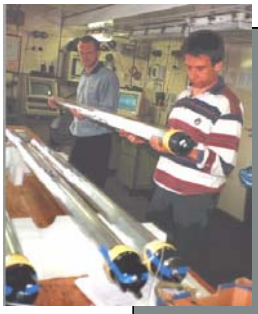
Institut für Meereskunde an der Universität Kiel



1999-2001

April 2002

Institut für Meereskunde an der Universität Kiel

Report 1999-2001

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Preface

The present report describes the achievements and events at the Institut für Meereskunde (IfM) at the University of Kiel for the years 1999-2001. During this period a major reorganisation of the IfM structure became effective, following a recommendation by the Wissenschaftsrat. The new structure which is described in section 1 of this report was introduced to enable IfM to successfully meet the future interdisciplinary challenges.

Along with these changes within IfM, the format of this report has changed as well. Apart from the new layout, a notable change is that this report is now available in English. This will enable the numerous international cooperation partners of IfM to access this report which is available and distributed widely through our Internet platform (www.ifm.uni-kiel.de) and available also on CD. The introductory and overview parts of this report will also be available in German, as well as a comprehensive overview on the IfM activities for the wider public in Germany through our web pages.

Another major change to previous annual reports of the IfM is its new structure. The core of the report is section 2, where the three new research divisions ("Forschungsbereiche") provide an overview about their activities followed by a description of selected research projects, highlighting current research topics within (and across) the divisions. These contributions are written in an essay style by selected authors summarizing accomplishments of larger research groups within IfM.

I hope that you will enjoy reading the IfM Report which in the future will be published bi-annually.

Kiel, 4.4.2002

Jürgen Willebrand

1. Mission and Development of the Institute

1.1 Historical Background and General Description

The Institut für Meereskunde (IfM) was founded in 1937 by the university, with the zoologist Adolf Remane as the first director. The second director was the chemist Hermann Wattenberg who lost his life together with nine staff members when the institute building was bombed in 1944. After the Second World War the institute re-developed and grew considerably under the leadership of the oceanographers Georg Wüst (1946-1959) and Günter Dietrich (1959-1968). In 1968 the increasing prominence of marine research led to an agreement between the state of Schleswig-Holstein and the federal government which enabled co-financing of the institute. Since 1977 the institute is included in the so-called "blue list" which regulates the joint financing by the federal government, the state of Schleswig-Holstein and the community of states. The institute is also a member of the Wissenschaftsgemeinschaft Gottfried Wilhelm Leibniz (WGL).

The main institute building at Düsternbrooker Weg 20 was completed in 1972, with an extension completed in 1988 (see Fig. 1). Other locations include the old institute building at the Hohenbergstraße, and office/storage space at the Seefischmarkt and the Technical Faculty.

Since 1968 the institute has been associated with the Christian-Albrechts University. It is governed by a Kuratorium which consists of representatives of state and federal governments, the dean of the faculty for science of the university, a scientist from another research institution and the chairman of the institute's Scientific Advisory Board (SAB) (see Appendix A).

The principal objective of the institute is to further basic research in marine sciences, specifically in all aspects of the physical, biogeochemical and biological sciences of the sea.

The research work of the institute is carried out under the Medium-Term Research Programme for 2001-2003. Much of the insti-

Fig. 1: IfM facilities at Düsternbrooker Weg. Note, that the seals basin was extended after the photo had been taken.

tute's research work contributes to international research efforts such as the World Climate Research Programme (WCRP) and the International Geosphere-Biosphere Programme (IGBP). Emphasis is on a better understanding of the ocean's role for climate variations and air-sea interactions, the role of biogeochemical transport and transformations in global change, and the response and sensitivity of marine ecosystems to external forcing.

IfM scientists have a long tradition of participating in national and international planning and execution of large-scale interdisciplinary research programmes. This includes programmes such as CLIVAR (Climate Variability and Predictability), BALTEX (Baltic Sea Experiment), JGOFS (Joint Global Ocean Flux Study), SOLAS (Surface Ocean Lower Atmosphere), GLOBEC (Global Ocean Ecosystems Dynamics) and others. Support for this work usually must be acquired through competitive proposals funded by the Federal Ministry of Research (BMBF), the European Union (EU) and the German Research Society (DFG for Deutsche Forschungsgemeinschaft), typically over periods of two or three years. Since 1996, the German Research Society has supported a longer-term special research programme on "Dynamics of Thermohaline Circulation Variability" (Sonderforschungsbereich (SFB) 460) that links the physical and chemical groups at IfM together with the GEOMAR research institute and the university (see section 4).

The results of the institute's research work are generally made available through a wide range of publications (see section 6). The main emphasis is on peer-reviewed international journals. Increasingly, the internet is also used to disseminate information.

Teaching of students has always been a very important activity at the IfM. In collaboration with the science faculty at Christian-Albrechts-University, courses are offered in nearly all fields of marine sciences except marine geology and geophysics. Specifically, curricula exist for diploma and Ph-D studies in physical oceanography, meteorology, biological oceanography, and fisheries biology. Marine Chemistry is offered as a minor. The involvement of diploma and Ph-D students in research projects is an important element of IfM research. The total number of students at IfM is approximately 300. Through the training of students and young scientists from Asia, Africa and South America, IfM has contributed to develop marine infrastructures in these regions (see section 9).

1.2 IfM Development 1999-2001

As mentioned earlier, a major reorganisation of the IfM structure became effective in mid-2000, following recommendations of the Wissenschaftsrat, the institute's Scientific Advisory Board (SAB) and of an external advisory committee. While the previous organisation into 10 research departments had served the institute well since 1968, it became increasingly clear that a new structure was needed to better enable IfM to meet the interdisciplinary challenges of the coming decade. The new structure consists of three research divisions: Ocean Circulation and Climate, Marine Biogeochemistry and Marine Ecology, supported by the central facilities of the IfM. The divisions are subdivided in research units and laboratories. The details can be seen from Fig. 2.

In order to further strengthen interdisciplinary research, the IfM's new structure enables the formation of interdisciplinary project groups for a limited period (up to three years), in addition to the three research divisions. Following an internal competition, in late 2000 the first such group was installed where young researchers from all three divisions under the leadership of Drs. A. Oschlies and J. LaRoche study the cycle of nitrogen in the Atlantic Ocean (see section 3).

Several exciting events occurred in the reporting period. In April 1999, funding for the SFB 460 "Dynamics of the Thermohaline Circulation Variability" was renewed for another 3.5 years until end of 2002. At the same time, support from the German Research Society (DFG) for a new "career development group" at IfM was given. This group started subse-

quently in April 2001 (headed by Dr. A. Timmermann) and works on modelling of past climate changes of the ocean. Under the coordination and with substantial participation of IfM scientists, the national CLIVAR-Marine programme started in March 1999 as a contribution to the World Climate Research Programme. Important for Marine Biogeochemistry was the first international science conference for SOLAS (Surface Ocean Lower Atmosphere Study) which was organised by IfM scientists and held in Damp in February 2000. The syntheses phase for the JGOFS (Joint Global ocean Flux Study) programmes in the Atlantic and Indian Oceans started with strong IfM participation. Several large grants from the EU have helped to develop interdisciplinary observing systems in the North Atlantic. Section 4 provides an overview about the participation of the IfM in long-term research programmes. An international data base for fisheries and ecology (FishBase) is now located at IfM.

Overall, IfM scientists have achieved grants for more than 30 Million DM (German Marks) in the reporting period.

The last three years have seen several important changes in the leading personnel of the institute. IfM director Prof. Peter Lemke who had directed the transition to the new structure left the institute to follow a call by the Alfred-Wegener-Institut für Polar und Meeresforschung Bremerhaven. Prof. Dr. Bernt Zeitzschel, Prof. Dr. Dieter Adelung and Prof. Dr. Harald Rosenthal retired after many years of excellent service for IfM. The institute is indebted to them.

Prof. Jürgen Willebrand succeeded Prof. Lemke as IfM-director on Febr. 1, 2001. Prof'es Claus Böning, Douglas Wallace and Ulrich Sommer assumed to take the lead of the three research divisions. Prof. Dr. Karin Lochte succeeded Prof. Zeitzschel as the new chair of biological oceanography in November 2000. Prof. Dr. Arne Körtzinger assumed a new professorship in chemical oceanography in June

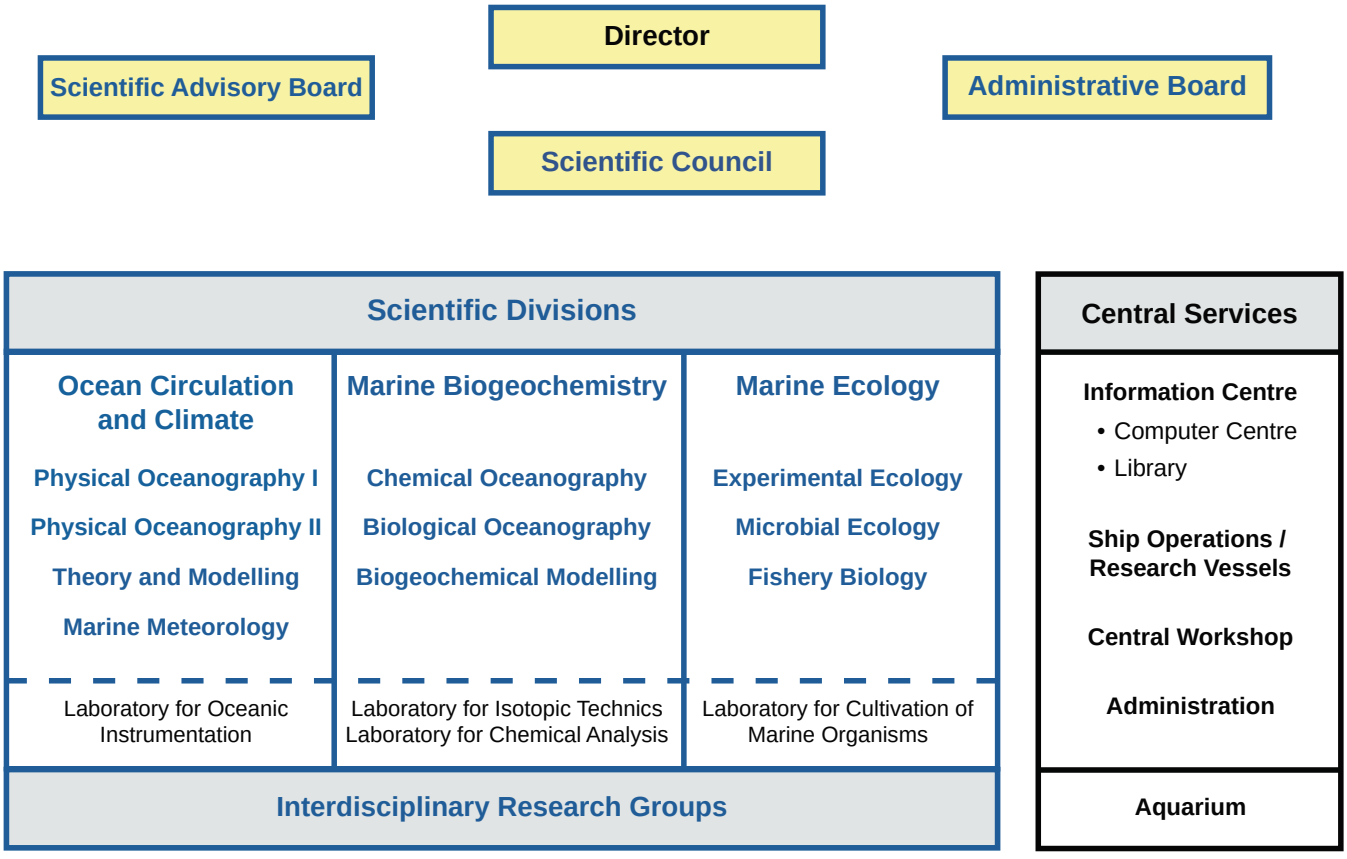


Fig. 2: Organisational structure of the IfM

2001. The institute hopes that in the near future appointments can be made for vacant professorships in the fields of i) meteorology, ii) biological oceanography/planktology, iii) biological oceanography/zoology, and iv) biogeochemical modelling, in order to complete the planned structure.

The cooperation with the GEOMAR Research Centre for Marine Geosciences has become closer in recent years. In 2001, it was agreed to increase the cooperation in several logistical areas, such as computer networks, joint use of instruments and laboratories, library and others, with the ultimate goal to merge both institutions. Jointly with GEOMAR and the University, a Centre for Applied Marine Sciences (ZAM: *Zentrum für angewandte Meereswissenschaften*) has been established. This is located at the Seefischmarkt and builds on the activities of several previously existing groups. Its purpose is to provide a connection between the basic science at both research institutes and practical applications. Mr. Holger Klindt became head of the ZAM on October 1, 2001.

Since 1998 all proposals for research cruises for German mid-size research vessels have been centrally evaluated (scientific pool), and ship scheduling has been coordinated between the operating institutions. Negotiations between the federal government and several states are underway with the aim to eventually create a service institution that can provide a logistic and financial pool for ship operations. So far the ship operations at IfM have continued to run smoothly (see sections 5 and 8.2). One exception was an accident aboard "RV Poseidon" in April 2001 which has led to an abrupt termination of the first cruise of the interdisciplinary project group; subsequently several other cruises had to be cancelled.

A highlight of the public relations work at IfM was the exhibition "Blue Ocean" which was prepared in cooperation with GEOMAR and several other groups from the university, and took place at the Norwegenkai, Kiel during summer/fall 2000 as part of the EXPO 2000 in Hannover, and which attracted more than 15,000 paying visitors. Other activities include e.g. a regular series of public lectures in the Aquarium, and open-ship days during Kiel Week. Another highlight was a visit by the minister for science and education of Schleswig-Holstein, Mrs. Erdsiek-Rave, to IfM in September 2001. Details of the public relations work are reported in section 10 of this document.

2. Reports of the Research Divisions

2.1 Ocean Circulation and Climate

2.1.1 Overview

The ocean is an integral part of the climate system. Through the air-sea exchange, re-distribution and storage of heat, freshwater and radiatively active trace gases the ocean with its intricate, three-dimensional pattern of circulation not only is a key factor shaping present-day climate; through the dynamics of ocean circulation and its interaction with the atmosphere it also assumes an active part in climate variability on interannual, decadal and longer time scales.

The research in the division "Ocean Circulation and Climate" aims at

- advancing our understanding of the physical processes and phenomena in the ocean and atmosphere which are critical to the large-scale behaviour and variability of the ocean-atmosphere system,
- developing numerical models that capture the essential dynamics to allow realistic simulations and an assessment of the predictability.

A particular strength of the division is the simultaneous availability of expertise in large-scale and process-oriented modelling and an observational and sea-going capability able to address most issues of relevance. Accordingly, the approach is to merge insights from observations directed at key phenomena of large-scale circulation variability, with model simulations of the mechanism driving basin-scale ocean circulation systems, of the ocean-atmosphere interaction, and of particular ocean processes deemed important. The main sites of "Forschungsbereich 1" (FB1) field programmes are highlighted in Fig. 1.

A phenomenon of prime importance for the climate of northwestern Europe is the formation of deep water in the subpolar North Atlantic, associated with a large heat loss to the atmosphere in winter. The conversion of the temperate, northward flowing upper-layer waters of the Gulf Stream and its extension, the North Atlantic Current, to the cold waters flowing southward between 1000 and 4000 m depth, is one of the key controls of the large-scale oceanic overturning circulation. In the Atlantic Ocean it is responsible for carrying heat far into the Nordic Seas, and, through the ensuing, deep reaching mixing of these waters in winter, for a sequestering of a significant share of the atmospheric load of anthropogenic trace gases like CO_2 or CFCs. However, various processes presumably critical for the system, its internal variability, and its tolerance to changes in external conditions, are still poorly understood.

A major venue for that research is the Sonderforschungsbereich (SFB) 460 "Dynamics of thermohaline circulation variations". Beyond active collaboration between the observational and modelling groups of the oceanographic and meteorological units of FB 1, it also provides an important framework for interaction with biogeochemical groups and, as a recent development, paleoceanographic studies related to large-scale circulation variability. The SFB work in the subpolar North Atlantic is complemented by a host of projects, supported by EU and other sources, which, e.g., include new technological developments such as multidisciplinary time series stations, or real-time telemetry of moored instruments.

Other key regions of interest due to their role in interannual-decadal climate variability are the tropical Atlantic and Indian Ocean. Both field programmes and modelling studies in FB 1 have joined in international efforts under the CLIVAR programme. They are directed at issues such as the interaction of the large-scale meridional overturning circulation with the intricacies of the along-equatorial wave guide, diapycnic mixing and upwelling in the Atlantic, and the interannual changes in the monsoon response of the Indian Ocean and the

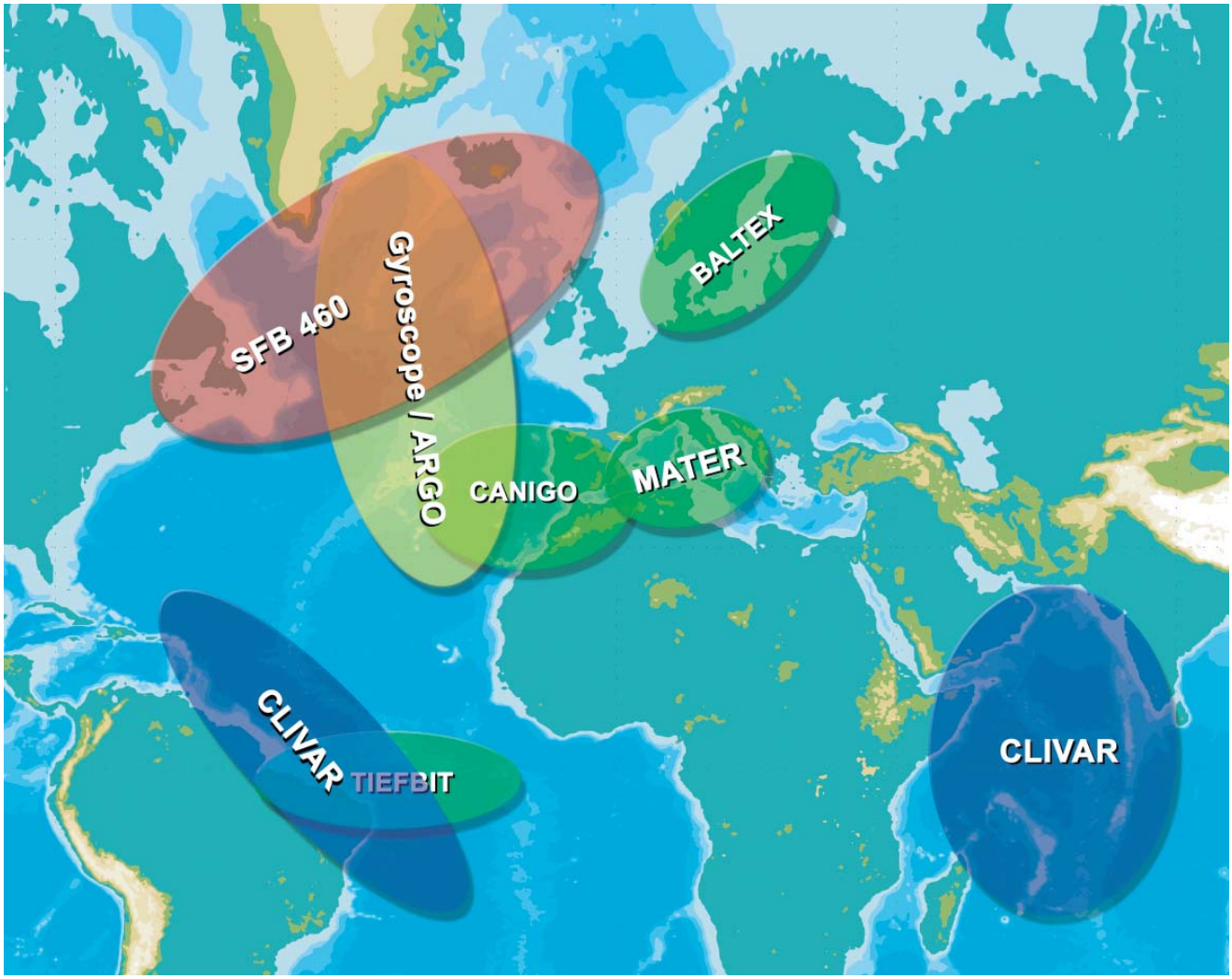


Fig. 1: Summary view of research programmes to which FB 1 groups provide major contributions.

associated climate signals. In addition, building on expertise from long-term research efforts in these areas, FB 1 scientists are engaged in studies of the water and energy cycle of the Baltic Sea (in the framework of the international BALTEX programme), and of the water mass transformations in the Mediterranean Sea and its exchanges with the Atlantic Ocean (as part of various EU projects).

Activities within the JGOFS programme included the development of coupled ecosystem-circulation models capable of a realistic description of the nitrate supply to the light-lit upper ocean in order to improve our understanding of the biological pump's drawdown of atmospheric carbon dioxide.

2.1.2 Future perspectives

The research programme of FB 1 is well positioned to play an instrumental role in the large international programmes related to Global Change research, and scientists of the FB are engaged at various positions in international advisory groups shaping future international research plans.

While the international CLIVAR programme will continue to provide a major focus of research activities during the next decade, there are certain areas where FB 1 strives to strengthen its research efforts, in particular through

- Thermohaline circulation variability: A data assimilation activity is planned within the

context of the national CLIVAR-marine programme for studying the North Atlantic thermohaline circulation variability over the past decade of WOCE observations and altimetry coverage. The focus will be on the top-to-bottom overturning circulation, making use of the cross-basin hydrographic lines and boundary array measurements of the SFB 460, and the national WOCE and CLIVAR programmes.

- **Decadal variability of the ocean-atmosphere system over the North Atlantic:** Studies were started in the SFB using ocean models driven by prescribed atmospheric conditions, e.g., time series of NCEP or COADS fluxes. It is envisioned to considerably expand these studies towards including atmospheric feedbacks and transport dynamics, by developing modelling activities for the coupled atmosphere-ocean-ice-system.

The work on the mechanisms of decadal-interdecadal variations will be complemented by stronger ties to paleoceanography groups, and coupled model studies of longer time scales. Particular questions addressed are:

- What caused the rapid climate transitions during the Last Glacial? Why have these been absent during the Holocene? And can we use paleoclimatic simulations in order to assess the probability of future abrupt changes of the climate state? The plan is to include a sophisticated ice-sheet model into the recently developed (intermediate-complexity) atmosphere-ocean model in order to study, for the first time, the interactions among ocean, ice-sheet and atmosphere during different climates.

An important goal for FB 1 is to strengthen interdisciplinary collaborative projects with the biological and chemical groups of the other research divisions. Particular plans are:

- **Biogeochemical modelling**: a) Inclusion of the full carbon cycle into its present, nitrogen-based models; attempting mechanistic parameterization of calcification. b) Identify and quantitatively assess biogeochemical feedback mechanisms in the climate system by applying the model to various paleo- and possible future climate scenarios; because of the long time scales (> 100 years) involved, this will probably require setting up a global model.

- **Interdisciplinary ocean observing systems:** Joint observation of ocean variability in both physical and biogeochemical conditions and processes are becoming increasingly important for studying and understanding global change in the ocean. In order to address these needs, FB 1 has initiated activities in the field of interdisciplinary time series moorings, with the aim of establishing an expertise for such programmes at the IfM and of contributing to an observational infrastructure for such (sustained) observations. An EU funded project (ANIMATE) is just starting, coordinated by FB 1, to build-up a European capability for this in the form of three time series stations in the open Atlantic, carrying physical, CO_2, biochemical, zooplankton, and sediment trap sensors. Further, participation of FB 1 has been instrumental in the creation of an international science team that is to work toward a global array of multidisciplinary time series stations.

- **New technology** has always played a major role in FB 1 research. We expect this will continue in the future. In addition to existing applications and in collaboration with the "*Zentrum für angewandte Meereswissenschaften*" (ZAM) and industrial partners, we expect to invest future efforts in
  - Autonomous gliders;
  - Moored profiling systems;
  - Multidisciplinary moored sensors and observing systems;
  - Real-time data telemetry;
  - Integration of different technologies (moored observations, end-point integrals, floats, tomography, gliders, altimetry).

2.1.3 Selected Research Projects

Small causes, large effects: Influence of Denmark Strait overflow on the large-scale ocean circulation

Control points for large-scale flows

Although ocean currents often extend across distances of several thousand kilometres, their dynamics may be susceptible to comparatively small topographic features of only a few kilometres in size.

One such example is the spreading of the cold dense water formed during winter cooling in the subarctic North Atlantic Ocean. This water moves south as a concentrated flow between 2000 m and 4000 m depth along the western rim of the Atlantic Ocean, from where it then continues to the deep Indic and Pacific. Contributions from the Greenland, Iceland and Norwegian (GIN) Sea to this deep branch of the so-called "global conveyor belt" have to pass through two key regions: the narrow Denmark Strait and the Faroer Bank Channel in the submarine Greenland-Iceland-Scotland Ridge (Fig. 1).

These narrow outlets of the GIN Sea (with widths of only about 20-40 km at the depths where overflow takes place) have long been suspected to constitute control points for the densest portions of the deep water flow. In the last years, research at IfM concentrated on one of these water masses, i.e. the Denmark Strait Overflow Water (DSOW) which makes the densest contribution to the North Atlantic Deep Water (NADW). The goal of these studies was to understand the local dynamics at the exit of the Strait, and the influence of this water mass on the large-scale transport of deep water.

Denmark Strait overflow

North of the Denmark Strait, the Greenland Sea with its deep-reaching but variable wintertime convection constitutes a large reservoir of dense water. This water mass continually drains through the Strait at a rate of several million cubic meters per second. Inside the narrow channel, this flow takes place in a thin sheet (about 50-350 m thick and 10-20 km wide) that hugs the continental slope of the East Greenland shelf at depths below 400 m. After exiting the Strait, the outflowing water is accelerated quickly when it sinks down to

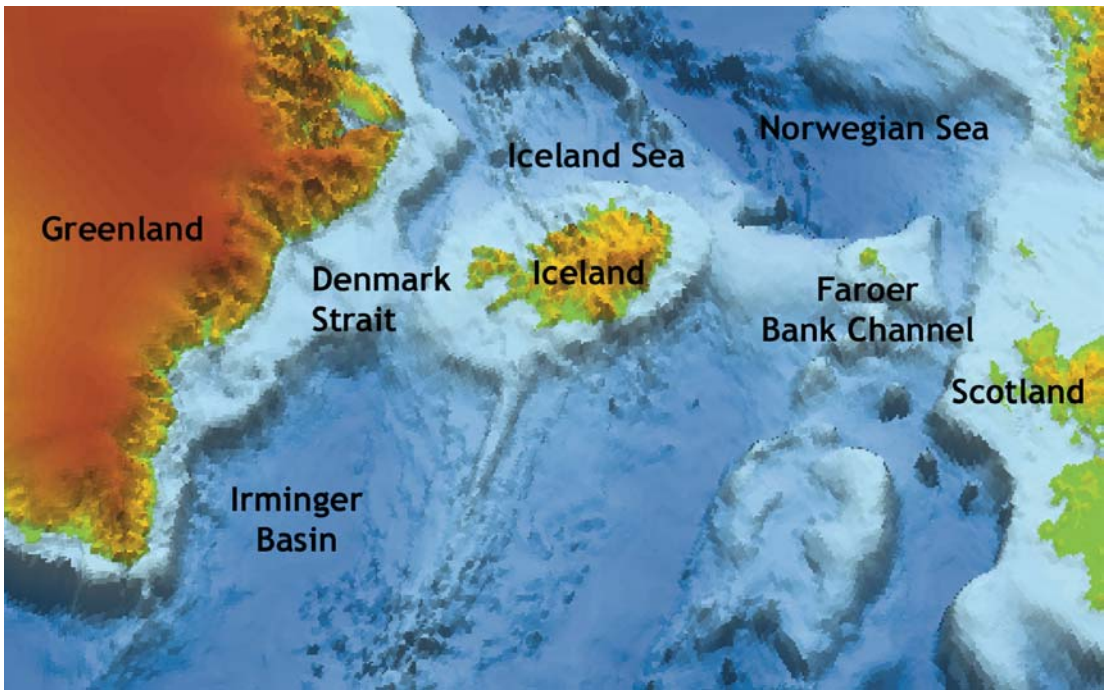


Fig.1: The sea floor topography between Greenland and Scotland: a bottleneck for the export of cold, deep water from the Nordic Seas.

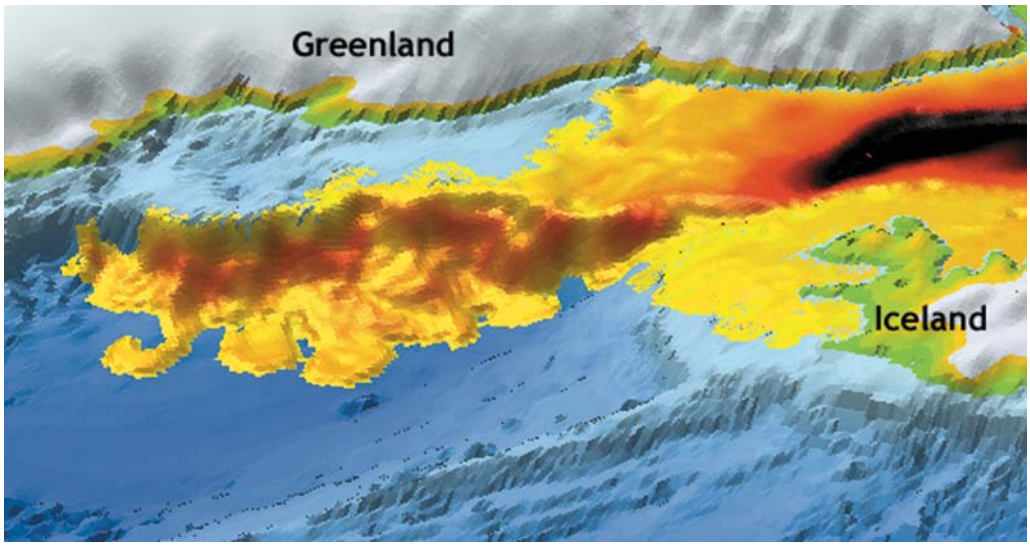


Fig. 2: Cold nordic water cascades through the Denmark Strait in a near-bottom plume of about 100 m thickness. (From a computer simulation; yellow indicates thinner, red to black: thicker plume thicknesses).

greater depth and mixes with surrounding water, thus increasing its volume and forming a so-called "plume".

In cooperation with the Applied Physics Laboratory in Seattle, USA, intensive surveys were conducted with IfM's research vessel "Poseidon" to study the characteristics of the overflow, especially the vertical structure of the plume, the volume transport and its spatial variability. To this purpose, CTD casts were supplemented by free-falling electro-magnetic velocity probes dropped from the ship underway.

In the interpretation of these observations, numerical ocean models with high spatial resolution were used that simulate the descent of the plume and its propagation along the continental slope. This combination of measurements and numerical model contributed greatly to the understanding of the mechanism of the overflow which is governed by the physical laws of hydrodynamics: inside the strait, the flow is subject to the (rotationally modified) hydraulic balance of forces, which limits the flow rate through this passage and ties the transport to the reservoir height (i.e. water level of dense source water) north of Iceland. Outside the constriction, eddies are shed from the outflow plume carrying dense water into the interior of the Irminger Basin (cf. Fig. 2, where a modelled plume with fast eddies along the Greenland continental slope (red patches) and slower and thinner ones at greater depth may be seen). Different from earlier assumptions, this horizontal stirring by eddies is an important process in the dynamics of this region.

Large-scale impacts

So far, ocean models of the type used for the computation of climate scenarios had inherent problems in modelling the large-scale effects of the overflow plume, mostly because these models were not able to reproduce the product of the mixing processes at the exit of the Strait. Usually, the models diluted the outflow water too strongly with the water in the environment, thus destroying any evidence of the overflow signal soon after outflow. Meanwhile, using new parametrizations, even coarse resolution models are capable of carrying the dense water for quite a distance south along the western boundary.

This makes it possible to study large-scale effects of changes in the properties (temperature, density, volume of transport) of the overflow water. First idealized experiments demonstrate that fairly small changes in reservoir height north of the sills can cause quite significant changes in the transport rates of the deep boundary current even as far south as the subtropical North Atlantic near the Bahamas. Figure 3 shows that at 24°N, the deep boundary current shifts its vertical position at the continental slope by +/- 200 m in response to a change in reservoir height north of Iceland of only +/- 40 m. The associated volume transports of the deep branch of the conveyor belt

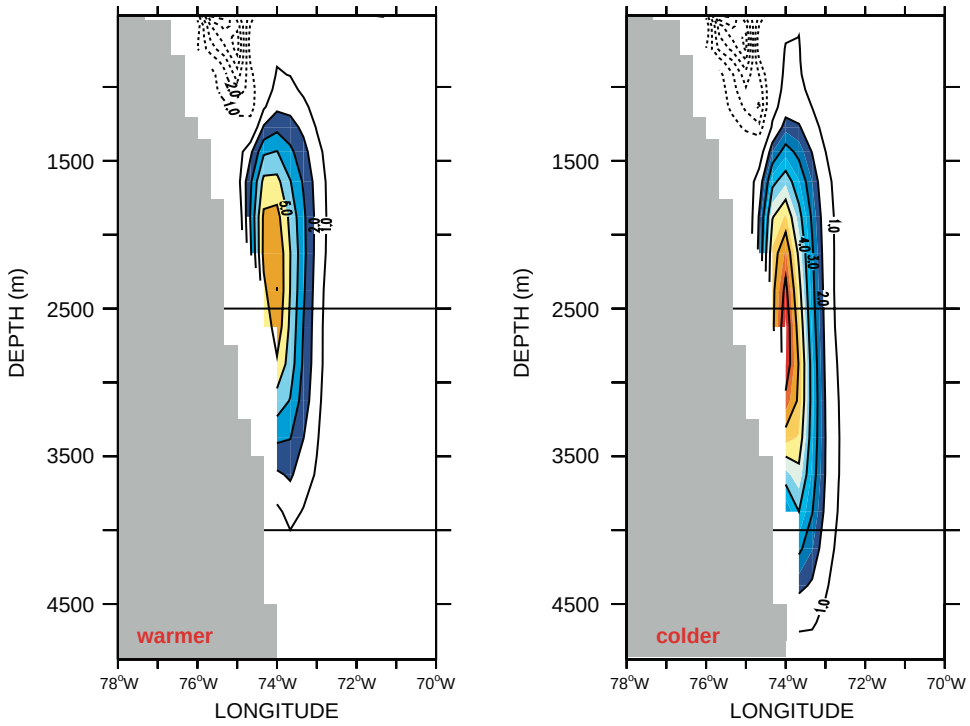


Fig.3: Changes in the overflow have effects on the currents throughout the Atlantic Ocean: the deep, southward current along the American continent (shown are velocities in cm/s) shifts downward (upward) in response to colder (warmer) source water. From a computer simulation in which the overflow temperature was changed by 1°C compared to a reference case (for which the positions of the current core and lower limit of the colored region are indicated by the horizontal lines).

vary by +/- 2 million cubic meters per second, which in turn translates into a change of +/- 12% of the total meridional heat transport in the North Atlantic.

While there is little doubt about the tendency of this response, the actual numbers are expected to depend quite critically on the details of the dilution of the DSOW plume south of the Denmark Strait. Thus, although progress has been made in including overflows in large-scale models, additional work is required to quantify their effects.

Consequences for research

This "tele-connection" of the deep branch of the global conveyor belt to small-scale mixing processes in the subpolar North Atlantic confronts ocean scientists with a logistic problem: for the study of global-scale features they can no longer ignore certain small-scale phenomena. For the observationalist, this implies that global observing systems have to be accompanied by very detailed surveys of key regions. For the ocean modeller, coarse resolution large-scale models have to be supplemented by high-resolution regional models to resolve critical processes.

On the other hand, the existence of potential control points may present oceanography with an opportunity to monitor specific global phenomena by concentrating on a few key regions. If this could be confirmed, it would greatly reduce the requirements for observing changes in the global ocean circulation.

Joachim Dengg and Rolf Käse

Convection in the Labrador Sea: Climate sensitivity and effect on the large-scale North Atlantic circulation

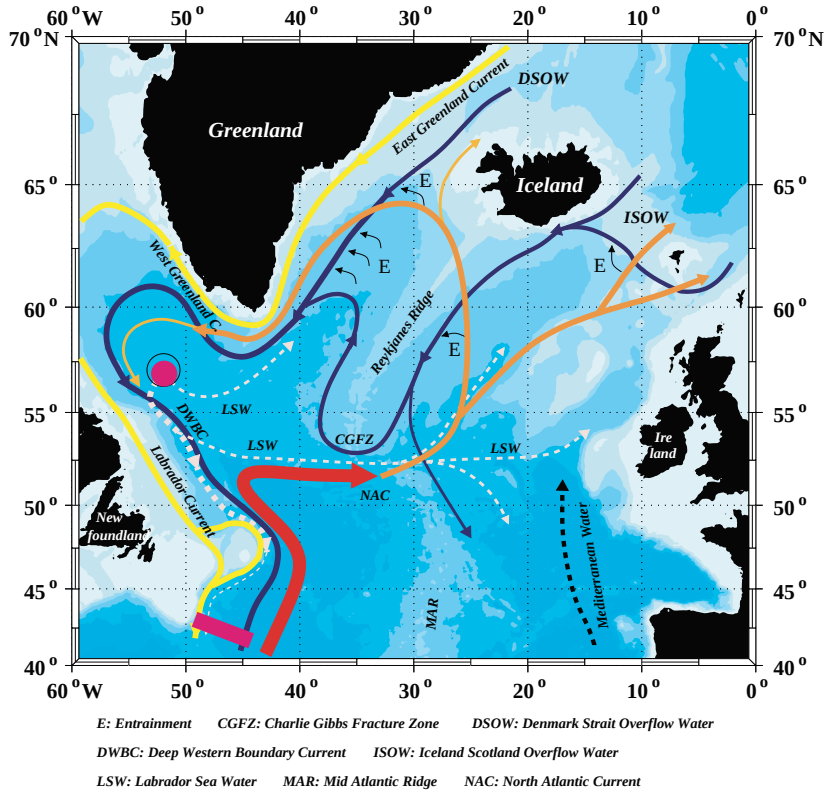
The Labrador Sea convection process

During strong winter cooling in the Labrador Sea, the water is vertically mixed, sometimes down to depths of 2000 m and more. The deep-mixing process, or convection, typically generates a near-homogeneous, deep-mixed patch of a horizontal scale of about 100 km, but the mixing within the patch occurs by small-scale "plumes" of only a few 100 m horizontal scale. Due to the counter clockwise rotation of the Labrador Sea circulation (Fig. 1), the stratification tilts upwards toward the centre of the basin, making this region a preferred site for deep convection.

As shown in the schematic diagram of Fig. 1, convection in the Labrador Sea is one of the supplies of the southward-flowing Deep Western Boundary Current (DWBC). It forms the uppermost level of the DWBC, while the Denmark Straits Overflow Water (DSOW; see previous section) forms the coldest, densest and deepest layer, passing through the Labrador Sea along the outer margin. In between both layers, water entering the western basin through the Mid-Atlantic Ridge (Fig. 1) and originating in the eastern overflow areas, passes along with the DWBC at intermediate levels.

Large recent changes in convection activity

The temperature development in the central Labrador Sea during the years 1996-2001 is shown in Fig. 2 (page 14). It has been measured by temperature recorders deployed on a moored station of the "Sonderforschungsbereich" (SFB) 460. While convection depths of more than 2000m were observed during 1991-1993, it is very obvious from Fig. 2 that a drastic decrease of convective activity occurred in recent years. The long time series of the Labrador Sea Water (LSW) layer thickness from the central Labrador Sea composed from historical observations (Fig. 3, page 14) is expanded with the recent data of IfM Kiel and shows that the production of LSW is approaching an all-time low, similar to the situation experienced in the early eighties. Superimposed on the thickness curve is the North Atlantic Oscillation (NAO) Index, indicating a relation of increased convection intensity with positive NAO Index at the longer time scales. Overall though, the causes of LSW convection variability, in particular relating to the recent changes, are not yet understood.



E: Entrainment CGFZ: Charlie Gibbs Fracture Zone DSOW: Denmark Strait Overflow Water
DWBC: Deep Western Boundary Current ISOW: Iceland Scotland Overflow Water
LSW: Labrador Sea Water MAR: Mid Atlantic Ridge NAC: North Atlantic Current

Fig. 1: Schematic circulation diagram showing the North Atlantic Current (red), and the three branches of the Deep Western Boundary Current. The Labrador Sea Water (LSW) is generated by deep convection in the central Labrador Sea (Convection mooring: magenta circle) and propagates preferentially along the indicated spreading paths (white). Also shown is location of Deep-Water Export Array east of Grand Banks (magenta line) (see Fig. 5).

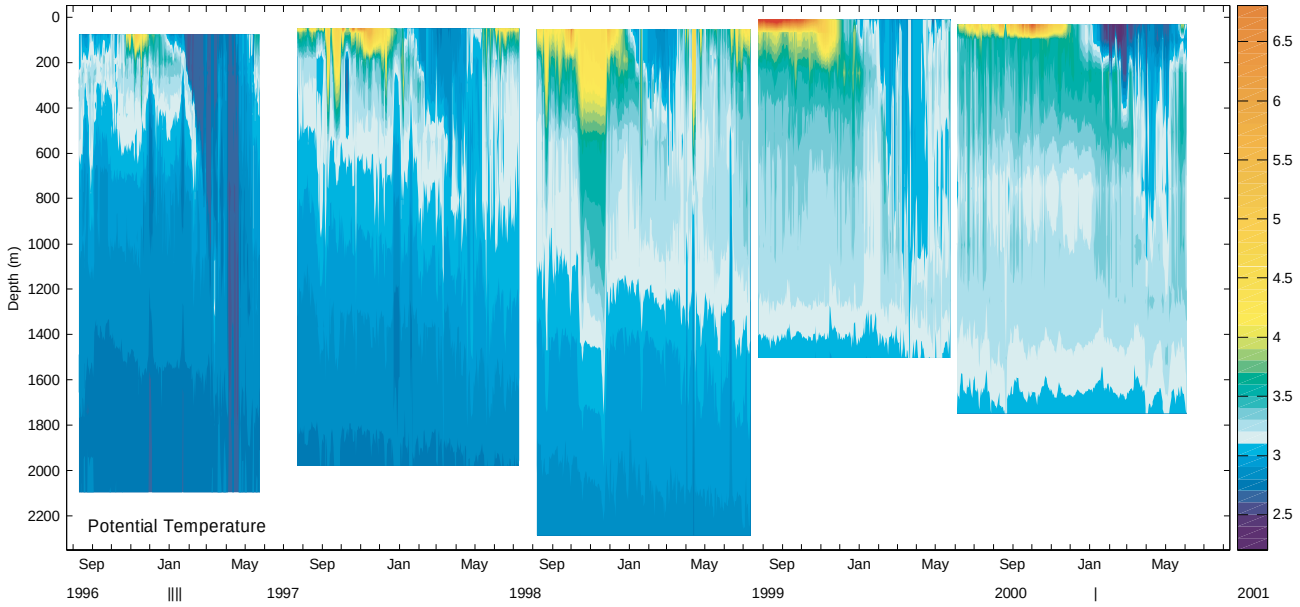


Fig. 2: Time series of temperature distribution in the upper 2000 m in the Labrador Sea convection regime, obtained during 1996-2001 by a moored station of the SFB 460. Note significant decrease of winter-mixed layers during the observational period.

