into a 20L plastic bucket filled with particle-free water (passed through 0.2 µm filters) to which non-fluorescent charcoal powder will be added. Experiments will be carried out in a temperature controlled room. Sub-samples of pteropods will be collected every 10 minutes for the first hour and every 20 minutes thereafter, with a total incubation time of 2 hours. Pteropods will be anaesthetised and sorted as described above, and gut pigments determined fluorometrically. The gut evacuation rate will be derived from the slope of the regression of the natural logarithm of gut pigments versus time.

In order to calculate gut pigment destruction rate (b^1) independent measurements of gut pigment loss will be made. Active individuals will be gently placed into a 20 L bucket of particle-free water (as described above for gut evacuation rates) and allowed to empty their guts for 24 hours. 8 L of natural seawater will be placed into a 10 L plastic bucket. A 500 mL sub-sample will be removed and the chlorophyll-a concentration assessed at the start of the incubation period. A single pteropod will then be placed into the remaining seawater and incubated for 1 hour, after which the chlorophyll-a concentration of the water and the gut pigment content of the animal will be estimated. A total of ten replicates will be prepared. Loss of pigment due to destruction can then be calculated using the following equation:

$$b^1 = \{[(Gt - Pb)/P]^{-1}\} \times 100$$

Where Gt is gut content per individual, Pb is background fluorescence per individual and P is total amount of pigment ingested per individual (calculated from the difference between control and experimental water assemblages).

3) Faecal pellet production
Evidence suggests that thecosome pteropods may contribute substantially to carbon flux in regions where they occur in abundance. Much of this research is focussed on the occurrence of pteropod shells and remains of mucous webs in sediment traps. The aim of this section of our research is to examine the faecal pellet production of *Limacina helicina* in order to assess the role that these thecosomes may potentially play in enhancing localised carbon flux through the sinking of their faecal pellets. Active individuals will be starved in particle-free seawater for 24 hours, after which they will be transferred to an aquarium containing natural seawater where they will be allowed to feed for 2 hours. At the end of the feeding period the animals will be removed and the water filtered out onto a small fine-meshed sieve. Any faecal pellets collected will be rinsed with distilled water. All faecal pellets will be counted and faecal pellet production rates per individual pteropod will be calculated. After this, a number of experiments will be conducted on the faecal pellets. Some faecal pellets will be used to determine sinking rates, which will involve measuring the time taken for a faecal pellet to sink a certain distance in a 1 L glass cylinder. Other faecal pellets will be used to determine the chlorophyll-*a* content and therefore carbon content of the pellets. Chlorophyll-a content of the pellets will be determined fluorometrically. Other faecal pellets will be dried and their biomass recorded.

15. CHAETOGNATHS IN THE ANTARCTIC PLANKTON FOOD WEB

Giesecke (Universidad de Concepción)

Background
Antarctic food web studies are principally dominated by studies on krill and vertebrates. Less attention is given to the rest of the planktonic food web and especially on the phylum chaetognatha. The first attempt to describe and characterize the zooplankton and micronekton community has been done by Hopkins (1985). Since then, many studies on the biology and ecology of the zooplankton community improved our knowledge, but, accurate information on feeding behaviour and trophic ecology of the carnivorous zooplankton is still lacking. The Southern Ocean covers an extensive area that contains different water masses with plankton communities of different structure, origin and living conditions. Therefore, large variations on the food web dynamics should be expected.
Chaetognaths are dominant zooplankton predators which may reach ~30% of the copepod wet weight biomass in global oceans including Antarctic oceans. Copepods form the basis of chaetognath diets, so predation impact and the role of these predators on population dynamics of copepods can be very significant, being one of the key species which structure the zooplankton community and the energy flow in the pelagic realm.

The most abundant species in Antarctic waters *are Eukrohnia hamata, Sagitta gazellae and S. marri* attaining 90 to 95% of total chaetognath abundance. Previous work on the trophic impact of this species has been carried out in a more precise way by Øresland (1995) and Froneman et al. (1998) in the Gerlache Strait and Marion Island, respectively. They established predation impacts by analyzing gut contents of individuals; however, they may have overestimated their feeding rate by applying a digestion time from organism living at higher temperatures (6°C). The proposed idea for further work on the Antarctica on chaetognaths ecology is to make experiments to improve the knowledge of feeding rate estimates with special interest on digestion time of E. *hamata*.

Objectives:
1) To assess the distribution and abundance of chaetognaths.
2) To study the predation impact of chaetognaths and their possible effects in modify the vertical fluxes of particulates.

The latter will be subjected to changes depending on the availability of fecal pellets to estimate sinking velocities and carbon content, as well as the possibility to analyze sediment trap samples to estimate chaetognath-faecal pellet export.
It is known that the large individuals of *Eukrohnia hamata* occurs deeper than small individuals (Hagen 1985), for this reason, the size spectrum of chaetognaths will be considered to study their trophic impacts.

Work at sea
On board I will perform experiments with live chaetognaths collected with and wp-2 net specially equipped to collect undamaged organisms. The organisms collected will be transferred into small aquaria and feed with natural diet and observed every 30 minutes to determine the moment when the chaetognath captures their prey and observed until it defecates (Giesecke and González 2004). The fecal pellets produced by those experiments will be used to estimate their sinking velocities and carbon content. All fecal pellets will be photographed and characterized in order to be able to identify them in the sediment trap samples.
I expect to obtain valuable information about the digestion time of the dominant species of chaetognaths (mainly *Eukrohnia hamata*) to be able determine predation impact of this specie on the copepod community. The later will be estimated by gut content analysis of chaetognaths. Parameters as species diversity will be related to oceanographic conditions, since certain chaetognaths species are characteristic of particular oceanographic conditions and therefore good indicators of water masses.

16. PELAGO-BENTHIC COUPLING UNDER AUSTRAL SPRING-SUMMER CONDITIONS

Broglio, Homs, Vendrell (ICM-CSIC)

Objectives
The main objective of the present project is to test several hypotheses on the mechanisms of the ecological success of benthic Antarctic suspension feeder communities. The research plan is based on recent research work in the Antarctic benthic ecosystems. We propose to investigate aspects related to the trophic ecology of suspension feeders and the environmental conditions which facilitate the energy transfer between water column and benthic systems. We want to clarify the following questions: To what extent are the abundance, reproduction and patchiness of suspension feeder communities a consequence of biological and environmental factors? In particular: Is the quantity and quality of sinking organic matter in the water column significant for benthic suspension feeders? Which processes are responsible for the availability of food for suspension feeders? Which is the role of bacteria in the diet of benthic organisms and how do the latter influence the growth and production of microbial communities near the bottom? How do suspension feeders participate in nutrient remineralisation?