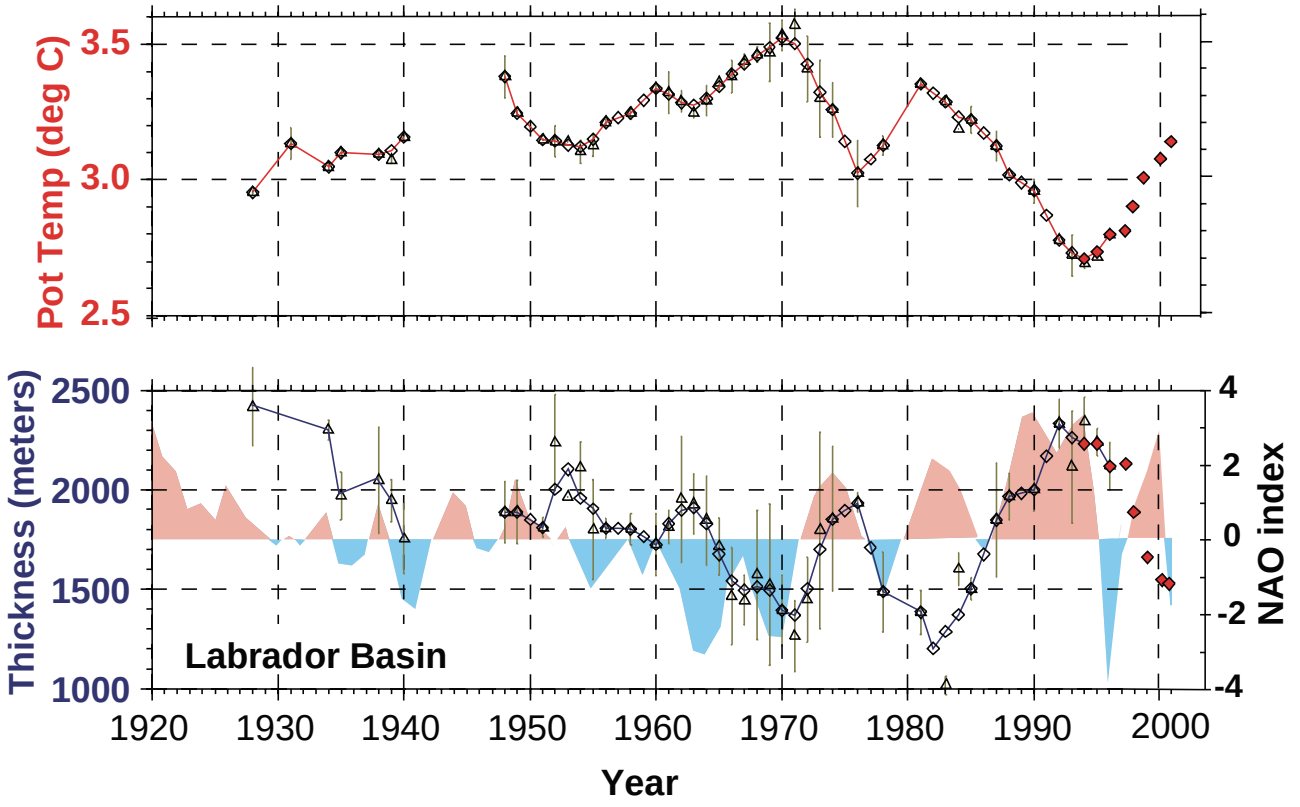


Fig. 3: Potential temperature (upper panel) and thickness (m) of the LSW layer from historical observations in the central Labrador Sea (lower panel). Also shown in the lower panel (shading) is the North Atlantic Oscillation (NAO) Index. Extension of the curve by SFB 460 observations since 1996 shows layer decrease of the LSW thickness towards a decadal minimum. In contrast the temperature of the LSW is increasing.

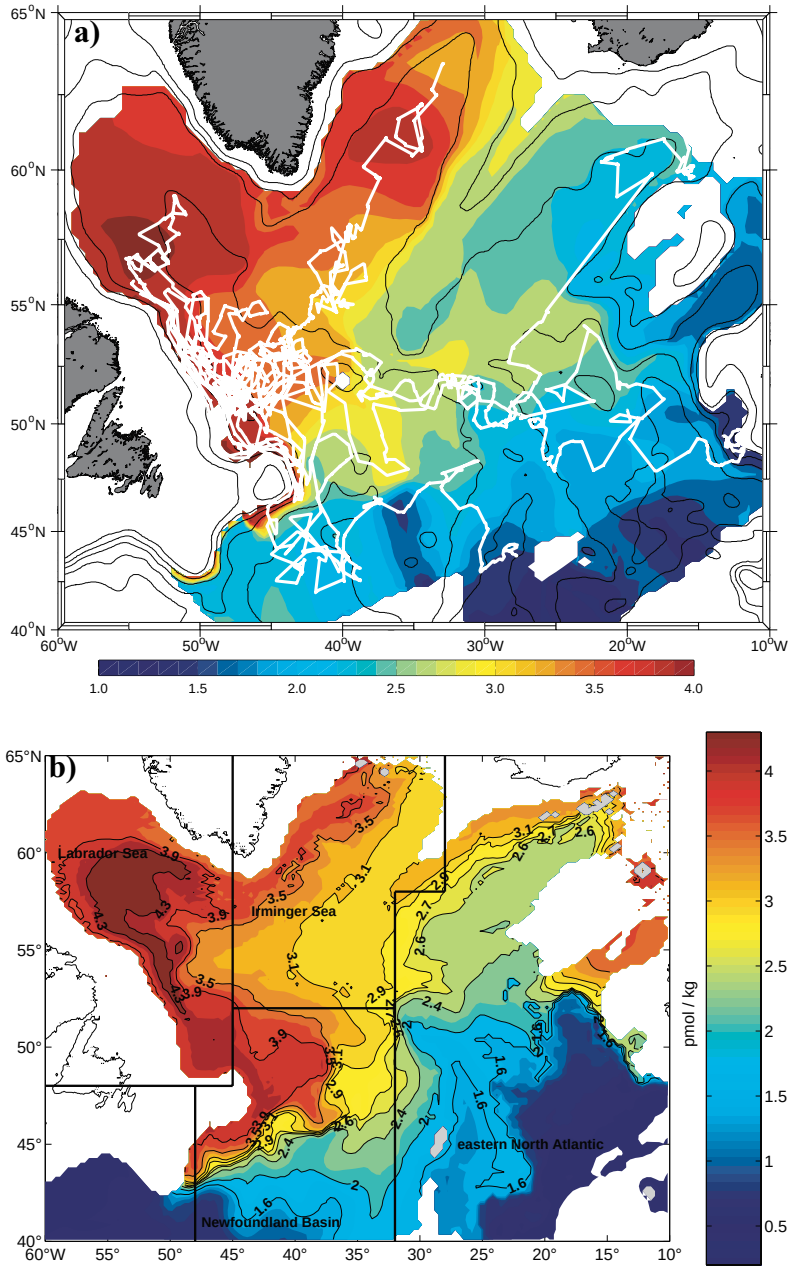


Fig. 4: a; upper panel) Spreading of LSW observed by profiling floats (1500 m trajectories) and by Freon distributions, b; lower panel) distributions of a tracer (Freon) injected into the FLAME model.

Spreading of LSW in the Atlantic

The merging of the newly formed LSW into the larger-scale environment of the Atlantic Ocean also is a puzzling research question. A superposition of tracer (Freon) observations from the LSW density layer, and trajectories of deep floats drifting at 1500 m depth is shown in Fig. 4a. Three preferential spreading paths are obvious: first, the expected path, from the exit of the Labrador Sea southward along the western boundary (see schematic diagram of Fig. 1); second, northeastward into the Irminger Sea, and third, along the northern flank of the North Atlantic Current into the eastern subpolar North Atlantic. The subpolar basin thus serves as a buffer before releasing newly formed LSW southward toward the subtropics. The FLAME model simulations (Fig. 4b), while in principle well representing the LSW spreading, still yield too little exchange with the eastern basin and more studies of this buffer process are needed, both observational and modelling.

Potential importance of LSW pulses in the subtropical and tropical Atlantic

IfM Kiel model simulations have shown the dominant role of atmospheric forcing over the Labrador Sea: when a North Atlantic model was forced with the interannual heat flux variations over the entire subpolar basin about the same variations of the LSW thickness and Atlantic overturning circulation resulted as when the fluxes were only applied to the Labrador Sea alone.

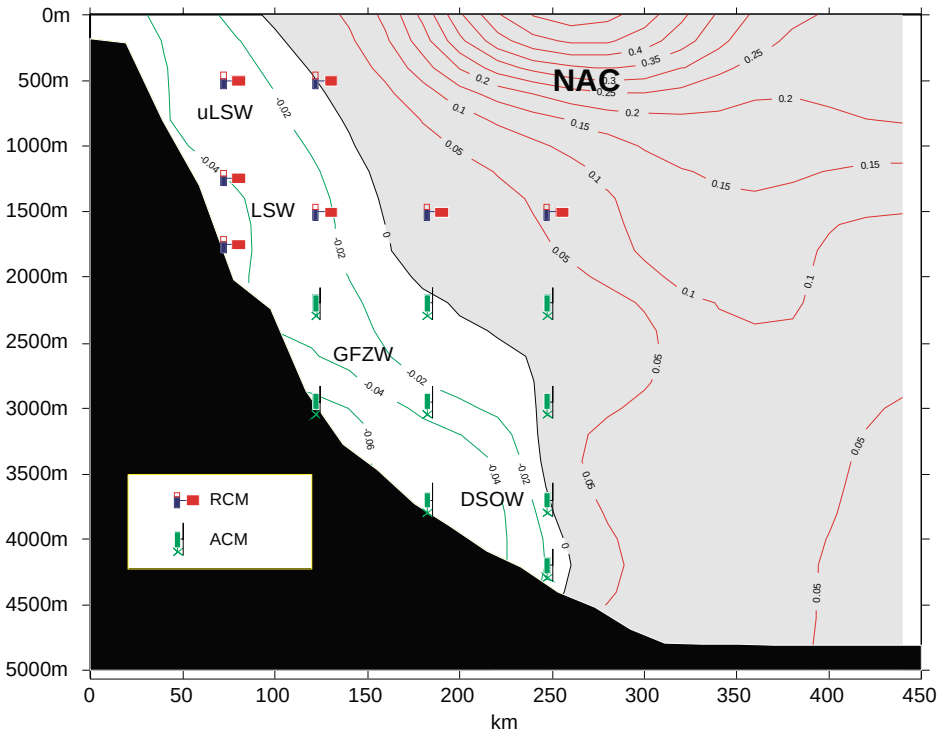


Fig. 5: Deep-Water Export Array along topography off the Grand Banks, with instrument distribution superimposed on mean currents as resulting from prior observations. While the North Atlantic Current (NAC) flows northward offshore, the southward export of the different Deep Water branches (see Fig. 1) happens close to the western boundary.

Research perspectives

As summarized above, important research questions are associated with the formation, variability and propagation of the Labrador Sea Water. As regards crucial observations, the outflow of convection water from the subpolar basin toward the subtropics occurs dominantly in a focused flow east of the Grand Banks (Fig. 1). Observations and time series of the outflow transports, watermass composition and variability in this region are therefore of primary importance for a better understanding of the role of the Atlantic meridional overturning circulation in climate variability.

Within the context of the SFB 460, a Deep Water Export Array has been installed since 1999 east of the Grand Banks. It consists of four stations with the instrument distribution as shown in Fig. 5, superimposed on the mean flow as known from previous studies. Repeat ship surveys of the larger-scale region will also be continued, in cooperation with partner groups from BSH (Hamburg) and Bedford Institute of Oceanography (Halifax, Canada). Data synthesis and interpretation will be carried out in close collaboration with the IfM FLAME modelling and other interested groups.

Friedrich Schott

Tropical Atlantic circulation

The water mass exchange of the Meridional Overturning Circulation (MOC) across the equator mainly takes place at the western boundary along the continental shelf of South America. In this region the Deep Western Boundary Current (DWBC) transports approximately 20 Sv of North Atlantic Deep Water southward, which are compensated by a net northward transport of warm and intermediate waters as well as by Antarctic Bottom Water (AABW). The north-south exchange is complicated by the general zonal circulation near the equator leading to interactions between different current bands and water mass transformations. Besides the top-to-bottom MOC, another meridional overturning circulation occurs in the upper tropical Atlantic Ocean: the subtropical cell (STC) connects the subduction regions of the subtropical Atlantic and the eastward equatorial and off-equatorial undercurrents that supply the equatorial and eastern-boundary upwelling regimes (Fig. 1). The equatorward flow within this cell is focused into a tight western boundary current, the North Brazil Undercurrent (NBUC). The western margin of the tropical south Atlantic is thus in ideal region for observing strength and variability of the MOC as well as STC. In the frame of the German CLIVAR programme, a mooring array that is deployed since March 2000 in this region is used together with repeated ship sections (see Fig. 1), profiling floats, analysis of satellite data and numerical simulations to study the Tropical Atlantic Variability (TAV), particularly with regard to its possible relation to MOC and STC variability.

Upper ocean circulation

The known warm water circulation in the tropical Atlantic includes the NBUC as its western boundary current, carrying warm water of South Atlantic origin across the equator. The NBUC transport has two different components: the transport of warm and intermediate waters of the MOC and the equatorward transport of subducted waters within the STC. The six repeats of the shipboard current profiling sec-

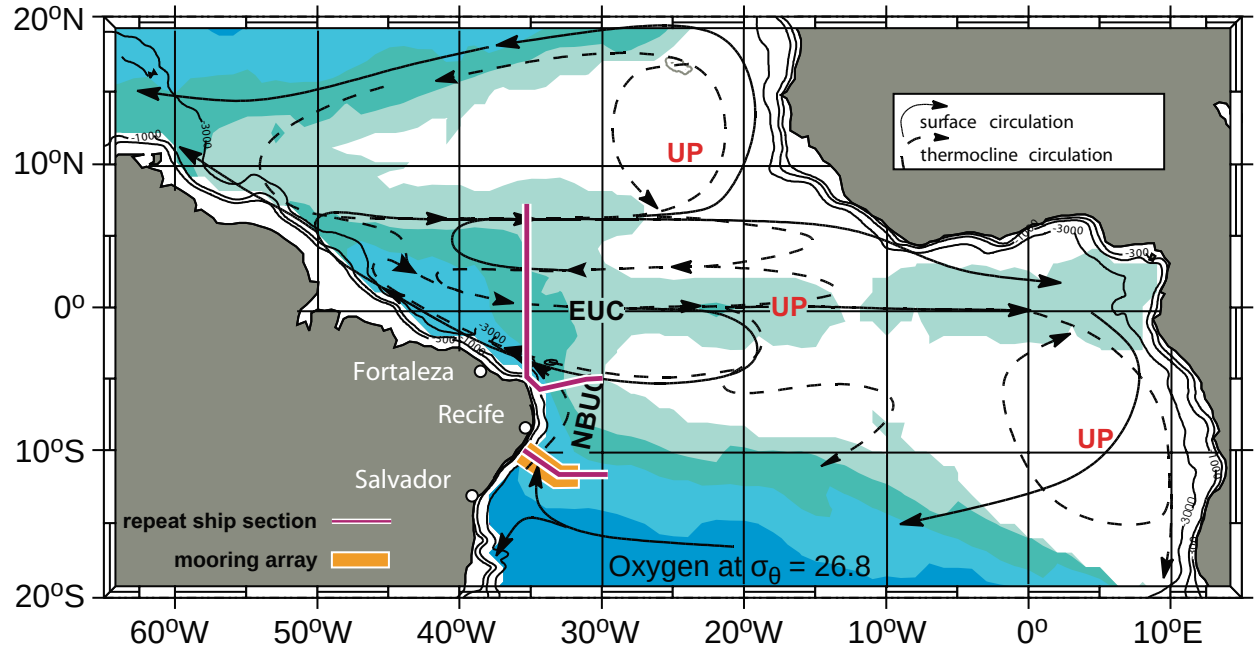


Fig. 1: Schematic diagram of shallow subtropical and tropical Atlantic circulation superimposed on climatological distribution of oxygen concentration on density surface 26.8 kg m^{-3} (depth about 250 m); the oxygen distribution indicates the spreading of oxygen-rich waters from the south-eastern subduction region via the North Brazil Undercurrent (NBUC) and the Equatorial Undercurrent (EUC) toward the equatorial and eastern-boundary upwelling regimes (UP). Also shown is the location of repeat shipboard current profiling sections and of the western-boundary mooring array referred to in the text.

tions along 5°S (Fig. 2) yield a total mean northward warm water flow within the NBUC of 25±4.4 Sv. About half of it supplies the eastward Equatorial Undercurrent (EUC). The NBUC is found to originate further south than 11°S and to have a mean core velocity at 250 m depth of about 60 cm s^{-1} at that latitude. In March and November of 2000 a total of 15 Autonomous Profiling Explorers (APEX) were deployed in the western tropical Atlantic. They drift at 200m (9 floats) and 400m (6 floats) depth to follow the water mass pathways from the western boundary into the interior of the tropical Atlantic. While some of the 15 floats do the expected, e.g. by following the NBUC along the western boundary or the offequatorial thermocline undercurrents eastward, some of the 400 m floats move meridionally through the zonal near-equatorial current field, suggesting that there are interior pathways connecting the subtropics with the equatorial regime. Besides the variability of the STCs, the mean pathways within the STC are still a main question. Results of different numerical simulations show, for example, considerable differences in the partitioning between the transport within the western-boundary undercurrents and interior meridional transports. Other important questions regarding the STCs that will be studied are the role of anomalies in transport or temperature of the STC on TAV.

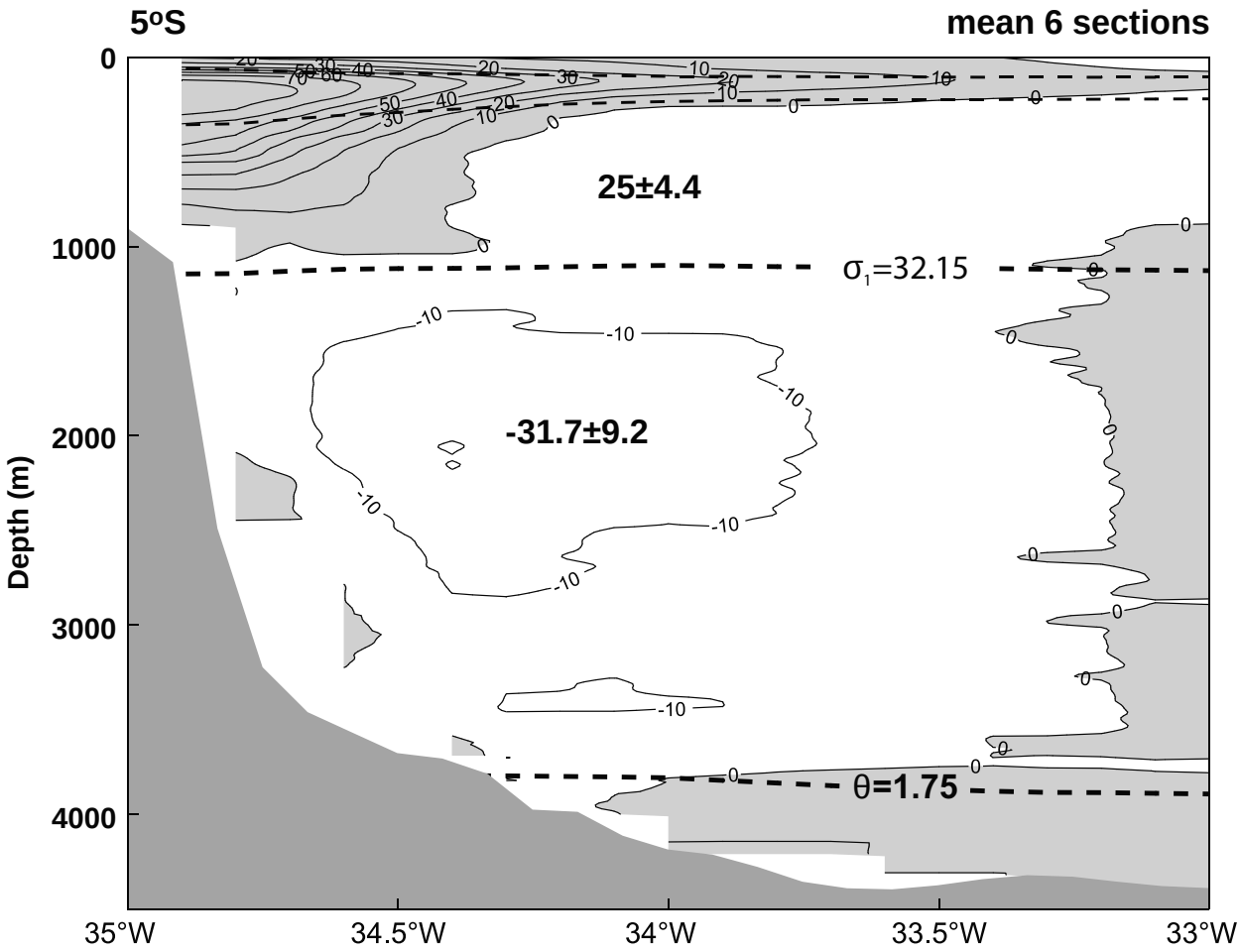


Fig. 2: Mean longshore current distribution (positive is northward) off Brazil at 5°S (see Fig. 1). Mean transport numbers and std. deviations are based on 6 sections, and are for the northward warm water flow above the isopycnal surface σ_1=32.15 kg m^{-3} and for the southward flowing NADW flow between this isopycnal and the potential temperature of 1.75°C, which marks the interface between NADW and the northward flowing AABW.

Variability in the Deep Western boundary current

Several time scales of variability are known to be present in the DWBC. They range from intra-seasonal to seasonal and long-term variability. Long-term mooring deployments are an ideal tool to investigate such variability. Current data obtained from moorings in the tropical South Atlantic at 10°S show, for example, that periods of about 30 days with northward flow along the continental slope exist in the depth range of the NADW. This is an interesting difference from current data acquired earlier north of the equator at 44°W. While in the region north of the equator a strong seasonal cycle in the current as well as in the hydrographic data was found, south of the equator variability with time scales of about 60 days dominates the current time-series. The moorings at 10°S as well as ship sections at 5 and 10°S also revealed that the southward NADW core is removed from the topography, at times with northward flow along the boundary (Fig. 2). The variability in the DWBC south of the equator, which is also characterized by a strong variability in the recirculation cells, is also much stronger than those of the warm water flow above (Fig. 2).

An important question regarding the long-term variability of the deep circulation is the effect of MOC/NADW pulses on the TAV. Recent numerical simulations have shown that such pulses that originate in variability of Labrador Sea Water (LSW) production or in the overflows have an impact on the Sea Surface Temperature (SST) in the tropical Atlantic. In particular, a large pulse of LSW was formed in the early 70ies, which has been documented to propagate down the western boundary and is now arriving at about 15°N. A goal of the observations is to study the effect on the TAV that it triggers when arriving the equatorial zone.

Research perspectives

As the climate over northeast Brazil or the Sahel Zone is correlated with the SST anomalies in the tropical Atlantic, the study of the variability in this region is an important topic. One of the main research questions is the role of subsurface to deep circulation in determining TAV, Intertropical Convergence Zone position and SST. The western margin of the tropical South Atlantic is a particularly interesting region for observing the water mass exchange within the STC/MOC. The deployed moorings at this location together with repeat surveys of the larger-scale region and profiling floats will enable us to focus on this research question. Interpretation of the data will be carried out in close collaboration with the IfM FLAME modelling.

Peter Brandt and Friedrich Schott

The North Atlantic Oscillation

The North Atlantic Oscillation, NAO, is a dominant phenomenon of the Northern Hemisphere's atmospheric circulation. It displays a relationship between the Azores high and the Iceland low, that is when the surface pressure rises in the south it simultaneously falls around Iceland and vice versa. In order to quantify the NAO, an NAO index is defined as the difference of the normalized (by the standard deviations) pressure anomalies (relative to the means) between Ponta Delgada (Azores) and Stykkisholmur (Iceland), in some studies data at Lisbon (Portugal) are used instead of Ponta Delgada. The NAO index (see Fig. 1) provides an expression for the strength of the westerlies over the North Atlantic: high NAO means strong mid-latitude westerlies (and increasing trade winds), low NAO gives weak westerlies (and decreasing trade winds).

Since the NAO exhibits a narrow relationship to the strength of the surface westerly winds over the North Atlantic, it is to be expected that it has an effect on the atmosphere-ocean interaction as well as on weather and climate of Europe. Strengthening surface windspeed results in an increase of the vertical flux of energy, water vapour and momentum through the ocean surface. As a consequence for the ocean the mixed layer must cool i.e. decreasing sea surface temperatures, SST, for the atmosphere the humidity will rise. In addition to these direct effects, the oceanic circulation can be altered due to changes in the wind field as consequence of the NAO.

Investigations are carried out at IfM on all these problems. The studies are performed by analysis of direct observations and model results and by development of numerical models which simulate oceanic processes depending on atmospheric forcing.

1. Characteristics of the NAO

The NAO is most pronounced during winter season and it shows a persistence between two winters, even though it almost vanishes during the seasons in between. Variation in many time scales is a characteristic feature, as Fig. 1 shows.

The NAO is an instationary phenomenon and has only weakly significant periodicity. Temporal variability between 8 to 10 years is often shown, but it exists only during certain periods during the last 150 years. An increase of the NAO and a shift of its centres of actions towards NE during the last 20 years has been analysed by our research group. It is hypothesized that the global temperature increase due to human activities is responsible for these changes, as results of climate models reveal. Since direct observations provide a time series of not longer than about 150 years, proxy data are applied as ice cores and tree rings to reconstruct the NAO index back to the 17th century. Such investigations should reveal whether the NAO increase of the last decades is unique or whether similar events happened already in earlier centuries.

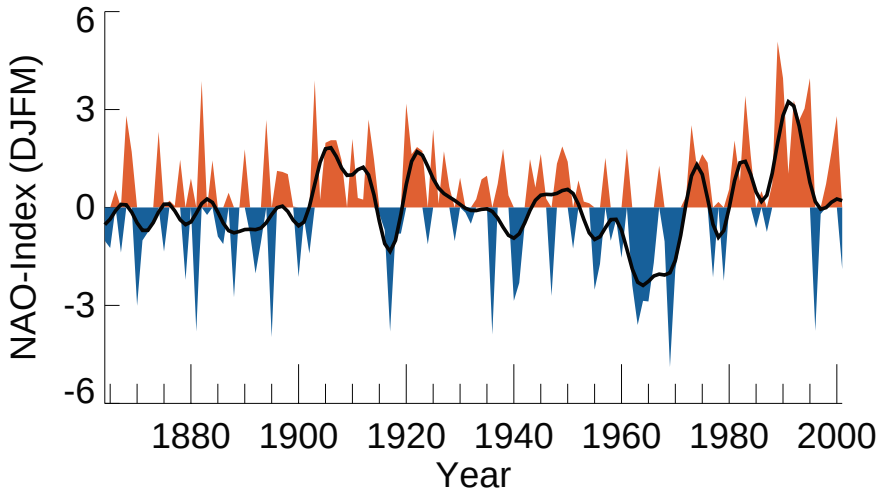


Fig. 1: Time series of the NAO index, winter mean for the months December to March. An 8-year low pass filter is applied to generate the full line.

2. Transports towards the European continent

European weather is strongly determined by cyclones most of which are generated over the North Atlantic. Afterwards they move towards the European continent and are responsible for the large variability of the European weather. With increasing NAO the number of cyclones grows and their tracks are directed more towards NE. During a low NAO phase the cyclone tracks turn more into zonal direction and hit the continent at a lower latitudinal band.

The cyclones together with the steady W-winds carry the temperate and humid Atlantic air masses towards Europe. One consequence of this fact is that the North Atlantic is the main source region of the European precipitation. The humidity transport strongly depends on the NAO phase, too. During high NAO, the transport is strong and directed towards northern Europe (Great Britain, Scandinavia), during low NAO, the transport decreases and hits more southern Europe (Portugal/Spain, Mediterranean) (Fig. 2).

3. Weather and climate in Europe

As consequence of the relationship between NAO and cyclone tracks and humidity transport the weather situations in northern and southern Europe change almost in anticorrelation: during high NAO, northern Europe is warm and humid with high precipitation during winter and opposite situation holds in the south; during low NAO, precipitation must increase in the Mediterranean and decrease in Scandinavia where the winters get cold.

Fig. 3 displays these conditions in three frequency distributions. The decrease of the winter temperatures in Scandinavia from high to low NAO phase is clearly demonstrated by the frequency distribution. The range of the mean Scandinavian temperature is between −16 to 1°C with a maximum at −5°C during low NAO, it increases from −9 to 6°C with a maximum at −1°C during the high NAO phase. The opposite behaviour of the precipitation in Scandinavia compared to Spain/Portugal in relation to the NAO is shown at the other two frequency distributions. The decrease of precipitation in the south during high NAO is drastic and can easily lead to draught situations. Whereas low NAO conditions produce heavy rainfall even in the mean. In Scandinavia the difference is not as large as in the south, but an increase by a factor of 2 from low to high NAO may happen, too.

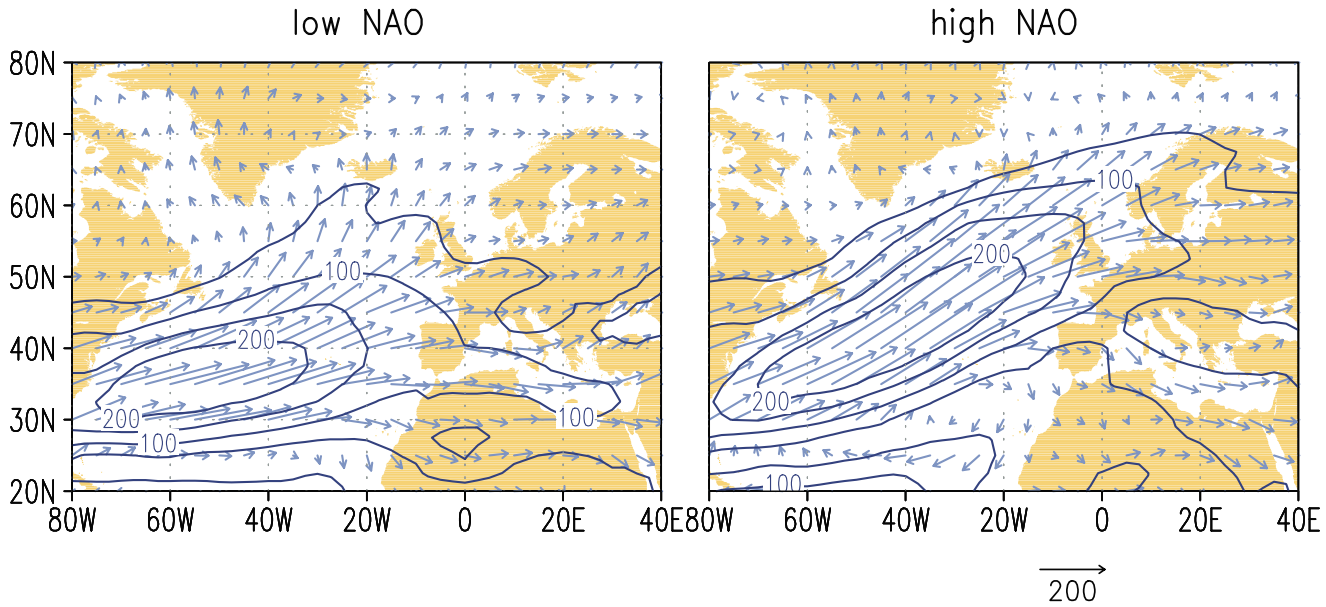


Fig. 2: Mean humidity transport over the North Atlantic during low (left) and high NAO (right). The vectors give magnitude (kg/ms) and direction of the transport; for a clearer indication of the transport magnitude isolines are drawn, too.

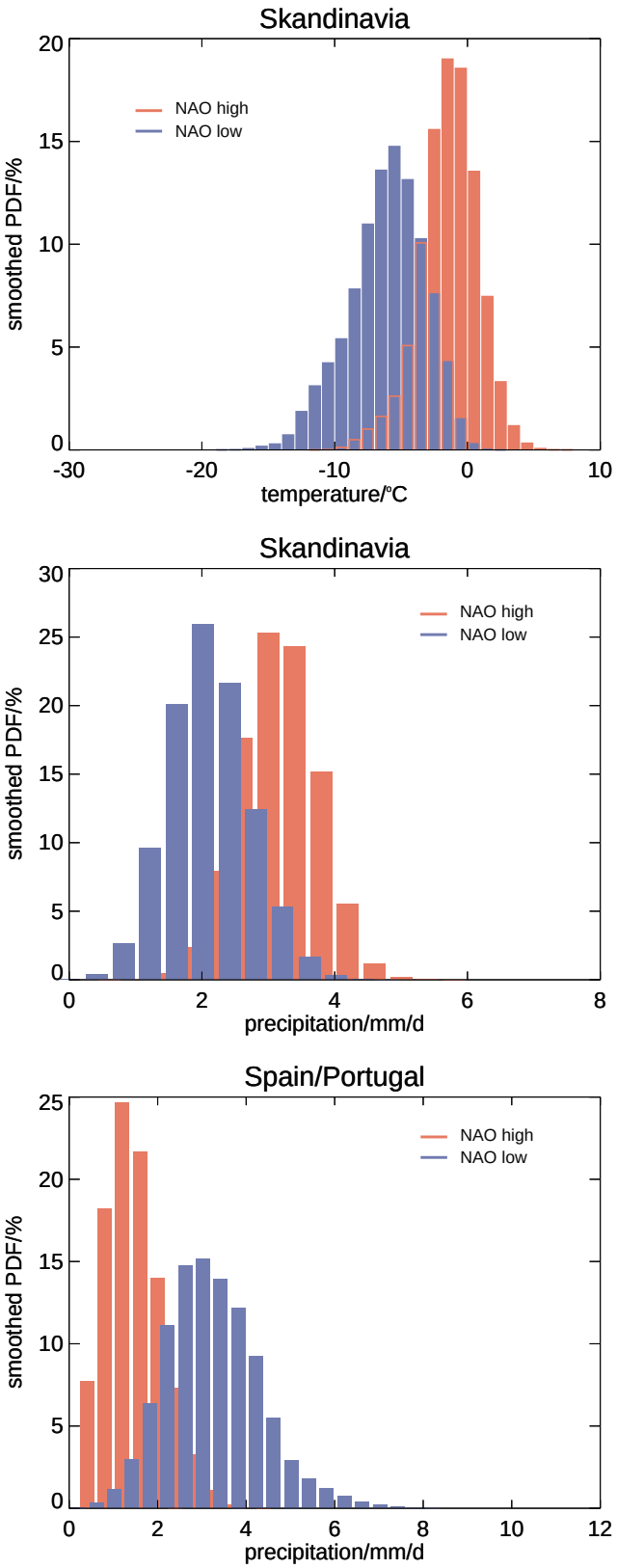


Fig. 3: Frequency distributions (pdf: probability density function) of mean winter temperature in Scandinavia and precipitation rate in Scandinavia and Spain/Portugal, a comparison between high (red) and low (blue) NAO.

However, the frequency distributions do not only give an overview about the mean change of certain parameters from high to low NAO phase. Extreme values can easily be determined which are very important when assessing the impact of changes in weather and climate on environment and society of the investigated region.

4. Changes in the ocean circulation

An ocean model forced by the heat and momentum fluxes at the ocean-atmosphere interface shows characteristic changes of the oceanic circulation when the forcing data vary in relation to the NAO. From these results it can be concluded that the strength of the thermohaline circulation as well as the subpolar gyre are affected by the NAO at different time scales. The contribution of the different surface fluxes, however, varies depending on the time scales. Oceanic response to interannual changes of the NAO is driven by surface heat and momentum fluxes, whereas response of interdecadal changes primarily depends on the surface heat flux only.

A serious problem of the NAO is still unsolved. Neither the analysis of observations nor numerical models give knowledge of the influence of the ocean on the NAO. The development of atmospheric disturbances forced by the mid-latitudinal ocean to produce a circulation phenomenon like the NAO has not yet been discovered. Thus, it is hypothesized that the forcing of the NAO comes either from the tropical ocean or from the mid-latitudinal continents e.g. due to large heat gradient between continent and ocean during winter.

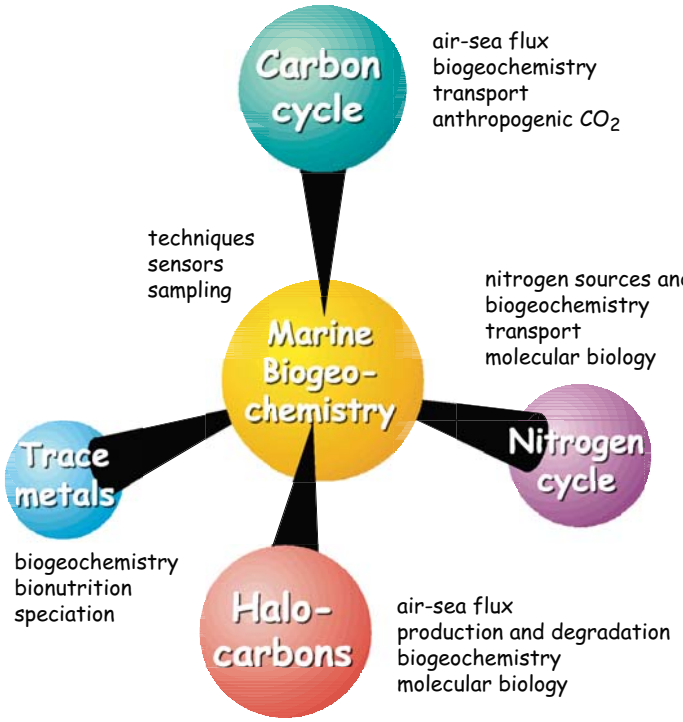
More research in this direction is needed and will also be done at IfM.

Eberhard Ruprecht

2.2 Marine Biogeochemistry

2.2.1 Overview

Marine biogeochemistry is the study of chemical transformations and exchanges in the marine environment. Because so many such transformations are mediated by organisms, scientific progress requires close integration of advanced chemical and biological expertise. The founding of the "Forschungsbereich Marine Biogeochemie" (FB 2) in May 2000 established a new research area at the IfM that complements long-standing strengths in physical oceanography and marine ecology / fisheries science. In practice, FB 2 was built on the foundation of the previous departments of Marine Chemistry and Planktology. These departments had already developed shared research programmes within the framework of the international programme JGOFS (Joint Global Ocean Flux Study). The sections were renamed "Chemical Oceanography" and "Biological Oceanography" to more accurately reflect their research orientation.



During the years covered by this report, the Forschungsbereich Marine Biogeochemie was "under construction". The retirements of Professor Duinker (1997) and Professor Zeitzschel (2000) together with the completion of JGOFS field-work in 1998 meant that the project base and recruitment of graduate students had slowed considerably. Research staff also changed, particularly in Chemical Oceanography, with the retirements of Drs. Manfred Ehrhardt (1998), Klaus Kremling (2000), and Christoph Osterroht (2001). Dr. Detlef Schulz-Bull was called to the Professorship of Marine Chemistry at the IOW-Warnemünde in April 2001. Hence the Chemical Oceanography section has experienced an almost complete replacement of its scientific staff. In Biological Oceanography the retirements of Prof. Jürgen Lenz (1998) and Dr. Rolf Boje (1999) resulted in loss of the zooplankton research. Professor Wallace joined the soon-to-be-born Forschungsbereich in August 1998 as head of Marine Chemistry. He was appointed Head of the "Forschungsbereich" upon its founding. Professor Zeitzschel´s successor, Professor Karin Lochte, was appointed head of the Biological Oceanography section in November 2000. Dr. Hermann Bange and Dr. Julie La Roche joined the Chemical Oceanography and Biological Oceanography Sections respectively, and Professor Arne Körtzinger was appointed as Professor of Marine Organic Chemistry in June 2001. At the time of writing, recruitment of a C3 Professor of Planktology and a C4 Professor of Biogeochemical Modelling is underway.

In contrast to the physical sciences, for which the CLIVAR project has provided some post-WOCE continuity of effort, the marine biogeochemical community had no obvious follow-on programme to JGOFS in mind. The

senior members of FB 2 have therefore been very active in planning for the major marine biogeochemical research programmes of the future. In particular, attention has focused on the development of SOLAS (Surface Ocean Lower Atmosphere Study, see page 63).

The overall goal of the "Forschungsbereich Marine Biogeochemie" is to improve understanding of the complex biological, chemical and physical processes involved in the cycling of key chemical elements within the ocean, and between the ocean and the atmosphere. Such understanding is central to the identification and assessment of climate and chemical feedbacks associated with changes in the physical and chemical environment (e.g. global change) mediated through ocean biology, marine chemistry and ocean transport. Work in FB 2 therefore covers the cycling of inorganic and organic forms of carbon, nitrogen and phosphorus, the production and fate of natural organohalogens and sulphur compounds, and the cycling and biogeochemical role of key trace elements. This requires both advanced analysis of the chemical species and investigations of the biological processes and organisms involved in these biogeochemical cycles. Our emphasis lies largely within the water-column and at the air-sea interface with a special emphasis on the Northern and Tropical Atlantic. In addition to field studies, laboratory studies are employed as appropriate; in particular to investigate key phytoplankton species and their reaction to environmental changes using molecular biological methods. Work within marine sediments and at the sediment-water interface is viewed as an area for closer cooperation with GEOMAR and we plan to extend this research field collaboratively in the future.

The FB 2 has acquired two new isotope ratio mass spectrometers: the first was acquired in 1999 and is used for compound-specific analyses, with a particular emphasis on trace gases. A second, acquired in 2001, is used to determine stable isotope ratios of C and N in bulk organic matter and organisms in order to examine metabolic processes and food web structure. Both instruments are used collaboratively with the other research divisions and GEOMAR.

A project-by-project listing of individual research efforts in these three main areas can be found on the IfM's web page. The overall scientific themes as defined in the IfM Medium-Term Research Programme 2001-2003 are described in the following sections.

Upper ocean processes and air-sea exchange

The atmospheric composition is a fundamental factor that determines the Earth's climate and its habitability. The composition itself is determined by biological, physical and chemical processes operating within the atmosphere, on land, and within the oceans. Atmospheric composition and transport in turn plays a significant role in determining the chemistry and biology of the ocean and land. Over the past 200 years, mankind has played an increasingly significant role in perturbing the "natural" composition of the atmosphere, including altered cycling of many elements including C, N, S, Fe and the halogens. The recognition of a key role for iron, which has a significant atmospheric source, in limiting ocean biological production further emphasises the importance of air-sea chemical transfers. The increased atmospheric deposition of nitrogen to the oceans is already significant over wide regions of the ocean surface and may be affecting ocean biological productivity. However the ocean also plays a major role in controlling the atmospheric composition, and in the context of global environmental change air-sea fluxes may also be altered with consequent effects on atmospheric radiation transfer or atmospheric chemistry. With respect to CO_2, there is an increasing socio-economic need to measure and understand the relative contributions of oceanic and terrestrial carbon source-sink behaviour. In this context, the magnitude and distribution of air-sea fluxes and the sensitivity of ocean-atmosphere carbon sinks to short-term climate variability and to long-term climate change needs to be better understood.

The FB 2 has been actively developing new research activities under this general theme. These relate directly to SOLAS and represent a major focus of present research. The topics that are being investigated include:

- the exchange of CO_2 between ocean and atmosphere in the North Atlantic;
- the flux of biogenic halogenated compounds from surface waters to the atmosphere;
- the distribution of N_2O in the Atlantic including attribution to denitrification and nitrification production pathways;
- the effect of iron on phytoplankton physiology including nitrogen fixation. This is studied in laboratory experiments and in the field using molecular biological methods;
- the biological production of dimethyl sulphide, which is released to the atmosphere and can affect cloud formation and albedo.

Mixed layer and deep ocean particle export

Work in this area focuses on particulate exchange between the atmosphere-forced surface layer and the deep ocean across the mixed layer boundary. The particle flux is coupled closely to surface layer physics and biology. Climate-related variations in these factors and hence the particle flux can be expected in the future. Research under this theme links qualitative and quantitative aspects of particle export to satellite-derived surface properties and upper-ocean biology. An emphasis is placed on developing and testing conceptual models of the link between production and flux on different time scales (see Fig. 1). Regional and basin-wide variations of particle flux are analysed to delineate differences in the strength of the biological pump within and between biogeochemical provinces. Individual organic compounds of natural and anthropogenic origin have also been used to study the transport of lipophilic compounds out of the surface ocean. Basic research is conducted into the formation of paleo-proxy relationships within organic biomarkers that are ultimately preserved in sediments. Specific processes of particle modification are investigated, including packaging by zooplankton and autotrophic aggregation, using experimental and field studies. Research into the particulate-phase transport of trace metals has sought to better understand their biogeochemical cycles, including their sensitivity to anthropogenic change.

Under this theme FB 2 investigated following topics:

- the analysis of particle sedimentation at the European continental margin (OMEX);
- JGOFS longterm study of the variability of the particle flux in the North Atlantic with emphasis on trace metals and organic compounds;
- PCBs in the marine environment;
- phytoplankton reactions to iron fertilization at the Antarctic Polar Front;
- nutrient management in the Danube basin and its impact on the Black Sea.

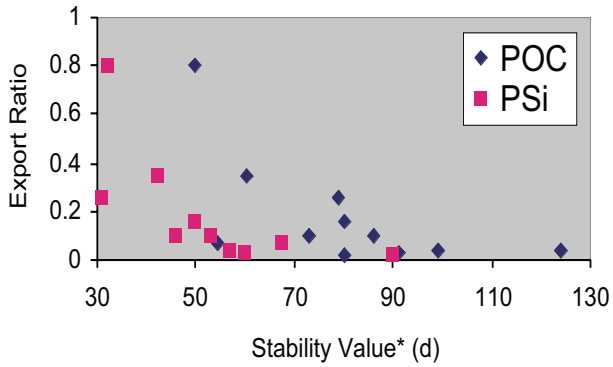


Fig. 1: Based on time-resolved measurements of the annual cycle of the downward particle flux, the export ratio (i.e. the proportion of primary production that is exported below 125 m) can be related to the seasonality of carbon export. In this plot, a "stability value" for the export flux is defined as the minimum time (in days) required for half of the total annual flux to take place. Lower values of this stability value reflect episodic fluxes (e.g. high seasonality); higher values represent more constant export over time. Relations are shown for both particulate organic carbon (POC) and particulate silicate (PSi). The data show that highly episodic regimes, such as polar regions and upwelling systems, tend to have higher export ratios than regions subject to steadier fluxes (e.g. the oligotrophic tropical Atlantic).

North Atlantic cycling of carbon and nitrogen

The North Atlantic Ocean plays a disproportionally large role in ocean bio-geochemical cycles in relation to its contribution to the total ocean surface area. Contributing factors include its unique physical characteristics, particularly the conversion of massive amounts of surface waters into dense, deep ocean water. This allows the North Atlantic to play a major role in the sequestration of anthropogenic carbon dioxide (see Fig. 2). The North Atlantic is also the recipient of a disproportionately high amount of river runoff and its relatively narrow width implies a strong role for biogeochemical processes at the ocean margins. Proximity to land, including the industrialised portions of the Northern Hemisphere, results in major input of continentally derived materials via the atmosphere (e.g. dust, nitrogen).

The North Atlantic has been a target of major oceanographic biogeochemical research of the IfM in international programmes of the past decade (e.g. JGOFS and OMEX). Through these programmes, a large body of knowledge concerning the main carbon and nitrogen fluxes has been acquired. FB 2 continues to analyse and synthesise this information to arrive at advanced understanding of the cycling of carbon, nitrogen and associated elements, including the uptake and transport of anthropogenic CO_2. Under this theme research within FB2 currently includes the following topics:

- the regulation mechanisms of the marine carbonate system for the natural cycling of carbon within the oceans (JGOFS);
- the climate sensitivity of the biological pump in the North Atlantic;
- uptake and transport pathways of anthropogenic CO_2 in the context of variations in the thermohaline circulation of the North Atlantic (SFB 460);
- estimation of stocks and flows of the carbon cycle in the pelagic waters in the Canary Islands, Azores, Gibraltar Observations (CANIGO);
- the availability of dissolved organic nitrogen compounds for the nutrition of phytoplankton.

Future perspectives

The research profile of the research divisions will continue to develop and expand with the recruitment of two new Professors during 2002. An effort will be made to maintain a clear focus on the themes contained in the Medium-Term Research Plan and, particularly, to expand closely integrated chemical-biological research. A major activity planned for the near-term is the initiation of SOLAS research in Germany starting with the cruise of RV "Meteor" No. 55 (Oct.-Nov. 2002), which will investigate a range of ocean-atmosphere exchange processes along 11°N in the tropical Atlantic. This region exhibits a wide-range of within-ocean biogeochemical conditions and is subject to large and variable atmospheric dust (iron) input. This cruise represents an opportunity to bring together the various individual research

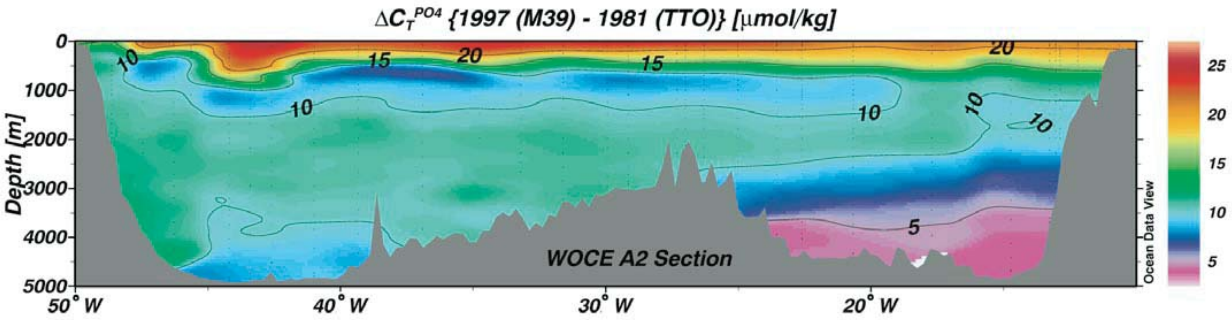


Fig. 2: An estimate of the anthropogenic CO_2-increase (in µmol kg^{-1}) in the water column between 1981 and 1997 along a hydrographic section in the Sub-Polar Gyre of the North Atlantic (K. Friis). This is based on a multivariate comparison of inorganic carbon data collected during the SFB460 and historical data from the same region during the Transient Tracers in the Ocean (TTO) study.

projects, activities and researchers of the FB 2 as well as international collaborators. It is expected that the Tropical Atlantic will become an important focus for future research.

The need to better understand and characterize biological metabolic processes in chemical cycling will require increased use of modern molecular biological and biochemical tools in close relation with studies in marine chemistry. A high priority for the Forschungsbereich is therefore the development and use of the planned Central Laboratory for Molecular Biology. The increasing appreciation of the role of trace metals in both limiting biological production, and controlling specific biogeochemical processes in the oceans (e.g. nitrogen fixation) requires a renewed emphasis on trace metal work at the IfM. The Forschungsbereich has excellent technical expertise as well as laboratory facilities suited to such research. The retirement of Dr. Klaus Kremling left a major gap in this area that we are presently seeking to fill.

As field and laboratory activities in the area of marine biogeochemistry continue to develop, the need to interpret and represent the global significance of such observations becomes ever larger. In this regard, the establishment and recruitment of a Professor for Marine Biogeochemical Modelling will be a major step forward.

As outlined below, a large effort of the past 3 years has been the establishment of a Carbon Observing Network within the North Atlantic Ocean. Such a network has scientific value in its own right but also offer possibilities for tackling additional basic research questions. Sustained biogeochemical observation of the "core" parameters, required for global carbon-cycle research, provides an opportunity to "piggy-back" specialized, basic research. In coming years, FB 2 will seek to build-upon and exploit such opportunities through, for example, initiating basic scientific research from volunteer observing ships and time-series moorings.

In order to foster closer links to the Forschungszentrum GEOMAR future joint research projects are being discussed. Development of proxies using stable isotopes and investigation of the associated biological production mechanisms is one field of common interest. Another potential joint research topic is the calcification process, which is of biological and geological significance and is a major factor affecting the carbon storage capacity of the ocean.

2.2.2 Selected Research Projects

Iron and biological production

Some areas of the open ocean are known to be deficient in iron, which is a critical micronutrient for phytoplankton growth. Iron reaches the ocean to a significant extent via the atmosphere in the form of dust (Fig. 1), but has very low solubility in oxic seawater. It therefore becomes scarce in areas far removed from land. If other nutrients are available in sufficient concentrations, iron can become the key factor limiting the development of phytoplankton and hence the biological uptake of CO_2 in the ocean. Several large-scale iron fertilisation experiments in different parts of the ocean in recent years have demonstrated that addition of iron does indeed stimulate phytoplankton growth. It is hypothesised that glacial-interglacial changes in the supply of dust from the continents may have had a major impact on past productivity and oceanic CO_2 uptake. These findings have also led to recent controversy as to whether deliberate iron-fertilization of parts of the ocean should be carried out on a large scale in order artificially to increase CO_2 sequestration by the ocean.

However many unresolved questions remain with respect to the bioavailability of iron, which organisms utilize it, what chemical form of iron is preferred by diverse phytoplankton groups, and what effects iron additions can have on the marine ecosystem as a whole. In fact, very little is known about the physiology of iron uptake by phytoplankton, including whether or not certain classes of eukaryotic and prokaryotic phytoplankton can excrete ligands that bind iron and help keep it in solution. This is a very active area of research and at the IfM we have been approaching this with molecular biological techniques. For example we have been developing and using cDNA subtraction libraries to isolate genes that may be iron-regulated and which code for proteins involved in the uptake of Fe. The iron-regulated gene encoding flavodoxin, has been isolated from this library.

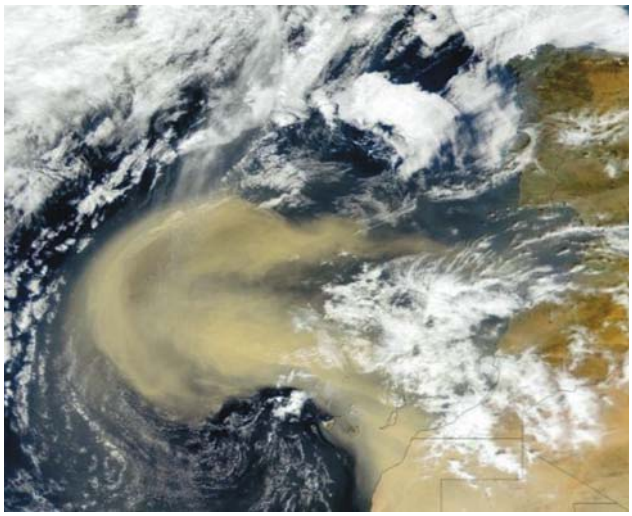


Fig. 1: A satellite image of a "dust storm" over the eastern Atlantic Ocean. Such storms carry iron in the form of mineral aerosol from land (e.g. desert areas) to the ocean. Such atmospheric transport and deposition represents an important pathway for supplying the important micronutrient iron to phytoplankton.

The Southern Ocean is one such iron-deficient but otherwise nutrient-rich area. A large-scale experiment ("EISENEX 1") was carried out aboard RV "Polarstern" in early austral spring 2000 in the Atlantic sector of the Southern Ocean under the scientific leadership of the Alfred-Wegener-Institute. Approximately 500 square kilometers of ocean surface were fertilized with iron and the plankton development was followed for 3 weeks. Scientists from FB2 participated in this experiment in order to determine phytoplankton composition based on pigment analysis and in order to apply molecular probes for proteins that are diagnostic of iron limitation. During SOIREE, an earlier iron-fertilization experiment in the Southern Ocean, the detection of flavodoxin in diatoms was used to confirm that the seed diatom population was indeed iron-limited before iron fertilization took place (Fig. 2).

During EISENEX I, chlorophyll concentrations increased fourfold inside the patch within 3 weeks after the iron addition. The IfM pigment analyses revealed that this large increase

in biomass was caused mainly by the growth of diatoms, which contributed about 75% of the biomass by the end of the experiment (Fig. 3). This group of phytoplankton were clearly seen to outcompete other groups present when sufficient iron was made available.

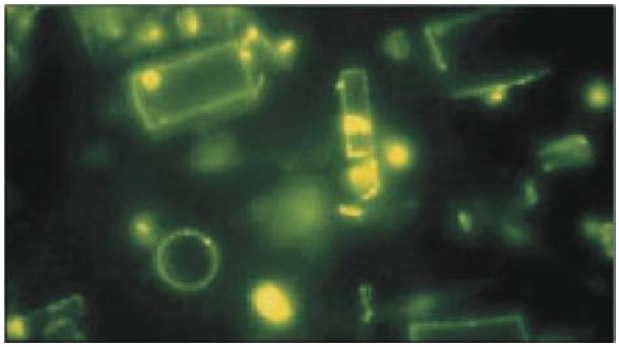


Fig. 2: A seed diatom population as photographed before the addition of iron during the SOIREE iron fertilization experiment in the Southern Ocean. The green fluorescence is the result of an in situ immunofluorescence reaction with polyclonal anti-flavodoxin antibodies, and shows the presence of flavodoxin in the chloroplasts (photo courtesy of Dr. M. Mackay). In diatoms, flavodoxin is expressed only under severe iron deficiency, confirming that in this particular diatom population, iron was limiting for the cells before iron was added. Such molecular probes have the potential to be used as large-scale survey tools to assess iron limitation in the ocean and are under continued development at the IfM.

This experiment once again demonstrated that phytoplankton can react strongly to iron enrichment. However the available observation period was too short to determine the extent to which biologically fixed CO_2 was ultimately exported to the deep ocean via sedimentation of organic material. This and a range of important questions related to the extent of iron limitation in the oceans as a whole, the bioavailability of naturally introduced iron, and the longer-term effects of artificial iron additions on phytoplankton physiology, composition, and ecosystem structures, remain unanswered. Scientists from FB2 plan to continue to address such questions through the application of sensitive analytical chemical techniques, diagnostic tools developed with the aid of molecular biology, and advanced methods to investigate phytoplankton community structure.

Ilka Peeken and Julie LaRoche

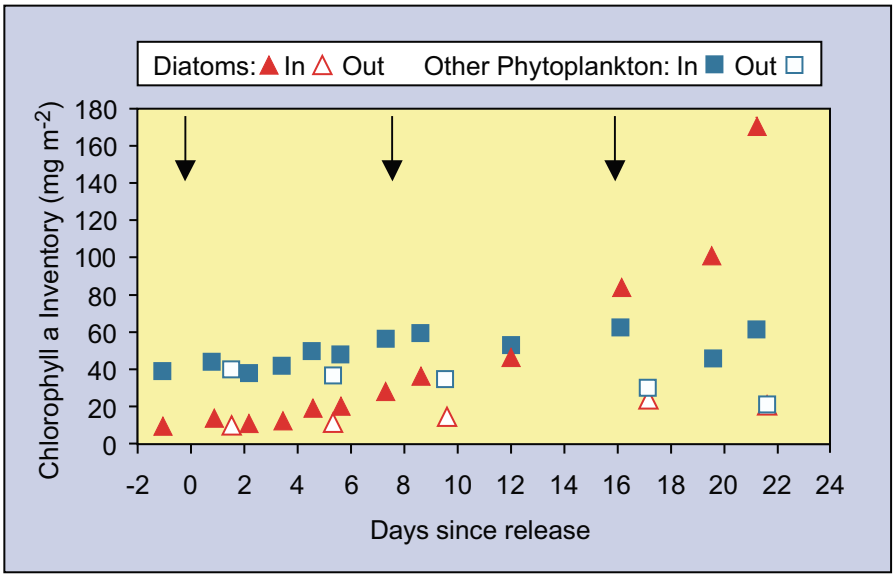


Fig. 3: Abundance of diatoms and "other phytoplankton species" both inside and outside an iron fertilised patch during the EISENEX I experiment. Biomass is expressed as depth-integrated (to 100 m) chlorophyll a concentration. Arrows denote times when iron was added to the patch. Diatom biomass increased dramatically with time inside the patch following iron addition whereas the abundance of other species remained approximately constant.

Observing $100 billion per year (Towards an ocean carbon observing network)

The level of CO_2 in our atmosphere is now higher than at any time during the past 400,000 years and possibly higher than at any time during the past 20 million years. This level may double again by 2100 with serious implications for climate, as well as for the terrestrial and marine carbon cycle itself. The oceans are a major player in ameliorating this increase through their ability to dissolve anthropogenic CO_2. This uptake is of the order 2 PgC/yr. The terrestrial biosphere also acts as a net sink due to processes that are not well understood. A major question facing mankind, and particularly policy makers attempting to limit future atmospheric CO_2 levels, is whether the oceanic and terrestrial sinks will remain constant, or whether there are strong feedbacks between increased CO_2 levels, climate change and future carbon sink behaviour. Unfortunately our scientific understanding of where these sinks are, and how they are controlled, is not complete: this makes future predictions shaky.

The variability in both space and time of carbon sources and sinks, both oceanic and terrestrial, is becoming clearer thanks to inverse modelling of long-time-series atmospheric CO_2 data.

This allows identification of cause and effect linkages between climate variability (e.g. El Niño) and carbon sinks. This is economically important science: terrestrial sinks have enormous economic and political significance in this era of international emissions control agreements. Projections of the future value of such sinks range between $20 and $100 per ton. This translates into a socio-economic "value" for the oceanic carbon sink of order $100 billion per year!!

In principle, the air-sea flux of CO_2 at ocean basin scales can be accurately estimated from measurements. Such estimates would help atmospheric inverse models address presently unresolved and difficult questions concerning the distribution and behaviour of terrestrial carbon sinks. However at present, the data concerning surface ocean CO_2 distributions and air-sea fluxes is insufficient for this task. The Forschungsbereich is therefore heavily involved in promoting and establishing Networks of Ocean Carbon Observations. The observational strategies and platforms required of such an observing system and the Forschungsbereich's contributions are as follows:

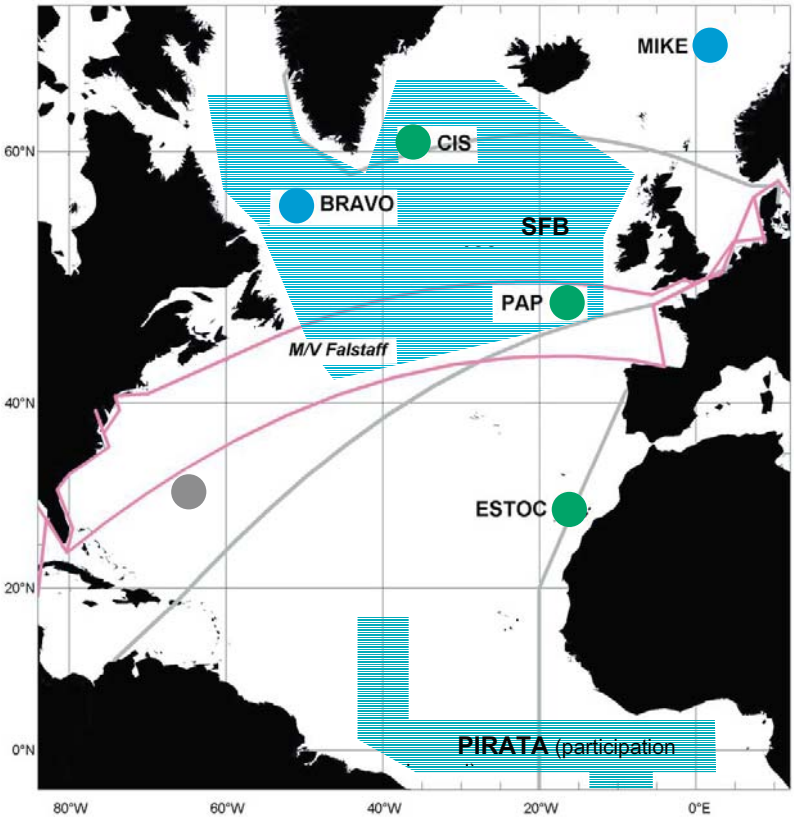


Fig. 1: Existing and currently planned elements of the North Atlantic Ocean Carbon Observing Network, with the IfM's contribution highlighted. Shown as lines, are the routes of four Volunteer Observing Ships that are presently supported under the EU-project CAVASSOO. The IfM is responsible for the central route (red line) aboard the car-carrier MV "Falstaff" (operated by Wallenius-Wilhelmsen). Also shown as green circles are time-series moorings with in-situ carbon sensors systems that are presently funded under the EU-project ANIMATE. Additional stations in the Labrador Sea, the Norwegian Sea and the equatorial Atlantic are proposed (blue circles). The BATS site (grey circle) is a time-series site at Bermuda, which includes a mooring that is funded by the US National Science Foundation.

- Surface measurements from Volunteer Observing Ships (EU-project CAVASSOO). We are establishing a new "ship-of-opportunity" programme for the measurement of atmospheric and oceanic pCO_2 on board a commercial vessel that crosses every 6 weeks between Bremerhaven and New York. The resulting estimates of air-sea CO_2 fluxes will be related to simultaneously measured temperature, salinity, fluorescence and remote sensing data. Longer-term we hope to considerably expand the range of measurements along this important route.

Fig. 2: Fully automated surface water pCO2 measurement system as installed on MV "Falstaff" of Wallenius Lines AS. Measurements are made every 6 weeks along the route shown in Figure 1.

- Long-term, fixed-point time series using moored sensors (New EU-project ANIMATE). In collaboration with members of the Ocean Circulation and Climate Forschungsbereich we are establishing 3 new long-term moored time-series of upper ocean pCO_2 using in-situ sensors. Together with simultaneously measured biological, physical and chemical parameters as well as sediment traps on the same moorings, these time-series will allow the response of pCO_2 and air-sea fluxes to internal ocean biological and physical processes to be identified.
- Hydrographic surveys of carbon system parameters within the interior ocean (SFB-460). We have estimated the oceanic inventory of anthropogenic CO_2 based on high-accuracy vertical profiles of inorganic parameters and a variety of additional biogeochemical and hydrographic variables collected during hydrographic surveys of the SFB-460. This approach allows estimation of total water column transports and long-term changes in inventories of carbon (see above). In addition, we have maintained collaboration with the BSH-Hamburg and measured CO_2 parameters on a repeat hydrographic transect along 48°N.

These measurement programmes are placed in the context of activities of our international partners in Fig. 1. Included are also additional planned activities of our Forschungsbereich. These activities are being coordinated by the IOC/SCOR Ocean CO_2 Advisory Panel which is presently chaired by Professor Wallace.

Douglas W. Wallace and Arne Körtzinger

The oceans" biological pump

The term "biological pump" describes the formation, modification and sedimentation of organic particles that mediate the transport of biogenic material from the surface ocean to abyssal depths and eventually to the sediments. Particles represent a major means by which chemical elements are transported downward through the ocean and are responsible for establishing vertical gradients in dissolved elemental distributions.

Algal photosynthesis, by decreasing the partial pressure of CO_2 in seawater, acts as a sink for atmospheric CO_2 – globally this is on the order of 45 Pg C yr^{-1}. The majority of the organic matter formed in the euphotic zone is, however, respired within the upper few hundred meters of the ocean. Most of this respired CO_2 can therefore re-equilibrate with the atmosphere over the depth to which surface mixing takes place. A fraction of the carbon sinks in form of particles below the base of the winter mixed layer. This carbon can be considered as being "sequestered" from the atmosphere for periods of time relevant to the time scale of the current anthropogenic CO_2 increase. Factors that regulate the strength and efficiency of the biological pump and the depth to which particulate carbon sinks are therefore of interest in estimating potential feedbacks between ocean productivity, atmospheric CO_2 levels and climate.

As part of the JGOFS (Joint Global Ocean Flux Study) synthesis, FB2 scientists have compiled data from the large number of sediment trap moorings deployed over the past decade with a view to:

- determining regional and interannual variability in the strength and efficiency of the downward particle flux within the Atlantic Ocean;
- estimating the sequestration of atmospheric CO_2 by the biological pump on climatically relevant time scales;
- examining the relationship between primary production, new production and particle flux.

Organic carbon has been the main currency by which the biological pump has been characterised to date and has received extensive study. However for controls on atmospheric CO_2, the downward transport of calcium carbonate is also important since this is a process that decreases the alkalinity of surface water and effectively counters the effect of photosynthesis with respect to the partial pressure of CO_2 in seawater. Marine calcification has recently been shown to be negatively impacted by the presently rising surface water CO_2 levels. In addition, the distribution of calcifiers is regionally variable and appears related to the vertical stratification of the ocean and hence climate. Biocalcification therefore represents a potentially important feedback mechanism whereby shifts in future CO_2 levels, climate and ocean circulation changes could alter the distribution of key groups of organisms that are responsible for this process and hence the carbon sequestration capacity of the ocean's biological pump.

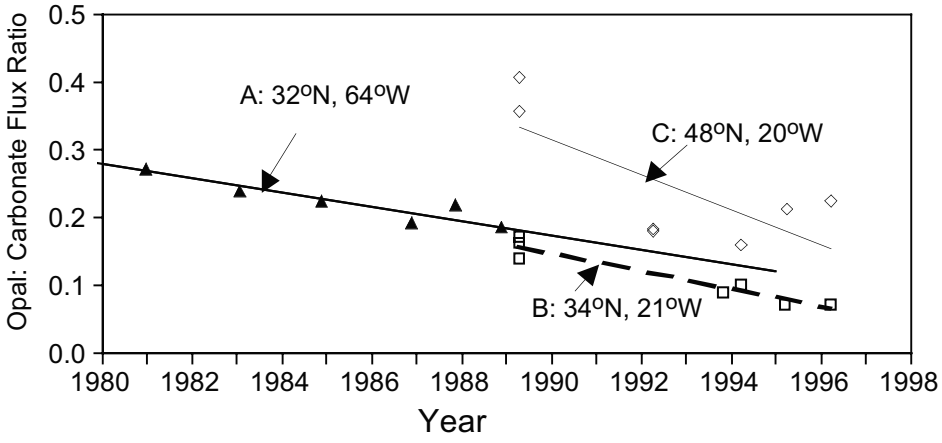


Fig. 1: A steady decrease over time in the ratio of opal to calcium carbonate within sinking particles at abyssal depths, as observed at three sediment-trap locations within the North Atlantic (the locations are indicated in the upper panel of Fig. 2). This is suggestive of a basin-wide change in the composition of biomineralizing species in the surface waters of the northern North Atlantic.

Based on a calibrated subset of the JGOFS sediment trap data, FB2 scientists have developed empirical algorithms that relate the organic carbon and calcium carbonate flux to water depth and primary production. Regional differences in the functioning of the biological pump and in the biogeochemistry of the mesopelagic ("twilight") zone were discerned, related to the seasonality of export and its composition. A temporal decrease in the ratio of opal-forming to calcifying organisms in the sinking flux could also be clearly identified across the north Atlantic basin (Fig. 1), indicating an ongoing change in pelagic upper ocean communities that are key determinants of the operation of the biological pump. The "effective" carbon flux (i.e. the flux that can contribute to sequestration of CO_2 for periods >1 year) was calculated from the net organic and $CaCO_3$-carbon fluxes as estimated for the local depth of wintertime mixing. The procedure takes into account the opposing effects of calcium carbonate production and organic carbon formation on surface pCO_2. Using these algorithms, the organic carbon flux at the base of the euphotic zone, corresponding to new, or export, production, has been estimated for the sub-polar Atlantic basin (excluding the continental margins).

The regional distribution of primary production (see Fig. 2, upper panel) is quite familiar and closely mirrors wintertime surface nutrient concentrations. The regional pattern of "effective" sequestration flux however (Fig. 2, lower panel) looks very different: deep mixing in the subpolar regions results in low net export despite high export production from the euphotic zone. A great deal of the carbon export production in these regions can potentially be re-equilibrated as CO_2 with the atmosphere seasonally (depending on the gas exchange kinetics). On the other hand, the biological pump in equatorial regions, where productivity is generally low, is in fact quite effective in sequestering CO_2, both due to shallow wintertime mixing but also because of the higher ratio of organic to inorganic carbon export at shallow depths.

Avan Antia

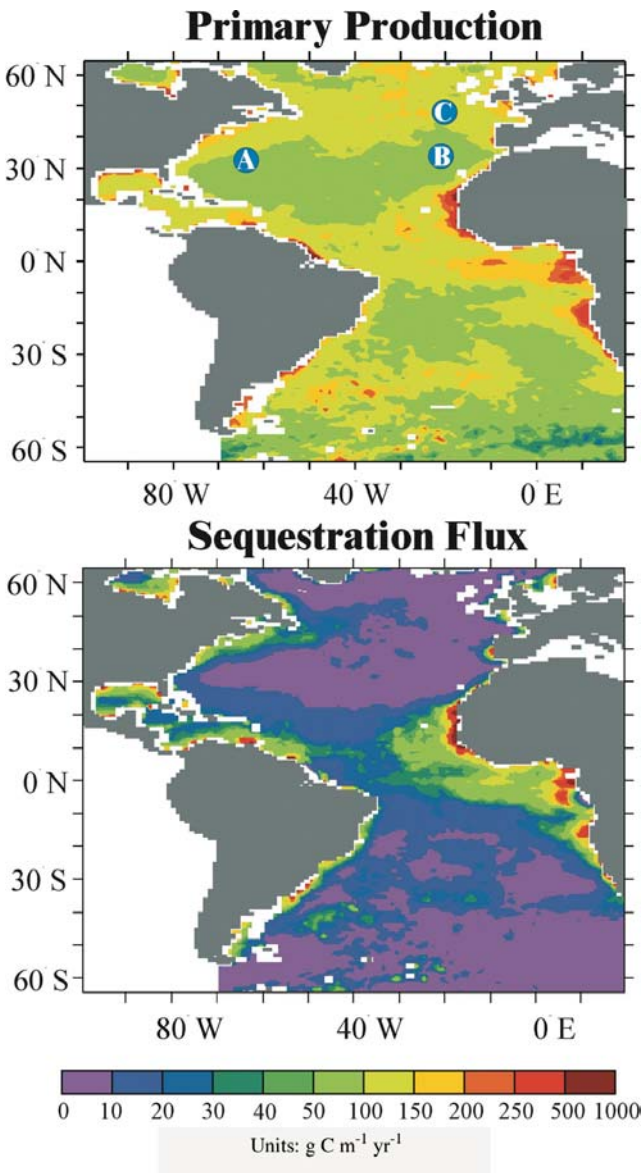


Fig. 2: Extrapolation of JGOFS sediment trap data to basin-scales allows the potential sequestration of carbon in the non-polar Atlantic Ocean to be estimated.

The upper panel shows the distribution of surface primary production (after Antoine et al., 1996). A, B, C, indicate the three sediment-trap locations within the North Atlantic (see Fig. 1). In stark contrast to this, the sequestration flux distribution (lower panel) shows that the tropical regions of upwelling, where surface mixed layers are shallow, play a larger role for the potential sequestration of CO_2 within the ocean via sinking particles, than do the subtropical and subpolar regions.

2.3 Marine Ecology

2.3.1 Overview

The research division "Marine Ecology" is focused on the analysis of cause-and-effect relationships within marine ecosystems. Such a mechanistic analysis is required in order to understand the sensitivity of marine ecosystems against natural and anthropogenic changes of the physico-chemical environment and exploitation of bioresources. For a proper management of the marine environment, it is critical to understand which burden of impact a local/regional ecosystem can tolerate before major structural changes occur and how reversible they are. Such changes include outbreaks of harmful organisms, demise of commercially valuable ones, and a complete re-orientation of biogeochemical cycles.

The response of ecosystems to natural and anthropogenic impacts cannot be understood by neglecting species and stock specific differences in the response of organisms and lumping them into broad categories (e.g. size classes, trophic levels) measured by biomass or productivity. This is especially true for ecosystems influenced by one or a few keystone species. Therefore, our research will encompass several hierarchical levels: ecophysiology of key species, dynamics and genetic of individual populations, interactions between populations, structure and response of entire food webs. Ecophysiological single-species studies concentrate on those aspects which define the role of a species in the food web or in biogeocheochemical cycles, e.g. energetic and nutritional demands, feeding selectivity, conversion of nutrition into growth, limitation of feeding and growth rates. Obviously, nutritional physiology is not only important for basic food web but also of applied interest, e.g. in aquaculture and in the management of marine bioresources, including new natural substances (e.g. antiviral drugs) from marine microorganisms.

At our research division, all components of the marine food web are represented in the research agenda, but there has been some shortage of expertise for the medium trophic levels (*herbivores and invertebrate carnivores*). This shortage will soon be overcome by filling the new C3-professorship "Biological Oceanography – Zoology". During the last years two major project clusters with a food web focus have been initiated, AQUAWEB and GLOBEC.

Within the AQUAWEB initiative we have taken up close cooperation with the Max-Planck-Institute of Limnology at Plön and the Zoological Institute of Kiel University. A number of coordinated DFG-projects have been started, to analyse differences and similarities between marine and freshwater food webs with special emphasis on the lower trophic levels (primary producers, herbivores, microbial loop). These projects are directed to both plankton and macrophyte dominated benthos communities. At present, we concentrate on comparing the impacts of different functional groups of herbivores (e.g. copepods, cladocerans and tunicates as herbivorous mesozooplankton; Fig. 1). The projects are mainly based on field mesocosms where the composition of the herbivore trophic level is manipulated experimentally, but laboratory experiments and observational field studies are included as well. Research sites are the North Atlantic (Norway), the Baltic Sea and the Plön lake area.

The food web studies of the reporting period have shed light on a highly dangerous aspect of the response of marine ecosystems to external pressure. Environmental conditions usually change gradually, but the response of ecosystems might consist of rather abrupt regime shifts. The different system states tend to be stabilised by internal feed-back mechanisms and it might be difficult to revert them when environmental pressures are mitigated. We have analysed two such examples in detail: the shifts between dominance by perennial macroalgae and by ephemeral filamentous algae in the littoral (the *Fucus-Enteromopha*-system) and between dominance of the Baltic Sea fish community by sprat and cod.

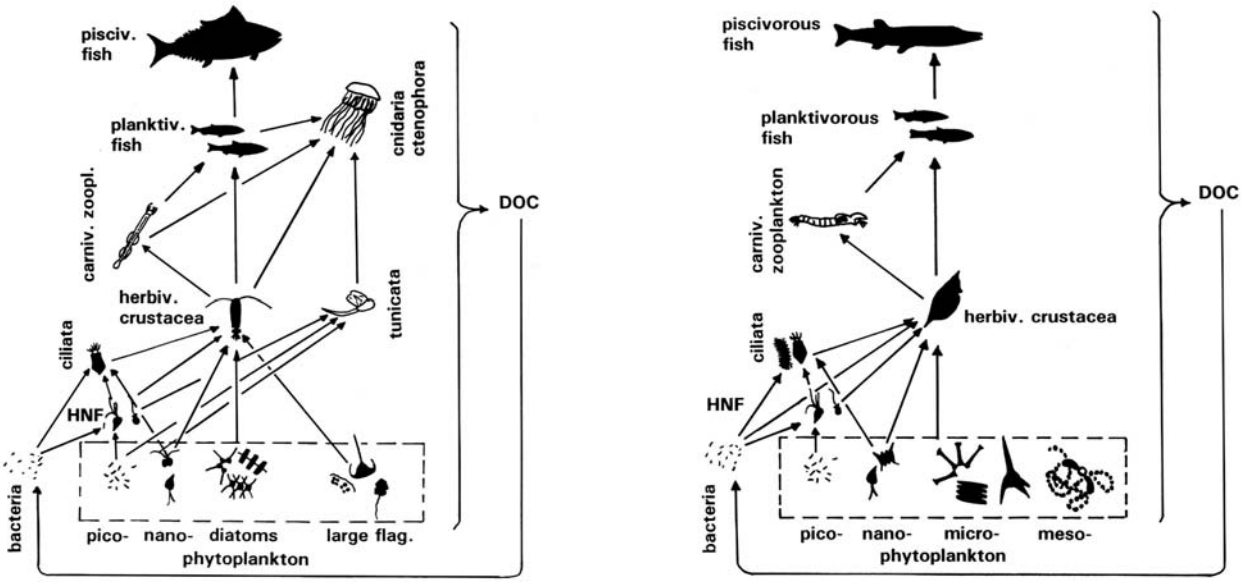


Fig. 1: Comparison of the pelagic food web in the sea (left) and in lakes (right). Please note the difference in herbivorous crustacean zooplankton: in the sea copepods dominate, in lakes cladocerans dominate, but there are also marine cladocerans and limnetic copepods. The "gelatinous" pathway of the food web (tunicates as herbiores/bacterivores and cnidaria/ctenophores as carinivres is lacking in lakes altogether. Cladocerans and tunicates are microphageous filter-feeders with a high efficiency of feeding on the smallest organisms, copepods are macrophageous and feed by individual particle capture.

Microbiological studies have been concerned with the role of sulphur oxidation and methane oxidation in cold seep (MAKRAN, TIEFBAK) and warm vent systems (HYFIFLUX, HYDROARC) in the deep sea and in Baltic Sea sediments (BASYS). Free living and endosymbiotic bacteria of marine invertebrates (TIEFBAK) were investigated. They had a focus on the close coupling between geological, geochemical and microbial processes and included production by chemoautotrophic bacterial communities. Work on the nitrogen cycle with emphasis on nitrate reduction in marine sediments was initiated.

In the frame of international cooperation we specifically focus at present on the GLOBEC initiative, which has become a large multidisciplinary IGBP-core project. The primary interest in this frame is directed to the zooplankton-fish interaction in marine food webs and on the role of oceanographic features (e.g. fronts) modulating the processes relevant for this linkage. GLOBEC research at our institute is funded by several running EU-projects and provides contributions to several international working groups. In addition a national German GLOBEC-project has been developed for the Baltic and the North Sea. Funding by BMBF, will start in early 2002. More detailed information of this focus in our work is given in section 4 (page 59).

Since 2001, the research division "Marine Ecology" hosts the headquarters of FishBase (http://www.fishbase.org), which is the largest world-wide data base for fish which is continually updated through global network partners. It provides information about many ecologically relevant properties (e.g. size, growth parameters, food, natural enemies, trophic level, genetics) as well as geo-referenced occurrence and abundance data. FishBase is a key partner in several international biodiversity initiatives, such as Species2000, the Census of Marine Life and the related Ocean Biogeographic Information system (OBIS), the European Network of Biodiversity Information (ENBI), and the Global Biodiversity Information Facility (GBIF). In addition, the FishBase group works closely together with the Canadian research group developing the ECOPATH and ECOSIM suite of models, food web models with emphasis on the higher trophic levels. These models are a necessary complement to the lower-trophic-level based models with a more biogeochemical orientation, and will add to the integration of research activities within the "Marine Ecolgy" division.

2.3.2 Selected Research Projects

Contrasting impact of different herbivorous zooplankton taxa on phytoplankton

Herbivorous mesozooplankton (200 µm – 2 mm body size) fill in a key position in pelagic food webs because they can directly link primary production to planktivorous fish. Moreover, both marine and freshwater research has shown potentially strong top down impacts on phytoplankton and a key role in recycling mineral nutrients and in mediating sedimentation by forming fecal pellets. In lake plankton, this functional group is frequently dominated by cladocerans, particularly by the genus *Daphnia*, but calanoid copepods might also be important locally and seasonally. In marine plankton, calanoid copepods are usually the dominant herbivorous mesozooplankton, but occasionally pelagic tunicates and cladocerans might be important as well.

There are well-known ecophysiological differences which distinguish those taxa: cladocerans and tunicates have a fast metabolism and reproduction, they are microphageous filter feeders feeding on particles as small as 1 µm or even less. Cladocerans have difficulties handling food particles >30 µm, but less is known about the upper size limits of tunicates. Calanoid copepods, on the other hand, are more selective feeders being able to capture food particles individually, usually do not feed on particles <5 µm and have less difficulties in handling larger food particles. Copepods and cladocerans are good food for fish, while tunicates are poor food because of their high water content. The fast growing cladocerans and the tunicates have a low N:P ratio in their body tissue, the copepods have a high one.

These differences make herbivorous mesozooplankton an ideal model system to test, whether ecophysiological differences between key organisms food web and ecosystem level processes. Together with colleagues from the Max-Planck-Institute of Limnology (principle investigators: B. Santer, K. Jürgens, M. Boersma) we have designed six comparative field experiments (3 sites: North Atlantic – Baltic Sea – Schöhsee; 2 seasons: spring – summer) where the impact of the different mesozooplankton groups on phytoplankton, protozoa, bacteria and nutrient cycling are studied. So far, we have completed the two lake experiments and the summer marine experiment at Sletvik Biological Station, Norway.

The experiments consisted of ca. 3.5 m^3 transparent enclosures (mesocosms) which were filled by natural near surface water sieved through 100 µm plankton gauze, in order to remove mesozooplankton. Then the mesocosms were seeded with different densities of the zooplankton from the different functional groups. A clear response of phytoplankton could be seen already after a few days. In the lake summer experiment total phytoplankton biomass did not respond to copepod or *Daphnia* density, but size structure and taxonomic composition showed a clear response: in the *Daphnia* treatments, the abundance of small phytoplankton species declined with *Daphnia*-abundance while large species (>30 µm) compensated for the losses of the small ones by enhanced growth. In the copepod treatments (mainly *Eudiaptomus*) the response vas vice versa: small algae were favoured, while large ones were decimated.

In the marine summer experiment in July 2001 the marine cladoceran *Evadne* did not grow in the enclosures. Therefore, we have to restrict the comparison on the copepod and the tunicate treatments. The copepods were represented by a mix of *Temora, Acartia, Centropages* and *Pseudocalanus*, the tunicates were represented by the appendicularian *Oikopleura dioica*. So far, we have only phytoplankton counts, while the samples for the microbial food-web, bacterial activities, phytoplankton and zooplankton elemental composition and isotopic signals (^{15}N, ^{13}C) are being processed.