Our overall objective is to analyse the pelago-benthic coupling on the Antarctic shelf. Therefore, our concrete objectives are:

1) to study environmental and biological features of the water column which facilitate the development of rich suspension feeder communities found in Antarctic shelf areas.
   In particular, to study the availability and the qualitative and quantitative changes of sinking phytoplankton, sea-ice algae and other particulate organic matter throughout the entire water column, from the surface layers to the benthic boundary layer.
2) to study benthic suspension feeders in order to evaluate their role in the enhancement of microbial processes due to their excretion products, as well as their role in matter remineralisation.
3) to analyse the differences in these processes in different areas, Lazarev Sea and Antarctic Peninsula area of the Weddell Sea.

Work at sea

I. We will collect water samples from the stations above the shelf with a CTD rosette at several depths from the sea surface to the bottom.
II. We will sample for the analysis of inorganic nutrients, chlorophyll a and phaeopigments, biochemical composition of particulate organic matter (carbon, nitrogen, biogenic silica, lipids, carbohydrates and proteins), dissolved organic matter, abundance and biomass of planktonic microbial assemblages.
III. We will collect sea-ice samples for the characterisation (abundance and biomass) of the associated microbial assemblages.
IV. We will analyse bacterial production in spring and summer by measuring tritiated leucine incorporation.
V. Samples of benthic suspension feeders will be collected from the sea floor and transferred to incubation chambers at in situ simulated conditions, where changes in selected parameters –nutrient concentrations, bacterial biomass, activity and production, eukaryotic composition and biomass, particulate organic matter (carbon, nitrogen, biogenic silica), as well as filtration rates will be measured.

Expected results

1) We expect a relative high nutritive value of microalgae and other organic matter reaching the bottom water layers in spring-summer due to sea-ice melting.
2) We expect higher organic matter content and higher nutritive value of organic matter near and in the bottom sediments in spring-summer than in summer-autumn due to seasonal euphotic zone exports.
3) We will be able to answer the question: do benthic organisms (gorgonians and sponges) feed on coarser particulate matter (nano- and microphytoplankton and/or faecal pellets), than in autumn, or do they always filter only the very fine fraction of seston?
4) Our investigations will expose a possible contribution of benthic metazoic communities to the remineralisation of nutrients.

17. JOURNALISTIC DOCUMENTATION

Demmler

The expedition ANT XXIII/2 focusses on the Antarctic krill (Euphausia superba). The biology, especially overwintering mechanisms and other aspects of species life cycle, is extremly important for research on the key species of the Antarctic pelagic systems. Moreover, these facets of polar biology raise strong interests in the general public. To accomplish the need for public information, the cruises of the AWI krill project will be accompanied by a journalist.
To achieve this goal, we will realize the following projects:

1. Contribution to the LAKRIS-websites
The websites on the krill project LAKRIS are organised in two parts: a scientific sec-tion and a documentation for politicians and the general public (including school children). We will contribute high quality photo documentation with pictures from the cruises, the scientific results and the work and correspondingly, informative but easy understandable written text. The public section will inform about aims, background, methods and results of krill research in the context of LAKRIS and of corresponding international programmes.
In more detail, photos will be taken of the different working groups using their instru-ments on deck and working in their laboratories and containers, and to compile later a selection of aesthetic, expressive photos to which short texts will be written. The required information about research methods and contents will be obtained particularly by discussions with the working groups on board.

2. Art book Antarctica
The participation in ANT III/2 also provides the opportunity to take photos for an artistic book about Antarctica, that should be published by Tecklenborg Publ. The book will show Antarctica mainly from the aesthetical-literary point of view. Among others, it will contain a selection of photos, drawings and paintings (also from the expedition painter Gerhard Rießbeck from previous cruises), extracts of diaries or expedition reports.

3. Articles for media
Last but not least, we will publish articles in newspapers and journals on demand and in relation to the events happening during the cruises. This will ensure that the public will be informed on interesting aspects on time.

All these activities will be prepared and carried out objectively in close cooperation with the scientists on board and in agreement with the goals and concepts of the scientific programmes.

18. BETEILIGTE INSTITUTE / PARTICIPATING INSTITUTES

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19. FAHRTTEILNEHMER / PARTICIPANTS

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Gerull	Linda	AWI	Student
Giesecke Astorga	Claudio R.	Universidad de Concepcion	Biologist
Glasgow	Debra	IWC	Biologist
Gurney	Leigh	University Vancouver	Biologist
Haraldsson	Matilda	BFA Fisch	Student
Hayden	Andreas	AWI	Student
Herrmann	Regine	AWI	Student
Hohn	Sönke	AWI	Biologist
Homs-Ramirez	Patricia	ICM-CSIC	Biologist
Hunt	Brian	University Vancouver	Biologist
Jennings	Michael E.	Rhodes University	Student
Klinck	Holger	AWI	Scientist
Koschnick	Nils	AWI	Technician
Krägefsky	Sören	AWI	Biologist
Kresling	Andreas	DWD	Meteorologist

Name	Vorname/ First Name	Institut/ Institute	Beruf / Profession
Leach	Harry	University Liverpool	Scientist
Lo Bue	Nadia	INGV Rome	Scientist
Lucassen	Magnus	AWI	Scientist
Meyer	Bettina	AWI	Biologist
Mühlenhard-Siegel	Ute	DZMB Hamburg	Biologist
Otto	Juliane	AWI	Student
Pape	Carsten	AWI	Biologist
Poppe	Ulrike	AWI	Student
Riedel	Sven	AWI	Geophysicist
Rohr	Harald	Optimare	Physicist
Schmidt	Gesine	AWI	Student
Schukat	Anna	University Bremen	Student
Siegel	Volker	BFA Fisch	Biologist
Sonnabend	Hartmut	DWD	Technician
Spahic	Susanne	AWI	Technician
Steinhage	Daniel	AWI	Geophysicist
Strass	Volker	AWI	Oceanographer
Stübing	Dorothea	University Bremen	Biologist
Vendrell	Begona	ICM-CSIC	Biologist
Vortkamp	Martina	BFA Fisch	Technician
Witt	Ralf	AWI	Mechanic
Wittmann	Astrid	AWI	Student
Ziffer	Albert	AWI	Mechanic
NN		AWI	Engineer