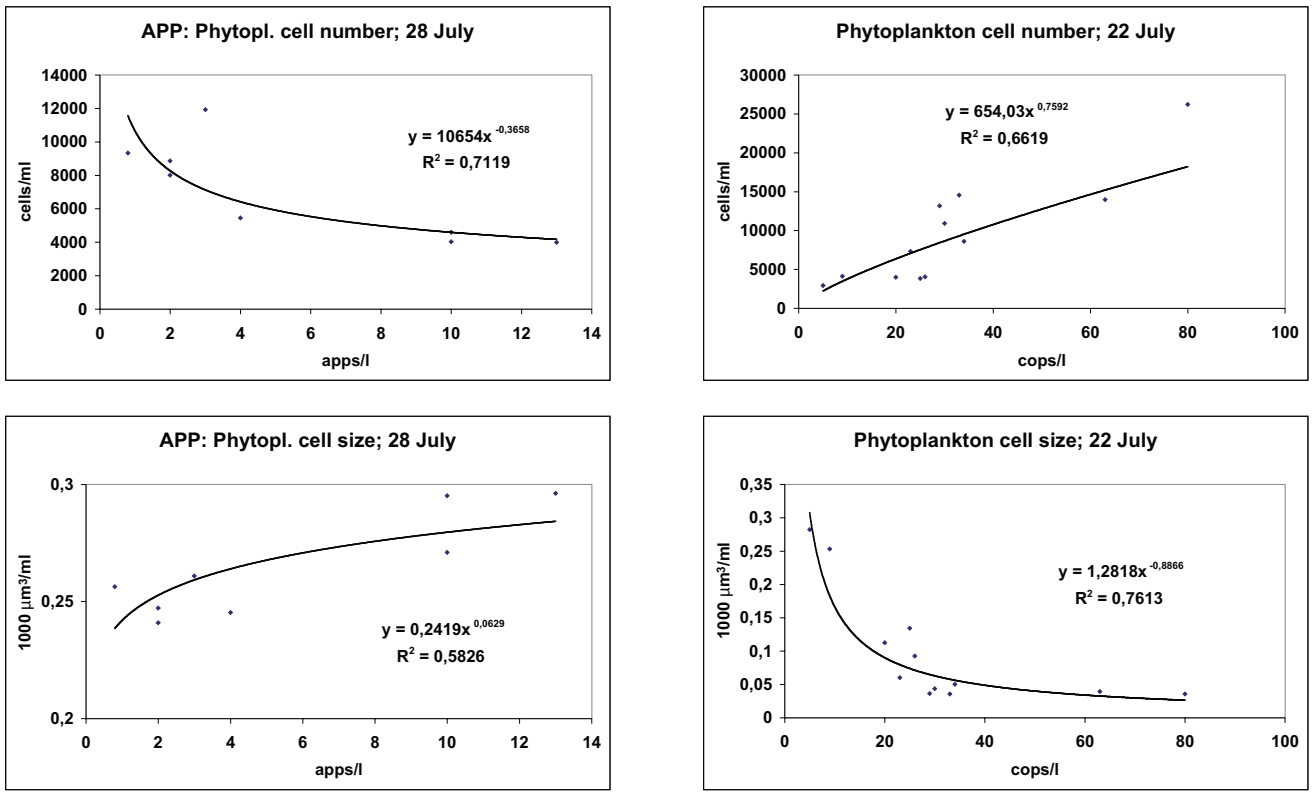


Fig. 1: Response of phytoplankton cell number (top; cells ml^{-1}) and mean cell size (bottom; 1000 µm^3 cell^{-1}) after 6 d of grazing by different densities of appendicularians (left) and copepods (right). Grazing by appendicularians selectively reduces the number of small cells without reducing the number of large cells similarly strong, thus leading to a decline in mean cell size. Copepoid grazing reduces large algae and protozoans. Small phytoplankton can increase, because of less grazing by protozoans.

Oikopleura had a similar impact on phytoplankton as *Daphnia*, decimating the smaller phytoplankton and permitting some compensatory growth by the larger species. Total cell number clearly declined with *Oikopleura*-density in the enclosure while mean cell size increased (Fig. 1). The copepods decimated ciliates and large phytoplankton, but cell numbers of small phytoplankton increased strongly with copepod density. Overall cell number increased with copepod density while mean cell size strongly decreased.

There are two mechanism by which the enhanced growth of small phytoplankton at high copepod densities can be explained. Small algae might use the nutrients recycled by copepods from larger algae for enhanced growth or they might be released from grazing by ciliates because of copepod predation on ciliates. The latter mechanism is supported by a strong negative correlation between copepod and ciliate density and between ciliate and small phytoplankton density.

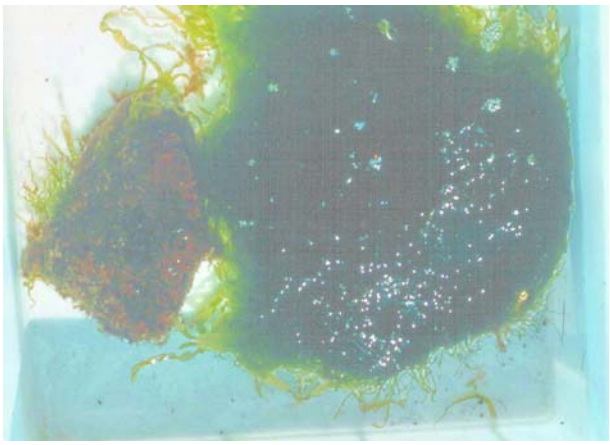
Copepod predation on ciliates would put them at a higher trophic level than "classic" herbivores. This should be seen in a stronger enrichment of the heavier nitrogen isotope 15N (ca. 3.5 ‰ per trophic level). Indeed, preliminary data from the summer lake experiment indicate a difference of almost one trophic level between the filter feeder *Daphnia* and the calanoid copepod *Eudiaptomus*. We expect a similar difference between the marine copepods and the tunicate *Oikopleura* sampled from the marine experiment. The samples will be processed in the near future.

Ulrich Sommer and Frank Sommer

Fucus or *Enteromorpha*: - Alternative stable states in the coastal zone -

There is growing concern, that marine ecosystems respond to man-made changes of environmental conditions not only by gradual changes but sometimes by abrupt state shifts. The new, in many cases undesirable state might be difficult to revert even if the environmental pressure is relaxed**.** Such a case has been discovered by the experimental analysis of the interaction between the perennial macroalga *Fucus vesiculosus* and the weedy, filamentous alga *Enteromorpha*.

In the temperate and boreal climates, hard substrates in the littoral zone are frequently covered by perennial macroalgae or by sessile, filter feeding animals, such as blue mussels. The explanation for the switch between a macroalgal and a mussel cover has become a cornerstone of marine ecology a quarter of a century ago. Mussels are the dominant space competitors which can replace other sessile macroorganisms, but space for colonisation by macroalgae becomes available if mussels are suppressed by predators, such as starfish or by physical destruction, e.g. ice scour.



In the course of cultural eutrophication a third state of littoral ecosystems has become more and more widespread: mats of filamentous algae. These short-living algae have very high growth rates at high nutrient levels and are therefore favoured under eutrophicated conditions at the expense of perennial macroalgae which are well adapted to low nutrient levels. In the Baltic Sea green algae of the genus *Enteromorpha* and brown algae of the genus *Pilayella* have become notorious for blooms of such filamentous algae and a danger for the remaining stands of perennial macroalgae, mainly *Fucus vesiculosus* at the Baltic coast.

Macroalgal communities in the coastal zone provide important ecosystem functions which makes their protection a high priority in coastal environmental management and nature conservation. They harbour a rich and diverse invertebrate fauna which serves as food source for demersal fish. Moreover, young fish find protection against predators in macroalgal beds, which therefore have been called "fish nurseries". Besides their importance for fisheries and the maintenance of coastal biodiversity, macroalgal communities are also highly important for coastal nutrient cycles. Perennial macroalgae bind nutrients, particularly nitrogen and phosphorous in their biomass which would otherwise be available for enhanced phytoplankton blooms in the open water. Thus, macroalgal beds along the coastline act as a

Fig. 1: Comparison of grazed and ungrazed rocks during spring: the ungrazed rock is covered by a dense mat of the green alga Enteromorpha while the grazed one is almost bare.

Fig. 2: The same rocks half a year later: the grazed rock is now covered by the perennial macroalgae Fucus vesiculosus, because it could be colonised by Fucus-zoospores. The ungrazed rock is now almost bare, because the Enteromorpha-mat in spring was an effective barrier against the settlement of Fucus-spores and after the decay of Enteromorpha there was no production of Fucus-spores anymore.

buffer against the consequences of eutrophication.

These ecosystem services cannot be provided by mats of short-lived filamentous algae. In spite of being a suitable food for herbivorous animals, they provide a hostile habitat for the invertebrate bottom fauna and for fish. The detrimental effects arise primarily from oxygen depletion during darkness and during the degradation of macroalgal biomass. Contrary to long lived algae, short lived algae do not act as a long-term nitrogen and phosphorus trap, because they release the incorporated nutrients whenever their biomass is degraded at the end of the growth season.

The mechanisms responsible for the state transition between dominance by the perennial macroalga *Fucus vesiculosus* and overgrowth by filamentous algae was performed in the Baltic Sea and at the Canadian coast of the North Atlantic Ocean. Three factors were manipulated in cages exposed at natural sites: exclusion or admission of herbivorous animals, nutrient enrichment at different levels and the presence or absence of overwintering spores. The experiments established that the early developmental stages of *Fucus*-plants are the critical phase for the state transition: if rock surfaces are covered by the filamentous alga *Enteromorpha*, *Fucus* spores cannot settle and grow into germlings. Nutrient enrichment and the presence of overwintering spores lead to dense cover of filamentous algae during the settlement period of *Fucus* spores (Fig. 1). Herbivorous animals, however, may keep rock surfaces bare for the settlement of *Fucus* spores and thus counteract the consequences of eutrophication and the presence of overwintering spores of filamentous algae to some extent. The most efficient herbivorous animals are snails of the genus *Littorina*. Surfaces which are kept bare by snails will be overgrown by young *Fucus* plants after some months (Fig. 2) while surfaces covered by filamentous algae will be bare after the end of the growth period.

Both, the *Fucus*-state and the *Enteromorpha*-state are stabilised by internal feedback mechanisms. *Fucus* provides shelter for herbivorous animals which keep rock surfaces free for colonisation by young *Fucus*. Therefore, a higher nutrient loading can be tolerated by *Fucus* dominated communities in the presence of snails than in their absence. However, once eutrophication has exceeded a critical limit, the capacity of herbivorous animals to counterbalance (i.e. eat) the growth of filamentous algae is exhausted. Then *Enteromorpha* or other filamentous algae take over and grow into dense mats which effectively suppress the benthic fauna. In addition, those mats produce a rich load of overwintering spores which at the beginning of the next vegetation period can monopolise substrate surfaces and prevent the settlement of *Fucus* spores. In order to restore the *Fucus*-state, a reduction of the nutrient loading has to proceed to a far lower level than to the critical threshold at which the switch from the *Fucus*- to the *Enteromorpha*-state took place.

There is reason to expect a major impact of climate change on the *Fucus-Enteromorpha*-system in the Baltic Sea. Regional climate models predict an increase of freshwater runoff in the catchment of the Baltic Sea and, thus, a decrease in the salinity of the surface water. This change will probably have strong impact on herbivorous snails (the marine genus *Littorina* in the more saline western part, the freshwater genus *Theodoxus* in the fresher northeastern part of the Baltic Sea). These snails are the most important components of the grazer guild and their function cannot be replaced by other grazers, such as isopods and amphipods. Their absence would probably lead a increased sensitivity of the *Fucus* communities against nutrient loading and to a switch to the *Enteromorpha*-state at much lower levels of eutrophication. Today, this phenomenon can be observed at the Lithuanian coast where the prevalent salinity of 4-5‰ excludes both freshwater and marine snails.

Boris Worm[1] and Ulrich Sommer

1. The first author obtained his PhD at the IfM in 2000 and works currently as an Emmy-Noether-fellow at Halifax, Canada. The research reported here has been honoured by the award of the Berlin-Brandenburg Academy of Sciences 2001 and by the state award of the Christian-Albrechts University 2001.

Regime shifts in the Baltic Sea, upper trophic levels

Within the Baltic fish community, which is dominated by sprat, herring and cod, a shift from a cod to a sprat dominated system occurred over the last two decades. This shift and the regulating factors and consequences for other parts of the system have been studied in depth within the frame of two large EU-projects, CORE and STORE, both incorporating all countries bordering the Baltic Sea and being coordinated by the IfM Kiel.

The population dynamics of fish stocks is largely driven by variations in the reproductive success, as well as by predation and fishing pressure. Cod and sprat in the Central Baltic utilize the same deep basins as spawning areas and have also overlapping spawning times. However, they utilize their spawning habitat with a pronounced difference in reproductive success, being in fact largely out of phase. Thus, the shift from a cod to a sprat dominated system may be explained by differences in the reproductive requirements of both fish species in a changing marine environment. Several new time series on stage specific abundance or production rates of early life stages of both species have been used to identify critical stages within the recruitment process of cod and sprat. A weak correlation between cod spawning stock biomass (SSB) and realized egg production (Table 1) indicates that the SSB is no reliable measure of egg production in Baltic cod. Significant changes in the age at attaining sexual maturation and individual fecundity, both traditionally not considered in the SSB determination, introduces inter-annual variability and longer-term trends in reproductive success. In contrast, SSB appears to be a reliable measure of egg production in sprat. The conducted exploratory analysis suggests further, that the egg stage and the early larval stage is critical for cod, while larval abundance is closely related to early juvenile abundance indicating only limited variability introduced in this life stage. Again sprat behaves different, the variability introduced up to the larval stage appears to be limited, but as larval abundance correlates poorly with early juvenile abundance, this life stage appears to be critical in sprat.

Cod eggs are less buoyant than sprat eggs, and thus, due to low surface salinities in the central Baltic Sea, concentrate within and below the permanent halocline. This water body is characterized by decreasing oxygen concentrations with depths. As 2 ml O_2/l is the minimum threshold for cod egg development, cod eggs are subject to strong mortality in the halocline during stagnation periods, i.e. periods without influx of highly oxygenated saline water from the North Sea. Sprat eggs, on the other hand, are less exposed to low oxygen concentration, and are subject to a lower predation pressure than cod eggs, mainly because of a less pronounced vertical overlap between eggs and clupeid predators dwelling during day time deeper within and below the halocline. Sprat recruitment is more dependent on the availability of suitable zooplankton prey, which is related strongly to spring temperatures. Variable prey concentrations may affect nutritional conditions, growth rates and subsequently survival of larvae, resembled in the low correlation between sprat larval and young fish abun-

Table 1: Coefficients for correlations between early life history stages of cod and sprat in main spawning areas of the Central Baltic Sea 1976-1999 (indicates significant correlation at 0.05 level).*

Variable 1	Variable 2	COD	SPRAT
Spawning stock biomass	Egg production stage 1	0.19	0.66*
egg production stage 1	Egg production stage 3	0.51	0.82*
egg production stage 3	larval abundance	0.36	0.81*
Larval abundance	0-group abundance	0.80*	0.32

dance. Also early cod larvae may face limitations in the supply with nauplii, especially after the pronounced decline of the copepod *Pseudocalanus elongatus* since the mid 1980's, coupled to decreasing salinity in Baltic deep water layers. However not only a temporal match between larvae and suitable prey, but also a transport to favourable nursery areas may be of importance for larval and early juvenile survival. Hydrodynamic modelling of flow fields within the Bornholm Basin has identified two contrasting scenarios. Firstly, low wind speed in variable directions results in a retention within the spawning area and secondly, relatively high wind forcing of westerly or easterly direction results in rapid transport towards different shallow coastal environments offering improved feeding conditions.

The decline of the cod stock in the Baltic was caused by a recruitment failure, which was driven by: i) anoxic conditions in deep water layers of spawning sites causing high egg mortalities, ii) high egg predation by sprat and herring in remaining spawning sites, iii) reduced early larval survival due to the decrease in abundance of *P. elongatus* nauplii, and iv) high juvenile cannibalism affecting later juvenile survival at high cod stock sizes. The intensity and significance of all these processes are in one way or the other steered by the hydrographic conditions, which were in the 1990´s characterized by low salinity due to lacking inflow of highly saline water from the North Sea and increased river run off, but also by warmer temperatures. An increasing fishing pressure accelerated the decline of the cod stock, with current exploitation levels being still on a very high level.

The decline of the cod stock released sprat from predation pressure, which in combination with high reproductive success, due to in general favourable temperature conditions, resulted in exceptionally high sprat stock sizes in the 1990s. As a result of these processes, a dominance of one of either predator may stabilize a cod-dominated or a sprat-dominated system (Fig. 1). Destabilization of the sprat dominated system may be caused either by unfavourable hydrographic conditions for reproduction, e.g. low water temperatures in spring following severe winter situations and subsequent recruitment failures of sprat, or high mortalities caused by the developing industrial fishery, with concurrent low fishing pressure on cod and North Sea inflow events.

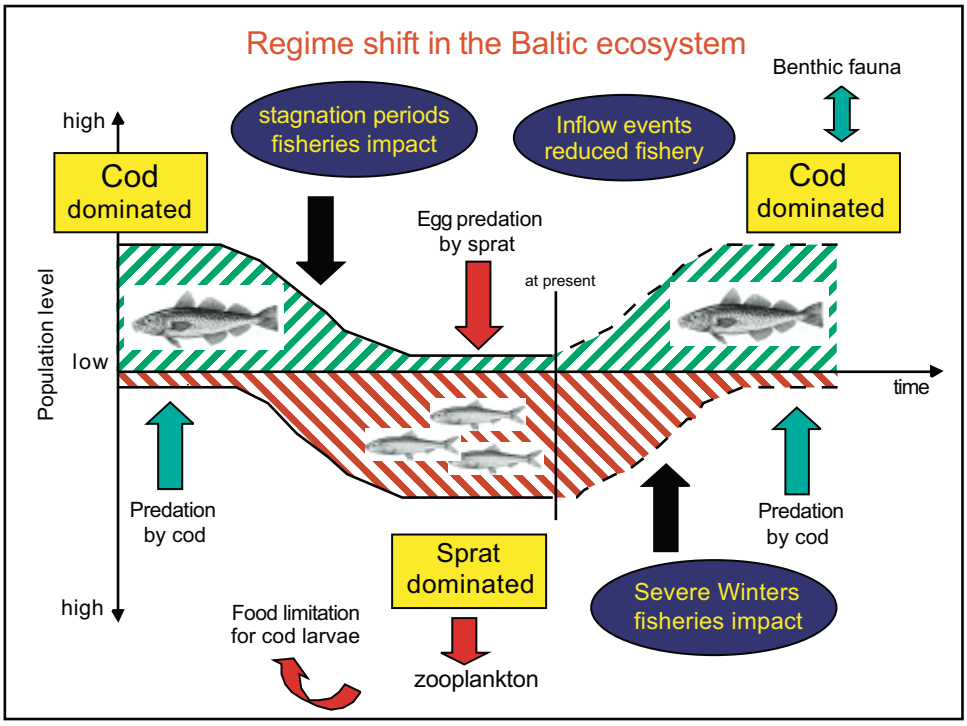


Fig. 1: Conceptual model of regime shifts in upper trophic levels of the Baltic Sea Ecosystem. The vertical line marks the situation in mid 1990's. The left part presents the observed development, the right part is hypothetical, depending on the indicated influences.

The scientific approach of CORE and STORE (STORE 2000 and 2001) is based on a combination of field and laboratory work, utilizing modern *in-situ* sampling and measuring systems as well as applying up-to-date laboratory methodology, e.g. image analysis systems, biochemical methods and otolith microstructure analysis. The activities in STORE are combined with mesocosm studies on maternal effects in recruitment success (MACOM) and covers all

relevant processes in parallel to resolve non-linear populations response due to interactions between various processes and spatial variability in forcing conditions. This approach has recently been transferred to other areas within the newly funded EU-project LIFECO, investigating the influence of physical processes on food web structure and ultimately on fish stock recruitment in the North Sea. This study conducted in frontal areas, extends fish recruitment research by considering explicitly lower trophic level processes. Based on the results and experiences gained in these large-scale international projects, designed as contributions to the GLOBEC Regional Programmes "Cod and Climate Changes" and "Small Pelagic Fishes and Climate Change", a German GLOBEC Initiative was set up, combining all aspects of zooplankton and fish dynamics in the North Sea and the Baltic in a comparative study (see GLOBEC description, page 59).

Dietrich Schnack, Friedrich-W. Köster and Christian Möllmann

Penguins predict their own dive performance

Air-breathing, warm-blooded, marine top predators, such as seals, dolphins and seabirds, are acknowledged as having highly complex foraging behaviours that are difficult to predict and understand, even if the conditions under which the animals are operating are known. Standard optimal foraging theory, which purports that animals should behave so as to maximize energetic gain while minimizing expenditure, augers for rather predictable behaviours; only one solution to a particular foraging situation can be regarded as optimal within the framework provided by the capacities of the animal itself. Perhaps the complexity of the observed behaviours stems from complexity in the environment! In any event, all other things being equal, studies of foraging decisions made by marine predators should help us understand the predators, their prey and the environment in which they interact.

We studied the extent to which Magellanic Penguins *Spheniscus magellanicus* tailored their breathing and feeding patterns according to optimal foraging principles during fieldwork conducted at a large colony located at Cabo Virgenes in the south of the Santa Cruz Province, Argentina. Before setting off to forage, birds were fitted with miniature gauges to record depth once every second and beak opening angle 10 times per second. Movement of beak angle allows the determination of the number of breaths taken during rests at the surface between dives (the beak opens and closes once per breath) as well as the number of prey taken during dives. During normal foraging, Magellanic Penguins conducted a

Fig. 1a

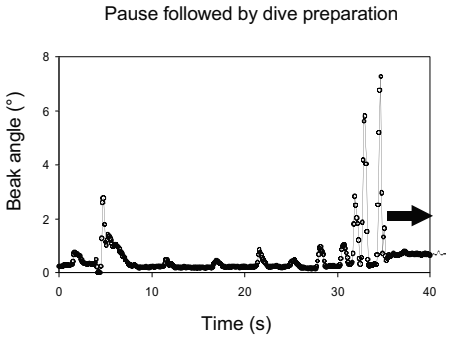


Fig. 1b

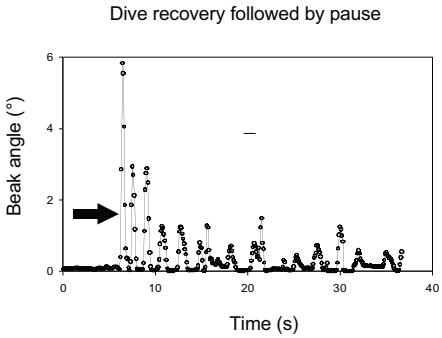


Fig. 1c

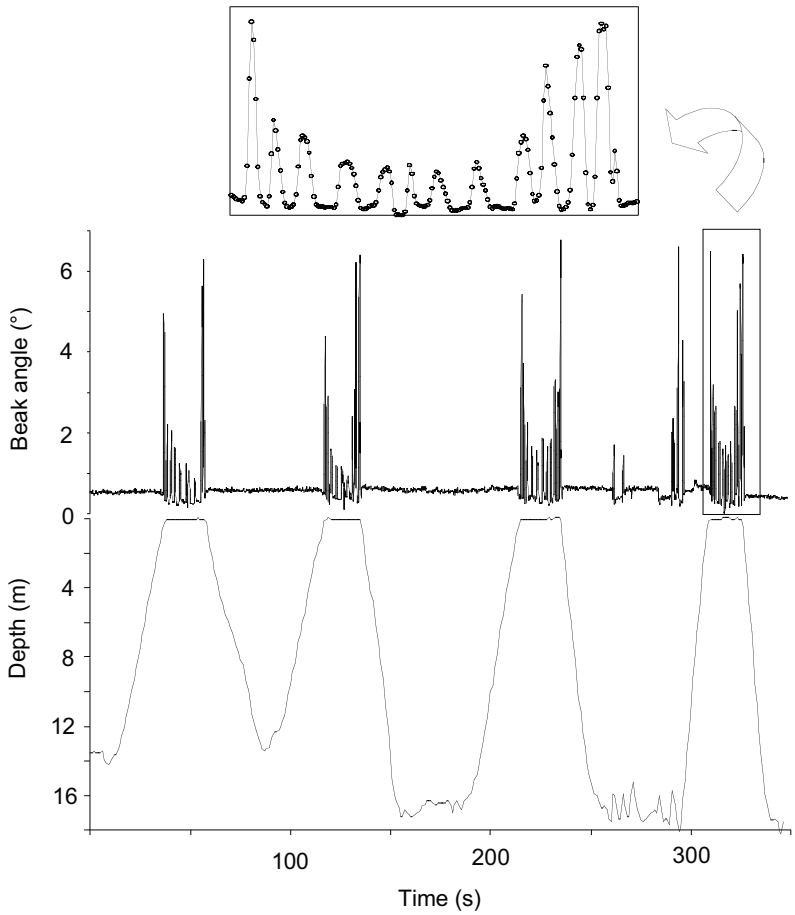


Fig. 1: Patterns in beak angle (corresponding to breath: the beak opens and closes once per breath) displayed by foraging Magellanic Penguins according to activity.
Fig. 1a shows the increase in beak angle (beak angle being indicative of the volume of air inspired) just prior to a dive (arrow denotes the time underwater) after an extended period at the surface. This is due to preparation for the dive.
Fig. 1b shows the initial high volume of air inspired, followed by lesser amounts per breath after a penguin has surfaced following a dive (arrow). This corresponds to recovery.
Fig. 1c shows beak angle changes during a short period at the surface and incorporates the features of both the recovery and the preparation. Penguin dive depth in relation to beak angle is also shown. Note that the beak opening that occurs underwater is due to prey ingestion.

number of dives (which varied in length between 15 and 180 s) interspaced with brief rests on the surface. These dives all occurred together in a so-called "bout". Bouts were separated from each other by periods of some minutes where birds rested at the surface. We noted that when birds rested for such extended periods they initially breathed deeply (beak angle is related to the amount of air inhaled per breath) immediately on surfacing, followed by sequentially shallower breaths until breathing was barely visible (Fig. 1). After an extended period at the surface, however, the shallow breaths became increasingly deeper until the bird re-submerged (Fig. 1b). We therefore concluded that the former pattern indicated recovery from the previous dive whereas the latter was part of preparation for the dive to come. This also fitted excellently with the breathing pattern of birds during the short pauses between dives in dive bouts; the pattern observed combined recovery from the previous dive with preparation for the next (Fig. 1c). Biologists have long believed that the time taken for the surface pause was solely used for recovery from the previous dive but our data indicate planning for the dive ahead. Indeed, analysis showed that the number of breaths taken to prepare for the dive was closely correlated with the length and depth of that dive (Fig. 2). That the depth of the dive is already decided at the surface was also made clear by the descent angle, which was steeper in deeper, longer dives.

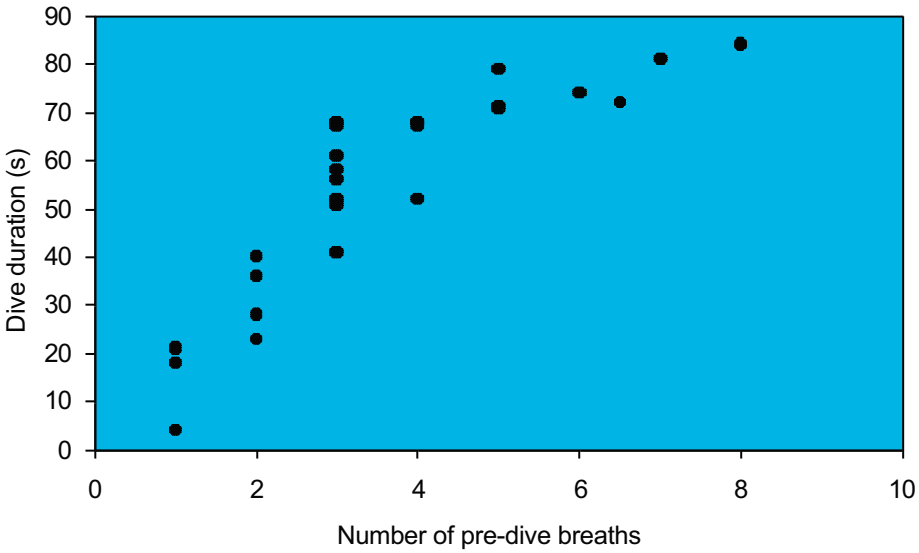


Fig. 2: Relationship between the number of preparatory breaths taken by a Magellanic Penguin and the length of the subsequent dive.

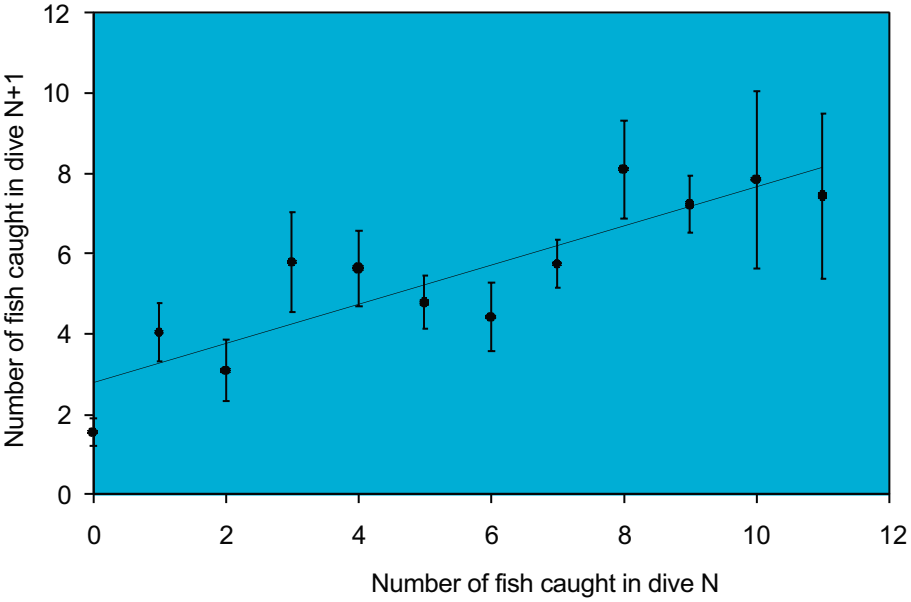


Fig. 3: Relationship between the number of fish caught in any particular dive (N) and the number of fish caught in the next dive (N+1). Points show means and vertical bars standard errors.

In order to minimize time at the surface, diving animals are thought to submerge with just enough oxygen in their bodies to cater for their needs underwater. By doing this birds surface with a substantial oxygen deficit which results in a high rate of oxygen uptake. This assumes that animals can "know" how much oxygen they need for their dive and during standard dives where no prey are encountered this might be the case. However, it is clearly disadvantageous for penguins to take down just enough oxygen for the standard dive because if prey are encountered there are no reserves that enable the birds to exploit these prey. Here, the only solution would be to return to the surface to replenish oxygen stores. Closer inspection showed, however, that Magellanic Penguins prepare their dives carefully, taking down extra oxygen according to the number of prey caught in the previous dive. For example, over and above the preparatory breaths taken for dives of a specific duration (where birds take ca. 1 breath for every projected 10 seconds underwater), an extra breath is taken for every 4 fish swallowed in the previous dive. Not surprisingly, the number of fish taken in any dive is closely correlated with the number taken in the following dive (Fig. 3). In this way birds can minimize the time they spend at the surface but have oxygen available for them underwater when needed.

The complexity of the penguin response befits this sophisticated predator and supports the principles behind optimal foraging theory. We have no doubt that careful consideration of other environmental features in tandem with penguin behaviour will reveal that current penguin eccentricities are actually strategies that enhance foraging success, enabling the birds to live as successfully and comfortably as possible.

Rory Wilson

Microbiology of deep sea vent and seep systems

Hot vent and cold seep systems of the deep sea are biological hot spots with abundant biological production and high biomass accumulation of free-living microorganisms and symbiotic associations. Primary production of chemoautotrophic bacteria is the basis of unique food chains and of the nutrition of the symbioses. The characteristic deep sea ecosystems depend on geological and geochemical processes resulting in the flux of reduced compounds into the deep sea. The bacteria live at the expense of these reduced substances as energy sources, the most pronounced of which is sulfide. The chemoautotrophic sulfur-oxidising bacteria are important players in these habitats and occupy different niches. The gliding sulfur bacteria occur in and on top of the sediments and position themselves at the borderline between the anoxic and oxic zones. Different types of sulfur bacteria live in the emanating waters. A third group of sulfur bacteria is found as endosymbionts in invertebrates which are specifically adapted to these habitats and dependent on the symbiotic bacteria as a source of food. Due to the strict dependence of the animal host from the chemosynthetic primary production of its symbiont, these symbioses are living entirely from inorganic substances, they are autotrophic.

Several research projects have been concerned with the activity of chemoautotrophic sulfur oxidising bacteria and methane oxidising bacteria at these deep sea locations. Due to the intimate relationship of geological and geochemical processes with the biology of these habitats, these projects were performed in close co-operation with geochemists and geologists from GEOMAR, the universities of Kiel and Berlin and the BGR in Hannover (MAKRAN, HYFIFLUX, TIEFBAK, HYDROARC).

At one of these locations in the North Fiji Basin different types of hydrothermal vents are located close together. During a research cruise with RV "Sonne" microbial studies using modern molecular-genetic methods were performed that revealed the presence of bacterial communities adapted to the warm vent waters but clearly different from those of the surrounding deep sea water. Studies of bacterial production through the whole water column (approx. 2000 m depth) revealed typical profiles for deep sea habitats with steadily decreasing bacterial production in deeper water horizons (see Fig. 1, page 46). A maximum of bacterial production was correlated with photosynthetic primary production in the photic layer and declined rapidly with depth. However, a second small maximum of bacterial production was found close to the sediment surface. The bottom water was analysed with an instrument specifically constructed for these purposes, the "Hydrobottom station", which is able to resolve gradients close to the ocean sediment up to 1 m above ocean ground. The bottom water at these hydrothermal vent sites was unusual because by passage through the ground it had cooled down and left the deep sea sediment only a few degree Celsius above the temperature of the deep sea water. However, the hydrothermal properties of these waters could be clearly established on the basis of temperature anomaly, increased concentrations of methane and sulfide, and high bacterial activities. Such warm vents and diffuse vent activities are thought to be much more abundant in the deep sea than the more exiting hot vents with rapidly flowing very hot hydrothermal water that form characteristic chimneys. By sequence analysis of bacterial genes from the warm hydrothermal water it became apparent that characteristic bacterial communities were present in these hydrothermal waters different from those of the surrounding sea water. Microscopic examinations demonstrated increased numbers of bacteria and increased volume of the individual bacterial cells. A good indicator for the hydrothermal water was the increased concentration of methane, which was, in contrast to sulfide, quite stable in the water and was only slowly transformed by microbial processes.

In another study, the unique symbioses of hot vent and cold seep locations were investigated. A variety of symbioses, characteristically tube worms and clams such as e.g. *Riftia pachyptila* and *Calyptogena pacifica* (see

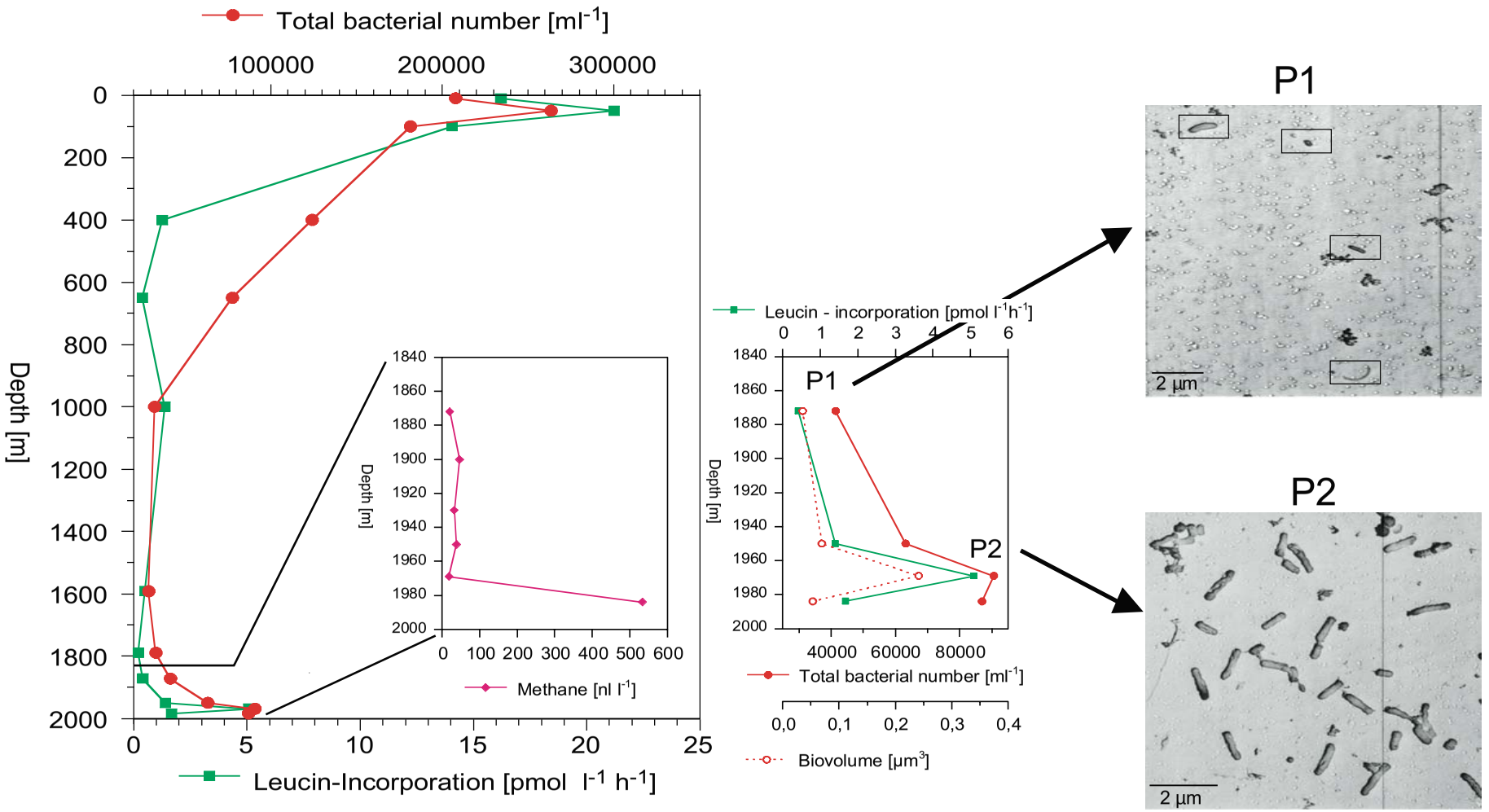


Fig. 1: Deep sea warm vents greatly stimulate bacterial activity. Both total bacterial numbers as well as bacterial cell size (measured as cell volume) generally are strongly reduced in the deep sea. However, in warm hydrothermal waters at a vent site in the North Fiji Basin both parameters strongly increase (see insert). The microscopic images taken with identical volumes of water at "P1" and "P2" demonstrate this relationship. Also bacterial activity and production (measured as incorporation of leucin) were stimulated. These changes correlated with environmental factors indicating the presence of hydrothermal waters, such as temperature anomaly and increased concentrations of methane.

Fig. 2: Calyptogena pacifica is a symbiotic association living in cold seep habitats around the world. The animal host harbours chemoautotrophic sulfur bacteria in the gills and is living at the expense of the biomass produced by these bacteria.

Fig. 2), were found at these habitats world wide. The interactions between symbiont and host is species specific, i.e. a particular animal host harbours specifically one species of sulfur bacterium. The phylogenetic relations of these sulfur-oxidising endosymbionts were investigated and compared to their free-living relatives (see Fig. 3). This work showed, that the symbiotic sulfur bacteria are clearly different from known free-living sulfur bacteria and that symbionts of closely related animal hosts have minor sequence variation and belong to the same bacterial species. Therefore, at least for some of these associations, the coevolution of host and symbiont appears to be quite likely.

Johannes F. Imhoff and Jörg Süling

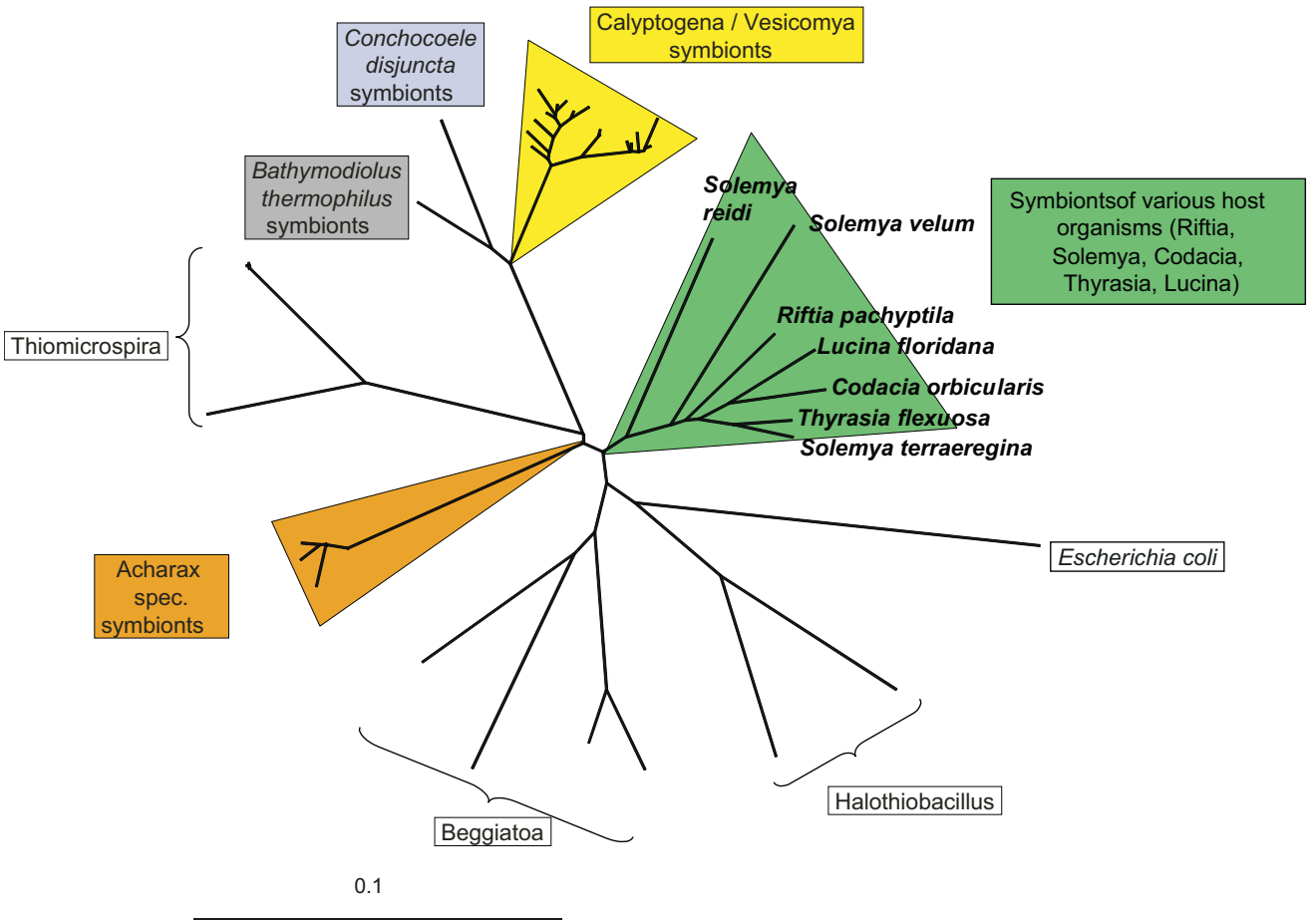


Fig. 3: Phylogeny of symbiotic and free living sulfur bacteria. The phylogenetic analysis of the bacterial symbionts of various symbiotic associations found at warm vent as well as at cold seep sites by 16S rDNA sequence comparison revealed species specific interrelationships between symbiont and host with just one species of symbiont within each host. The presentation indicates separate evolution of symbionts from different animal hosts. It also demonstrates their genetic differentiation of symbiotiic sulfur bacteria from their free living relatives such as species of Beggiatoa, Halothiobacillus, or Thiomicrospira.