20. SCHIFFSBESATZUNG / SHIP'S CREW

Reederei F.Laeisz G.m.b.H — Reise/leg ANT XXIII/2
Name of Ship : — RV POLARSTERN
Nationality : — GERMAN Cape Town - Punta Arenas

No.	Name	Rank
01.	Schwarze, Stefan	Master
02.	Spielke, Steffen	1.Offc.
03.	Farysch, Bernd	Ch. Eng.
04.	Fallei, Holger	2. Offc.
05.	Peine, Lutz	2.Offc.
06.	Niehusen, Frank	2.Offc.
07.	Kohlberg, Eberhard	Doctor
08.	Hecht, Andreas	R.Offc.
09.	Minzlaff, Hans-Ulrich	2.Eng.
10.	Westphal, Henning	3.Eng.
11.	Sümnicht, Stefan	3.Eng.
12.	Scholz, Manfred	Elec.Tech.
13.	Nasis, Ilias	Electron.
14.	Verhoeven, Roger	Electron.
15.	Muhle, Helmut	Electron.
16.	Schulz, Harry	Electron
17.	Loidl, Reiner	Boatsw.
18.	Reise, Lutz	Carpenter
19.	Vehlow, Ringo	A.B.
20.	NN	A.B.
21.	Winkler, Michael	A.B.
22.	Guse, Hartmut	A.B.
23.	Hagemann, Manfred	A.B.
24.	Schmidt, Uwe	A.B.
25.	Bäcker, Andreas	A.B.
26.	NN	A.B.
27.	NN	A.B.
28.	Preußner, Jörg	Storek.
29.	Ipsen, Michael	Mot-man
30.	Voy, Bernd	Mot-man
31.	Elsner, Klaus	Mot-man
32.	Hartmann,Ernst-Uwe	Mot-man
33.	Grafe,	Jens
34.	Müller-Homburg, Ralf-Dieter	Cook
35.	Silinski, Frank	Cooksmate
36.	Völske, Thomas	Cooksmate
37.	Jürgens, Monika	1.Stwdess
38.	Wöckener, Martina	Stwdss/KS
39.	Czyborra, Bärbel	2.Stwdess
40.	Silinski, Carmen	2.Stwdess
41.	Gaude, Hans-Jürgen	2.Steward
42.	Möller, Wolfgang	2.Steward
43.	Huang, Wu-Mei	2.Steward
44.	Yu, Kwok Yuen	Laundrym.

ANT XXIII/3

14.01.2006 - 08.02.2006

Punta Arenas - Punta Arenas

Fahrtleiter/Chief Scientist:

ANT XXIII/3

Christine Provost

ANT XXIII/3

1. ÜBERBLICK UND FAHRTVERLAUF

Christine Provost

Die FS POLARSTERN wird in Punta Arenas am 14. Januar 2006 auslaufen und nach einer dreiwöchigen Fahrt am 8. Februar 2006 wieder zurückkehren. Abb. 1 zeigt den Fahrtverlauf (M1 bis M10: Verankerungen, rot: hydroliogische Stationen). Nach dem Verlassen der Magellanstraße in östlicher Richtung wird FS POLARSTERN einen Süd-Ost Kurs steuern, um zum nördlichen Ende der Drake-Passage zu gelangen. Da Schiff wird dann der Spur 104 des Jason-1-Satelliten folgen, der die Meereshöhe mit einem Altimeter vermisst.

Zehn Verankerungen mit Strömungsmessgeräten sowie zwei Bodendruckmessgeräte werden entlang der Spur 104 ausgelegt werden. An circa 60 Stationen werden CTD Messungen durchgeführt und Wasserproben aus 24 Tiefenschichten entnommen, um die Konzentrationen der gelösten Nährstoffe, des Sauerstoffs, von Spurenelementen (Heliumisotope, Neon, Freone, radioaktives Thorium und Radium, ...) und von CO_2 in der Wassersäule zu bestimmen. Auch eine geodätische Vermessung der Meeresoberfläche mittels GPS ist geplant. Hierzu werden GPS-Referenzmessungen am Pegel von Punta Arenas bei Abfahrt und Ankunft sowie an den Polarstationen Dallman-Jubany und King Sejong auf der King-George-Insel durchgeführt und mit den Schiffs-GPS-Empfängern abgeglichen. Wenn Wetter und Zeitplan es erlauben, werden auch GPS-Bojenmessungen an jeder Verankerungsstation vorgenommen. Eine Cariocaboje wird ausgesetzt werden. Für einen Zeitraum von 24 Stunden werden vor der King-George-Insel Fischfallen ausgelegt.

Die endgültige Anzahl der hydrologischen- und GPS-Stationen wird an die Situation vor Ort angepasst. Zeitverlust durch unvorhergesehene Ereignisse oder langsameres Vorankommen muss durch kürzere Stationszeiten ausgeglichen werden.

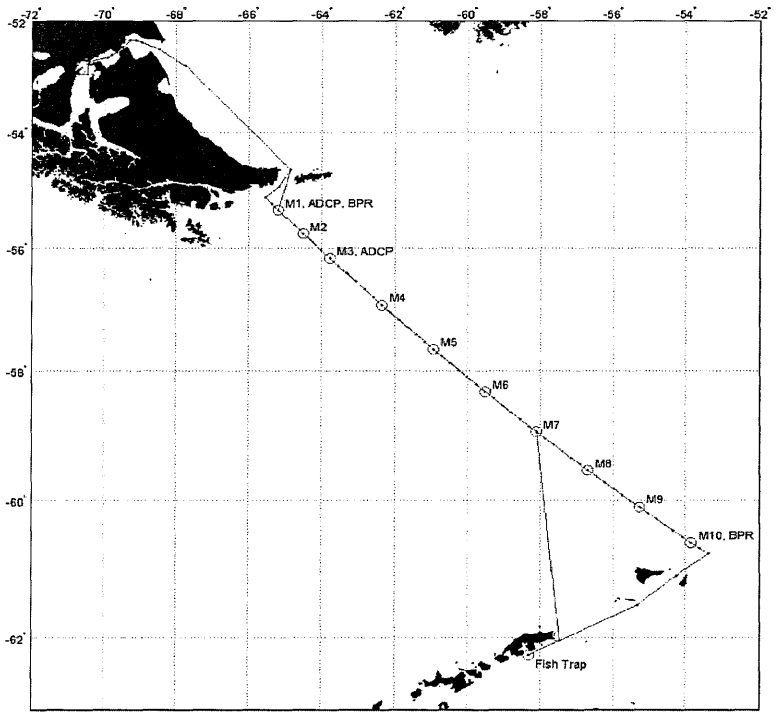

Fig. 1: Planned route and station locations for Drake Passage cruise. M1 to M10 are mooring locations. Dots are planned hydrographical stations.