Mariculture research at IfM

Mariculture is the cultivation of marine organisms involving a great variety of species and various types of facilities. The aim of mariculture research at IfM is the development of innovative technologies for environmentally sound farming systems, for individual species, and integrated facilities for the simultaneous culture of animals, plants, and algae. During previous years the mariculture group at IfM was focused on water recirculation systems for finfish farming to supplement conventional fishing. This will continue with the long-term objective being a precautionary approach (i.e. improvement of biotechnology) in view of the rapid development of finfish aquaculture worldwide (Table 1) and its potential threat to coastal and oceanic ecosystems. IfM has been instrumental in establishing this technology in Germany. A first recirculation system is now operating in Schleswig-Holstein as a result of a panel discussion on recirculation technology held at IfM and it is to be expected that the technological progresses achieved, by means of fundamental science, will lead to engineering improvements and more successful mariculture operations.

Currently, mariculture facilities are mainly run as open production plants, such as net pens, that are in direct interaction with the natural environment. Such installations may cause serious environmental impacts on coastal ecosystems: increased nutrient and solid matter flows, unintentional transfer of non-indigenous organisms, and transfer of diseases to name a few examples. Another problem is that these net pen operations may themselves become threatened by other forms of environmental pollution. Open systems may run at a high operational risk as environmental disasters (e.g. oil spills, toxic phytoplankton (red tides), heavy metal contamination) may lead to high losses. Closed production plants like land-based recirculation systems, on the other hand, are independent from the surrounding environment and may, therefore, be operated safely even at critical locations. These systems are environmentally sound: the water they utilise is largely recycled and the impact on the natural environment can be controlled, limited and even avoided. However, the development of such systems is complex and still incomplete. Intensive research on recirculation system dynamics and components is needed.

Research activities of the mariculture group at IfM are directed towards the biology of species and the key factors influencing their metabolism, husbandry, and successful culture. The approach is by numerical simulations based on results from fundamental research. In close co-operation with engineers three different prototype re-circulating systems were established and operated using different species of a variety of taxa. The recirculation systems consist basically of a farming tank and water treatment components . The design used in a prototype development is comprised of a multiple-step solid matter removal (sedimentation, hydrocyclone, ozone enhanced foam fractionation), biological filtration (nitrification, denitrification), degassing (CO_2) and aeration (O_2) of the water. Because of the particular properties of seawater the water treatment components are in part different from those used in freshwater and conventional recirculation systems for marine fish. In doing so, the suspended solid load is minimised and small particles are removed from the system water that might otherwise hamper biological processes.

Table 1: FAO statistics of finfish aquaculture in marine and brackish water. Production is given in metric tonnes (mt). AAGR: average annual growth rate (% per year) for the period.

Year	1971-1975	1976-1980	1981-1985	1986-1990	1991-1995	1996-1999
Production (mt)	301,119	449,334	617,618	1,123,298	1,573,971	2,466,269
AAGR (% / a)	7	8	7	13	7	12

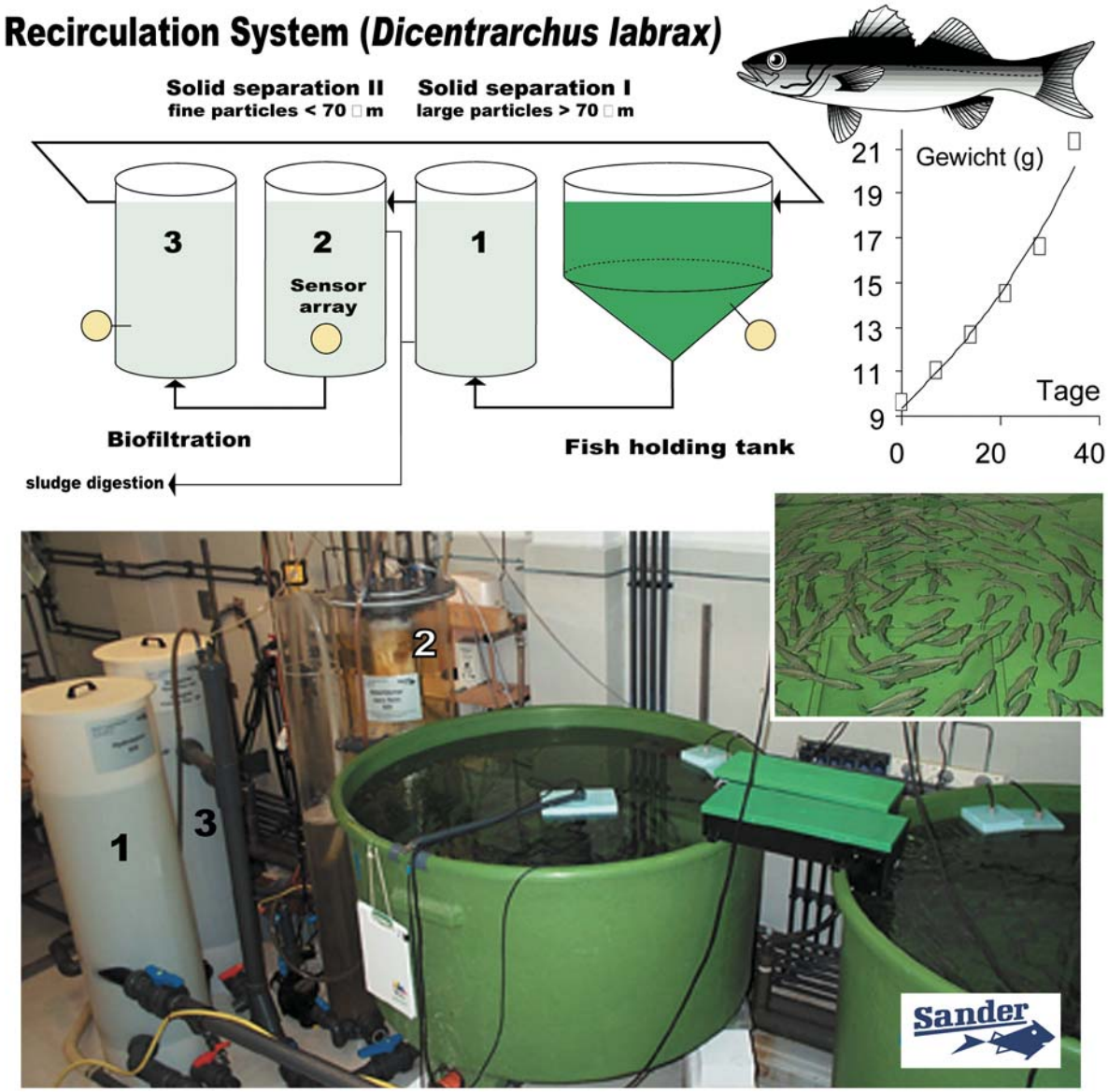


Fig. 1: Set up of the marine recirculation system. The schematic drawing (top) shows the main components and water flow pattern. The growth of seabass (Dicentrarchus labrax) is rapid (see graph in the upper left corner) and comparable to other results published for this species. The high water quality is shown in a part of one holding tank containing 20 g fish (lower, insert).

The results from a preliminary test run with Tilapia (*Oreochromis niloticus*) in a prototype I system proved the components could function successfully and the fish were brought to market size.

Next step, a prototype II system was constructed in co-operation with *Sander Elektroapparatebau GmbH*, Germany, which aimed at a significant reduction of water and energy consumption. Over a period of more than two years, seabass (*Dicentrarchus labrax*) of different sizes were reared in the system. The low head water circulation allowed operation at minimal costs. The water quality was stable with water exchange rate of less than 4% of the system volume per day. Besides safe levels of nutrients (NH_4 < 0.8 mg/l, NO_2 < 1.6 mg/l, average values for a 18 week period), the water was clear and no discoloration or atypical smell or taste was detected. Most of the oxygen was introduced during the foaming process and at the same time part of the CO_2 was stripped (7.4 < pH < 8.0). These side effects reduced the operational costs as oxygenation and pH control became necessary

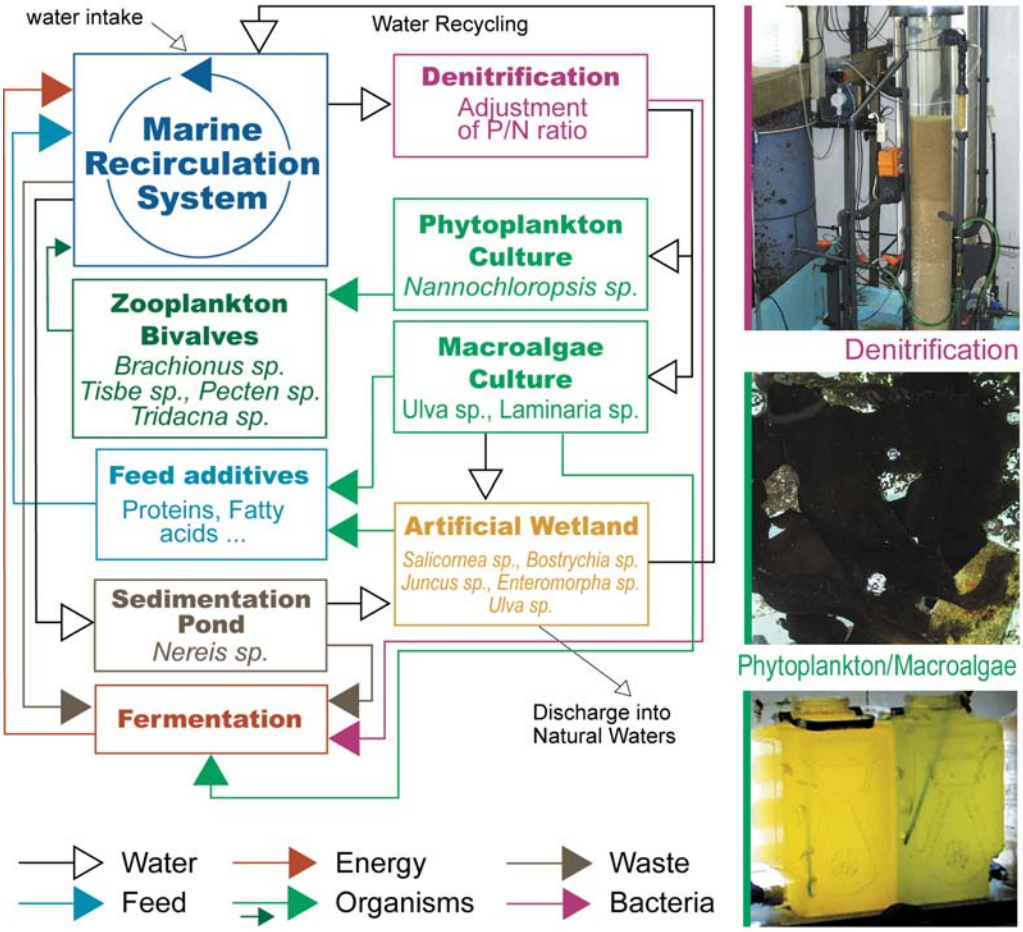


Fig. 2: The integration of a marine recirculation system into secondary and tertiary production loops. The schematic drawing shows the basic concept, main components and water flow pattern. Photographs illustrate different experimental approaches.

only during the end of the rearing cycle. The very good overall health status of the animals was associated with fast growth and few mortalities.

A slightly modified prototype III is presently being operated in Kiel (Fig. 1). The focus of this experimental run is on the quantification of suspended matter, particle size distribution, and enhancement of particle separation as these remain as major constraints in marine recirculation systems. The ozone enhanced foam formation technology has the potential to resolve the problems associated with particle loads in closed systems; this realisation is based on more than 25 years of experience in culture facilities at IfM.

Presently, secondary treatments to purify the effluent water are under development. Because of the clarity of the water effluent in previously outlined recirculation system, the post treatment of water can be based on primary production processes and secondary consumers (Fig. 2) embracing macro- and microalgae and various invertebrate animals:

To efficiently remove nutrients by means of algal production a control of nitrogen/phosphorous ratio (N:P) in the effluent water is necessary; the N:P ratio in the effluent water of a closed fish culture system is increased towards the end of the production cycle and differs significantly from the required ratio of approximately 10:1 (N:P) reported for autotrophic growth. Intensive research was directed towards fluidised bed denitrification filters. With the data from several test runs, algorithms were developed to describe water flows and substrate dosage (methanol, CH_3OH) that are now available for future applications.

Marine phytoplankton cultures are the starting point for zooplankton produced in a subse-

quent step that can be utilised as food for early life history stages of marine fish. Based on an artificial food chain, miscellaneous marine fish larvae were successfully reared in the aquarium. Although it is acknowledged that a great variety of plankton species of different sizes is required for the cultivation. An advantage could be the re-introduction of larvae into the recirculation system.

In another experiment, macroalgae (*Laminaria saccharina*) were grown in the water effluent of a brackish water recirculation system (Co-operation with *Coastal Research & Management*, Kiel). The growth rate amounted to 0.9 – 2.6% increase in leaf area per day under normal daylight conditions (May - July 2001) (Waller and Probst, 2001). Supplemental light (metal halide lamp) increased growth rate to 1.4 – 5.0% / d. The production of valuable by-products in integrated systems is possible and these secondary loops may generate additional revenue. However, the produced biomass also may be digested in a fermentation process (energy recycling).

Suspended solids and fish waste can also be utilised. Particulate matter from recirculation systems has a high organic content and can be used to feed invertebrate animals (ZAFIRA, EU-project, initiated January 2002). However, the amount of waste is high and cannot be processed using one way method. Fermentation and biogas production is another form of waste processing.

In summary, the research activities of the mariculture group of IfM are directed towards understanding the key processes and dynamics of closed loop farming systems. These issues are addressed by theoretical studies, numerical simulations, and experimentation. An interdisciplinary approach has been vital in success to date and will continue, i.e. the co-operation with partners from other fields of biology (marine botany, microbiology), physics (sensor technology), chemistry (water analysis), and the engineering sector (plant construction). The commercial sector will need the support of management consultants to conduct economic feasibility studies.

Uwe Waller

3. An Interdisciplinary Approach: Nitrogen Cycle in the North Atlantic

The contribution of the subtropical ocean to global carbon cycling is discussed controversely. For a long time, the consensus had been to view the subtropical gyres of the ocean as deserts (similar to the terrestrial deserts in the same latitude range), infertile and unproductive, and contributing little to nothing to the export and sequestration of carbon in the ocean. Observational estimates of relatively high oxygen consumption, indicative of organic matter remineralization, have challenged this view. This is exemplified in an area in the eastern subtropical North Atlantic, the "beta triangle" (Fig. 1), where oxygen utilization rates in subsurface water imply much higher productivity than thought possible. Various attempts to track down a nutrient supply to the light-lit surface layer high enough to sustain a corresponding production have, however, failed so far.

A new interdisciplinary working group was established at the institute in October 2000 with the aim to resolve this apparent observational discrepancy. In particular, the group is investigating the following hypothetical nitrogen supply mechanisms:

1. nitrate supply by vertical motions associated with meso-scale eddies (eddy hypothesis);
2. lateral input of nitrogen in organic rather than inorganic form (organic-nitrogen hypothesis);

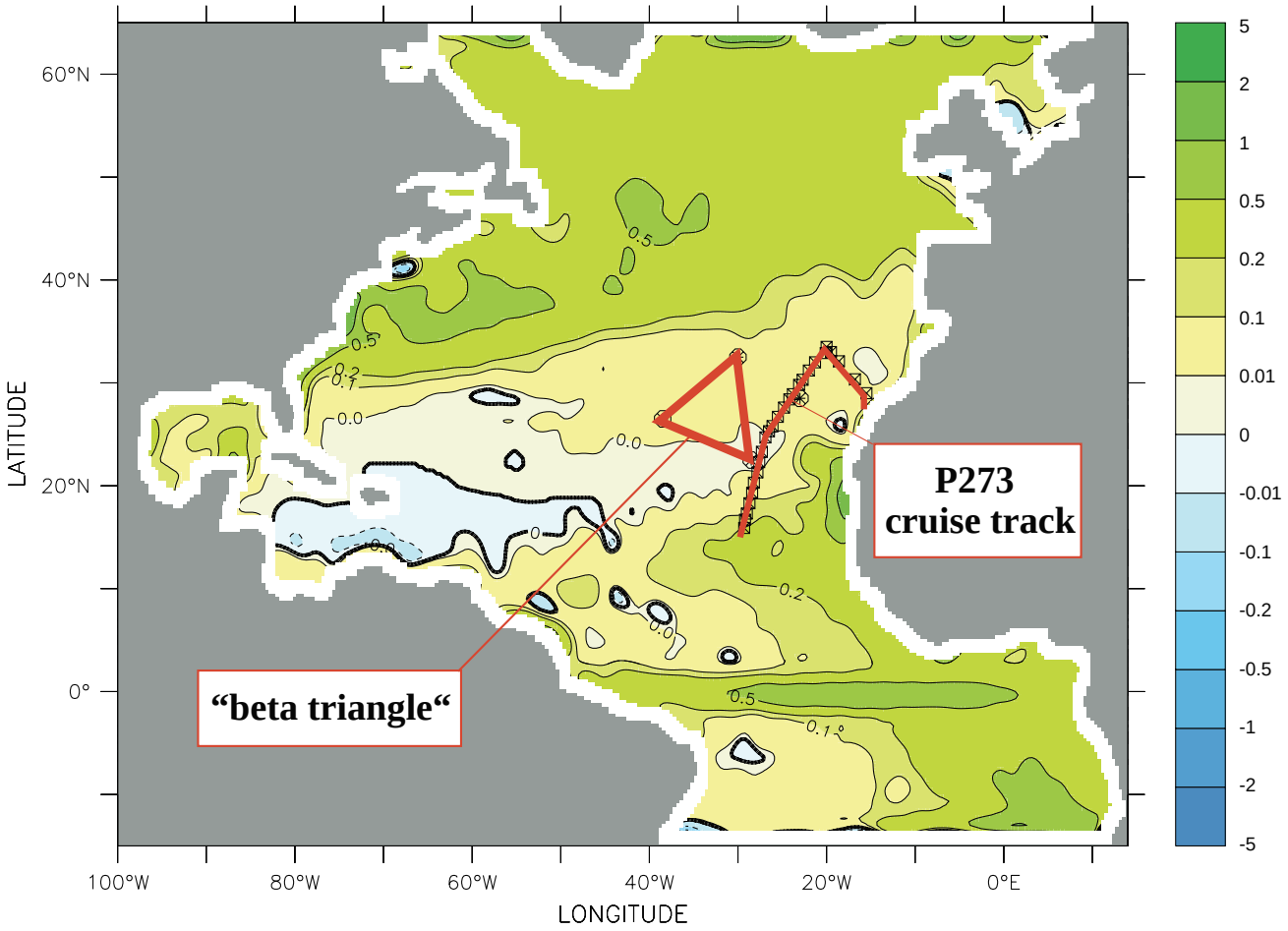


Fig. 1: Annual mean nitrate supply into the upper layers (126m), simulated by a high resolution ecosystem-circulation model. Also indicated are the beta triangle, where obervational estimates of oxygen consumption had been performed, and the stations of the RV "Poseidon" cruise in spring 2001.

3. direct fixation of atmospheric nitrogen gas (nitrogen-fixation hypothesis);
4. export of carbon-rich (nitrogen-poor) organic matter (C-rich export hypothesis).

On a cruise into the Eastern Subtropical North Atlantic (RV "Poseidon" No. 273) during Spring 2001 measurements of physical variables (temperature, salinity, near-surface currents) nutrients, and oxygen were taken. In addition, measurements of the ship-mounted Acoustic Doppler Current Profiler (ADCP) and Conductivity-Temperature-Depth (CTD) have been used to estimate turbulent diffusion. When combined with the nutrient measurements, diffusive nitrate supply could be computed and was found to be similarly low as suggested by earlier observations. Also, oxygen measurements on density surfaces in the upper 1000 m were in good agreement with historical data that had been used to estimate the much higher rates of export production. Data measured during the cruise are therefore consistent with earlier observations, and the existence of an apparent observational discrepancy between low nutrient input and large export production can be confirmed.

The eddy hypothesis

Of the four above-listed alternatives which can possibly reconcile the carbon and nitrogen budgets in the study area, the first hypothesis has been rejected using a high-resolution numerical circulation model. Meso-scale eddies in the ocean have typical scales of some 100 km and are the equivalent of storms in the atmosphere. Because of their relative smallness and their rarity, they are easily overlooked in ocean surveys and difficult to simulate in basin-scale models. In order to address the eddy hypothesis, a new model with a grid resolution of about 10km, fine enough to resolve meso-scale features, has therefore been set up and run with a simple ecosystem model embedded into the physical circulation model (Fig. 2). Results from this model indicate that eddies can indeed give rise to localised nutrient injections into the light-lit upper layer of the ocean, but that the average contribution of this process can close only about a tenth of the gap.

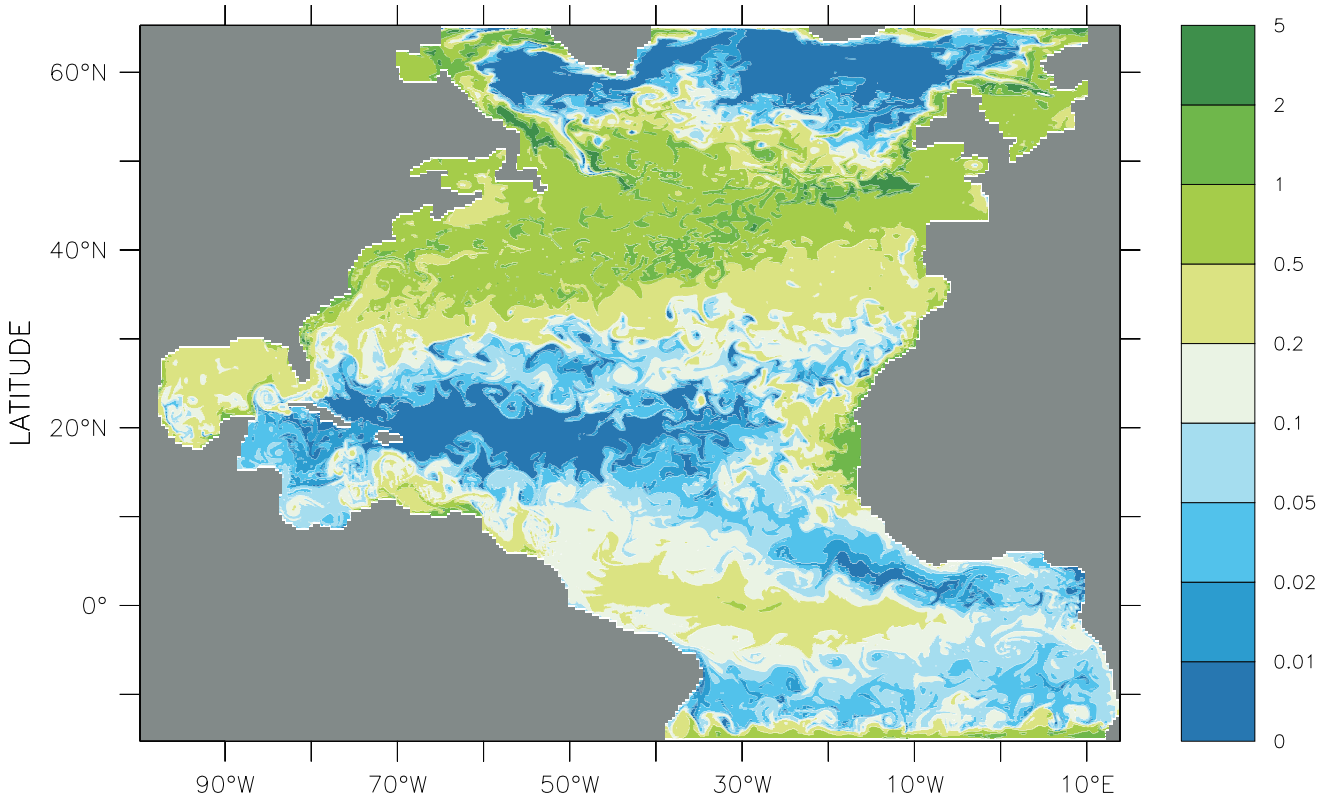


Fig. 2: Sea surface chlorophyll (in mg per cubic meter) in mid April as simulated by an eddy-resolving coupled ecosystem-circulation model.

The organic-nitrogen hypothesis

The possibility of lateral input of nitrogen in organic rather than inorganic form is presently investigated by combining measured stocks of particulate and dissolved organic nitrogen along the track of the cruise in spring 2001 with measured and model-derived advection velocities in the surface layer.

The nitrogen-fixation hypothesis

Close similarity of the isotopic composition of nitrogen in particulate organic matter with that of the atmosphere in all collected samples identifies nitrogen fixation as an important component of the nitrogen cycle in the study area. This was confirmed by on-board incubations with isotopically labelled nitrogen gas which showed high rates of nitrogen fixation. Extrapolation of these results yields annual rates far higher than needed to close the hitherto unexplained gap between low nitrate supply and high oxygen consumption at depth. As yet, neither the controls of this high nitrogen fixation are understood, nor do we know the fate of the nitrogen fixed in this process.

The C-rich export hypothesis

In a study using the isopycnal distribution of nutrient and oxygen data taken on the cruise, the possibility of either the export of carbon-rich material, which, on decomposition, would consume oxygen without nutrient generation, or the addition of newly fixed atmospheric nitrogen to the system are investigated.

Future perspectives

DNA, RNA, and protein samples also collected during the cruise should have helped to identify presence, diversity, and the potential activity of nitrogen fixing organisms. Unfortunately, all these samples were lost due to fire on board terminating field work and spoiling all frozen samples. Analysis of substitute DNA samples from another cruise in the tropical North Atlantic could already demonstrate a very high occurrence of unicellular nitrogen-fixing bacteria other than the well-known filamentous, colony-forming Trichodesmium sp..

A follow-up cruise in spring 2002 will help to obtain a more complete data set, further including carbon and nitrogen fluxes into particulate and dissolved organic matter, as well as the oxygen balance in, and sedimentation out of, the surface layer. To achieve a complete understanding of the controls of the high nitrogen fixation rates (as observed during the cruise in spring 2001) and of the fate of the fixed nitrogen in the ocean, a detailed analysis of various satellite data available (surface chlorophyll, atmospheric aerosol content, wind speed) addresses the role of Saharan dust input (and with it the micronutrient iron) into the subtropical North Atlantic.

4. Contributions to Long-Term Research Programmes

4.1 Sonderforschungsbereich 460: "Dynamics of Thermohaline Circulation Variability"

The overall objective of Sonderforschungsbereich (SFB) 460 "Dynamics of thermohaline circulation variability" is a better understanding of the processes relating variations in air-sea fluxes in the subpolar North Atlantic and inflow boundary conditions on the one hand with the variations in the formation and circulation of deep waters on the other. The ultimate goal of SFB 460 research is elucidation of the role and importance of air-sea interaction variability on interannual to decadal time scales for regional climate anomalies.

Of particular interest to the SFB are process studies on open-ocean deep convection and of overflows over the submarine sills between Greenland, Iceland and Europe and of the role of these processes in the variability of warm-to cold water conversion. A further important objective of the SFB is determination of uptake of anthropogenic CO_2 and of its pathways and redistribution within the deep thermohaline circulation.

The programme is funded by the German Science Foundation (DFG) and was established in July 1996. In the second funding period, beginning in 1999, the SFB was awarded a junior research group (Nachwuchsgruppe), which was added as project B4 (see below). The SFB 460 is supported by the physical and geochemical research divisions of IfM Kiel as well as by a working group from GEOMAR, by the Leibniz Laboratory for Radiometric Dating and Isotope Research of CAU and by a tracer oceanography group at the University of Bremen. In the reporting period, the SFB consisted of the following projects:

Project domain A: Thermohaline processes and deep water circulation

- A1: Overflow and mixing processes in the Irminger Sea;
- A2: Deep convection: Processes and integral effects on water mass variability;
- A3: Transformation of water masses in the eastern basin;

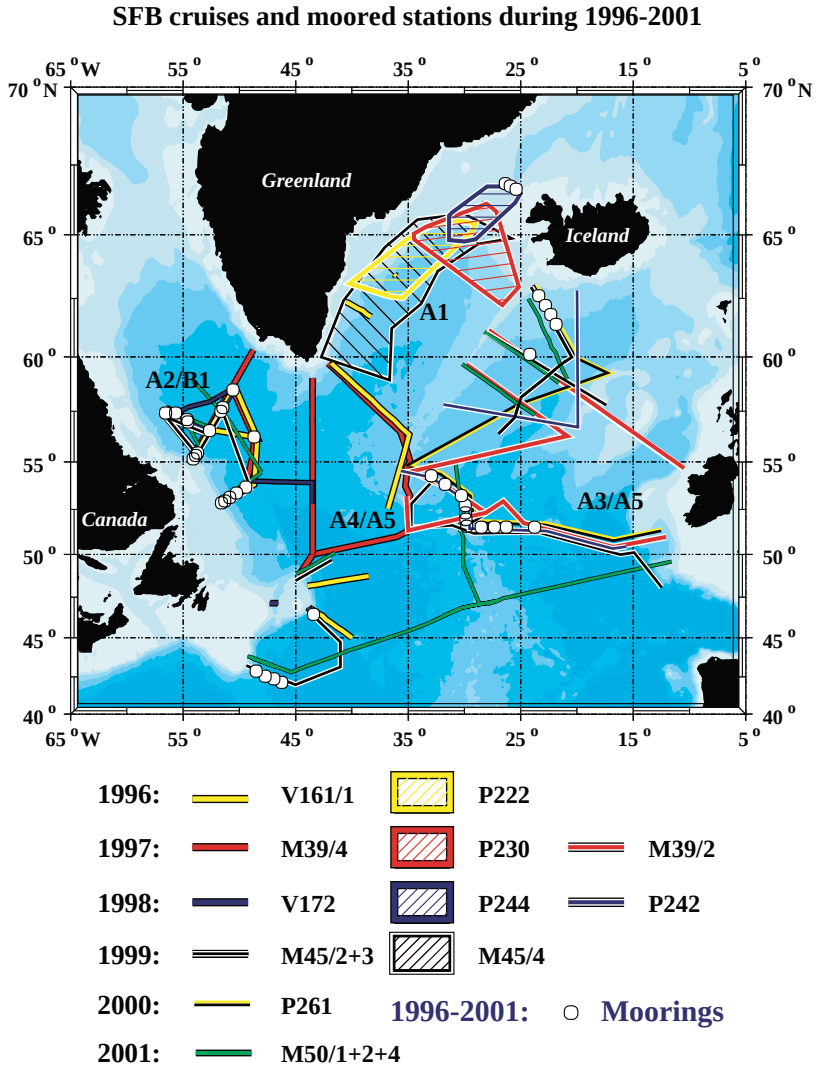


Fig.1: Schematic overview of SFB 460 field work by shipboard sections and by small-scale overflow surveys (hatched), and with moored stations (circles). Cruise identifiers are for "Meteor" (M), "Poseidon" (P) and "Valdivia" (V).

- A4: Variability of water mass distribution and circulation in the western basin;
- A5: Uptake and pathways of anthropogenic carbon dioxide;
- A6: Simulation with high resolution models.

Project domain B: Variability of ocean-atmosphere interaction

- B1: Atmosphere-ocean interaction on different time scales;
- B2: The role of sea-ice variability for the exchange of water and energy between ocean and atmosphere;
- B3: Long-term variability of ocean-atmosphere interactions in the North Atlantic;
- B4: Paleoclimatic modelling.

The activity chart in Fig. 1 shows the distribution of the SFB 460 field work in the subpolar North Atlantic (carried out by the observational projects A1-A5) which includes

- annual cruises by RV "Meteor" and IfM vessels in the different research areas to measure the year-to year variations of circulation and water mass distributions;
- moored station arrays in the Labrador convection region, in the overflows and the deep western boundary currents of the eastern and western basins;
- the release of floats which follow the deep water masses and also take hydrographic profiles along the way.

The SFB observational analysis and interpretation is closely linked with the modelling studies, using various model types which range from small-scale process models to Atlantic and global scales (projects A6, B3). The interpretation of past climates by the paleo-projects (B1, B4) in conjunction with long model runs (B3) allows comparison of the observed present-day variability with other climate scenarios.

4.2 Baltic Sea Experiment (BALTEX)

The Baltic Sea experiment (BALTEX) is one of the five continental-scale experiments of the Global Energy and Water Cycle Experiment (GEWEX). BALTEX aims to provide a better understanding of the processes of the climate system and to improve and to validate the water cycle in regional numerical models for weather forecasting and climate studies. A major effort is undertaken to couple interactively the atmosphere with the vegetated continental surfaces and the Baltic Sea including its sea-ice. Major achievements have been obtained in an improved understanding of related exchange processes. For the first time an interactive atmosphere-ocean-land surface model for the BALTEX area was tested.

The "Institut für Meereskunde" has been involved in BALTEX since the beginning in several projects, comprehending both, modelling and measuring activities. This includes the investigation of the energy and water cycle from global numerical models like the NCAR/NCEP-re-analysis projects as well as the development of a fully coupled regional atmosphere-ocean model based on the regional atmospheric model REMO and the coupled sea-ice-ocean model BSIOM. Due to the lack of suitable instruments to measure precipitation under high wind speeds, the development of a new ship rain gauge started several years ago within the frame of WOCE (World Ocean Experiment) and was completed within BALTEX. This new type of ship rain gauges has been mounted on several merchant ships travelling from Germany to Finland to perform routinely precipitation measurements over the Baltic Sea.

Major contributions to BALTEX have been provided by the IfM Kiel through the EU-Projects BASYS (Baltic Sea System Study, 1996-1999) and PEP (Pilot Study of Evaporation and Precipitation in BALTEX, 1998-2000) and the BMBF-funded project Water Cycle (1994-2000). Within a DFG-funded project, the Kiel Baltic Sea model (BSIOM) has been coupled to the regional atmospheric model

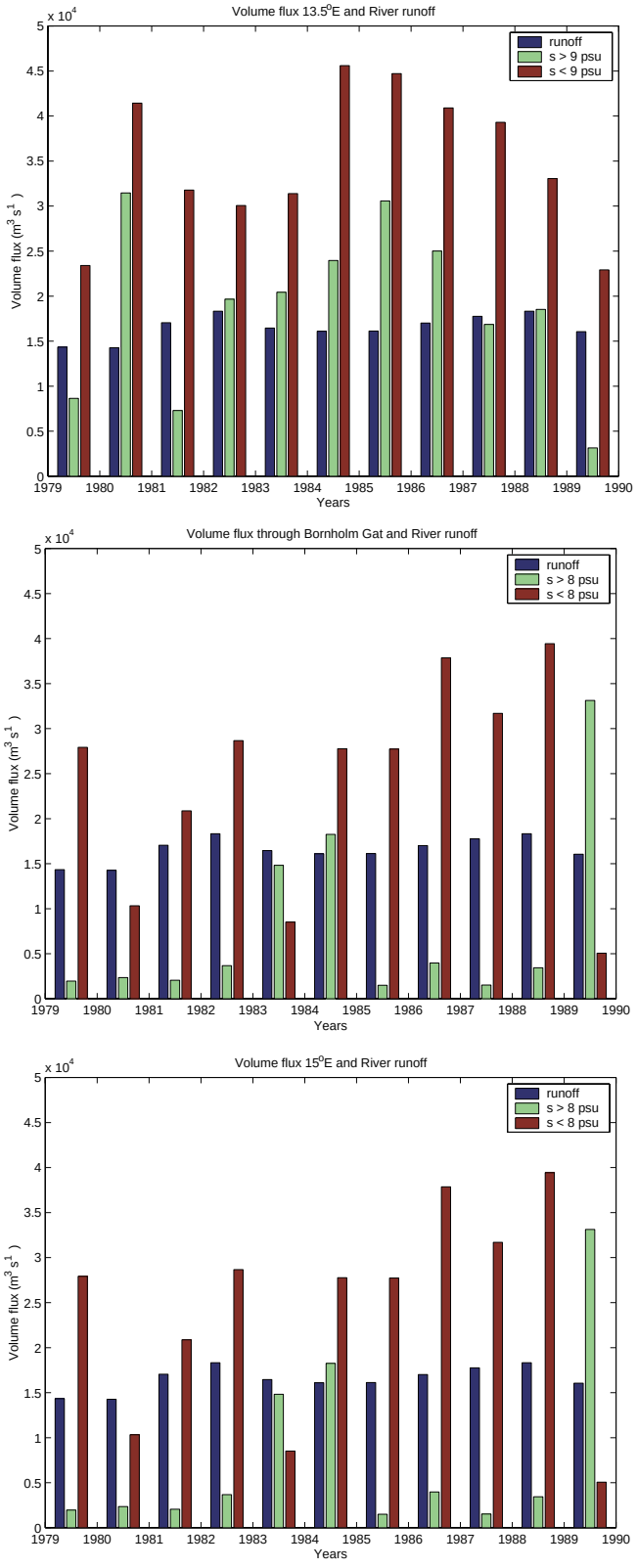


Fig. 1: Annual mean volume fluxes through the Arkona Basin (a), Bornholm Gat (b), across a hydrographic section along 15°E (c) together with the annual mean river runoff to the Baltic Sea. The flow of brackish Baltic Sea water (<9 psu) is directed to the west except for the Bornholm Gat, the flow within and below the halocline is directed to the east.

REMO to study the coupling mechanisms on a regional scale.

Since recent years the coupled sea-ice-ocean model BSIOM has been improved and applied to improve the understanding of the circulation in the Baltic Sea, the water exchange with the North Sea and within the deep basin of the Baltic Sea. Despite of the ephemeral nature of the atmospheric conditions over the BALTEX area, the general circulation shows rather persistent flow bands comprising the deep basins of the Baltic Sea. The rotational sense and the strength of the circulation patterns are affected by the prevailing wind directions. Changes in the circulation are related to changes in the large-scale atmospheric circulation which can be described by the NAO. The upper layer flow in the Arkona Basin, on average directed to the west, opposite to the mean wind direction, is compensated by a flow of higher saline water in deeper layers (Fig. 1a). Increasing upper layer flow result in an increased lower layer flow in opposite direction. In accordance to the mean circulation, the flow through the Bornholm Gat (Fig. 1b) is on average directed to the east, and south of Bornholm (Fig. 1c) the flow is directed to the west indicating an import of heat and salt through the Bornholm Gat and an export south of Bornholm.

From NCEP/NCAR-re-analysis data the vertically integrated water vapour flux into and out of the BALTEX area has been analysed. The water vapour transport goes mainly from west to east according to the prevailing wind direction, where the inflow of water vapour at western boundaries considerably exceeds the outflow at the eastern boundaries. Taking into account the net effect of precipitation minus evaporation, the water balance calculated from the NCEP/NCAR is not closed.

Precipitation is one of the main components of the hydrological cycle. However, reliable precipitation measurements over the open ocean are not available. This affects also the accuracy of precipitation estimated by remote sensing techniques due to the lack of reliable *in-situ* data to derive algorithms. Routinely precipitation measurements taken by mer-

chant ships travelling from Germany to Finland have been used to determine seasonal precipitation fields with a spatial resolution of 1° latitude/longitude. These measurements can be used to validate precipitation fields obtained from the BALTRAD radar network.

Since May 2001 the German climate research programme DEKLIM (BMBF) started which includes a special BALTEX component. Within two project compounds IfM Kiel contributes to DEKLIM. Accurate measurements of the areal precipitation over land and sea, and the influence of the Baltic Sea and its annual ice coverage on the water and energy budget of the BALTEX area (BASEWECS: http://ww.ifm.uni-kiel.de/fb/fb1/tm/research/baltex/BASEWECS/basewecs.htm) are subject of the investigations.

4.3 Climate Variability and Predictability (CLIVAR)

The German CLIVAR Programme began in 1998, with several projects funded at IfM Kiel (by BMBF) to either work on the analysis, interpretation, modelling and synthesis (AIMS) of the World Ocean Circulation Experiment (WOCE) observations or begin new CLIVAR-related studies. The IfM CLIVAR projects, supported by FB1, focus on the tropical-subtropical Atlantic and on the monsoon circulation of the Indian Ocean:

Tropical-subtropical interaction in the Atlantic

Research objectives are the transports and pathways of the tropical-subtropical coupling by the shallow thermohaline circulation cell in the tropical South Atlantic. This subtropical cell (STC) connects the subduction regions of the eastern subtropics with the equatorial upwelling zone. One of the CLIVAR goals is to investigate the potential role of STC variations on tropical climate variability and on the larger-scale meridional circulation. The field work (FB1/PO1) is carried out by repeat deployments of moored current meter arrays in the NBUC near 10°S for obtaining multiyear records of transport and water mass variability (first deployment of the CLIVAR array in March 2000), and by repeated ship surveys (with cruises in March and November, 2000) of hydrographic and current variability. In addition, profiling floats were deployed to follow the warm water pathways in western tropical Atlantic. The observational work is evaluated in collaboration with high-resolution modelling efforts of the research unit "Theory and Modelling" within FB1.

Determining time series of the Atlantic thermohaline circulation

The thermohaline circulation (THC) plays an important role for the state of the climate system. Models have found a variety of processes which can lead to such variability on decadal and longer time scales, but observational evidence is lacking. A key objective in CLIVAR therefore is to initiate long-term observations of the THC are required in order to relate its variability to the mechanism and the forcing. The research unit "Physical Oceanography 2" (PO2) has started to establish a moored array, which will provide horizontal integrals of mass and temperature transport in the subtropical Atlantic across 16°N. Since the THC is not confined to the boundary current regime, so-called end point techniques are especially suitable for efficiently obtaining large-scale integrals of deep circulation. The array employs moored temperature /conductivity and pressure observations for geostrophic transports, accurate bottom pressure sensors combined with inverted echo sounders (PIES), deep floats for observations of currents at the reference levels. Repeated ship surveys provide observations at higher spatial resolution to calibrate the array measurements.

Synthesizing the monsoon circulation of the Indian Ocean

The principal objective of this project is to obtain a quantitative description as well as a dynamical understanding of the circulation in the northern Indian Ocean, including its seasonal, meso-scale and interannual variability. This objective is pursued through interpretation and synthesis of WOCE observations, in combination with a high-resolution circulation model. The field observations resulted from previous projects of the international WOCE programme, in particular observations from moored arrays and hydrographic / tracer programmes. Altimetric data were also included in the analysis. In the reporting period, the emphasis was on the response physics of the Somali Current and the meridional overturning circulation of the Arabian Sea.

4.4 Global Ocean Ecosystem Dynamics (GLOBEC)

GLOBEC is a large international research initiative, which has become a core-project of the "International Geosphere-Biosphere Programme" (IGBP). The general objective is to: *"advance our understanding of the structure and functioning of the global ocean ecosystem, its major subsystems, and its response to physical forcing so that a capability can be developed to forecast the responses of the marine ecosystem to global change"* (GLOBEC Science Plan, 1997). The Science Plan has been implemented and initiated a series of regional GLOBEC programmes (GLOBEC Implementation Plan, 1999), which aim at developing corresponding knowledge from different marine ecosystems for a global comparative perspective: i.e. the Southern Ocean Programme (SO-GLOBEC), Cod and Climate Change (CCC), Small Pelagic Fishes and Climate Changes (SPACC) and Climate Change and Carrying Capacity (CCCC), complemented by strong national research initiatives (e.g. US Georges Bank GLOBEC). IfM Kiel contributes actively to two of the regional programmes, CCC with focus on the North Atlantic and SPACC operating world wide in shelf regions. In each of these regional programmes four major research foci are addressed: 1) Retrospective analysis and time series studies, 2) Process studies, 3) Predictive and modelling capabilities and 4) Feedbacks from changes in marine ecosystem structure.