ITINARY AND SUMMARY

RV POLARSTERN will leave Punta Arenas on January 14th 2006 and return to Punta Arenas on February 8th 2006 after a 3-weeks' cruise through Drake Passage. The cruise's planned route is shown in Fig.1. After leaving the Magellan Channel, RV POLARSTERN will head southeast towards the north of Drake Passage. Then she will follow ground track 104 of Jason-1 satellite which observes the sea surface elevation with an altimeter.

Along ground track 104, 10 current meter moorings, 2 bottom pressure recorders will be installed (Fig.1). CTD measurements will be carried out on approximately 60 hydrographical stations with water samples taken at 24 depths to determine the concentration of dissolved nutrients, oxygen, tracers (helium isotopes, neon, freons, Thorium and radium radionuclides,...) and CO_2 parameters in the water column. Geodetic GPS-observations are planned. Before the ship's departure from Punta Arenas as well as after its return a geodetic connection will be performed between the RV POLARSTERN GPS and the tide gauge in Punta Arenas. This will be also done at King George Island with the tide gauges of Dallman/Jubany and King Sejong stations. GPS buoy stations will be performed at each mooring, if time/weather permits. A Carioca buoy will be launched. A fishtrap will be installed for 24 hours near King George Island for collection of Antarctic fish.

The final number of hydrographical and GPS stations will be adjusted to the progress of work. Time losses due to unexpected events or slower progress than expected will be buffered by a reduction of station time.

2. MONITORING THE ACC TRANSPORT THROUGH DRAKE PASSAGE

Kartavtseff, Rouault, Provost, Bournot-Marec, Martin, Houssais, Schauer, Sultan, Chouaib, Sennechael, Guigand, Lanoisellé, Le Goff, Monglon, Rafizadeh, Stoehr, Vivier, Barré, Busdraghi, Spadone (LOCEAN); Hak Lee, Chul Hwang (KORDI); Welsch (IfM HH); Chastel, Clement-Chastel (CNRS Villiers)

Scientific background

The Antarctic Circumpolar Current (ACC), the world's largest current in terms of volume and mass transport, connects the three ocean basins, Atlantic, Indian and Pacific thus allowing water heat, salt and other properties to flow from one to another. This current is therefore considered to be a key element of the global climate system. Many studies have been devoted to trying to quantify the transport of the ACC and its variability.

Drake Passage has been the most well-studied location within the ACC, due to its being constricted to its narrowest extent (about 700 km) at this passage. The observations performed during the International Southern Ocean Study (ISOS) intensive field program from 1974 to 1981 in Drake Passage are fundamental and provide the base of our understanding of the ACC. The ISOS data showed that the ACC is closely associated with deep-reaching oceanic frontal systems. Two major fronts are continuous features of the ACC: the Subantarctic (SAF) and Polar (PF) Fronts. The ISOS experiment provided the first estimate of ACC transport 134 ± 13 Sv (1Sv = 10^6 m^3s-1) and showed an even distribution between baroclinic and barotropic transport. The range of uncertainty about the mean net

transport estimate has been re-examined recently and found to be much larger, close to 35 Sv. ISOS data also showed that eddies are instrumental for the poleward transport of heat across the current, which would otherwise block meridional heat transfer.
The existing 10-year-long record of satellite altimetric data has stimulated attempts to compute transport through Drake Passage with altimetry. However, because the shape of the geoid is not known with sufficient accuracy, it is impossible to derive mean currents on scales less than about 2000 km from altimetry alone. Almost all altimeter studies on smaller scales have therefore concentrated on the variability of currents. Attempts to combine altimetric data with ship measurements of density and current proved difficult with one realisation of in situ data because the data were nor completely synoptic. In contrast, combining altimetry with time series from inverted echo-sounders or current meters has provided convincing results in various regions.

Objectives
Monitoring the ACC transport is essential for understanding the coupling of this major current with climate change. The main objective of the expedition is to monitor the magnitude and variability of the ACC through Drake Passage. Therefore one of the main task of the expedition is the deployment of a mooring array below track 104 of altimetric satellite Jason-1 for at least two years.
The 2-year long in situ measurements of the currents through the Passage coupled with the satellite altimetric observations should provide **estimations of variations of the mass transport on time scale from month to interannual**. At the end of 2008 we should be able to produce a 16 year long time series of transport through Drake. Then we shall examine the mechanisms responsible for the variability of the transport. Hopefully, the comparison of this 16-year-long time series with the time series obtained by ISOS at the end of the 1970 will monitor the changes on a 30 year time scale.

A proper use of the altimetric data at high latitudes requires a better understanding of the altimetric signal. In particular, the rough sea state and atmospheric conditions require a precise examination of the corrections to be applied for the ocean response to the atmospheric pressure and the sea state effects on the altimetric measurements. **Therefore an important technical objective is a precise validation of the altimetric signal**.

High frequencies and transients
Our objective is to document eddies and transient structures to improve our understanding of their interactions with the mean current and the role they play for the transport of properties across the current.

Water masses: Water masses enter Drake Passage where they undergo substantial modifications. Our objectives concerning water masses are the following:

- Identify precisely water masses, their sources and trajectories
- Estimate the "age" of the water masses (age= elapsed time since they last saw the surface)
- Study mixing by multiparameter analysis and small scale structure examination
- Estimate effect of relative small scale topographic features on horizontal flow regimes and vertical mixing
- Estimate anthropogenic carbon in intermediate waters
- Study climate change in water masses using the two refined sections made at 16-year-interval (WOCE A21 on board METEOR in 1990 and ours).

Work at sea:

1) Deployment of moorings.

Two bottom pressure recorders (from Proudman Oceanographic Laboratory) will be deployed at both ends of the section: one near mooring M1 and the other near mooring M10. 10 subsurface current meter moorings (M1 to M10) will be deployed. Each mooring will carry 3 current meters and seacats. M1 and M3 will carry an upward-looking ADCP on top. M10 will bear two sediment traps.