A primary interest of GLOBEC is: "The linkage between zooplankton and fisheries through interactions in the plankton" (Science Plan, 1997). The activities and expertise in the Research Division Marine Ecology at the IfM Kiel, as well as its focus on the shelf region and on the interactions between fishery and natural ecosystem components, are very precisely on line with this international research initiative. Correspondingly, the EU projects CORE (1994-1998), BASYS (1996-1999), STORE (1999-2002), MACOM (2000-2002), LIFECO (2000-2004) and the national GLOBEC programme in the North Sea and the Baltic (starting in early 2002) refer closely to the four GLOBEC re-

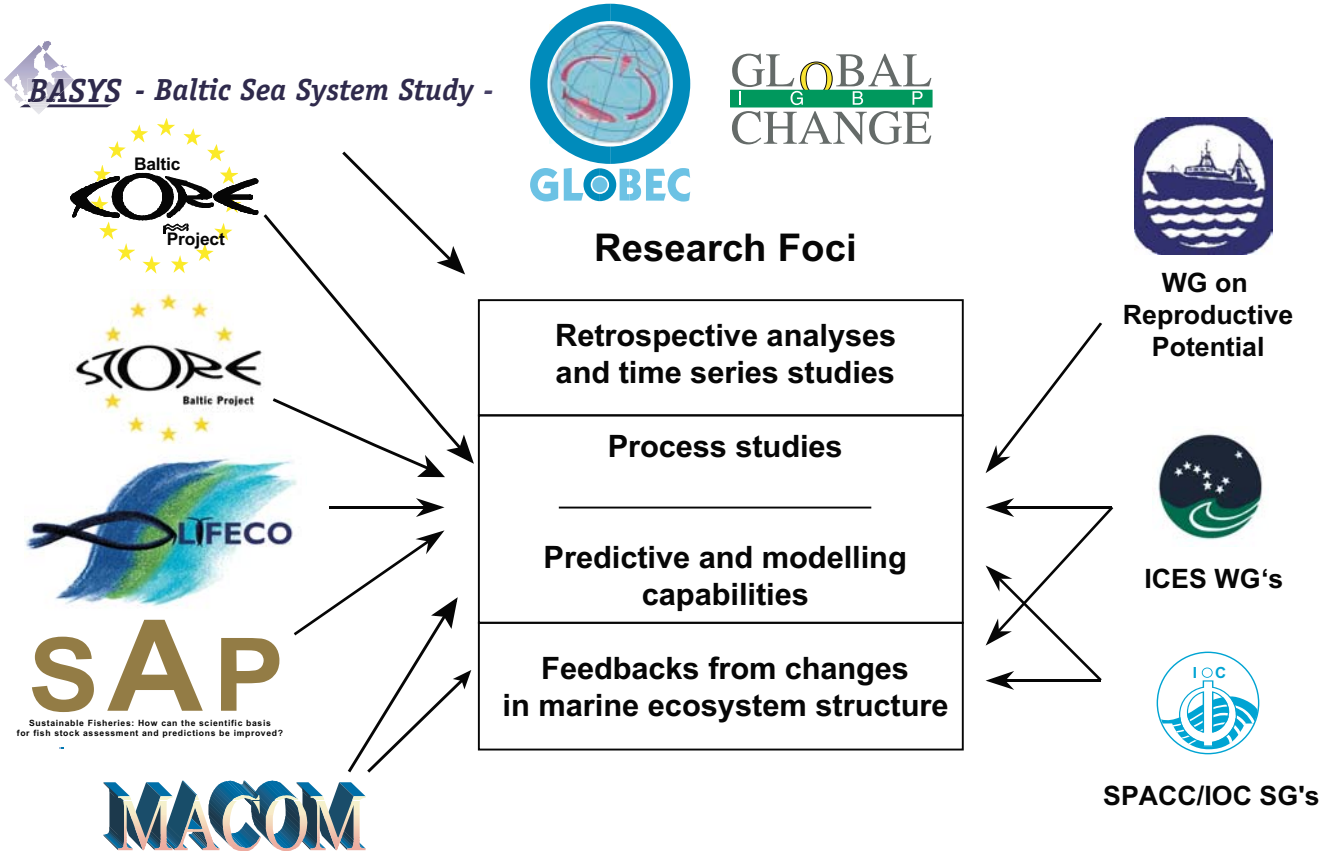


Fig. 1: Schematic diagram of interaction and cooperations within GLOBEC.

search foci. The projects CORE (Cod recruitment in the Baltic) and STORE (Fish stock recruitment in the Baltic) address primarily GLOBEC focus 2 and 3 with respect to the reproductive success of fish stocks in the Baltic, while BASYS (Baltic Sea System Study, Subproject 1b) was designed to cover focus 1 in zooplankton including fish eggs and larvae (Fig. 1). The CORE project has been used as a template for world wide recruitment research projects to study and inter-link reproduction, recruitment and species interaction, and also LIFECO (Impact of frontal activities on fish recruitment in the North Sea) follows this line. However, LIFECO comprehends more trophic levels and focuses on the effects of frontal activity on food web processes including primary and secondary production as well as their impact on fish stock recruitment. Transfer of scientific knowledge into applied fish stock assessment and improvement of stock predictions was the aim of the EU-Concerted Action SAP (1998-2001), suggesting that derived information on various biological processes and ecological features may be utilized to substantially enhance the reliability of present stock assessment methods and increase the time horizon and precision of fish stock predictions.

Based on these EU-project and a variety of individual contributions to the international GLOBEC initiative from different German research groups, a comprehensive cooperative German GLOBEC programme has be developed, starting into the implementation phase in early 2002. It includes a comparative study of the Baltic Sea and the North Sea and aims at a better understanding of the interactions between zooplankton and fish under the influence of physical processes. Thereby the principal mechanisms will be investigated accounting for the high variability of copepod production and of reproductive success of fishes. The results will form the basis for strategic modelling of the recruitment success and the dynamics of marine fish stock, along the lines derived in SAP. The German GLOBEC programme is interlinked with various initiatives conducted by

international organizations, e.g. the European Commission (DG XIV), Intergovernmental Oceanographic Commission (IOC), International Council for the Exploration of the Sea (ICES) and Northwest Atlantic Fisheries Organization (NAFO), addressing among other foci specifically the implementation of scientific results in assessment and management procedures, corresponding to GLOBEC focus 4 (feedbacks from changes in marine ecosystem structure) (Fig. 1).

Within the German GLOBEC programme in the North Sea and the Baltic the Marine Ecology Division at IfM Kiel will lead two of the seven sub-projects: Subproject 1 (D. Schnack) deals with the spatio-temporal distribution, growth and death rates early life-stages of fish as well as with the availability of suitable food and its effect on reproductive success and growth of fish larvae in relation to the physical environment. The experimental ecology group is engaged in the analysis of mesozooplankton feeding selectivity.

The goal of Subproject 7 (F.W. Köster) concentrates on coupled tropho- and hydrodynamic modelling: Individual-based models (IBM) will be developed to investigate the relative influence of food availability and physical processes on growth and survival considering temporal and spatial variability in environmental conditions by coupling IBM's to 3-D circulation models.

4.5 Joint Global Ocean Flux Study (JGOFS)

J G F S

For many years research projects of the IfM were associated with the international JGOFS programme. This provided a scientific focus in particular for the former Departments "Planktologie" and "Meereschemie". The project concentrated on the North Atlantic and the Arabian Sea; the last field studies were conducted in 1998 in the Arabian Sea. A number of synthesis projects followed with the aim to arrive at an overarching view and an improved modelling of the biogeochemical processes in these two regions.

In the North Atlantic, 3 synthesis projects were carried out from October 1997 to March 2000. One aspect was the analysis of nutrient budgets of the pelagic system with particular attention to the estimation of winter nutrient concentrations and the effect of convective mixing for episodic inputs to the upper mixed layer. Estimates of seasonal nutrient and CO_2 consumption indicated a carbon overconsumption exceeding the commonly assumed "Redfield Ratio". Export of particulate matter was another aspect of the JGOFS North Atlantic projects. The importance of convective mixing for particle export was highlighted for the early part of the spring phytoplankton bloom. An analysis of seasonal and interannual variability of particle export to the deep ocean was made and the trapping efficiency of the sediment traps was investigated. A third aspect was the development of a coupled physical-biogeochemical ecosystem model in close cooperation between biological and chemical oceanographers and modellers. Comparison with data from the German BIOTRANS Station, the French EUMELI stations and the American BAT time series station were used to improve the model.

Investigations in the Arabian Sea centred on the description of the epipelagic system at different phases of the monsoon. Three distinctly different oceanic regions were identified and described. A relatively large influence on

plankton production, albeit locally restricted and highly variable, is caused by filaments of upwelled water extending into the central part of the Arabian Sea. The influence of phytoplankton aggregation on sedimentation rates was investigated and a model description of aggregation processes was developed jointly between FB1 and FB2. A high proportion of the sedimenting material is made up of calcium carbonate from sedimenting foraminifera. Since formation of $CaCO_3$ increases the pCO_2 in the upper water column, experiments were carried out to determine the calcification rate of coccolithophorids, which were reported by previous studies to be a major component of the phytoplankton in the Arabian Sea. Unfortunately, the abundance and growth rate of coccolithophorids during the time of investigation was too low to measure significant rates of calcification. Therefore, this aspect remained unresolved.

At present the final synthesis projects are under way (July 2001 - June 2003) concentrating on the North Atlantic. The effect of changes in the climatic forcing, such as the NAO, on the development of phytoplankton and the efficiency of the biological pump is studied and predictions about potential future changes under altered climate scenarios will be attempted. The high resolution coupled biogeochemical model driven by real climate forcing will be compared to JGOFS data from the respective years to analyse the effect of changing climatic conditions.

An issue with growing importance in the later stages of JGOFS is the data management. The German JGOFS Data manager was in the past located at the IfM Kiel and this will continue in the present synthesis project. The tasks of the data manager are to bring together separate data in one uniform and publically accessible data bank, help users to access the data, and to liaise with the international JGOFS Data Management Task Team. The data are now being transferred to the PANGAEA data information system in the World Data Center at Marum, Bremen, for long-term archiving.

Furthermore, the new information gained by JGOFS into the ocean's biogeochemistry will be made accessible in an easily understandable form for the general public and for use in schools in particular. This is done in cooperation with the Institut für Pädagogik der Naturwissenschaften (IPN) of the Christian-Albrecht University.

4.6 Surface Ocean Lower Atmosphere Study (SOLAS)

The Institut für Meereskunde in Kiel has already played a major role in the initiation and early development of the large new international research programme SOLAS (Surface Ocean Lower Atmosphere Study). SOLAS will investigate the biogeochemical coupling between atmosphere and ocean. In addition to the exchanges of heat and vapour that directly influence climate (and that are major foci for the international CLIVAR programme) there are important exchanges of gases and particles that also affect climate or alternatively impact atmospheric chemistry and/or ocean biological activity. Examples of such exchanges, include:

- the air-sea exchange of CO_2 and N_2O;
- the air-sea exchange of dimethyl sulphide (the oxidation products of which can affect cloud albedo);
- the effects of sea-salt aerosol on atmospheric radiation transfer and chemical processes;
- the effect of atmospheric deposition of iron on ocean productivity.

To-date, despite these linkages, atmosphere and ocean have tended to be studied separately by the meteorology / atmospheric chemistry research community and the oceanographic community respectively. Within international global change research programmes there has also been division of effort: atmospheric chemists worked within the International Global Atmospheric Chemistry programme (IGAC) whereas the oceanographic community worked within Joint Global Ocean Flux Study (JGOFS). The result is that little work has been conducted on the important biogeochemical coupling between atmosphere and ocean. SOLAS seeks to correct this situation: indeed the scientific issues to be studied under SOLAS will require these communities to work closely together. This new orientation has potentially important implications for the future development of the IfM.

International planning for SOLAS was initiated at an Open Science Conference which was held in Damp, Schleswig-Holstein in February 2000. This meeting was hosted by the former department "Meereschemie" of the IfM. Financial support came from several national and international agencies as well as the IfM itself. The meeting was attended by more than 250 scientists from 22 countries, representing a diverse array of disciplines including: chemical, biological and physical oceanography, marine ecology, atmospheric chemistry and physics, remote sensing, air-sea interaction and biogeochemical modelling.

On the basis of discussions held at the conference, a draft international science plan was written (see http://www.ifm.uni-kiel.de/fb/fb2/ch/research/solas/frameset.htm). Professor Wallace of FB2 was a member of the core editorial team responsible for drafting the Science Plan. SOLAS subsequently became an officially sponsored programme of the International Geosphere-Biosphere Programme (IGBP) in February 2001 and has also been endorsed by the Scientific Committee for Ocean Research (SCOR) and the Commission for Atmospheric Chemistry and Global Pollution (CACGP). The Science Plan includes a strong focus on physical exchange processes and may become the first research programme to be co-sponsored by both the IGBP and the World Climate Research Programme (WCRP). SOLAS has now entered a vigorous planning phase, with national committees having been formed in many countries. Present momentum suggests that "official" international SOLAS research will commence in 2004. Within Germany, the IfM (Professors Wallace and Lochte) together with Professor Ulrich Platt of the University of Heidelberg organised a 1-day National SOLAS Workshop in Hannover (27 February 2001). This was attended by represen-tatives from 10 universities and research institutes. Enquiries and discussions with national funding agencies responsible for both atmospheric and oceanic research have been

made with a view to initiating funded SOLAS research within Germany.

Within the IfM, the conference at Damp had a significant impact on research directions and planning. Several SOLAS-oriented proposals have subsequently been submitted to national and European agencies, and several more such research plans are being formulated. Examples include work already underway on dimethyl sulphide production, air-sea exchange of CO_2 and N_2O, biological cycling of iron, nitrogen fixation, effects of phytoplankton on bubble dynamics, etc. Future plans include major collaborative expeditions to address SOLAS research questions.

5. Expeditions

5.1 Introduction

Members of IfM staff acted as chief scientists on a host of major research cruises with various research vessels, and joined numerous other cruises as Principal Investigators (PI's). The vessels include the German ships "Meteor", "Sonne", "Poseidon," "Walter Herwig", "Polarstern", "Heincke", "Solea", and vessels from abroad like "Hudson" (Canada), "Knorr" (US), "B. Saemundsson" (Icel.), "Hvidbjoernen" (DK), "Dana" (DK). In many cases, projects of other groups working in other fields of marine sciences were supported onboard.

A comprehensive overview on the cruises of the IfM research vessels is provided in section 8 (page 143).

5.2 Expeditions with IfM contributions

*Chief scientists / PIs from IfM are indicated in **bold**.*

Year / Month	Cruise / Vessel	Chief Scientist / PI	Area	Project	Major work	Cooperation with
1999						
January		**Rohlf**	South North Sea, English Channel	HERSUR	Hydrography, ichthyo-plankton	DIFRES, RIVO
Jan.-Feb.	Poseidon 247	**Müller**	Can. Basin	K 276, ESTOC	Moorings, hydrography, plankton	ICCM, IOW, Univ. Tübingen
Feb. - March	Dana 03/99	**Tomkiewicz**	Baltic Sea	STORE/ BITS	Hydrography, fisheries	DIFRES
April	Alkor 141	**Köster**	Baltic Sea	STORE	Fisheries, ichthyo-, and zooplankton	AtlantNIRO, IOW
May-June	Walther Herwig III 206	Gröhsler	Baltic Sea	STORE/ BIAS	Hydroacoustics, fisheries	IOR
May-June	RV Atlantniro	Zerzera	Baltic Sea	STORE	Hydrography, fisheries, ichthyo-, zoo- and phyto-plankton, Meteorology	DIFRES, IOW, AtlantNIRO, LATFRI

5. Expeditions

Year / Month	Cruise / Vessel	Chief Scientist / PI	Area	Project	Major work	Cooperation with
May-June	Alkor 143	**Köster**	Baltic Sea	STORE	Hydrography, fisheries, ichthyo-, zooplankton	DIFRES, AtlantNIRO, LATFRI
May-June	Polarstern	Fahrbach / **Zenk**	Cape Basin	KAPEX	Recover RAFOS sound source	Univ. Cape Town, WHOI
June-July	Meteor 45/2	**Zenk**	Icel.- Sea	SFB460	Moorings, hydrography, tracer	Univ. Bremen, IOW
June-July	Alkor 145	**Kraus**	Baltic Sea	STORE	Hydrography, fisheries, ichthyo- and zooplankton, Meteorology	IOW, Atlant-NIRO
July	Dana 12/99	**Tomkiewicz**	Baltic Sea	STORE	Hydrography, fisheries	DIFRES
July-Aug.	Meteor 45/3	**Schott**	Lab.-Sea	SFB460	Moorings, hydrography, tomography, floats	IFREMER
August	Alkor 147	**Koester**	Baltic Sea	STORE	Hydrography, fisheries, ichthyo-, zooplankton	DIFRES, IOW, AtlantNIRO, LATFRI
August-Sept.	Alkor 148	**Voss**	Baltic Sea	STORE/ BASYS	Hydrography, fisheries, ichthyo-, zooplankton	DIFRES, IOW, AtlantNIRO, LATFRI
Sept.	Saemundsson	Malmberg / **Reppin**	DK-Strait	SFB460	Moorings	MRI, Reykjavik
Sept.	Alkor	**Rohlf**	Northern North Sea	HERSUR	Hydrography, ichthyo-plankton	DIFRES, RIVO
October	Solea	Böttcher	Baltic Sea	STORE	Fisheries	IOR
October	Atlantida	Feldmann	Baltic Sea	STORE	Hydroacoustic	AtlantNiro, LATFRI
Nov.	Dana 17/99	Nielsen	Baltic Sea	STORE/ BITS	Hydrography, fisheries	DIFRES
Nov.	Meteor 45/5	Neuer / **Müller**	Can. Islands	ESTOC	Hydrography	GeoB, ICCM, IEO
Dec.	Solea	Böttcher	Baltic Sea	STORE	Fisheries	IOR
2000						
January	Alkor 153	**Rohlf**	South North Sea, English Channel	HERSUR	Hydrography, ichthyo-plankton	DIFRES, RIVO
Jan.-Feb.	Knorr	McCartney / **Send**	West. subtr. Atlantic	CLIVAR	Moorings, floats, hydrography	WHOI
February	Saemundsson	Valdimarsson / **Reppin**	DK.-Strait	SFB460	Moorings	MRI, Reykjavik
Feb.-Mar.	Meteor 46/4	Wefer / **Müller**	Vema Ch.	Vema	Moorings	GeoB
March	Dana 04/00	Prince	Baltic Sea	STORE	Hydrography, fisheries	DIFRES
Mar.-Apr.	Meteor 47/1	**Schott**	Trop. Atlantic	CLIVAR	Moorings, hydrography, tracer, floats	Univ. Bremen
March	Poseidon 257	Llinas / **Lenz**	Can. Islands	ESTOC	Hydrography	ICCM, Telde

Year / Month	Cruise / Vessel	Chief Scientist / PI	Area	Project	Major work	Cooperation with
April	Poseidon 259	**Müller**	Can. Basin	ESTOC, K276	Moorings, hydrography	ICCM, Telde, IOW
April	Heincke 131	**Kraus**	Baltic Sea	STORE	Hydrography, fisheries, ichthyo-, zooplankton	IHF, DIFRES, IOW
May-June	Alkor 161	**Hermann**	Baltic Sea	STORE	Hydrography, fisheries, ichthyo-, zooplankton	IHF; Atlant-Niro, LATFRI
June-July	Hudson	Clarke / **Send**	Lab.-Sea	SFB460	Moorings, hydrography	BIO
June-July	Poseidon 261/ 262	**Müller**	Icel.- Sea, DK.-Strait	SFB460	Moorings, hydrography, floats	MRI Reykjavik GEOMAR
July	Alkor 163	Temming	Baltic Sea	STORE	Hydrography, fisheries, ichthyo-, zooplankton	IHF, DIFRES
July-Aug.	Alkor	**Möllmann**	Baltic Sea	STORE	Hydrography, fisheries, ichthyo-, zooplankton	IHF, LATFRI, IOW
Sept.	Alkor 168	**Rohlf**	Northern North Sea	HERSUR	Hydrography, ichthyo-plankton	DIFRES, RIVO
Sept.-October	Solea	Gröhsler	Baltic Sea	STORE/ BIAS	Hydroacoustics, fisheries	IOR
October	Meteor 48/5	Alheit	Benguela, Namibia	SPACC/ BENEFIT	Hydrography, ichthyo-, zoo- and phytoplankton, meteorology	IOW, University of Cape Town
Oct.-Nov.	Polarstern XVIII/2	Smetacek/ **Peeken**	Southern Ocean	EISENEX	Iron fertilisation, plankton ecology	AWI
Oct.-Nov.	Sonne 151	**Stramma**	West. trop. Atlantic	CLIVAR	Moorings, hydrography, tracer	Univ. Bremen
Nov.	Atlantida	Feldmann	Baltic Sea	STORE	Hydroacoustic, fisheries	LATFRI
Nov.-Dec.	Sonne 152	**Rhein / Zenk**	Subtr. NA.	CLIVAR	Hydrography, tracer, floats	
Dec.-Jan.	Sonne 153	**Send**	Westl. trop. Atlantic	CLIVAR	Moorings, hydrography, floats	WHOI
2001						
January	Alkor 172	Klimpel	South North Sea, English Channel	HERSUR	Hydrography, ichthyo-plankton	DIFRES, RIVO
January	Hvidbjoernen	**Müller**	DK.-Strait	SFB460	Rescue mooring parts	Danish navy, MRI Reykjavik
February	Saemundsson	Valdimarsson / **Müller**	DK.-Strait	SFB460	Moorings	MRI Reykjavik
March	Dana 03/01	St. John	North Sea	LIFECO	Hydroacoustic, fisheries, ichthyo-, zoo- and phyto-plankton	DIFRES
April	Alkor 180	**Kraus**	Baltic Sea, North Sea	STORE/ LIFECO	Hydrography, fisheries, ichthyo-, zooplankton	IHF, CEFAS
April	Poseidon 273	**Oschlies/ Kähler**	NE Atlantic	Inter-disc. WG	Hydrography, nitrogen cycle, and phytoplankton	FB2

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Year / Month	Cruise / Vessel	Chief Scientist / PI	Area	Project	Major work	Cooperation with
April-May	DANA 04/01	Munk	North Sea	LIFECO	Hydroacoustic, ichthyo-, zoo- and phytoplankton	DIFRES
May	Saemundsson	Valdimarsson / **Müller**	DK.-Strait	SFB460	Moorings	MRI Reykjavik
May	Meteor 50/1	**Fischer**	West. subpolar NA	SFB460	East. subtr. North Atlantic	IFM Kiel/IPG1
May-June	Heincke 147	**Piatkowski**	North Sea	LIFECO	Hydrograpy, fisheries, ichthyo- and zooplankton	IHF, CEFAS
May-June	Alkor 182	**Möllmann**	Baltic Sea	STORE	Hydrography, fisheries, ichthyo-, zooplankton	LATFRI, DIFRES, AtlantNIRO
May-June	Dana 05/01	Munk	North Sea	LIFECO	Hydroacoustic, ichthyo-, zoo- and phytoplankton	DIFRES, IOW
May-June	Walther Herwig III 228b	Böttcher	Baltic Sea	STORE	Hydrography, fisheries, ichthyo-, zooplankton	IOR
June	Solea 477	Mieske	Baltic Sea	STORE	Hydroacoustics, fisheries	IOR
June	Meteor 50/2	**Schott**	Lab.- Sea	SFB460	Moorings, tomography, hydrography	Univ. Bremen
July	Alkor 184	Hansen	Baltic Sea	STORE	Hydrography, fisheries, ichthyo-, zooplankton	IOW, Atlant-Niro
July	Dana 07/01	St.John	North Sea	LIFECO	Hydroacoustic, fisheries, ichthyo-, zoo- and phytoplankton	DIFRES, IOW
July-Aug.	Walther Herwig III 230	Ehrich	North Sea	LIFECO	Hydroacoustics, fisheries	ISH
July-Aug.	Meteor 50/4	**Zenk**	DK.-Strait, Icel.-Sea	SFB460	Moorings, hydrography, tracer, floats	Univ. Bremen, GEOMAR
Sept.	Alkor 189 I	Floeter	North Sea	LIFECO	Hydrography, fisheries, ichthyo-, zoo- and phytoplankton	IHF, DIFRES, CEFAS
Sept.	Alkor 189 II	**Rohlf**	Northern North Sea	HERSUR	Hydrography, ichthyoplankton	DIFRES, RIVO
Nov.	Heincke 161	Floeter	North Sea	LIFECO	Hydrograpy, fisheries, ichthyo-, zoo- and phytoplankton	IHF, DIFRES

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7. Scientific Exchange and Cooperation

7.1 Membership in National and International Organisations

7.1.1 International Global Change Programmes

I. World Climate Research Programme (WCRP)

a) Joint Scientific Committee: *Lemke, P. (Chair)*

b) JSC/CLIVAR Working Group on Coupled Modelling: *Böning, C.*

c) World Ocean Circulation Experiment (WOCE)

- Scientific Steering Group: *Böning, C*
- WOCE/CLIVAR Working Group on Ocean Model Development: *Böning, C. (Chair)*.

d) Climate Variability and Predictability (CLIVAR)

- Scientific Steering Group: *Willebrand, J. (Co-chair)*
- Ocean Observation Panel: *Send, U.*
- Atlantic Implementation Panel: *Schott, F.*

e) Global Energy and Water Cycle Exeriment (GEWEX)

- BALTEX Working Group on Energy and Water Cycles: *Bumke, K.*
- BALTEX, Working Group on Process Studies: *Ruprecht, E. (Chair, until November 2000).*
- BALTEX representative of BALEX at NOPEX: *Ruprecht, E. (until end of 2000).*

II. Global Ocean Observing System (GOOS)

- GOOS Science Steering Committee: *Schott, F., Wallace, D.W.R.*
- GCOS/GOOS/WCRP Ocean Observations Panel for Climate: *Zenk, W.*
- IOC/SCOR Ocean CO_2 Panel: *Wallace, D.W.R. (Chair).*

III. International Geosphere Biosphere Programme (IGBP)

- IGBP Scientific Steering Group: *Lochte, K.*
- IGBP, Ocean Futures Planning Group: *Wallace, D.R.W.*
- GLOBEC SPACC/IOC Study Group on the use of Environmental Indices in the Management of Pelagic Fish Populations: *Köster, F.W.*

a) Joint Global Ocean Flux Study (JGOFS)

- International JGOFS Science Steering Committee: *Lochte, K., Wallace, D.W.R*
- Global Synthesis Working Group: *Oschlies, A.*
- JGOFS North Atlantic Synthesis Task Team: *Wallace, D.W.R.*
- JGOFS-Paleo-Task Team: *Lochte, K. (Chair).*
- US JGOFS Science Steering Committee: *Wallace, D.W.R.*

b) Surface Ocean Lower Atmosphere Study (SOLAS)

- International Steering Committee: *Wallace, D.W.R.*
- SOLAS Planning Committee: *Wallace, D.W.R.*
- SOLAS Science Plan Editorial Team: *Wallace, D.W.R.*

IV. International Council for the Exploation of the Seas (ICES)

- International Council for the Exploration of the Sea (ICES), national delegate: *Schnack, D.*
- ICES/GLOBEC North Atlantic Programme and Regional Office: *Köster, F.W. (Co-Chair)*.
- ICES/HELCOM Steering Group on Quality Assurance of Biol. Measurements in the Baltic Sea: *Rumohr, H.*
- ICES/IOC/IMO Study Group on Ballast and other Ship Vectors: *Gollasch, S.: (Chair).*
- ICES/OSPAR Steering Group on Quality Assurance of Biol. Measurements in the North Atlantic: *Rumohr, H*.
- Living Resources Committee: *Piatkowski, U.*
- Mariculture Committee: *Trippel, E.A., Waller, U.*
- Marine Habitat Committee: *Rumohr, H.*

- Resource Management Committee: *Köster, F.W.*
- Planning Group for Herring Surveys: *Rohlf, N., Schnack, D.*
- Study Group on Baltic Herring and Sprat Maturity: *Köster, F.W.*
- Study Group on Incorporation of Process Information into Stock-Recruitment Models: *Hinrichsen, H.*
- Study Group on Modelling of Physical/Biological Interactions: *Hinrichsen, H.*
- Study Group on Multispecies Predictions in the Baltic: *Köster, F.W. (Chair), Voss, R.*
- Study Group on Multispecies Model Implementation in the Baltic: *Köster, F.W. (Chair), Möllmann, C., Voss, R.*
- WG Baltic Fisheries Assessment: *Köster, F.W., Möllmann, C., Tomkiewicz, J.*
- WG Benthos Ecology: *Rumohr, H.*
- WG Cephalapod Life Cycles and Fisheries: *Piatkowski, U.*
- WG Cod and Climate Change (GLOBEC): *Köster, F.W., Schnack, D.*
- WG Environmental Interactions of Mariculture: *Rosenthal, H., Rumohr, H., Waller, U.*
- WG Herring Assessment for the Area South of 62°N: *Rohlf, N., Schnack, D.*
- WG Introduction and Transfers of Marine Organisms: *Gollasch, S. (Chair), Lenz, J., Rosenthal, H., Rumohr, H.*
- WG Mackerel and Horse Mackerel Egg Surveys: *Schnack, D.*
- WG Marine Habitat Mapping: *Rumohr, H.*
- WG Multispecies Assessment: *Köster, F.W.*
- WG Phytoplankton Ecology: *Lenz, J.*
- WG Quality Assurance of Biol. Measurements in the Northeast Atlantic: *Rumohr, H.*
- WG Recruitment Processes: *Clemmesen, C., Schnack, D.*
- WG Seabird Ecology: *Garthe, S.*
- WG Zooplankton Ecology: *Lenz, J., Möllmann, C.*

7.1.2 National and International Review Panels

a) National Panels

- Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven: *Lochte, K.: Scientific Advisory Board.*
- Bundesministeriums für Bildung, Wissenschaft, Forschung und Technologie (BMBF), Steuergruppe "Mittelgroße Forschungsschiffe": *Lochte, K., Zenk, W.*
- Deutsche Forschungsgemeinschaft (DFG): Senat: *Schott, F.*
- Deutsche Forschungsgemeinschaft (DFG): Senatskommission für Ozeanographie: *Lochte, K., Schott, F., Willebrand, J.*
- Deutsche Forschungsgemeinschaft (DFG): *Ruprecht, E.: Reviewer.*
- Deutsche Wissenschaftliche Kommission für Meeresforschung (DWK): *Schnack, D. (Chair), Köster, F.W., Piatkowski, U., Rosenthal, H., Rumohr, H., Waller, U.*
- Institut für Chemie und Biologie des Meeres, Carl-von-Ossietzky-Universität, Oldenburg: *Lochte, K., Sommer, U.: Scientific Advisory Board.*
- Institut für Ostseeforschung, Warnemünde: *Wallace, D.W.R.: Scientific Advisory Board.*
- Kuratoriums des Max-Planck-Insitituts für Limnologie, Plön: *Sommer, U. (Chair).*
- Max-Planck-Institut für Meteorologie, Hamburg, Stammkommission: *Willebrand, J.*
- Nationales Komitee für Global Change Forschung: *Lochte, K., Schott, F.*

b) International Panels

- Hadley Centre, Bracknell, UK: *Willebrand, J.: Scientific Review Committee (Chair).*
- Memorial of University of Newfoundland, St. John's, Canada: *Trippel, E.A.: External Examiner.*
- National Environmental Research Council, (NERC), UK: *Hoppe, H.-G., Send, U., Willebrand, J., Wilson, R.P., Zenk, W.: Reviewer.*
- National Oceanic and Atmospheric Administration, USA: *Willebrand, J.: Reviewer; Trippel, E.A.: Scientific Review Group for US Atlantic.*
- National Science and Environment Research Council, Canada: *Willebrand, J.: Reviewer.*

- National Science Foundation, USA: *Böning, C., Hoppe, H.-G., Willebrand, J., Zenk, W.: Reviewer.*
- Netherlands Institute for Sea Research (NIOZ), Texel, The Netherlands: *Lochte, K.: Scientific advisory board.*
- Koninklijk Nederlands Meteorologisch Instituut (KNMI), de Bilt, The Netherlands: *Willebrand, J.: Review Committee.*
- Southampton University, UK: *Willebrand, J.: Reviewer.*
- University of Newcastle, Southampton, UK: *Rosenthal, H: External Examiner.*
- University of Bergen, Bergen, Norway: *Trippel, E.A., External Examiner.*
- University of Dalhousie, Dalhousie, Canada: *Trippel, E.A., External Examiner.*

7.1.3 Other Memberships

- American Fisheries Society, Resource Policy Committee: *Trippel, E.A.*
- American Fisheries Society, Canadian Aquatic Resources Section: *Trippel, E.A.*
- ARGO Science Team: *Send, U.*
- BMBF: Sektorkoordinator Aquatic Sciences für die Deutsch-Brazilianische und für die Deutsch-Kanadische Zusammenarbeit: *Rosenthal, H.*
- BMBF-Arbeitskreis Modellierung in der Klimaforschung: *Böning, C.*
- Bundesministerium für Verbraucherschutz, Ernährung und Landwirtschaft (BMVEL): Arbeitsgruppe für tropische und subtropische Agrarforschung (ATSAF): *Rosenthal, H.*
- Census of Marine Life (CoML) pilot project: Patterns and processes of the ecosystems of the northern mid-Atlantic (MAR-ECO): Scientific Steering Committee: *Piatkowski, U.*
- Cephalopod International Advirsory Council: *Piatkowski, U.*
- Deutscher Fischereiverband: Abwasserausschuss: *Rosenthal, H.*
- Deutscher Fischereiverband: Beratungsgruppe Aquakultur: *Rosenthal, H.*
- Deutscher Fischereiverband: Wissenschaftlicher Beirat: *Schnack, D.*
- Deutsche Gesellschaft für Protozoology (DGP): *Berninger, U.-G.: General Secretary.*
- Deutsche Meteorologische Gesellschaft (DMG), ständiger Vertreter bei der Deutschen Physikalischen Gesellschaft: *Ruprecht, E.*
- EU Management Committee COST 712: *Ruprecht, E.*
- European Ichthyological Society: *Froese, R.*
- European Union of Aquarium Curators (EUAC): *Waller, U.*
- Hydralab Association of Large-Scale European Hydraulic Facilities: Member User Selection Panel: *Käse, R.*
- International Microbiology: *Imhoff, J.F.*
- International Committee on Systematic Bacteriology, subcomittee on the Taxonomy of Bacteria: *Imhoff, J.F.*
- International Panel on Climate Change (IPCC), Third IPCC Assessment Report:

  Lead author chapter 3: The Carbon Cycle and the Atmosphere: *Wallace, D.R.W.*

  Lead author chapter 7: Physical Climate Processes and Feedbacks: *Willebrand, J.*
- National GLOBEC-Programme in the North Sea and the Baltic, Steering Group: *Köster, F.W., Lehmann, A.*
- National Oceanic and Atmospheric Administration (NOAA): Gulf of Mexico Marine Mammal State Assessments: *Trippel, E.A.*
- NOAA Ocean-Atmosphere Carbon Exchange Study Steering Group: *Wallace, D.W.R.*
- Northwest Atlantic Fisheries Organization (NAFO): WG Reproductive Potential: *Trippel, E.A. (chair), Kraus, G., Tomkiewicz, J.*
- Nova Scotia Aquaculture Devolopment Committee: *Trippel, E.A.*
- Species 2000 Management Team: *Froese, R.*
- Ocean Biogeographic Information System (OBIS): Scientific Steering Committee: *Froese, R.*
- Royal Swedish Academy of Science (Agriculture, Forestry and Fisheries): *Rosenthal, H.*
- Science Team for a Global Timeseries Observatory System: *Send, U. (Co-Chair).*
- Technical Advisory Group of GloBallast (TAG) of the International Martitime Organization (IMO): *Gollasch, S.*
- Vereinigung für Allgemeine und Angewandte Mikrobiologie: Arbeitsgruppe Wasser/ Abwasser: *Imhoff, J.F.*
- Working Group on Intercomparison of 3D Radiation Codes (I3RC) of the International Radiation Commission: *Macke, A.*

- World Aquaculture Society: Honorary Life Member: *Rosenthal, H.*

7.2 Editiorial Boards Membership

- Anales del Instituto de Investigaciones Marinas de Punta de Betin, Columbia: *Gocke, K. (Editorial Advisor)*
- Aquaculture Engeneering: *Rosenthal, H. (Editorial Board).*
- Aquatic Living Resources: *Rosenthal, H. (Editorial Board).*
- Aquatic Microbial Ecology: *Berninger, U.-G., Hoppe, H.-G. (Review editors), Lochte, K. (Subject Editor).*
- Aquatic Sciences: *Sommer, U. (Editorial Board).*
- Archive of Fishery and Marine Research: *Lenz, J. (Co-Editor), Schnack, D. (Editorial Board).*
- Atlantic Seabird: *Garthe, S. (Editorial Board).*
- Atmospheric and Oceanographic Sciences Library: *Schott, F. (Associate Editor).*
- Basic and Applied Ecology: *Sommer, U. (Editorial Board).*
- CLIVAR Exchanges, Newsletter of the International CLIVAR Programme: *Villwock, A. (Editor).*
- Deep-Sea Research II Volume, "Physical Oceanography of the Indian Ocean during the WOCE period": *Schott, F. (Guest Editor).*
- Deep-sea Research II Volume, "New Views of the Atlantic – A Tribute to Gerold Siedler", 1997-1999: *Zenk, W. (Guest Editor)*
- Deep-Sea Research II Volume, "The Biogeochemistry of the Deep Arabian Sea": *Lochte, K. (Guest Editor)*
- Ecological Studies: *Sommer, U. (Series Editor).*
- Ecology Letters: *Sommer, U. (Editorial Board).*
- Elasmoskop: *Frentzel-Beyme, B.Z. (Editor).*
- Fishery Bulletin: *Rosenthal, H. (Editorial Board).*
- International Review of Hydrobiology: *Sommer, U. (Editorial Board).*
- J. Appl. Ichthyol.: *Rosenthal, H. (Editor in Chief); Froese, R. (Editorial Board); Schnack, D. (Editor).*
- J. Phys. Oceanogr.: *Böning, C. (Associate Editor).*
- J. Plankt. Res.: *Lenz, J. (Editorial Board).*
- J. Aquaculture in the Tropics: *Rosenthal, H. (Editorial Board).*
- J. Microbiol.: *Hoppe, H.-G. (Advisory Board)*
- Marine Ecology Progress Series: *Hoppe, H.-G. (Review Editor)*
- Marine Ornithology: *Wilson, R.P. (Editorial Board).*
- Neobiota: *Gollasch, S. (Editorial Board).*
- Ocean Dynamics: *Oschlies, A. (Editor).*
- Ocean Modelling: *Böning, C. (Editor).*
- Physics and Chemistry of the Earth "Energy and Water Cycles over Larger and Medium Sized Catchments": *Macke, A. (Guest Editor).*
- Polar Biology: *Culik, B. (Editorial Board).*
- Progress in Oceanography "Dynamics of North Atlantic Circulation": *Willebrand, J. (Guest Editor).*
- Recirc Today: *Rosenthal, H. (Editorial Board).*
- Revista de Biologica Tropical, Costa Rica: *Gocke, K. (Editorial Advisor)*
- Rivista Italiana di Aquacoltura: *Rosenthal, H. (Editorial Board).*
- Zeitschrift für Angewandte Zoologie: *Rosenthal, H. (Editorial Board).*

7.3 Visiting scientists at IfM

Aro, E.: Finnish Game and Fisheries Research Institute, Helsinki, Finland, 11.6-15.6.2001.

Berg, G.M.: Stipendium der Alexander von Humboldt-Stiftung, 1.7.1999-28.2.2003.

Blume, H.: Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven, 6.9.-9.9.2000.

Bower, A.: Woods Hole Oceanographic Institution, Woods Hole, USA, 29.4.-12.5.2001.

Buckley, L.: University of Rhode Island, Narragansett, Rhode Island, USA, 4.4.-7.4.2000.

Chave, A.: Scripps Institution of Oceanography, La Jolla, San Diego, USA, 17.7.-20.7.2001.

Cornuelle, B.: Scripps Institution of Oceanography, La Jolla, USA, 21.5.-2.6.1999.

Dau, K.: Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven, 1.3.-7.4.2000.

De Girolamo, M.: Department of Biology, University of Padua, Padua, Italy, 3.3.-7.4.2001.

De Rocha Oliveira, I.: Instituto Oceanografico, Universidade de São Paulo, São Paulo, Brazil, 15.7.-5.8.2000.

Evans, G.T.: Department of Fisheries and Ocean, St. Johns, Newfoundland, Canada, 11.5.-17.5.2001.

Ferraz-Dias, J.: Instituto Oceanografico, Universidade de São Paulo, São Paulo, Brazil, 15.7.-5.8.2000.

Ferry, N. : LEGOS / GRGS, Toulouse, France, 24.-30.4.1999.

Greatbatch, R.: Department of Oceanography, Dalhousie University, Halifax, Canada, 27.5.-2.6.2000; 29.10.-7.11.2001.

Gulev, S.: P.P. Shirshov Institute of Oceanology, Moscow, Russia, 15.2.-2.3.2001.

Johnson, K.: Upton, New York, 1.7.-30.11.2000.

Karakassis, I.: Institute of Marine Biology, Heraklion, Crete, Greece, 19.11.-25.11.2000.

Karassiova, E.: Atlantic Scientific Research, Institute of Marine Fisheries and Oceanography, Kaliningrad, Russia, 3.8.-16.8.2001.

Karstensen, Johannes: Lamont Doherty Earth Observatory, Columbia University, Palisades, NY, USA, 1.3.-1.7.2000 and 11.8.2001-31.3.2002.

Khatoon, J.: Bangladesh Atomic Energy Commission, Institute of Food & Radiation Biology, Dhaka, Bangladesh, 31.1.-31.3.2000.

Kim, C.: California, USA, Fullbright- Stipendium, 1.4.1999-31.3.2000.

Krahmann, G.: Lamont Doherty Earth Observatory, Columbia University, USA, 1.5.-5.6.2000.

Lazar, A.: LODYC, Université Pierre et Marie Curie, Paris, France, 8.7.-11.7.2001.

Lilly, J.: School of Oceanography, University of Washington, Seattle, USA, 23.7-27.7.2001.

Makarchouk, A.: Latvian Fisheries Research Institute, Riga, Latavia, 24.5.-9.6.2000.

Marshall, J.: MIT, Dept. of EAPS, Cambridge, MA, USA, 21.2.- 24.2.2001.

McCreary, J.: IPRC/SOEST, University of Hawaii, Honolulu, USA, 15.10.-20.10.2000.

McKay, L.: Bowling Green State University, Bowling Green, Ohio, USA, 16.11.-30.11.1999.

Metha, V.: University of Maryland, USA, 26.2.-2.3.2001.

Mertens, F.: Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven, 6.9.-9.9.2000.

Meyer-Harms, B.: Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven, 6.9.-9.9.2000.

Nissling, A.: Gotland University College, Ar Research Station, Gotland, Schweden, 17.4.-27.4.2000, 24.5.-9.6.2000.

Nojiri, Y.: National Institute for Environmental Studies, Tsukuba, Japan, 19.11.-14.12.2001

Papadopolou, N.: Institute of Marine Biology, Heraklion, Crete, Greece, 18.6.-26.6.2000.

Plikshs, M.: Latvian Fisheries Research Institute, Riga, Latavia, 1.1.-14.8.1999.

Rossi-Wongtschowski, C.: Instituto Oceanografico, Universidade de São Paulo, São Paulo, Brazil, 15.7.-5.8.2000.

Sanford, T.: Applied Physics Laboratory, University of Washington, Seattle, USA, 7.6.-10.6.1999.

Sarmiento, J.: AOS Program, Princeton University, Princeton, USA, 20.6.-26.6.1999.

Skarsoulis, E.: FORTH, Heraklion, Greece, 23.6.-15.7.1999.

Smith, C.: Institute of Marine Biology, Heraklion, Crete, Greece, 18.6.-26.6.2000.

Stammer, D.: Scripps Institution of Oceanography, La Jolla, USA, 27.6.-31.8.2001.