Table 1: location and depth of each mooring

Mooring	Latitude	Longitude	Depth (m)
M1	55° 20.47' S	65° 11.3' W	1739
M1-BPR	55° 20.47' S	65° 11.3' W	1739
M2	55° 45.3' S	64° 29.95' W	3742
M3	56° 9.68' S	63° 46.2' W	4003
M4	56° 56.24' S	62° 21.25' W	4000
M5	57° 39.11' S	60° 56.16' W	3492
M6	58° 19.78' S	59° 31.2' W	3013
M7	58° 57.49' S	58° 6.07' W	3540
M8	59° 32.85' S	56° 41.14' W	3548
M9	60° 6.11' S	55° 15.82' W	3466
M10	60° 37.19' S	53° 50.94' W	2722
M10-BPR	60° 37.19' S	53° 50.94' W	2722

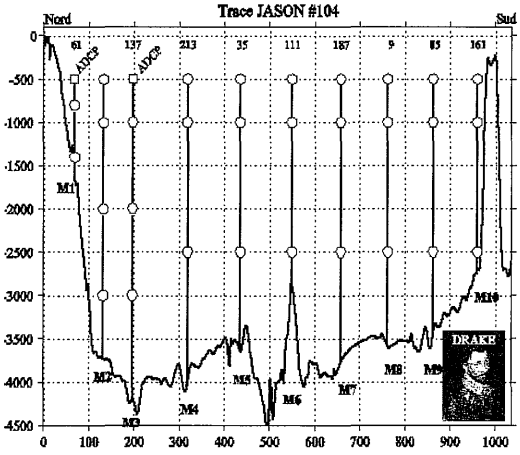

Figure 2:
Distribution of moored instruments t
be deployed during ANTXXIII/3.
On the horizontal axis the distance i
km along track 104 is shown.

A proper use of the altimetric data requires a validation of the altimetric signal. For that geodetic GPS measurements will be performed and the upward-looking ADCPs on moorings M1 and M3 will provide data for validation.

In addition to the GPS and altimetric measurements we will use the gravimeter onboard RV POLARSTERN to gain better knowledge of the geoid along the track. This will allow us to obtain an independent measurement of the current velocity that can be confronted with the mooring data.

2) Hydrographical stations
To complement the mooring array, we shall perform a high resolution CTD/LADCP station section (dots on fig.1). The distance between adjacent stations will be less than about 20 km with a closer spacing in the frontal regions. The hydrographic stations will gather water samples at different levels for tracers.

3) En route measurements
Temperature, salinity and ocean currents will be measured with the thermosalinographs and acoustic Doppler profiler from the moving vessel. During the whole cruise, the ship-borne gravimeter KSS-31 and GPS will be operated. A pCO_2 carioca buoy will be launched as part of the CARBOOCEAN EU project.

Expected Results
The data to be gathered will provide

- new information on the velocity field at Drake Passage (time scales, vertical structure, transients, mean flow) 30 years after ISOS (from current meters and full depth LADCP)
- new full depth high resolution hydrography with tracers 16 years after last similar cruise (METEOR A21) thus information on variability in water mass characteristics
- a better understanding of the altimetric signal in the Drake Passage
- an improvement of the geoid in the area
- a precise documentation of the mass and volume transport through DRAKE on the mean and variability

The present project is an integral part of the IPY activity CASO Climate of Antarctica and the Southern Ocean, The Ocean Circulation Cluster.

3. SEA LEVEL AND SEA-STATE MEASUREMENTS BY GPS

Boldo, Faillot, Ménard (CNES Toulouse)

Scientific Background
To monitor the magnitude and variability of the Antarctic Circumpolar Current, the DRAKE campaign proposes to deploy moorings along the Jason-1 altimetric ground track n°104. The altimetric data need to be complemented and carefully validated. This is why additional GPS surveys will be performed along the Jason track, in order to provide independent sea level data.

Scientific objectives
These along-track GPS measurements in the Drake passage have two objectives:

- To measure accurately the sea level with respect to the geodetic network, i.e. with respect to the International Terrestrial Reference Frame (ITRF). These sea level data combined with hydrographic, altimetric and gravimetric data should allow to cross-

compare the sea level estimates and to compute the geoid undulations along the JASON ground track giving access to the absolute transport in this area.

- To measure the Significant Wave Height (SWH) during the cruise across the Drake Passage. High-frequency GPS measurements (1 second sampling) will provide a good estimate of this parameter. As sea state bias is one of the major sources of altimetric errors, these independent SWH measurements should allow a better validation and correction of the altimetric data .

GPS receivers on board of RV POLARSTERN will be used for doing this sea level and sea-state survey. These GPS data will be processed in a kinematic mode using GPS receivers at Ushuaïa, Puntas Arenas, Rio Grande, O'Higgins, Dallmann/ Jubany (King Georges Island), and Belgrano as reference points. The Rio Grande and Belgrano multi-technique stations will permit a geodetic connection between GPS and nearby Doris stations (both systems being used for the precise orbit determination of the Jason satellite).

Work at sea
The tide gauges of Puntas Arenas and King Georges Island will be used to determine the reference sea level to which the sea level GPS measurements will be connected during the cruise. Thus, a geodetic connection will be performed between the RV POLARSTERN GPS and the tide gauge in Puntas Arenas, before ship's departure and after ship's arrival, and in King Georges Island with the tide gauges of Dallmann /Jubany and King Sejong stations.
The on-board GPS measurements will be completed by GPS buoy stations at each mooring. During these stations GPS buoys will be deployed and buoy/ship positioning data collected.

In order to use the near real time GPS data during the cruise, we need to:

- Collect the raw data of the four GPS receivers with the appropriate sampling,
- Archive these primary data,
- Store the RINEX data ,
- Calculate the ship's position with two different methods to have a first checking of the collected data
- Perform fix GPS reference stations during the cruise in accordance with weather
- Verify and compute the GPS buoy data,
- Filter swell, roll and pitch movements from the GPS data.

Expected results
The data sets will be used and carefully analysed to provide a precise connection between the tide gauges, the GPS (ships, buoys and in-land,), the ITRF and the Jason orbit, and to compute the needed sea level in the Drake Passage.