Tomkiewicz, J.: Danish Institute for Fisheries Research, Charlottenlund, Denmark, 1.5.2000-31.12.2001.

Visbeck, M.: Lamont Doherty Earth Observatory, Columbia University, USA, 19.8.-28.8.2001.

Würtz, S.: Institut für Gewässerökologie und Binnenfischerei, Berlin, 6.3.-8.3.2001.

Yashayaev, I.: Bedford Institute of Oceanography, Dartmouth, Canada, 12.10.-20.10.2001.

You, Z.Y.: Center for Climate System Research, University of Tokyo, Tokyo, 1.1.-31.3.1999.

Zolina, O.: P.P. Shirshov Institute of Oceanology, Moscow, Russia, 15.2.-20.3.2001.

7.4 IfM staff visiting scientific institutions abroad

Bange, H.: Ocean Research Group, University Newcastle upon Tyne, Department of Marine Science and Coastal Management, Newcastle, UK, 22.5.-3.7.2000.

Biastoch, A.: Department of Oceanography, University of Cape Town, Cape Town, South Africa, 20.1.1999-19.2.2000.

Brandt, P.: Trondheim Marine Systems, Large Scale Facility, Trondheim, Norway, 15.8.–15.9.1999.

Brandt, P.: Laboratoire des Ecoulements Geophysiques et Industrielles (LEGI), Groupe CORIOLIS, Grenoble, France, 5.9.–13.10.2000.

Clemmesen, C.: Department of Fisheries and Ocean, St. Johns, Newfoundland, Canada, 17.8.-29.8.1999.

Clemmesen, C.: Instituto Oceanografico, Universidade de São Paulo, Brazil, 24.11.-9.12.2000.

Diekmann, R.: Rosenstiel School of Marine and Atmospheric Sciences (RSMAS), Miami, USA, 5.9.-21.9.2000.

Gocke, K.: Departamento de Oceanografía, Concepción, Chile, 3.1.-25.1.1999.

Gocke, K.: Departamento de Microbiología, Universidad de Concepción, Concepcion, Chile, 11.11.-8.12.2000.

Käse, R.: Scripps Institution of Oceanography, University of California - San Diego, La Jolla, USA, 20.7.-4.11.2000.

Käse, R.: Institute for Oceanography, University Lisabon, Lisabon, Portugal, 7.6.-15.6.2001.

Käse, R.: Scripps Institution of Oceanography, University of California - San Diego, La Jolla, USA, 15.7.-15.9.2001.

Käse, R.: Applied Physics Laboratory, University of Washington, Seattle, USA, 17.9.-15.10.2001.

Peeken, I.: Scripps Institution of Oceanography, University of California - San Diego, La Jolla, USA, 28.10.1998-30.4.2000.

Ruprecht; E.: P.P. Shirshov Institute of Oceanology, Moscow, Russia, 2.9.-8.9.2000.

Schott, F.: International Pacific Research Institute (IPRC), University of Hawaii, Honolulu, USA, 30.10.-30.11.1999.

Schott, F.: Cooperative Institute for Marine and Atmospheric Studies (CIMAS), University of Miami, Miami, USA, 1.12.1999–29.2.2000.

Schott, F.: International Pacific Research Institute (IPRC), University of Hawaii, USA, 26.12.2000–13.1.2001.

Schott, F.: Cooperative Institute for Marine and Atmospheric Studies (CIMAS), University of Miami, Miami, USA, 23.3.–18.4.2001.

Schott, F.: International Pacific Research Institute (IPRC), University of Hawaii, Honolulu, USA, 14.9.–10.10.2001.

Send, U.: Scripps Institution of Oceanography, University of California - San Diego, La Jolla, USA, 30.11.-5.12.1999.

Send, U.: Scripps Institution of Oceanography, Scripps Institution of Oceanography, University of California - San Diego, La Jolla, USA, 24.7.-31.8.2000.

Sommer, U., Sommer, F., Brepohl, D., Hoppe, H.G., and Gocke, K.: Sletvik Biological Station, University of Trondheim, Norway, 10.7.-4.8.2001.

Willebrand, J.: Department of Marine Science, CSIRO, Hobart, Australia, 19.2.-6.3.2000.

Wilson, R.P.: National Polar Research Institute, Tokyo, Japan, 14.2.-2.5.2000.

7.5 Conferences at IfM / Workshops organized by IfM staff

Böning, C.: Scientific Organisation Committee, WOCE Tracer Workshop, Bremen, 22.2.-26.2.1999.

Böning, C.: Scientific Organisation Committee, WOCE North Atlantic Workshop, Institut für Meereskunde, Kiel, 23.8.-27.8.1999.

Böning, C.: WOCE / CLIVAR WGOMD Workshop, Ocean Model Requirements for Climate Studies, Santa Fe, USA, 5.3.-7.3.2001.

Böning, C., and Schmitt, R.: Symposium on Representation of Ocean Processes in Models, Joint assemblies of IAPSO-IABO, Mar del Plata, Argentina, 23.10.-25.10.2001.

Bower, A., and Zenk, W.: Atlantic Climate Change Experiment (ACCE) RAFOS Workshop. 11 participants from 4 countries, Institut für Meereskunde Kiel, 3.5.-4.5.2001.

Bumke, K.: 3rd annual PEP in BALTEX Workshop, Institut für Meereskunde, Kiel, 11.9.-12.9.2000.

Frentzel-Beyme, B.Z.: European Elasmobranch Association 5th Annual Science Meeting 2001, Institut für Meereskunde, Kiel, 19.10.-21.10.2001.

Herrmann, J., and Waniek, J.: Meeting of the international JGOFS Data Management Task Team, Institut für Meereskunde, Kiel, 5.1.-6.1.2000.

Hinrichsen, H.-H.: STORE Workshop on Identification of Hydrographic Factors influencing Survival Success of Early Life History Stages, Riga, Latvia, 30.3-1.4.2001.

Köster, F.W.: STORE Modelling meeting I, Charlottenlund, Denmark, 1.3.-2.3.2000.

Köster, F.W.: STORE Predator/Prey Interaction Workshop, Charlottenlund, Denmark, 26.2.-1.3.2001.

Köster, F.W.: STORE Modelling Meeting II, Seili, Finland, 10.12.-12.12.2001.

Lochte, K.: Biologische und chemische Sensoren für die Überwachung mariner Prozesse, InWaterTec, Kiel, 31.8.2001.

Lochte, K.: First Workshop of the Paleo-JGOFS Task Team (PJTT), Gif-sur-Yvette, France, 15.-16.11. 2001.

Lochte, K.: JGOFS Synthese Workshop, Kiel, 5.12.-6.12.2001.

Lemke, P.: 20th Session of the Joint Scientific Committee of the World Climate Research Programme, Institut für Meereskunde, Kiel, 15.-20.3.1999.

Lemke, P.: WCRP ACSYS/CliC Scientific Steering Group, Institut für Meereskunde, Kiel, 20.-27.10.2000.

Macke, A.: EGS 1999, Symposium on Energy and Water Cycles on a Regional Scale, Nice, France, 19.4.-23.4.1999.

Macke, A.: EGS 2000, Symposium on Energy and Water Cycles over Larger and Medium Sized Catchments, Nice, France, 25.4.-29.4.2000.

Macke, A.: EGS 2001, Symposium on Clouds in Radiative, Hydrological and Chemical Processes, Nice, France, 25.3.-30.3.2001.

Macke, A.: CLIWA-Net Workshop, Institut für Meereskunde, Kiel, 11.10.-12.10.2001.

Mintrop, L., Wallace, D.W.R., and Wefer, G.: Workshop "CO_2 in the Northern North Atlantic", Hanse Wissenschaftskolleg, Delmenhorst, 9.6.-11.6.1999

Piatkowski, U.: 10. Verleihung des Annette-Barthelt-Preises für Meeresforschung zum Gedenken an die Terroropfer von Djibouti Annette Barthelt, Daniel Reinschmidt, Marco Buchalla und Hans-Wilhelm Halbeisen, Institut für Meereskunde, Kiel, 20.3.1999.

Piatkowski, U.: 11. Verleihung des Annette-Barthelt-Preises für Meeresforschung zum Gedenken an die Terroropfer von Djibouti Annette Barthelt, Daniel Reinschmidt, Marco Buchalla und Hans-Wilhelm Halbeisen, Institut für Meereskunde, Kiel, 18.3.2000.

Piatkowski, U.: 12. Verleihung des Annette-Barthelt-Preises für Meeresforschung zum Gedenken an die Terroropfer von Djibouti Annette Barthelt, Daniel Reinschmidt, Marco Buchalla und Hans-Wilhelm Halbeisen, Institut für Meereskunde, Kiel, 17.3.2001.

Piatkowski, U.: ICES Annual Science Conference. Theme Session on the Response of Cephalopod Populations and Fisheries to Changing Environment and Ecosystems, Oslo, Norway, 28.9.-29.9.2001.

Rosenthal, H.: Asia – EU SimCoast ™ Workshop "Industrial Development", Institut für Meereskunde, Kiel, 14.3.-21.3.1999.

Rosenthal, H.: Scoping Workshop. Cooperation in Marine Science and Technology between Zhejiang Province of China and the State of Schleswig-Holstein, Institut für Meereskunde, Kiel, 26.3.-31.3.2001.

Ruprecht, E., and Gustafsson, N.: BALTEX Workshop: Parameterization of surface fluxes, atmospheric planetary boundary layer and ocean mixed layer turbulence for BRIDGE. Abisko, Sweden, 20.6.-21.6.1999.

Schnack, D.: STORE Co-ordination Meeting, Charlottenlund, Denmark, 24.2.-25.2.1999.

Schnack, D.: STORE Annual Meeting, Stockholm, Sweden, 28.9.1999.

Schnack, D.: STORE Annual Meeting, Brugge, Belgium, 29.9.2000.

Schnack, D.: STORE Annual Meeting, Oslo, Norway, 29.9.2001.

Schnack, D.: ICES Annual Science Conference. Theme Session Spatial and Temporal Patterns in Recruitment Processes, Brugge, Belgium, 29.9.-30.9.2000.

Schnack, D.: Symposium on Fish Stock Assessments and Predictions: Integrating Relevant Knowledge, Bergen, Norway, 4.12.-6.12.2000.

Schott, F.: TIEFBIT-Status-Seminar, Institut für Meereskunde, Kiel, 19.1.1999.

Schott, F.: SFB 460 Planungs-Workshop Salzau, Landeskulturzentrum Salzau, 25.1.–27.1.1999.

Schott, F.: WOCE North Atlantic Workshop, Institut für Meereskunde Kiel, 23.8.-27.8.1999.

Schott, F.: WOCE North West Indian Ocean Workshop, Rosenstiel School of Marine and Atmospheric Science (RSMAS), Miami, USA, 10.5.–11.5.2000.

Schott, F.: CLIVAR/marin Status-Seminar, Institut für Meereskunde, Kiel, 3.7.2000.

Schott, F.: CLIVAR/marin Status-Seminar, Institut für Meereskunde, Kiel, 21.5.-22.5.2001.

Send, U.: Octopus Workshop, Institut für Meereskunde, Kiel, 13.10.-15.10.1999.

Send, U.: ANIMATE Kick off Meeting, Institut für Meereskunde, Kiel, 5.12.-7.12.2001.

Sommer, U.: Aquatic Food Webs, Kulturforum, Plön, 26.3.-28.3.2001.

Tomkiewicz, J.: STORE Workshop on Parental Impact on Reproductive Success of Baltic Cod and Sprat stocks, Institut für Meereskunde, Kiel, 23.5.-24.5.2000.

Wallace, D.W.R.: Co-Chair, Carbon in the North Atlantic Workshop (CARINA), Delmenhorst, 9.6.-11.6.1999.

Wallace, D.W.R., Weidinger, U.: SOLAS Open Science Conference. Damp, 20.2.-24.2.2000.

Wallace, D.W.R.: SOLAS-Deutschland National Meeting, Hannover, 27.2.2001.

Wilson, R.P.: (co-organiser) The 4th International Conference on Penguins, La Serena, Chile, 4.9.-8.9.2000.

7.6 Presentations and Posters

7.6.1 Scientific Presentations

Alexandrov, V.Y., Martin, T., Kolatschek, J.S., Eicken, H., Kreyscher, M., and Makshtas, A.P.: Studies of sea-ice motion in the Laptev Sea with the use of satellite remote sensing and numerical modelling. International Geoscience and Remote Sensing Symposium, IGARSS'99, Hamburg, 1.7.1999.

Antia, A.N., Maaßen, J., and Voß, M.: Linking particle export with surface processes at the continental margin. International Liège Colloqium on Ocean Hydrodynamics, Liège, Belgium, 10.5.2000.

Antia, A.N., Kremling, K., Blanz, T., Koeve, W., Fehner, U., Fischer, G., Kuss, J., Neuer, S., Scholten, J., and Schulz-Bull, D.: Variability in the characteristics of particle flux in the Atlantic Ocean and the implications for estimation of regional and basin-wide export. Biogeochemical Cycles: German contributions to International JGOFS, Bremen, 20.9.2000.

Bange. H.: Non-CO_2 trace gas measurements during JGOFS. Symposium Biogeochemical Cycles: German Contributions to International JGOFS, Bremen, 18.9.2000.

Bange, H.: N_2O and CH_4 emissions from tropical oceanic ecosystems. Max-Planck-Institut für Biogeochemiie, Jena, 26.10.2000.

Bange, H.: Biogenic trace gases. German-Vietnamese Workshop on Marine Sciences & Short Course on Biogeochemistry and Ecology of Tropical Coastal Seas, Nha Trang, Vietnam, 30.9.2000.

Bange, H.: N_2O im Ozean. Max-Planck-Institut für Kernphysik, Heidelberg, 28.11.2001.

Baschek, B., and Send, U.: Flow and transport measurements in the Strait of Gibraltar. TAO (Topics in the Atmosphere and the Ocean) Seminar, Victoria, Canada, 26.3.1999.

Baschek, B., and Send, U.: Analysis of flow and transport measurements in the Strait of Gibraltar. 22nd General Assembly of the International Union of Geodesy and Geophysics (IUGG), Birmingham, UK, 29.7.1999.

Baschek, B., and Send, U.: Analysis of flow and transport measurements in the Strait of Gibraltar. Ocean Sciences Meeting, San Antonio, USA, 24.1.2000.

Beismann, J.-O., Redler, R., Czeschel, L., Völker, C., Dengg, J., and Böning, C.: Hindcasting the uptake of anthropogenic trace gases with an eddy-permitting model of the Atlantic Ocean. Results and Review-Workshop, Höchstleistungsrechenzentrum Stuttgart, Stuttgart, 9.10.2001.

Berninger, U.-G.: Warum Protozoen? Bearbeitung aktueller Forschungsfragen anhand von Einzellern als Modellorganismen. Institut für Meereskunde, Kiel, 17.12.1999.

Berninger, U.-G.: Zur Ökologie freilebender Protisten – Modellorganismen in der Biologie. Universität Rostock, Rostock, 17.6.1999.

Berninger, U.-G.: Zur Ökologie freilebender Protisten. ICBM. Universität Oldenburg, Oldenburg, 1.6.1999.

Berninger, U.-G.: Die Schlüsselrolle von Protisten in aquatischen Nahrungsnetzen. Universität Salzburg, Salzburg, Austria, 12.10.2000.

Berninger, U.-G.: Die Schlüsselrolle von Protisten in aquatischen Nahrungsnetzen. Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven, 8.9.2000.

Berninger, U.-G., and Wickham, S.: Control of picoplankton in the Gulf of Aqaba during the spring bloom. American Society of Limnology and Oceanography, Copenhagen, Denmark, 6.6.2000.

Berninger, U.-G., and Wickham, S.A.: Antwort des mikrobiellen Nahrungsnetzes auf Nährstoff- und Räubermanipulation im ultraoligotrophen Golf von Aqaba und dem nördlichen Roten Meer. Jahrestagung der Deutschen Gesellschaft für Protozoologie, Bonn, 28.2.2001.

Biastoch, A.: Meso-scale to seasonal variability in the Agulhas Current system. Scripps Institution of Oceanography, Physical Oceanography Research, Division Seminar Series, La Jolla, USA, 26.4.2000.

Biastoch, A., Reason, C., Lutjeharms, J., and Boebel O.: The importance of flow in the Mozambique Channel to seasonality in the greater Agulhas Current system. University of Cape Town, Cape Town, South Africa, 25.1.2000.

Biastoch, A., Reason, C., Lutjeharms, J., and Boebel, O.: The importance of flow in the Mozambique Channel to seasonality in the greater Agulhas Current system. Ocean Sciences Meeting, San Antonio, USA, 25.1.2000.

Böning, C.: Modelling the ocean circulation. Conference "*The development of the next generation climate models*", Center for Climate System Research, Tokyo, Japan, 9.3.1999.

Böning, C.: Ocean modelling for climate studies: What are the key issues? Joint Scientific Committee of the World Climate Research Programme, 20th Session, Institut für Meereskunde, Kiel, 17.3.1999.

Böning, C.: Die Ozeane im Modell - Simulation komplexer Stromsysteme. WOCE-Schlusssitzung und Pressekonferenz, Alfred-Wegener-Institut für

Polar- und Meeresforschung, Bremerhaven, 28.4.1999.

Böning, C.: Modelling large-scale ocean circulation: Lessons from sensitivity and intercomparison studies. 22nd General Assembly of the International Union of Geodesy and Geophysics (IUGG), Birmingham, UK, 20.7.1999.

Böning, C.: Ocean model development: Initial activities of WGOMD. 26th Session of the WOCE Scientific Steering Group, Scripps Institution of Oceanography, La Jolla, USA, 5.10.1999.

Böning, C.: World Climate Research Programme: Status and developments of ocean modelling. JSC/CLIVAR Working Group for Coupled Modelling, Max-Planck-Institut für Meteorologie, Hamburg, 21.9.1999.

Böning, C.: Proposed activities to stimulate the development of ocean models for climate research. WOCE/CLIVAR Working Group on Ocean Model Development, Rosenstiel School of Marine and Atmospheric Sciences, Miami, USA, 2.3.2000.

Böning, C.: Equatorial Atlantic: Pathways of interhemispheric transports, seasonal cycle. CLIPPER-FLAME Meeting, IFREMER, Brest, France, 7.6.2000.

Böning, C.: Mechanisms of seasonal variations in the Labrador Sea boundary currents - comparison with local observations at 53°N. CLIPPER-FLAME Meeting, IFREMER, Brest, France, 8.6.2000.

Böning, C.: Simulation of CFC and perturbation CO_2 uptake in the Atlantic: Effects of model resolution and representation of overflows. Carbon Cycle Model Intercomparison Project, 2nd Workshop, Princeton, USA, 6.7.2000.

Böning, C.: Circulation and warm water pathways in the equatorial Atlantic: Model simulations. CLIVAR Workshop on Shallow Tropical - Subtropical Overturning Cells, Venice, Italy, 10.10.2000.

Böning, C.: Activities of the Working Group on Ocean Model Development. 27th Session of the WOCE Scientific Steering Group, Fukuoka, Japan, 11.10.2000.

Böning, C.: Proposed initiatives to stimulate ocean model development for climate studies. WOCE/CLIVAR Working Group on Ocean Model Development, 2nd Session, Santa Fe, USA, 5.3.2001.

Böning, C.: Ocean models: Status, developments and scientific requirements. PRISM/COACH Workshop on Climate Modelling in Europe, Les Diablerets, Switzerland, 26.6.2001.

Böning, C., and Dengg, J.: Effects of overflows on the large-scale circulation in a numerical model of the North Atlantic. Joint Assemblies of IAPSO and IABO, Mar del Plata, Argentina, 21.10.2001.

Böning, C.: Initiatives of the Working Group on Ocean Model Developement. 28th Session of the WOCE Scientific Steering Group, Scripps Institution of Oceanography, La Jolla, USA, 6.12.2001.

Bold, G., Chiu, C.S., Colosi, J., v, B., Dushaw, B., Dzieciuch, M., Forbes, A., Gaillard, F., Gould, J., Howe, B., Lawrence, M., Lynch, J., Menemenlis, D., Mercer, J., Mikhalevski, P., Munk, W., Nakano, I., Schott, F., Send, U., Spindel, R., Terre, T., Worcester, P., and Wunsch, C.: Observing the ocean in the 2000's: a strategy for the role of acoustic tomography in ocean climate observation. OCEANOBS 99 - The Ocean Observing System for Climate, Saint-Raphael, France, 18.10.-22.10.1999.

Bollmann, J., Barth, H., Knoll, M., Lenz, B., Llinas, O., Müller, T., Reuter, R., and Zielinski, O.: Distribution of living Coccolithophores along a zonal transect (29°N) North of the Canary Islands: Vertical, seasonal and interannual variations. CANIGO Conference, Las Palmas, Spain, 15.9.1999.

Brandt, P., Fischer, J., Stramma, L., Dengler, M., Hamann, M., and Schott, F.: Surface currents in the tropical Atlantic from *in situ* measurements and altimetry. European Geophysical Society, 26th General Assembly, Nice, France, 27.3.2001.

Brandt, P., Schott F., Stramma L., Fischer J., Hamann, M.: Western-boundary warmwater circulation in the tropical South Atlantic: pathways and variability. Joint Assemblies of IAPSO and IABO, Mar del Plata, Argentina, 25.10.2001.

Bremen, L. von, Ruprecht, E., and Macke, A.: Modelling the beamfilling errors in passive microwave remote sensing for broken clouds. European Geophysical Society, 24th General Assembly, Den Hague, The Netherlands, 22.4.1999.

Bremen, L. von, Ruprecht, E., and Macke, A.: Modelling study of beamfilling effects in passive microwave remote sensing. IEEE 1999 International Geoscience and Remote Sensing Symposium (IGARSS'99), Hamburg, 28.6.1999.

Bremen, L. von, Ruprecht, E., and Macke, A.: The beamfilling problem in passive microwave LWP-retrieval. European Geophysical Society, 26th General Assembly, Nice, France, 26.3.2001.

Bröckel, K. von, and Sellmer, C.: SW-Monsoon in the western Arabian Sea: Phytoplankton dynamics. JGOFS International Scientific Symposium. Biogeochemistry of the Arabian Sea: Synthesis and Modelling, Bangalore, India, 19.1.1999.

Bröckel, K. von: The importance of phytoplankton studies for understanding the carbon cycle in the Arabian Sea. Cukurova Üniversitesi, Faculty of Fisheries Biology, Adana, Turkey, 17.5.2001.

Bröckel, K. von: Phytoplankton ecology and the carbon cycle during the SW-Monsoon in the Arabian Sea. Ege Üniversitesi, Faculty of Fisheries Biology, Izmir, Turkey, 22.5.2001.

Bühler, V., Clemmesen, D., Svendsen, E.: Growth of Atlantic herring in response to climatic long term trends (NAO) and to hydrographical features in the northern North Sea in the period 1990-1997. ICES Annual Science Conference, Stockholm, Sweden, 24.9.1999.

Bühler,V., Clemmesen, C., and Moksness, E.: Effect of temporal variations in feeding conditions on growth and survival of cod larvae (*Gadus morhua*). American Fisheries Society, Larval Fish Conference, Sandy Hook, New Jersey, USA, 10.8.2001.

Bumke, K., Clemens, M., and Hasse, L.: Precipitation and turbulence measurements over the Baltic Sea. PEP-Meeting, Hamburg, 22.3.1999.

Bumke, K.: Air-sea interaction over the Baltic Sea. PEP-Meeting, Uppsala, Sweden, 4.10.1999.

Bumke, K.: Comparison of turbulent heat flux measured onboard RV Heincke to landborn measurements. PEP-Meeting, Roskilde, Denmark, 10.4.2000.

Bumke, K.: Turbulent fluxes of sensible and latent heat derived by applying the inertial description method. PEP-Meeting, Kiel, 11.9.2000.

Bumke, K., and Clemens, M.: Precipitation measurements over sea. WCRP/SCOR Workshop on Intercomparison and Validation of Ocean-Atmosphere Flux Fields, Washington DC, USA, 24.5.2001.

Clemens, M.: Precipitation measurements on ferries. PEP-Meeting, Uppsala, Sweden, 4.10.1999.

Clemens, M.: Precipitation over the Baltic Sea. PEP-Meeting, Roskilde, Denmark, 11.4.2000.

Clemens, M.: Validation of precipitation measurements against synoptic observation and numerical methods. PEP-Meeting, Kiel, 12.9.2000.

Clemens, M. und Bumke, K.: Precipitation fields over the Baltic Sea derived from ship rain gauge measurements on merchant ships. 3rd Study Conference on BALTEX, Mariehamn, Finland, 6.7.2001.

Clemmesen, C.: Newest results on recruitment studies at the IfM Kiel. ICES Working Group on Recruitment Processes, Bergen, Norway, 7.4.2000.

Clemmesen, C.: What happened to the likely larvae? American Fisheries Society, Larval Fish Conference, Sandy Hook, New Jersey, USA, 9.8.2001.

Clemmesen, C.: Measurements of larval condition and growth of cod larvae in large mesocosms- individual variability as a function of environmental condition or genetics. ICES Annual Science Conference, Oslo, Norway, 26.9.2001.

Culik, B.M.: Pinguine: Tauchphysiologische Anpassungen und Verhalten auf See. Fachbereich Biologie, Gesamthochschule Essen, Essen, 15.6.1999.

Culik, B.M.: Migratory behaviour as revealed by telemetry in penguins. 20th Anniversary of the Bonn Convention on Migratory Species, Bonn, 24.6.1999.

Culik, B.M.: Investigation of the behaviour and physiology of animals at sea via telemetry. Sealife Center, Seward, USA, 19.7.1999.

Culik, B.M.: Telemetric techniques to investigate the behaviour and physiology of animals at sea. University of Fairbanks, USA, 21.7.1999.

Culik, B.M.: Body size and method of propulsion: effects on diving energetics in semi-aquatic and aquatic homeotherms. 26th International Ethological Conference, Bangalore, Indien, 5.8.1999.

Culik, B.M.: Energetik und Tauchphysiologie bei Pinguinen. Institut für Zoologie und Anthropologie, Universität Göttingen, Göttingen, 20.10.1999.

Culik, B.M., and Koschinski, S.: Harbour porpoises and pingers: Field investigations in Clayoquot Sound, Vancouver, Canada. Fjord and Baelt Center, Kerteminde, Denmark, 10.3.2000.

Culik, B.M.: Energy requirements for submerged feet/wing/flipper driven swimming in birds and mammals. Experimental Biology 2000 – Milestones and Goals, Cambridge, UK, 1.8.2000.

Culik, B.M., Hennicke, J., and Martin, T.: Humboldt penguins outmanoeuvering El Niño. 4th International Penguin Conference, Coquimbo, Chile, 5.9.2000.

Culik, B.M., and Luna-Jorquera, G.: Metabolic rate of swimming Humboldt penguins. 4th International Penguin Conference, Coquimbo, Chile, 8.9.2000.

Culik, B.M., Koschinski, S., Tregenza, N., and Ellis, G. M.: Harbour porpoises and pingers: prospect and prejudice. 30. Jahrestagung der Gesellschaft für Ökologie, Kiel, 15.9.2000.

Culik, B.M.: Energie- und Sauerstoffbedarf unter Wasser schwimmender Vögel und Säuger: Ein Vergleich der verschiedenen Antriebsarten. Zoologisches Institut der Universität Wien, Wien, Austria, 13.10.2000.

Culik, B.M., Hagemann, S., Hennicke, J., and Martin, T.: Phytoplankton and DMS: ringing the dinner- bell for Humboldt penguins in the open sea. Workshop: Aquatic Food Webs, Kulturforum, Plön, 27.3.2001.

Culik, B.M.: Small Cetaceans: Distribution, behaviour, migration and threats: a review. CMS Scientific Council. Edinburgh, UK, 4.5.2001.

Culik, B.M.: Finding food in the open ocean: Foraging strategies in penguins. Symposium: Leben und Überleben im Meer. 94. Jahrestagung der Deutschen Zoologischen Gesellschaft, Osnabrück, 7.6.2001.

Culik, B.M.: Einsatz telemetrischer Methoden bei Verhaltensökologischen Untersuchungen aquatischer Warmblüter. Österreichische Akademie der Wissenschaften, Wien, Austria, 28.9.2001.

Culik, B.M.: Reactions of harbour porpoises and herring to pingers. Workshop "*Using pingers to reduce marine mammal bycatch in commercial fisheries*". 14th Biennial Conference on the Biology of Marine Mammals, Vancouver, Canada. 28.11.2001.

Dengg, J.: Numerische Modellierung der Zirkulation des Atlantischen Ozeans. Power-User und Supercomputer Workshop, Konrad-Zuse-Zentrum für Informationstechnik, Berlin, 19.5.1999.

Dengg, J.: Aspects of deep water formation in the subpolar North Atlantic: Role of overflow and convection, and model dependencies (resolution, BBL, mixing parameterizations). CLIPPER-FLAME Meeting, IFREMER, Brest, France, 7.6.2000.

Dengg, J.: Overview of FLAME experiments (4/3°, 1/3°, 1/12° models, series of sensitivity experiments). CLIPPER-FLAME Meeting, IFREMER, Brest, France, 7.6.2000.

Dengg, J., and Böning, C.: Effects of Denmark straits overflow on the large-scale circulation in a numerical model of the North Atlantic. DOME Workshop, Rosenstiel School of Marine and Atmospheric Science, Miami, USA, 23.2.2001.

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Sommer, U.: Grazing and nutrient control of phytoplankton in the Gulf of Aqaba and the Northern Red Sea. Zentrum für Marine Tropenökologie, Universität Bremen, Bremen, 1.12.1999.

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Sommer, U., Stibor, H., Katechakis, A., Sommer, F., and Hansen, T.: Pelagic food web configurations at different levels of nutrient richness and their implications for the ratio fish production: Primary production. MARICULT-Conference, Trondheim, Norway, 27.6.2000.

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Sommer, U.: Comparing marine and limnetic pelagic food webs: The role of the herbivorous mesozooplankton guild. Food Web Conference, Kyoto, Japan, 8.12.2000.

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Storch, S.: Tauchaktivitäten der Karettschildkröte *Eretmochelys imbricata* im Karibischen Meer. Meeresbotanisch-Meereszoologisches Seminar, Institut für Meereskunde, Kiel, 2.11.1999.

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Atlantiks. Statusseminar: Meeresforschung mit FS "Sonne", Hannover, 14.3.2001.

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Theede, H.: Quality of life in cultured landscapes: Adaptations of marine animals to hydrogen sulphide. 9th Annual Meeting of the Society of Environmental Toxicology and Chemistry (SETAC) – Europe, Leipzig, 25.5.1999.

Timm, O.: Rekonstruktionsmöglichkeiten des Nordatlantischen Oszillationsindexes anhand von Proxydaten. DACH Meteorologentagung, Wien, Austria, 20.9.2001.

Tuominen, L., Carman, R., Edlund, G., Drews, M., Imhoff, J.F., Mäkelä, K., and Kuparinen, J.: Sediment processes – oxygen consumption and nutrient fluxes through the water-sediment interface. 3rd BASYS Annual Science Conference, Warnemünde, 21.9.1999.

Ubl, S.: Variabilität von Zykloneneigenschaften über dem Nordatlantik. DACH Meteorologentagung, Wien, Austria, 20.9.2001.

Voss, R.: Sources of uncertainty in ichthyoplankton surveys: modelling advective losses. ICES Young Scientists Conference on Marine Ecosystem Perspectives, Gilleleje, Denmark, 21.11.1999.

Wallace, D.W.R.: Presentation on SOLAS planning to the Joint Scientific Committee of the World Climate Research Programme, Kiel, 18.3.1999.

Wallace, D.W.R.: Storage and transport of carbon in the oceans: Research needs. Senatskommission für Ozeanographie, Deutsche Forschungsgemeinschaft, Bremen, 28.9. 1999.

Wallace, D.W.R.: Anthropogenic CO_2 and the oceans. German Chemical Society Meeting, Bremen, 25.10.1999.

Wallace, D.W.R.: Storage and transport of excess CO_2 in the ocean. Woods Hole Oceanographic Institution, Woods Hole, USA, 12.5.2000.

Wallace, D.W.R.: SOLAS – a new international science programme. Institut für Ostseeforschung, Warnemünde, 12.7.2000.

Wallace, D.W.R.: Carbon transport in the Atlantic Ocean. Joint USA-European Workshop on Ocean Carbon Cycle Science, Paris, France, 7.9.2000.

Wallace, D.W.R.: Reconciling observations and models of Excess CO_2 Uptake. German JGOFS Conference, Bremen, 19.9.2000.

Wallace, D.W.R.: JGOFS – Achievements. IGBP-Deutschland Synthesis Workshop, Potsdam, 30.10.2000.

Wallace, D.W.R.: SOLAS: planning and building a new international research programme. Universität Hamburg, Hamburg, 30.11.2000.

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Wallace, D.W.R.: Ocean biogeochemistry and global change. Gesellschaft Deutscher Chemiker, Hannover, 14.6.2001.

Wallace, D.W.R.: The role of ocean transport in the global carbon cycle. WOCE/JGOFS Workshop, Southampton, UK, 27.6.2001.

Wallace, D.W.R.: An ocean carbon observing system. Swedish Society for Marine Sciences Annual Meeting, Göteborg, Sweden, 3.10.2001.

Wallace, D.W.R.: Austausch von Stoffen über die Grenzfläche Ozean-Atmosphäre, Deutsche Gesellschaft für Meeresforschung, Hamburg, 12.10.2001.

Wallace, D.W.R.: Kohlenstoffkreislauf und Klimaentwicklung, Mittelstandsakademie, Rostock, 13.11.2001.

Waller, U.: The use of ozone in sea water. University of Bergen, Bergen, Norway, 10.2.2000.

Waller, U.: Mitigation of nutrient inputs into natural water bodies from land-based aquaculture systems. German-Canadian Cooperation, University of New Brunswick, Saint John, Canada, 16.10.2000.

Waller, U.: Low energy and low water consumption recirculation system for marine fish: first results from a test run with *Dicentrarchus labrax* in an improved recirculation system and suggestions on an integration into secondary production lines. European Aquaculture Society, Trondheim, Norway, 5.8.2001.

Waller, U.: Stand und Chancen der Aquakultur. Bundesverband der deutschen Fischindustrie, Frankfurt, 5.7.2001.

Waller, U.: Ein verbessertes Verfahren für die marine Kreislauftechnik. Handelskammer Hamburg, Hamburg, 27.11.2001.

Wengert, M., and Berninger, U.-G.: Trophic interactions between scyphopolyps and ciliates. Workshop: Aquatic Food Webs, Kulturforum, Plön, 28.3.2001.

Wickham, S.A., Nagel, S., Berninger, U.-G., and Hilleband, H.: Top-down and bottom-up control of epibenthic ciliate communities. North American Benthological Society, La Crosse, USA, 5.6.2001.

Willebrand, J.: Modelling the ocean circulation. Max-Planck-Institut für Meteorologie, Hamburg, 31.3.2000.

Willebrand, J.: Modelling the thermohaline circulation. NOAA-Commission on Abrupt Climate Change, Zermatt, Switzerland, 23.9.2000.

Wilson, R.P.: Beyond rings on birds for the determination of movements: Whither the archival tag? International conference on 100 years of bird ringing, Helgoland, 2.10.1999.

Wilson, R.P.: Global Location Sensing (GLS) y tecnologías alternativas: sus applicaciones en el estudio de la distribución pelágica de pingüinos y otras aves marinas. Workshop on the distribution of the Humboldt Penguin during the non reproductive period, Valparaiso, Chile, 12.1.2000.

Wilson, R.P.: Remote techniques for studying remote animals. Institute for Polar Research, Tokyo, Japan, 28.2.2000.

Wilson, R.P.: Competition and co-existence in Pygoscelis penguins. Institute for Polar Research, Tokyo, Japan, 10.3.2000.

Wilson, R.P.: Theoretical and practical aspects of competition in Polar penguins. Lake Biwa Museum, Kusatsu, Japan, 27.4.2000.

Wilson, R.P., and Steinfurth, A.: Cycling down and free-wheeling up: Buoyancy changes in diving Magellanic Penguins. 4th International Penguin Conference, La Serena, Chile, 7.9.2000.

Wilson, R.P.: Movement patterns of Adelie Penguins foraging from Ardley Island, Antarctica: Circles within spirals, wheels within wheels. 13th Symposium on Antarctic Biology, National Institute for Polar Research, Tokyo, Japan. 7.12.2000.

Wilson, R.P.: Competition in Pygoscelid penguins: MacArthur's warblers revisited. Workshop: Aquatic Food Webs, Kulturforum, Plön, 27.3.2001.

Worm B., Lotze, H.K, and Sommer, U.: Herbivorie und Dormanzstadien annueller Algen als gegenläufige Puffermechanismen in eutrophen Küstenökosystemen. Symposium: Ökologische Puffermechanismen, Bad Homburg, 26.11.1999.

Worm, B., Lotze, H.K., and Sommer, U.: Species diversity and ecosystem function in the coastal zone controlled by nutrient loading and consumer pressure. Symposium: Marine Ecosystem perspectives. ICES, Copenhagen, Denmark, 17.11.1999.

Worm B., and Lotze, H.K.: Nutrient pollution, low-trophic harvesting and cumulative human impacts on coastal ecosystems. Workshop: Gulf of Maine Rockweed - Management in the face of scientific uncertainty, Huntsman Marine Science Center, St. Andrews, New Brunswick, Canada, 5.12.1999.

Worm, B.: Marine food webs: experimental model systems and the great unknowns. Workshop: Aquatic Food Webs, Kulturforum, Plön, 27.3.2001.

Zenk, W., Richardson, P., and Bower, A.: A summary of meddies tracked with floats in the eastern North Atlantic. 31st International Liège Colloquium on ocean hydrodynamics, Liège, Belgium, 5.5.1999.

Zenk, W.: The RAFOS float park: from a simple idea to first results. Woods Hole Oceanographic Institution, Woods Hole, USA, 17.5.1999.

Zenk, W.: Direct observations of the Iceland Basin cyclone at mid depths. Annual Science Conference of ICES, Brugge, Belgium 23.9.-25.9.2000.

Zenk, W.: Introductory remarks on AAIW theme. WOCE: DBE Meeting, Woods Hole, USA, 15.11.1999.

Zenk, W.: New observations of circulation components in the deeper Iceland Basin. Seminar, Graduate School of Oceanography, University of Rhode Island, Narragansett, USA, 19.11.1999.

Zenk, W., Becker, S., and Müller, T.J.: Spreading of Labrador Water in the Iceland Basin from a Lagrangian perspective. European Geophysical Society, 25th General Assembly, Nice, France, 25.4.2000.

Zenk, W.: Zur Tiefenzirkulation im Islandbecken. Kolloquiumsvortrag. Institut für Meereskunde, Universität Hamburg, Hamburg, 29.5.2001.

Zenk, W., Müller, T.J., and Jungclaus, J.: Mixing events in the Vema Channel, a gateway for Antarctic Bottom Water in the South Atlantic. Joint IAPSO/IABO Assembly 2001: An Ocean Odyssey, Mar del Plata, Argentina, 24.10.2001.

Zöllner, E., Jürgens, K., and Hoppe, H.-G.: Structuring effects of different metazooplankton communities fon the microbial food web: First results of a mesocosm experiment. Workshop Aquatic Food Webs. Plön, 28.3.2001.

7.6.2 Colloquium Seminars at IfM

1999

Gustafsson, Dr. Ö., Institute of Applied Environmental Research University of Stockholm, Sweden: "Physico-chemical phase distribution of hydrophobic chemicals in the ocean: Implications for fate and transport", 8.2.1999.

Peters, Priv.-Doz. Dr. A., Institut für Meereskunde, Kiel: "Molekularsystematische Forschung an Meereslagen" –Antrittsvorlesung–, 15.1.1999.

Bjørge, Dr. A., Norwegian Institute for Nature Research Oslo, Norway: "Habitat use of harbour seals in a complex coastal archipelago: Spatial distribution of activity and energy uptake", 18.1.1999.

Schiel, Priv.-Doz. Dr. S., Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven: "Saisonalität und Lebensstrategien antarktischer Copepoden" –Antrittsvorlesung–, 22.1.1999.

Wallace, Prof. Dr. D., Institut für Meereskunde, Kiel: "Perspectives of Marine Chemistry Research at the Institut für Meereskunde" -Antrittsvorlesung–, 29.1.1999.

Flügel, Prof. Dr. H., Institut für Meereskunde, Kiel: "Symbiosen im Meer", 12.2.1999.

LaRoche, Dr. J.A., Institut für Meereskunde, Kiel: "Iron limitation of natural phytoplankton populations in the ocean", 30.4.1999.

Antia, Dr. A., Institut für Meereskunde, Kiel: "Beckenweite Abschätzungen des Kohlenstoffflusses im Atlantik", 7.5.1999.

Böning, Prof. Dr. C., Institut für Meereskunde, Kiel: "Modellierung der thermohalinen Zirkulation" –Antrittsvorlesung–, 21.5.1999.

Bange, Dr. H., Max-Planck-Institut für Chemie, Mainz: "N_2O-Kreislauf im Ozean", 28.5.1999.

Claussen, Prof. Dr. M., Potsdam-Institut für Klimafolgeforschung, Potsdam: "Biogeophysikalische Rückkopplungen im Klimasystem", 4.6.1999.

Conley, Dr. D., National Environmental Research Institute, Roskilde, Denmark: "Declines in Si supply to the coastal ocean", 11.6.1999.

Babenzien, Dr. D., Institut für Süßwasserökologie, Abteilung Limnologie, Neuglobsow: "Unterschiedliche Relevanz der Sulfatreduktion in Boddengewässern und Bergbaurestseen", 18.6.1999.

Sarmiento, Prof. Dr. J., Atmospheric and Ocean Sciences Programme, Princeton University, Princeton, USA: "The scientific issues underlying attempts to limit future atmospheric CO_2 growth", 25.6.1999.

Send, Prof. Dr. U., Institut für Meereskunde, Kiel: "Neue Untersuchungen und Erkenntnisse zur Ozeanographie des Mittelmeeres" –Antrittsvorlesung–, 2.7.1999.

Schulz-Bull, Priv.-Doz. Dr. D., Institut für Meereskunde, Kiel: "Biogeochemie von organischen Spurenstoffen im Atlantischen Ozean" –Antrittsvorlesung–, 9.7.1999.

Gerdts, Dr. G., Biologische Anstalt Helgoland, Helgoland: "Bakterien und toxische Algenblüten", 16.7.1999.

Theede, Prof. Dr. H., Institut für Meereskunde, Kiel: "Anpassungen von Meerestieren an Schwefelwasserstoff" –Abschiedsvorlesung–, 29.10.1999.

Abele, Priv.-Doz. Dr. D., Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven: "Wenn Sauerstoff zum Stressfaktor wird: UV-induzierte O_2-Radikalbildung im Wattenmeer und ihre Wirkung auf Benthos-Tiere", 29.10.1999.

Schneppenheim, Prof. Dr. R., Universitätskrankenhaus Eppendorf, Kinderklinik, Hamburg: "Molekulargenetik der Frostschutz-Glykoproteine antarktischer Fische", 29.10.1999.

Neuhoff, Reg.-Dir. Dr. H.-G., Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, Bonn: "Von der Meereszoologie in die Verwaltung", 29.10.1999.

Boje, Dr. R., Institut für Meereskunde, Kiel: "Eutrophierung und Blaualgen", 5.11.1999.

Rick, Dr. J.-J., Institut für Meereskunde, Kiel: "Silikat-Kupfer Interaktion bei marinen Diatomeen", 12.11.1999.

Garthe, Dr. S., Institut für Meereskunde, Kiel: "Ernährungsstrategien von Seevögeln im Nord-Atlantik: Fronten, Fische, Fischerei", 19.11.1999.