4. DISSOLVED NUTRIENTS MEASUREMENTS

Garçon, Lacombé, Sudre (CNES Toulouse); Oriol (Laboratoire ARAGO)

Objectives
The Drake Passage is an important entry point for several water masses from the Pacific into the Atlantic Ocean. They are carried with the Antarctic Circumpolar Current (ACC) around the Antarctic continent and thus, can enter the South Atlantic and Weddell Sea. It is crucial to quantify the importance of the cold water route of the return flow of the thermohaline

circulation but also its variability. Indeed, the last detailed CTD survey across Drake Passage is from the WOCE A21 cruise on board F.S. Meteor in 1990 and a picture of the water mass mixing 16 years later will tell us about any climatic evolution.

Work at sea
We will sample for nitrates, phosphates and silicates determinations at each CTD station along the north-south transect through Drake Passage. The CTD network will be such to resolve the fine scale structure (roughly every 20 km) and on the vertical the 24 depths will be sampled from the Niskin bottles. The samples will be analyzed on board with an Autoanalyzer SKALAR by the LEGOS/ARAGO team.

Expected results
The distribution of the dissolved nutrients mentioned will give information on water masses origin and pathways, variability in water masses characteristics in the cold water route of the thermohaline circulation. This work is an integral part of the IPY activity CASO Climate of Antarctica and the Southern Ocean, the Ocean Circulation Cluster.

5. TRACER MEASUREMENTS: HELIUM ISOTOPES, NEON, CFCS

Feyen, Huhn (IUP)

Objectives
The Drake Passage is an important entry for several water masses as well as for trace substances like helium and CFCs from the Pacific into the Atlantic Ocean. They are carried with the Antarctic Circumpolar Current (ACC) around the Antarctic Continent and, thus, can enter the South Atlantic and the Weddell Sea. Circumpolar Deep Water (CDW) is partly advected with the Weddell Gyre into the Weddell Sea and is a precursor for the dominating Warm Deep Water (WDW). Thus, it is also involved in the formation of Weddell See Deep and Bottom Water (WSDW/WSBW), one major source of Antarctic Bottom Water. Other fractions of CDW are advected into the South Atlantic.

Ocean surface water is mostly in equilibrium with atmospheric helium (mainly ^{4}He), the helium isotope ratio (^{3}He/^{4}He) and neon. Neon has no internal oceanic sources while primordial helium enters the ocean from spreading regions of the submarine ridge systems (mainly in the Pacific, mantle helium with a far higher ^{3}He/^{4}He ratio), from the earth crust (lower ^{3}He/^{4}He), and from glacial ice, in which atmospheric helium is trapped in bubbles and which is dissolved completely by melting the ice under high pressure from below.

CFCs are anthropogenic tracers and enter the ocean by gas exchange with the atmosphere. The evolution of these transient tracers in the ocean interior is determined by their temporal increase in the atmosphere since the middle of the last century and the formation and mixing processes of intermediate, deep and bottom water.

A distinct water mass (southeast Pacific Deep Slope Water, SPDSW) carried by the ACC into the Atlantic was revealed on a tracer section across Drake Passage by its very high ^{3}He/^{4}He ratios close to the continental slope of South America. This tracer signal originates from a very old water mass which was in contact with the submarine ridge system in the deep Pacific. This water mass enters the South Atlantic and is an important source of ^{3}He for the Atlantic Ocean and the Weddell Sea. The signal can be traced far further to the east and

to the north. However, on a repeat section several years later this high $^{3}He/^{4}He$ core was split into two and partly shifted off the slope.

Work at Sea
In this cruise we will repeat the tracer section across Drake Passage measuring helium, its isotope ratio, neon, and chlorofluorocarbons (CFCs) in high resolution. One aim is to observe the spatial and temporal variability of the high $^{3}He/^{4}He$ core from the deep Pacific (SPDSW). These measurements will be accompanied by velocity distributions from a lADCP and oxygen and nutrient measurements, enabling a multiparameter analysis. The transport into the Atlantic will be calculated by combining the velocity field with the distribution of the SPDSW fraction. Further we will repeat the observation of the evolution of the CFC inventory in the water masses entering the Atlantic Ocean from the Pacific, which are basically old but no longer CFC free.

Expected Results
The helium and neon samples are stored in sealed copper tubes, and they are analysed later in the Bremen mass spectrometer lab. About 150 samples are planned. The CFC sampling (300 planned) are performed 'off-line'. Water samples will be stored in glass ampoules and be sealed off after a CFC free headspace of pure nitrogen has been applied. The CFC samples are analysed later in the Bremen gas chromatography lab.

6. TRACER AND ISOTOPES

Beaumont, Jeandel, Pradoux (CNES Toulouse); van der Loeff, Friedrich (AWI)

Objectives
Developing a full understanding of the distribution and biogeochemical behaviour of **trace elements and their isotopes** (TEIs) in seawater has the potential to provide unique insights into a wide range of oceanic processes: quantifying key processes regulating the marine carbon cycle, insight into the mean velocity field and mixing processes in the ocean on very slow timescales with a direct link to the climate forcing (on present-day and past scales) and better calibration of paleo-oceanographic proxies related to the climate forcing.

Drake passage is of primary interest since it is a key route for main water masses involved in the thermohaline circulation. Among them, the importance of the cold route for the returning flow in the South Atlantic has to be quantified. Another main target is to understand the role of the southern American tip (Patagonian Shelf) and the Antarctic Peninsula on the circulation and composition of the water masses flowing through the Drake Passage, as for example the southeast Pacific Deep Slope Water, SPDSW.

Selected trace elements and isotopes are planned to be measured in the framework of the DRAKE ANT XXIII/3 cruise since they are useful tools for tracing the slow ventilation rates, the origin and pathways of the water masses.

- The group of thorium (Th) isotopes is of particular interest due to the particle reactivity of the element and the variability in half-lives amongst the isotopes. The Th isotopes differ strongly in their distribution pattern in the ocean as a consequence of their differing sources and half lives: they can be used to quantify the rate of particulate

organic export at different time scales from days to weeks to scales associated with quaternary studies.

- ^{231}Pa is the decay product of ^{235}U, which is like ^{234}U conservatively distributed in the ocean. The study of the $^{230}Th/^{231}Pa$ distributions on the dissolved and different particulate phases, associated with the other tracers, helps to understand the story of the water masses: their "ventilation age", their pathways, and eventually if they have encountered intense particle scavenging.

- The couple Nd concentration - isotopic composition (IC) is an interesting tracer of the origin and of the circulation of oceanic water masses on the scale of an oceanic basin. Studying the distribution of this element in the deep waters (those imprinting the authigenic metalliferous sediments used for paleo-reconstructions) can also be used to calibrate the "proxy" Nd for paleo-studies.

- Besides the particle-reactive tracers mentioned above, the radioisotopes will also be documented in the companion study proposed by Michiel Rutgers van der Loeff (AWI) . In addition, precious complementary information will be provided by the high resolution sections of helium, its isotope ratio, neon, and chlorofluorocarbons (see O. Huhn).

Work at sea
We will determine the following tracers at selected stations on this transect through Drake Passage: ^{230}Th, ^{232}Th, ^{231}Pa, REE concentrations and Nd isotopes.
We will collect 15-L samples from the CTD/Rosette allowing to measure simultaneously Nd isotopes, ^{231}Pa, ^{230}Th and ^{232}Th. The latter two tracers will be inter-compared with the AWI group. Suspended matter in surface waters will be collected with a continuous centrifuge using the ship's seawater supply. This material will be analysed for all tracers in Toulouse and also contribute to the intercomparison exercise. Suspended particles for REE, Pa/Th and Nd isotope measurements will be collected using in situ-pumps (see Rutgers van der Loeff).

Expected results
The distribution of the tracers mentioned will give information on the origin and pathways of water masses, and on the export of particles out of the euphotic zone. The present project is a valuable pilot for a full GEOTRACES transect in the Drake Passage that will be carried out two years later in the framework of IPY (Expedition Zero and Drake).

7. RADIOISOTOPES IN DRAKE PASSAGE

van der Loeff, Friedrich (AWI)

Objectives
This is a companion study to the program carried out by the group of Catherine Jeandel (LEGOS) and is likewise related to the new international tracer program GEOTRACES. It is important to know the distribution of Trace Elements and their Isotopes (TEI) in the water masses entering the Atlantic Ocean through Drake Passage: All tracer studies in the Southern Atlantic rely for their interpretation on data on this input function. The first deep ^{226}Ra and shallow ^{228}Ra profiles in the Drake Passage were obtained in the GEOSECS program. In the past decade, various studies on radionuclides in the Drake Passage have been carried out. A detailed section of ^{226}Ra and a course section of ^{228}Ra in the surface water were made by Hanfland, and the first ^{237}Ac profile was obtained by Geibert. Especially for ^{228}Ra, tracer of contact with coast and shelf sediments, and ^{237}Ac, tracer for upwelling of

deep waters, the data base for their distribution in Drake Passage is extremely thin. We have previously made sections of ^{234}Th in surface water of the Bransfield Strait and the SE Pacific, but a section of this isotope, which is a measure of export production, has not yet been made across the Drake Passage.

Work at sea

We will determine the following tracers on this transect through Drake Passage:
^{234}Th, ^{230}Th, 232Th, ^{228}Ra, ^{226}Ra, ^{227}Ac
We will determine ^{234}Th in surface waters using a newly developed automated technique. At selected stations we would like to collect 5-L samples from the Rosette from the upper 1000m for discrete sampling of ^{234}Th. We will collect 2-L samples for ^{230}Th and 232Th for later analysis in Bremerhaven for intercomparison with the techniques used by Catherine Jeandel. Suspended matter in surface waters will be collected with a continuous centrifuge. This material will be analysed by gamma spectroscopy for ^{234}Th and Ra isotopes, and for other isotopes in cooperation with Catherine Jeandel.
We will use in situ pumps to filter several m3 on deep water stations. The particulate material will be analysed by Catherine Jeandel for REE isotopes. The pumps will be equipped with MnO_2 cartridges that will collect dissolved ^{226}Ra, ^{228}Ra and ^{227}Ac.

Expected results

The distribution of the isotopes mentioned will give information on the origin and pathways of water masses, and on the export of particles out of the euphotic zone. The present project is a valuable pilot for a full GEOTRACES transect in the Drake Passage that will be carried out two years later in the framework of IPY (Expedition Zero and Drake).

8. ADAPTIVE COMPETENCE AND ECOLOGY OF COLD-STENOTHERMAL TELEOSTEI IN THE EASTERN WEDDELL SEA AND AT THE ANTARCTIC PENINSULA IN COMPARISON TO SUB-ANTARCTIC SPECIES (AWI)

Lucassen, Koschnick (AWI)

Objectives

Temperature is one of the main abiotic factors determining the biogeography of poikilothermal fish. Latitudinal distribution of fish populations is thus mainly defined by their tolerance towards temperature, i.e. eurythermal fish inhabit wider latitudinal ranges than stenothermal species. In polar Teleostei, temperature adaptability differs between high-Antarctic and sub-Antarctic animals. Zoarcidae, which inhabit temperate, subpolar and polar waters, represent a model system for the study of temperature adaptation versus acclimatisation. Our recent studies suggest that Antarctic Zoarcidae avoid the extreme cold high-Antarctic waters, thereby possessing higher tolerance against warm temperature. On the other hand Notothenioidei represent the most important and most specialized fish group in the Southern oceans, occupying all available habitats. Comparative physiological, biochemical and molecular studies of sub-polar species from Bouvet Island and species from the Eastern Weddell Sea as well as from the Antarctic Peninsula from both fish groups should give an insight into universal principles of thermal adaptation strategies at higher phylogenetic levels. Collecting live animals for the continuous work at the AWI is one major aim of the cruise. During the cruise we intend to take a close look on the major cellular energy demanding and providing processes. Ion and pH regulation as a result of active and passive processes across the membrane are very sensitive to temperature changes.

Different strategies in the relation of active and passive fractions are discussed for cold-adapted and temperate species. In gills, a close relationship between ion regulation and energy demand becomes visible, as the main ion pump, the Na+/K+-ATPase, is located in the mitochondrial-rich chloride cells. Therefore, the capacities of key enzymes for ion regulation should be linked to aerobic capacities in different species along the latitudinal cline. The second approach will focus on genomic techniques to identify differentially expressed genes within the latitudinal cline and new candidate genes with so far unknown functions, which contribute to thermal plasticity. Therefore, samples from freshly captured as well as acclimated fish will be taken for further analyses at the AWI. DNA extraction and later analyses shall give further insight into phylogenetic relationships of high- and sub-Antarctic fauna, and catch composition of the sub-Antarctic Agassiz trawls will be compared with high Antarctic catches from the eastern Weddell Sea.

Work at sea

The programme will be performed during ANTXXIII/2 and ANTXXIII/3. By means of baited bottom traps and Agassiz trawls we aim to catch sub-Antarctic eelpouts (zoarcids, supposedly more cold eurythermal) and Notothenioidei off Bouvet Island during the first days of the cruise. In high Antarctic waters (Atka Bay) we expect to catch further, more stenothermal eelpouts and cold-adapted Notothenioidei (ANTXXIII/2). Since the last attempts on ANTXXI/2 to catch eelpouts in these extreme cold waters of the shelf failed, we will use new traps especially designed for deeper waters on this cruise. During ANTXXIII/3, we aim to catch fish at the Antarctic Peninsula near King George Island and/or Elephant Island. 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 on board and at the AWI. For ecological studies the fish composition of all catches will be examined and whole specimens will be preserved for further analyses at the AWI.

Live specimens of sub-Antarctic and high-Antarctic 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 RV POLARSTERN at environmental temperature conditions, and will be sent alive to the AWI at the end of each leg.

On board RV POLARSTERN we intend to investigate the capacity and temperature sensitivity of a number of key enzymes of the respiratory chain, the Krebs cycle and ion regulation in tissue homogenates, membrane preparations and mitochondrial suspensions. In parallel, serum osmolality will be determined for the respective specimens. The data will be completed by specific mRNA expression studies and protein quantification by means of antibodies at the AWI. The mRNA samples will be further analysed for differentially expressed genes at the institute. Thereby, we hope to identify various strategies of energetic and thermal adaptations in these species along a latitudinal cline and the underlying molecular mechanisms.

9. BETEILIGTE INSTITUTE / PARTICIPATING INSTITUTES

	Adresse /Address
AWI	Stiftung Alfred-Wegener-Institut für Polar- und Meeresforschung in der Helmholtz-Gemeinschaft Postfach 12 01 61 27515 Bremerhaven/Germany
CNES Meudon	1 Place Aristide Briand 92195 Meudon Cedex France
CNRS Villiers	CEBC Villiers en Bois 79360 Beauvoir sur Niort France
Laboratoire ARAGO	Laboratoire ARAGO Service accueil, BP 44 66651 Banyuls/Mer France
CNRS Plouzané	DT-Insu/CNRS Bât IPEV BP 74 29280 Plouzané France
CNES Toulouse	SIMB, CNES DCT/PO/AL 18 avenue Edouard Belin 31055 Toulouse France
DWD	Deutscher Wetterdienst Bernhard-Nocht Str. 76 20359 Hamburg Germany

	Adresse /Address
IfM HH	Institute of Oceanography (IfM) Bundesstr. 55, Geomatikum, 4th. floor D-20146 Hamburg Germany
INSU	Institut National des Sciences de l'Univers (INSU) 3, Rue Michel-Ange 75766 Paris, FRANCE
IUP	Universität Bremen Institut für Umweltphysik (IUP) - Ozeanographie Institute of Environmental Physics (IUP) - Oceanography Otto-Hahn-Allee 1 D-28359 Bremen/Germany
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LOCEAN	Université Pierre et Marie Curie 4 place de Jussieu T45-55 5E 75252 Paris Cedex 05 France

10. FAHRTTEILNEHMER / PARTICIPANTS

Fahrtleiter/Chief Scientist: Christine Provost
Punta Arenas - Punta Arenas

Name	Vorname/ First Name	Institut/ Institute	Beruf / Profession
Balestrini	Carlos	SHN, Argentina	(Observer)
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Boldo	François	CNES Toulouse	Scientist
Bournot-Marec	Claudie	CNRS Plouzane	Engineer
Busdraghi	Fabiono	LOCEAN	Student
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Houssais	Marie-Noelle	LOCEAN	Scientist
Huhn	Oliver	University Bremen	Physicist
Hwang	Sang Chul	KORDI, Korea	Scientist
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Knobelsdorf	Michael	DWD	Meteorologist
Koschnick	Nils	AWI	Technician
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Martin	Nicolas	LOCEAN	Engineer
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Vivier	Fréderic	LOCEAN	Scientist
Warpakowski	Andrea		Journalist
Welsch	Andreas	IfM HH	Technician

11. SCHIFFSBESATZUNG / SHIP'S CREW

Reederei F.Laeisz G.m.b.H — Reise/leg ANT XXIII/3
Name of Ship : — RV POLARSTERN
Nationality : — GERMAN — Punta Arenas - Punta Arenas

No.	Name	Rank
01.	Pahl, Uwe	Master
02.	Grundmann, Uwe	1.Offc.
03.	Ziemann, Olaf	Ch.Eng.
04.	Bratz, Herbert	2.Offc.
05.	Wunderlich, Thomas	2.Offc.
06.	Hering,Igor	2.Offc.
07.	NN	Doctor
08.	Koch, Georg	R.Offc.
09.	Sümnicht, Stefan	2.Eng.
10.	Simon, Wolfgang	2.Eng.
11.	Kotnik, Herbert	3.Eng.
12.	Holtz, Hartmut	Elec.Tech.
13.	Dimmler, Werner	Electron.
14.	Riess, Felix	Electron.
15.	Fröb, Martin	Electron.
16.	Feiertag, Thomas	Electron.
17.	Clasen, Burkhard	Boatsw.
18.	Neisner,Winfried	Carpenter
19.	Kreis, Reinhard	A.B.
20.	Schultz, Ottomar	A.B.
21.	Burzan, G.-Ekkehard	A.B.
22.	Schröder, Norbert	A.B.
23.	Moser, Siegfried	A.B.
24.	Pousada Martinez, S.	A.B.
25.	Hartwig-L., Andreas	A.B.
26.	NN	A.B.
27.	Beth, Detlef	Storekeep.
28.	NN	Mot-man
29.	Fritz, Günter	Mot-man
30.	Krösche, Eckard	Mot-man
31.	Dinse, Horst	Mot-man
32.	Toeltl, Siegfried	Mot-man
33.	Fischer, Matthias	Cook
34.	Tupy,Mario	Cooksmate
35.	Martens, Michael	Cooksmate
36.	Dinse, Petra	1.Stwdess
37.	Tillmann, Barbara	Stwdss/KS
38.	Streit, Christina	2.Stwdess
39.	Schmidt,Maria	2.Stwdess
40.	Deuß, Stefanie	2.Stwdess
41.	NN	2.Steward
42.	Sun,Yong Sheng	2.Steward
43.	Yu, Chung Leung	Laundrym.
44.	Woeckner, Nikolas	Trainee
45.	Felsenstein, Thomas	Trainee