Lochte, Prof. Dr. K., Institut für Ostseeforschung, Warnemünde: "Bildung, Sedimentation und Abbau von Partikeln als Transportmechanismen im marinen Stickstoffkreislauf", 29.11.1999.

Passow, Dr. U., Marine Science Institute, University of California, Santa Barbara, USA: "Vom gelösten Material zum Meeresschnee. Gelpartikel wandeln unser Verständnis der Dynamik von Partikeln und Organismen im Meer", 29.11.1999.

Herndl, Prof. Dr. G., Netherlands Institute for Sea Research (NIOZ), Department of Biological Oceanography, Texel, The Netherlands: "Der Sonnenbrand des Bakterioplankton: eine komplexe Interaktion zwischen gelöstem organischen Material und Bakterioplankton", 29.11.1999.

Riebesell, Dr. U., Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven: "Globaler Wandel - (wie) reagiert die marine Biosphäre?", 29.11.1999.

Bathmann, Priv.-Doz. Dr. U., Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven: "Einfluss pelagischer Ökosysteme im südlichen Ozean auf biogeochemische Kreisläufe", 29.11.1999.

Reusch, Dr. T., Max-Planck-Institut für Limnologie, Plön: "Die Anwendung von Mikrosatelliten-Markern in der Populationsbiologie: Auskreuzungsraten, Genfluss und Kolonisierungsprozesse beim Großen Seegras", 3.12.1999.

Simon, Prof. Dr. M., Institut für Chemie und Biologie des Meeres, Carl von Ossietzky-Universität, Oldenburg: "Biogeochemische Stoffumsatzprozesse im marinen Pelagial - die Bedeutung und Funktion des heterotrophen Bakterioplanktons", 6.12.1999.

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Wanninkhof, Dr. R., NOAA, Atlantic Oceanographic and Meteorological Laboratory, Miami, USA: "Improving the estimates of global air-sea fluxes of CO_2", 22.6.2001.

Pauly, Prof. Dr. D., Fisheries Centre, University of British Columbia, Vancouver, Canada: "Recent developments in ecosystem modelling", 29.6.2001.

Riebesell, Dr. U., Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven: "Eisendüngung im Südpolarmeer – Maßnahme zur CO_2-Reduktion?", 2.7.2001.

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Tett, Dr. S., UK Meteorological Office, Hadley Centre, Bracknell, UK: "Recent Temperature Changes: human or naturally caused?", 11.7.2001.

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Marotzke, Prof. Dr. J., Southampton Oceanography Centre, Southampton, UK: "Abrupt climate change and thermohaline circulation – mechanisms and predictability", 13.7.2001.

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von Bröckel, Dr. K., Institut für Meereskunde, Kiel: "Das neue deutsche Eisrandforschungsschiff", 19.10.2001.

Uher, Dr. G., Biogeochemical Oceanography, University of Newcastle upon Tyne, UK: "Photochemische Prozesse im Ozean und der Klimawandel", 2.11.2001.

Trippel, Dr. E., The Saint Andrews Biological Station, St. Andrews, New Brunswick, Canada: "Atlantic Cod: Stock declines and reproductive problems in Canadian waters", 9.11.2001.

Pepin, Dr. P., Northwest Atlantic Fisheries Centre, Department of Fisheries and Oceans, St. John's, Canada: "The study of larval fish dispersal – A multidisciplinary approach for better understanding of fish stock dynamics", 21.11.2001.

Kallenrode, Prof. Dr. M.-B., Universität Osnabrück, Fachbereich Physik, Osnabrück: "Energiereiche Teilchen und das Klima", 23.11.2001.

Nojiri, Dr. Y., National Institute for Environmental Studies, Tsukuba, Japan: "Ship-of-opportunity monitoring programs of NIES in the Pacific – atmospheric CO_2 measurements since 1992 and oceanic pCO_2 measurement since 1995", 30.11.2001.

Gruber, Prof. Dr. N., Institute of Geophysics and Planetary Physics, University of California, Los Angeles, USA: "Der Einfluss der NAO auf die interannuelle Variabilität des Kohlenstoffkreislaufs im Nordatlantik", 7.12.2001.

Philander, Prof. Dr. G., Department of Geosciences, Princeton University, Princeton, New Jersey, USA: "The 41K cycle – Is ice incidental to the ice ages?", 14.12.2001.

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Alexander, B., and Imhoff, J.F.: Diversity of green sulfur bacteria in natural environments. 4th Workshop on Green and Heliobacteria, Girona, Spain, 28.8.-31.8.1999.

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Antia, A.N., and Kremling, K.: Regional and basin-wide particle flux in the Atlantic. Ocean Biogeochemistry: a new paradigm. JGOFS Open Science Conference, Bergen, Norway, 13.4.-17.4.2000.

Antia, A.N., and Peinert, R.: Fluxes of particles at the continental margin at the Celtic Sea and Iberian Margin. International Liège Colloqium on Ocean Hydrodynamics, Liège, Belgium, 8.5.-12.5.2000.

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Bange, H.W.: Possible feedback mechanisms mediated by nitrous oxide in the ocean-atmosphere system. SOLAS Open Science Conference, Damp, 12.2-20.2.2000.

Bange, H.W., and Andreae, M.O.: Modeling the seasonal variability of dissolved nitrous oxide and methane in the Arabian Sea mixed layer. JGOFS Open Science Conference, Bergen, Norway, 13.4.-17.4.2000.

Beismann, J.-O., and Barnier, B.: Decadal variations of the Atlantic Ocean thermohaline circulation in an OGCM, Poster. European Geophysical Society, 24th Assembly, The Hague, The Netherlands, 19.4.-23.4.1999.

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Biemann, M.D., and Piatkowski, U.: Investigation on the winter population of *Loligo forbesi* (Cephalopoda: Loliginidae) from the North Sea. Cephalopod Biomass and Production Symposium, Aberdeen, UK, 3.7.-7.7.2000.

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Zumholz, K., and Piatkowski, U.: Beak length analysis of *Loligo forbesi*, *Todaropsis eblanae* and *Todarodes sagittatus* from the northern North Sea. Cephalopod Biomass and Production Symposium, Aberdeen, UK, 3.7.-7.7.2000.

7.7 Honors

Bange, H.: "Mare" Award for Marine Research 1999, 13.1.2000.

Hillebrand, H.: Faculty Award 2000 of the CAU Kiel.

Lotze, H.: Research Award "Aktion Seeklar" 1999.

Theede, H.: SETAC Environmental Education Award 1999, Society of Environmental Toxicology and Chemistry (SETAC), 1999.

Theede, H.: Medal of the University of Gdansk (Danzig), 1999.

Waller, U.: Technology Award 2001 of the K.E.R.N. region, 30.8.2001.

Willebrand, J.: Fritjof-Nansen-Medal of the European Geophysical Society, 25.3.2001.

Worm, B.: Research Award "Aktion Seeklar" 2000.

Worm, B.: Faculty Award 2001 of the CAU Kiel.

Worm, B.: Academy Award 2001 of the "Berlin-Brandenburgischen Akademie der Wissenschaften", founded by the "Gottlieb Daimler and Karl Benz Foundation".

7.8 Patents

Waller, U.: Aufzuchtsvorrichtung für marine Organismen und Verfahren zur Steuerung einer solchen Vorrichtung, Verfahrenspatent, Fraunhofer Gesellschaft. Deutsches Patent- und Markenamt 199 61 142.4, 17. 1999 – Status: Registered.

8. Central Services and Facilities

8.1 Information centre

8.1.1 Library

In 2000 the Library merged with the Computer Centre to form the new IfM Information Centre.

The IfM library stocks consists of scientific literature in the field of all disciplines of marine sciences, meteorology and all related subjects. Within the years 1999 to 2001 the number of media items increased to 77,000. At the moment the library has subscriptions for 795 journals.

Within the last 3 years the library ordered approx. 600 copies and interlibrary loans respectively. Conversely, approx. 500 calls for help from other libraries were able to be answered.

Much effort was invested to improve the standard of service to users by networking. Cooperation with other marine science libraries was expanded on a national and international level. Due to this effort articles can be acquired within an extremely short period of time. Please note that approx. 90% of the requested literature can be obtained without any payment on the part of the user.

Within the years under review the members of the "Arbeitsgemeinschaft meereskundlicher Bibliotheken" met semi-annually. The head of the library also represents the IfM Library at the "Arbeitsgemeinschaft der Spezialbibliotheken", the "European Association of Aquatic Libraries and Information Centres (EURASLIC)" and the "International Association of Aquatic and Marine Science Libraries and Information Centers (IAMSLIC)".

The library's web pages were continously updated, providing the library address, opening hours, staff, borrowing information and the library catalogue - as well as links to other marine science libraries, interesting web sites,

booksellers and publishers. Particularly important are the data bases ASFA and FishBase, which can be searched through the homepage of the library.

The library offers two X-Terminals for users who have no Internet connection of their own.

In autumn 2001 the library computer system was updated from BIS-LOK to Alephino. This update offers a new and further-developed OPAC (Online Public Access Catalogue) – which can be found at the following url:

http://biblios.ifm.uni-kiel.de.

8.1.2 Computer centre

Tasks

At IfM Kiel information technology is used in all scientific, technical and administrative areas. The institute relies on an adequate and basic infrastructure in information technology and on a continuous adaptation to modern developments in this area. The core of this infrastructure comprises an efficient communication and data network with international connection, a broad variety of computing resources, service and application software, a comprehensive, time- and location-independent information and data service, and a qualified staff.

It is the obligation of the computer centre at IfM to maintain this infrastructure. The computer centre is a central facility and supports the scientific staff in using information technology. It takes care of the following tasks:

- Planning, selection and purchase of central IT-technology as it is requested in a scientific surrounding.
- Maintenance and operation of the active components of the IT-infrastructure with as few interruptions as possible (e.g. network, central and non-central computer systems, E-mail-server, fileserver, computeserver, data backup, migration and archiving, etc.).
- Maintenance of standard application software (for scientific data analysis and visualization or other tools, administration of licenses, etc.).
- Support of information management (data formats, data banks, internet, public relations, web sites, system management of the library computers, etc.).
- Help and support in information technology for students and employees.
- Support in accessing non-local supercomputer facilities (University and outside), coordination of the user requests and maintenance of the connections to the supercomputers.
- Maintenance of the network on board the IfM owned research vessels and their connections to the intranet at the IfM pier.

This variety of tasks cannot be fulfilled by only the personnel of the computer centre at IfM. Therefore, in the last years, a close cooperation has been established with the computer centre at the University of Kiel to outsource parts of the above duties to their IT-team.

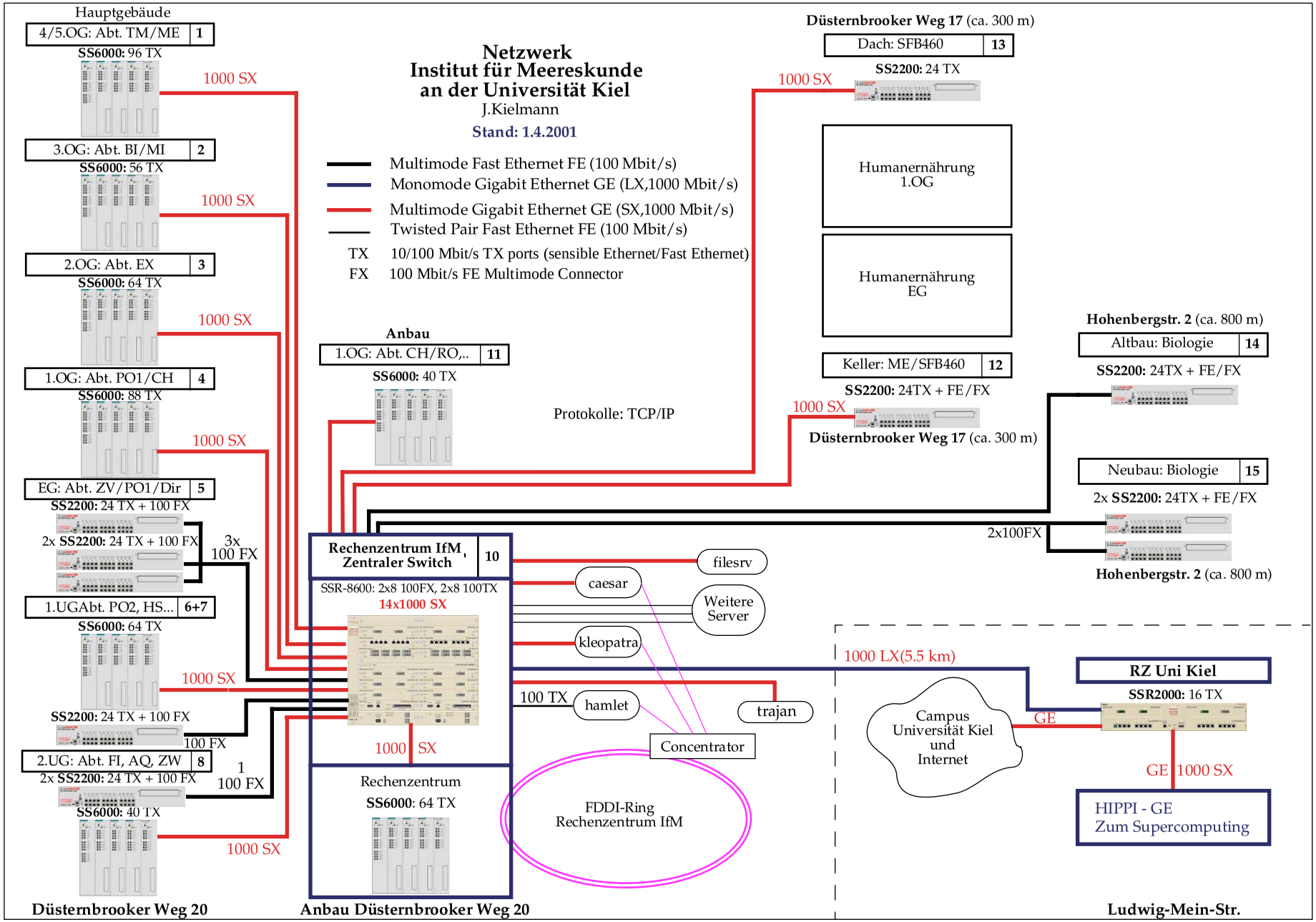
Developments 1999-2001

Some statistical numbers:

There are about 500 registered users of the IfM computer centre. About 4000 E-mails pass the IfM Mailserver per working day. About 400 PCs, 45 X-terminals, 40 Unix workstations and 10 servers, most of them Compaq Alpha machines, and 30 printers are connected over the high bandwidth network. The traffic is guided by about 40 active switch components, which connect the different computers with the collapsed backbone router at the IfM computer centre.

The network

Because of the strong communication demands in the local area network during the last years, it became necessary to completely restore the computer network by a new high bandwidth net. First a new structured cabeling was installed in 3 buildings belonging to IfM (ca. 800 copper sockets in the offices, fiber technique between the buildings and between the floors and the computer centre). On this passive infrastructure the network was built using high performance switches and a high-end router as collapsed backbone. The gross structure of the network can be seen from Fig. 1 (page 141). All connections from buildings, floors and from some of the servers end at the central router in the computer centre, which establishes the heart of the network with a theoretical throughput of 32 Gigabit/s. The bandwidth on the backbone net and on the lines to the main servers is 1 Gigabit/s, the maximum bandwidth to the user's PCs and workstations is 100 Megabit/s. The network is capable to take multicast traffic so that point-to-point video conference connections can be established over the internet. Groups of users can also connect to existing conferences on the "Mbone" of the DFN scientific network. The local network is connected to the university net-


Netzwerk
Institut für Meereskunde
an der Universität Kiel
J.Kielmann
Stand: 1.4.2001
Multimode Fast Ethernet FE (100 Mbit/s)
Monomode Gigabit Ethernet GE (LX,1000 Mbit/s)
Multimode Gigabit Ethernet GE (SX,1000 Mbit/s)
Twisted Pair Fast Ethernet FE (100 Mbit/s)
TX 10/100 Mbit/s TX ports (sensible Ethernet/Fast Ethernet)
FX 100 Mbit/s FE Multimode Connector
Protokolle: TCP/IP
Hauptgebäude
4/5.OG: Abt. TM/ME 1
SS6000: 96 TX
3.OG: Abt. BI/MI 2
SS6000: 56 TX
2.OG: Abt. EX 3
SS6000: 64 TX
1.OG: Abt. PO1/CH 4
SS6000: 88 TX
EG: Abt. ZV/PO1/Dir 5
SS2200: 24 TX + 100 FX
2x SS2200: 24 TX + 100 FX
3x 100 FX
1.UGAbt. PO2, HS... 6+7
SS6000: 64 TX
SS2200: 24 TX + 100 FX
100 FX
2.UG: Abt. FI, AQ, ZW 8
2x SS2200: 24 TX + 100 FX
1 100 FX
SS6000: 40 TX
1000 SX
Düsternbrooker Weg 20
Anbau
1.OG: Abt. CH/RO,.. 11
SS6000: 40 TX
Rechenzentrum IfM Zentraler Switch 10
SSR-8600: 2x8 100FX, 2x8 100TX
14x1000 SX
1000 SX
Rechenzentrum
SS6000: 64 TX
Anbau Düsternbrooker Weg 20
filesrv
caesar
Weitere Server
kleopatra
100 TX
hamlet
trajan
Concentrator
FDDI-Ring
Rechenzentrum IfM
Düsternbrooker Weg 17 (ca. 300 m)
Dach: SFB460 13
SS2200: 24 TX
Humanernährung 1.OG
Humanernährung EG
Keller: ME/SFB460 12
SS2200: 24TX + FE/FX
Düsternbrooker Weg 17 (ca. 300 m)
Hohenbergstr. 2 (ca. 800 m)
Altbau: Biologie 14
SS2200: 24TX + FE/FX
Neubau: Biologie 15
2x SS2200: 24TX + FE/FX
2x100FX
Hohenbergstr. 2 (ca. 800 m)
1000 LX(5.5 km)
RZ Uni Kiel
SSR2000: 16 TX
GE
Campus Universität Kiel und Internet
GE 1000 SX
HIPPI - GE
Zum Supercomputing
Ludwig-Mein-Str.

work by a Gigabit Ethernet fiber connection, which is split into 3 legs, one is directly connected to the Hippi supercomputer network, the second to the university campus and the third to the internet.

Administration and the connection to the "Landesnetz"

The Landesnetz of Schleswig-Holstein is a 2 Megabit backbone network which connects all governmental institutions for electronic data and information exchange including telephone techniques over the IP protocol. The new local area network of the IfM administration is also connected to the Landesnetz in order to be able to use SAP client systems for their administrative tasks. The SAP server is located in the Landesdatenzentrale Schleswig-Holstein, which is also connected to the Landesnetz. The IfM administration's local area network belongs physically to the scientific network, but is logically separated from the scientific net in order to ensure data protection.

Fileserver

In order to establish a centralized data backup, migration and archiving some fileservers and a cassette roboting system with a capacity of a total of 14 Terabyte were purchased. For MS-Windows users a Unix fileserver with a central capacity of 300 Gigabyte was set up. The computer centre maintains a dedicated fileserver under Linux for the administration. Additionally, for the Unix-users, a data migration area has been set up where the user data are automatically transferred to the roboter cassettes if the migration area on the fileserver is running out of space. The data are automatically restored on disk if the owner starts to operate on the migrated files. The total disk area available at IfM for the time being is estimated to 4.5 Terabyte. 1.5 Terabyte of the 4.5 is central space located in a protected area in the IfM computer centre. Another part of data is stored in the computer centre at the University.

Future plans

During the next years the central servers have to be replaced because their capacity will not be sufficient to meet the future demands. We also have to expand the functionality of the servers in order to improve the organization and consolidation of the PC purchasing and management. There are plans to install a mixture of client-server-based systems and central management components for Windows- and Unix-computers.

8.2 Research vessel operations and logistics

It should be noted that according to the IfM main mission to conduct basic research in the blue water part of the ocean, several groups of the IfM participated in cruises on "Meteor" and "Sonne" as well as "Polarstern". Details for some of these cruises are referred to in the reports of the Research Divisions.

RV "Alkor" *(1990; 1000 BRT, l: 55,2,8 m, b: 12,5 m).*

The Institute of Marine Research (IfM) operates two medium- sized research vessels ("Poseidon" and "Alkor") and two smaller coastal crafts ("Littorina" and "Polarfuchs"). Due to budget restrains the vessels can be used only for 210 days at sea in a year. However, additional cruises for Hamburg University were scheduled on a charter basis. Both "Poseidon" and "Alkor" are operated under contract with RF (Reedereigemeinschaft Forschungsschiffahrt) GmbH, Bremen.

RV "Poseidon" *(1976; 1059 BRT, l: 60,8 m, b: 11,4 m).*

"Poseidon" and "Alkor" are operated in a national scientific pool. Cruises are scheduled after a central reviewing procedure by the Steering Group for the medium-sized research vessels in Hamburg.

RC "Littorina" *(1975; 168 BRT, l: 29,5 m, b: 7,5 m).*

Both vessels are to become part of the planned Pool for this category in the future according to an agreement between the Federal Ministry of Research and the coastal states of Schleswig-Holstein, Mecklenburg-Vorpommern, Bremen and Hamburg.

RB "Polarfuchs" *(1982; 16 BRT, l: 12,7 m, b: 4,4 m).*

In 2001 an expert study was made by a consultant company to analyse the possibilities to improve the organizational structure and financial input by centralizing the coordination to operate medium-sized vessels in German.

Beside the IfM vessels "Poseidon" and "Alkor", "Heincke (AWI) and "Humboldt" (IOW) belong to this group. In 2004 "Humboldt" will be replaced by a new vessel with an ice-edge capacity.

All cruises of "Poseidon" and "Alkor" in 1999, 2000 and 2001 are listed with relevant details in the attached tables. In addition, "Alkor" is used for student training on 34 – 40 days per year. Other short cruises were organized for instrument tests. "Alkor" continues to be the workhorse of the Institute in the Baltic and North Sea.

In summary "Poseidon" made 26 cruises in 1999-2001 (POS 247-273), mostly in the Eastern North Atlantic from Cap Verde Islands to Iceland. There were no missions to the Mediterranean. 1999 was an exceptional year with a high profile. For the first time "Poseidon" crossed the Equator (29.3.1999) and was sent to Angola and Namibia (POS 250). Later that year "Poseidon" made two transsects across the Atlantic to Halifax and back to Brest (Pos 255). The follow-up cruise POS 256 was for a IFREMER group on an international barter basis (Tripartite Agreement).

In 2001 "Poseidon" was completely disabled in the central tropical Atlantic 200 nm west of Cap Verde Islands by a fire in the central switch board room on May 29th. This incident was the most unhappy since the vessel went into service 1976. Fortunately nobody was injured. "Poseidon" was towed first to the Cap Verde Islands and – after it became clear that repair works could not be done there – back to Germany. All subsequence cruises scheduled for 2001 had to be cancelled. As the vessel is not insured against this risk all budget funds for "Poseidon" were used for the reinstallation of the electrical systems. In December 2001 "Poseidon" is ready to put to sea again for the upcoming cruises in 2002.

As the table attached shows for 2000 as a typical year of IfM marine operations, the vessels were 614 days at sea with 2.307 scientists/students and covered 55.427 nm, which is 2,6 times around the globe. For further information please visit the IfM Research Vessel page:
http://www.ifm.uni-kiel.de/ze/zs/index.htm

IfM Research Vessels Statistics 2000

Ship	Days at Sea	Nautical Miles	No. Scientists
R.V. "Poseidon"	154	20.418	101
R.V. "Alkor"	184	21.493	624
R.C. "Littorina"	174	11.321	1007
R.B. "Polarfuchs"	102	2.195	575
all vessels	614	55.427	2.307

1999

Cruises R.V. "POSEIDON" 1999

No.	Dates	Institute/Department and Chief Scientists	Area of Operation
POS 247	6.1.-11.2.	IfM-Marine Physics/Univ.Tübingen *T.J. Müller/R. Schiebel*	Canary Islands, Acores
POS 248	15.2.-26.2.	Univ. Bremen *S. Neuer*	Canary Islands
POS 249	2.3.-17.3.	Univ.Oldenburg *R. Reuter*	Canary Islands, Acores, Gibraltar, ESTOC-Stations
POS 250/1	19.3.-29.4.	IOW Warnemünde *M. Schmidt*	Area off Angola/Namibia
POS 250/2	1.5.-10.5.	MPI Bremen *B. Jørgensen*	Area off Namibia
	11.5.-28.5.	Transit	Walsvisbay - Las Palmas
POS 251a	31.5.-1.6.	IfM - Marine Physics *T.J. Mülle*	ESTOC-Stations
POS 251	2.6.-20.6.	Inst. for Geosciences *F. Theilen*	Canary Islands
POS 252	23.6.-6.7.	Inst. for Geosciences *F. Theilen*	Area off Iceland
POS 253	9.7.-22.7.	Inst. for Geosciences *R. Botz/J. Scholten*	Kolbeinsey Ridge, Iceland
POS 254	24.7.-6.8.	Univ. Hamburg *W. Michaelis*	Norwegian Shelf
POS 255	16.8.-4.10.	IfM - Marine Chemistry *D. Wallace, D. Schulz-Bull, T. Blanz*	North Atlantic, Canada, Bermuda
POS 256	7.10.-14.10.	IFREMER (Charter Cruise) ?? *B. Le Cann*	Biskaya
	14.10.-15.11.	Repair works in Portugal	
	16.11.-31.12.		Viano do Castelo

Foreign port calls:

Pta. Delgada (Portugal), Las Palmas (Spain), Arrecife (Spain), Luanda (Angola),Walvisbay (Namibia), Reykjavik (Iceland), Bremerhaven, Halifax (Canada), St. George's (Bermuda), Brest (France), shipyard in Viano do Castelo (Portugal).

Longer Cruises of R.V. "ALKOR" 1999

No.	Dates	Institute/Department and Chief Scientists	Area of Operation
AL 138	1.2.-6.2.	IfM - Marine Zoology *H. Flügel*	Kattegat, Skagerrak
AL 139	16.2.-19.2.	Inst. for Geosciences *F. Theilen*	Kiel Bight (practical)
AL 140	23.2.-26.2.	IfM - Marine Physics *J. Reppin*	Kiel - Rügen (practical)
AL 140 a	18.3..-31.3.	IOW Warnemünde (MON) *G. Nausch*	Kiel Bight - Northern Gotland Basin
AL 141	13.4.-28.4.	IOW Warnemünde / IfM - Fishery Biology *J. Alheit/F. Köster*	Arkona-, Bornholm- , Gotlandbasin, Gdansk Deep
AL 142	10.5.-12.5.	Inst. for Geosciences *C. Müller*	Kiel Bight (practical)
AL 143	17.5.-6.6.	IfM - Fishery Biology *F. Köster*	Central Baltic, Arkona Basin, Bornholm Basin, Gdansk Deep, Gotland Basin
AL 143a	14.6.-19.6.	IfM - Marine Physics *J. Reppin*	Kiel - Rügen - Bornholm
AL 144	cancelled (now 146b)		
AL 145	28.6.-6.7.	IfM - Fishery Biology *G. Kraus*	Arkona-, Bornholm Basin, Danziger Deep
AL 146a	12.7.-16.7.	Res.-Institut Senckenberg *Dr. H. Fock*	North Sea
AL 146b	17.7.-20.7.	IfM - Marine Microbiology *R. Stöhr*	German Bight
AL 147	24.7.-16.8.	IOW / IfM - Fishery Biology *Dr. J. Alheit / F. Köster*	Central Baltic
AL 148	24.8.-1.9.	IfM - Fishery Biology *R. Voss*	Central Baltic
AL 149	3.9.-15.9.	IfM - Marine Planktology *B. Zeitschel*	Areas off UK, The Netherlands and German Bight (practical)
AL 150	21.9.-23.9.	IFM - Marine Physics *U. Send*	Western Baltic (practical)
AL 145	27.9.-1.10.	IfM - Marine Meteorology *K. Uhlig*	Mecklenburg Bight, Bornholm Basin (practical)
AL 152	(transferred to 2000 ->AL156)		
	2.10.-31.12.	IfM Pier/Home Port	

Foreign port calls: Rønne, Bornholm (Denmark), Visby (Sweden), Riga (Latvia), Ventspils (Latvia).

2000

Cruises R.V. "POSEIDON" 2000

No.	Dates	Institute/Department and Chief Scientists	Area of Operation
	1.1.-7.3.		Viano do Castello (Portugal)
	7.3.-11.3.		Transfer: Viano do Castelo - Las Palmas
POS 257	14.3.-21.3.	Instituto Canario de Ciencias Marinas, Telde, GC, Spanien *O. Llinas*	Canary Islands
POS 258	24.03.-3.4.	Univ. Bremen *G. Meinecke*	Canary Islands
POS 259	6.4.-21.4.	IfM-Physical Oceanography II *T.J. Müller*	Canary Islands, Madeira
POS 260	26.4.-23.6.	GEOMAR *O. Pfannkuche/U. Witte/B. Springer*	NE-Atlantic
POS 261	25.6.-15.7.	IfM-Physical Oceanography II *T.J. Müller*	Iceland Basin
POS 262	16.7.-31.7.	IfM-Physical Oceanography II *T.J. Müller*	Denmark Strait
POS 263	3.8.-23.8.	Univ. HH *U. Hübner*	Eastern Greenland, Denmark Strait
POS 264	25.8.-11.9.	Univ. HH *D. Hainbucher*	Faroer, Iceland Basin
POS 265	13.9.-4.10. (finished 30.9.)	Univ. Tübingen *Dr. Freiwald*	Faroer, NE Atlantic
	5.10.-31.10.	Repairs work	
	1.11.-31.12.	IfM Pier/Home Port	

Foreign port calls:

Viano do Castelo (Portugal), Las Palmas (Spain), Galway (Ireland), Cork (Ireland), Reykjavik (Iceland), Thorshavn (Denmark/Faroer), Galway (Ireland).

Longer Cruises of "ALKOR" 2000

No.	Dates	Institute/Department and Chief Scientists	Area of Operation
AL 153	6.1.-24.1.	IfM-Fishery Biology (ICES) *N. Rohlf*	South North Sea, Engl. Channel
AL 154	26.1.-31.1.	Inst. for Geosciences *F. Theilen*	Arkona Basin
AL 155	1.2.-4.2.	IfM-Physical Oceanography II *J. Reppin*	Baltic Sea (practical)
AL 156	23.3.-2.4.	IfM-Marine Microbiology *K. Gocke*	Western/Cental Baltic
AL 157	5.4.-11.4.	Univ. HH (ME) *G. Müller*	Baltic Sea
AL 158 (cancelled)	12.4.-17.4.	IfM-Theory & Modelling *A. Lehmann*	Baltic Sea
AL 159	4.5.-12.5.	IfM-Marine Chemisty *D. Schulz-Bull*	Kattegat, Skagerrak
AL 160	17.5.-22.5.	Inst. for Geosciences *F. Theilen*	Area around Rügen (practical)
AL 161	24.5.-9.6.	Univ. HH *Dr. J.P. Hermann*	Arkona-, Bornholm-, Gotland Basin, Gdansk Deep
AL 162	14.6.-20.6.	Univ. HH (ME) *S. Thiemann*	Baltic Sea
AL 163	3.7.-11.7.	Univ. HH *A. Temming*	Arkona-, Bornholm-, Gotland Basin, Gdansk Deep
AL 164	14.7.-17.7.	IfM-Physical Oceanography II *S. Harms*	Mecklenburg Bight, Arkona Basin (practical)
AL 165	25.7.-27.7.	IfM-Marine Microbiology *K. Gocke*	Kiel Channel, Elbe aestuary
AL 166	31.7.-10.8.	IfM-Fishery Biology *R. Voss*	Arkona-, Bornholm-, Gotland Basin, Gdansk Deep
AL 167	23.8.-5.9.	IfM-Marine Planctology *B. Zeitschel*	Central and eastern Baltic
AL 168	7.9.-30.9.	IfM-Fishery Biology (ICES) *N. Rohlf*	Northern North Sea
AL 169	4.10.-7.10.	IfM-Physical Oceanography II *S. Harms*	Mecklenburg Bight, Arkona Basin (practical)
AL 170 (cancelled, engine failure)	9.10.-13.10	IfM-Marine Meteorology *K. Uhlig*	Mecklenburg Bight
AL 171	25.10.-31.10.	Univ. HH (ME) *G. Müller*	Baltic Sea

Longer Cruises of "ALKOR" 2000

No.	Dates	Institute/Department and Chief Scientists	Area of Operation
	1.11.-17.11.	Repair works	
	18.11.-31.12.	IfM Pier/Home Port	

Foreign Port calls:

Visby (Sweden), Hirtshals (Denmark), Liepaja, Riga (Latvia), Rønne, Bornholm (Denmark), Stockholm (Sweden), Wick (UK).

2001

Cruises R.V. "POSEIDON" 2001

No.	Dates	Institute/Department and Chief Scientists	Area of Operation
POS 266	8.1.-12.1.	Institute for Geosciences *F. Theilen*	Arkona Basin, Baltic Sea
POS 267	13.1.-29.1.	Univ. Hamburg *L. Mintrop*	NE Atlantic
POS 268	31.1.-12.2.	IfM-FB2, Chem. Oceanography *D. Schulz-Bull*	Canary Basin
POS 268	15.2.-27.2.	Univ. Oldenburg *R. Reuter*	Canary Islands
POS 270	2.3.-15.3.	GEOMAR *T. Hansteen*	Canary Islands
POS 271	19.3.-29.3.	Univ. Bremen *G. Meinecke*	Canary Islands
POS 272	1.4.-14.4.	Univ. Bremen *H. Meggers*	NE Atlantic
POS 273	19.4.-15.5. **29.4.** Fire on board, ship disabled	IfM Interdisciplinary Project Group *A. Oschlies, P. Kähler*	NE Atlantic
POS 274-POS 281	Cruises cancelled, vessel towed to Cape Verde Islands and to Bremerhaven		
	3.5.-14.6.		Porto Grande/Mindelo
	since 2.7.		Bremerhaven

Port calls:

Funchal (Madeira, Portugal), Las Palmas (Spain), Porto Grande, Bremerhaven.

Longer Cruises of R.V. "ALKOR" 2001

No.	Dates	Institute/Department and Chief Scientists	Area of Operation
AL 172	6.1.-23.1.	IfM-FB3, Fishery Biology (ICES) *N. Rohlf*	Southern North Sea
AL 173	27.1.-2.2.	IfM-FB3 *S. Garthe*	Baltic Sea
AL 174	5.2.-9.2.	Institute for Geophysics *F. Theilen*	Kiel Bight, Arkona Basin (practical)
AL 175	18.2.-21.2.	IfM-FB1, Physical Oceanogr. II *S. Harms*	Kiel - Rügen (practical)
AL 176	26.2.-2.3.	Institute for Geophysics *K. Schwarzer*	Lübeck Bight (practical)
AL 177	6.3.-16.3.	Univ. Hamburg *B. Christiansen*	North Sea, Skagerrak
AL 178	19.3.-23.3.	IfM-FB1, Marine Meteorology *K. Uhlig*	Mecklenburg - Vorpom-mern (practical)
AL 179a	27.3.-30.3.	IfM-FB2, Chem. Oceanography *H. Bange*	Baltic Sea (practical)
AL 179b	2.4.-11.4.	Univ. HH (ME) *G. Müller*	Baltic Sea
AL 180	17.4.-29.4.	IfM-FB3, Fishery Biology *G. Kraus*	Bornholm Basin, Katte-gat, Skagerrak
AL 181	14.5.-18.5.	Institute for Geophysics *F. Theilen*	Mecklenburg Bight (practical)
AL 182	22.5.-8.6.	IfM-FB3, Fishery Biology *F. Köster*	Central Baltic
AL 183	12.6.-20.6.	Univ. HH (ME) *G. Müller*	Baltic Sea
AL 184	2.7.-12.7.	IOW Warnemünde *J. Alheit*	Central Baltic
AL 185	16.7.-24.7.	Univ. HH *C. Hübscher*	Western Baltic
AL 186	30.7.-2.8.	IfM-FB1, Physical Oceanogr. II *S. Harms*	Kiel - Rügen (practical)
AL 187	3.8.-16.8.	IfM-FB3, Fishery Biology *R. Voss*	Central Baltic
AL 188	18.8.-24.8.	Institute for Geophysics *F. Theilen*	Arkona Basin
AL 189 (now 2002)	27.8.-31.8.	IfM-FB1, Theory Modelling *A. Lehmann*	Western Baltic
AL 190/I	3.9.-16.9.	Univ. HH *J. Floeter*	German Bight, Skagerrak

Longer Cruises of R.V. "ALKOR" 2001

No.	Dates	Institute/Department and Chief Scientists	Area of Operation
AL 190/II	16.9.-27.9.	IfM-FB3, Fishery Biology *N. Rohlf*	Orkney/Shetland
AL 191	1.10.-5.10.	IfM-FB1, Maritime Meteorology *K. Uhlig*	Mecklenburg-Vorpom-mern, (practical)
AL 191b	8.10.-11.10	IfM-FB1, Physical Oceanogr. II *S. Harms*	Kiel - Rügen (practical)
AL 192	13.10.-26.10.	GEOMAR *O. Pfannkuche*	Skagerrak
AL 193	29.10.-7.11.	Univ. HH (ME) *G. Müller*	Baltic Sea
	12.11.-31.12.	IFM Pier/Home Port	

Foreign Port calls:

Kopenhagen (Denmark), Rønne, Bornholm (Denmark), Slite, Gotland (Sweden), Riga (Latvia), Klaipeda (Lithuania), Kristiansand (Norway), Hirtshals (Denmark).

8.3 Aquarium

The aquarium of the institute is tied into the scientific research besides his central function in the public relations. An intensive co-operation with scientists especially exists in the area of mariculture.

The aquarium maintains and exhibits a great variety of organisms from the temperate marine environment, fresh water lakes and rivers, as well as species from tropical waters and coral reefs. However, the species shown represent only a minority of the thousands of different fish species, mussels, snails, crustaceans, echinoderms, corals, and other aquatic forms of life. Outside the aquarium on the water front a group of harbour seals is displayed, which are well known in Kiel.

The herring (Clupea harengus) school

An aquarium provides living space for different animals and plants. In combination with complex life-support systems the holding conditions are maintained at appropriate levels. The water treatment guarantees that the water quality is always within safe limits using mechanical filters, foam towers, and algae scrubbers. By doing so, even very sensitive organisms can be kept in the systems. The water treatment technology corresponds to the latest state of the art. Due to the level of knowledge an intensive advice of public institutions and private companies exist on the national and international level.

Technical facilities

More than 30 displays having volumes between 100 and 11,000 litres are connected to different recirculation and life-support systems. The recirculation system for the Baltic Sea and the recirculation for the North Sea and the Atlantic contain between 30,000 and 50,000 litres at a temperature of around l0°C and salinities of 13 and 36, respectively. The recirculating systems for the fresh water and tropical aquaria have volumes of 5000 and 7000 litres. The temperature in the fresh water is kept between 18 and 20°C. In the tropical seawater the temperature is set to around 26°C and the salinities between 29 and 35. All systems are permanently operating and instant access to holding facilities is provided for almost every creature from the various aquatic habitats.

Mariculture research

The maintenance of aquaria and technical systems is carried out by two keepers and a technical manager supervised by the curator. Additionally, students are employed for part-time learning about maintenance theory while at the same time putting this theory into prac-

tice.Within the previous years the technical support of scientific projects by the aquarium team became intensified. To this the new technical management has contributed significantly. Today the staff do valuable contributions for the scientific work in the institute and special research tasks are based on this particular support.

8.4 Administration

During the reporting period the administration of the institute developed the annual economic and financial plans and contributed to the research agenda by supporting the national and international activities of the research groups at IfM. Amongst other tasks, the administration has carried out the administrative parts of existing or new externally funded research projects, construction projects, research travel and expeditions.

Fundamental changes of European and national health and safety regulations required timely applications of federal legislation. In addition, replies to numerous statistical inquiries required major efforts.

Due to the restructuring of the institute and the introduction of the Euro currency a large number of organisational adjustments were required in all working areas, including updates of the existing databases.

In 2001, the restructuring of the accounting to a decentralised management using SAP software went off smoothly. In parallel, the preparations for the introduction of a cost and performance based budgeting (including controlling) have been performed.

Since 2001, the administration of the institute has its own website which provides information about organisation and responsibilities (http://www.ifm.uni-kiel.de/ze/zv/).

All of this has been achieved while the number of staff in the administration has been reduced by one position.

8.5 Central workshop

The central workshop plays a major role in the preparation and implementation of research work of all research divisions (*Forschungsbereiche*). The work load comprises new constructions, modifications and repair of scientific apparatus and auxiliary equipment. Between 1999 and 2001 19.500 man hours distributed on 492 work orders were achieved. The number of orders ascended from 113 in 1999 to 194 in the last year of this report. Newly developed and adapted instrumentation included air sediment traps, trawl resistant near-bottom moorings, carrier for *in-situ* incubation experiments and for satellite transmitters for grey whales as well as various other gear for deep-sea applications.

By the end of 2001 the workshop's human resources included six technicians, two trainees and two house keepers. In January 2001 one trainee graduated as *Geselle* of mechatronics. His successor was employed in September. In the reporting period seven members were on call for 20.000 hours. They responded to 60 emergency calls partly under rather unfavourable conditions. The ensemble of workshop machines remained unchanged until the end of 2001.

A new turning lathe for larger work pieces was ordered for delivery in summer 2002. In this context the central workshop went through an internal evaluation process under the supervision of Professor Krauss. The *ad-hoc* commission recommended unanimously to preserve the workshop's management structure. Earlier experience has repeatedly shown that outsourcing of orders cannot guarantee the demanded quality. The nature of highly specialised work orders of the workshop requires personnel with long-standing experience in marine technology. An additional request for the preservation of the workshop originates from the co-operation contract with the *Zentrum für angewandte Meereswissenschaften*. The *ad-hoc* commission was concerned about the development of the human resources for the next years. Foreseeable constraints originating from early retirement plans must be managed by timely arrangements for the leaving personnel.

A second topic of the central workshop deals with management and modernisation of existing buildings and planning extensions. These actions were closely co-ordinated by the workshop supervisor with the GMSH, i.e. the former *Landesbauamt*. Major achievements included the renovation of numerous building parts such as the elevator, various laboratories, electricity stations and communication network systems. Roofs and bridge pylons had to be renewed. Future activities were planned towards the establishment of the molecular biological laboratory, the exchange of windows of the main building and the refit of the lobby.

In late fall 2001 the main building appeared to the public temporarily in an extraordinary appearance. Caused by the extensive paint work the building was completely wrapped up by plastic foils (see photo by I. Oelrichs).

For the reporting period we assure once again that the existing system of the central workshop worked very flexibly and with great efficiency.

9. Curricula and Teaching Activities

9.1 Introduction

The institute provides a specific contribution to the regular teaching-programme of Kiel University, including a broad selection of marine oriented lectures and courses.

Complete curricula are provided for **Physical Oceanography** and **Meteorology**. The basic education within these two curricula are very much comparable to that in Physics; thus, the first examination ("Vordiplom") in Physics, is accepted as basic education for Physical Oceanography and Meteorology as well.

The curriculum in Biology at Kiel University is supported by two marine oriented subjects, **Biological Oceanography** and **Fishery Biology**, which can be chosen as main or subsidiary subjects after the first examination ("Vordiplom") in Biology. In addition, **Marine Chemistry** is provided as a subsidiary subject for Chemistry or Biology and Physics as well.

The course programme of the institute is given below for the last three years (six terms). Note, that these sections are only available in German.

9.2 Teaching courses

Sommersemester 1999

Physikalische Ozeanographie	
Meßmethoden der Physikalischen Ozeanographie (2)	*U. Send*
Einführung in die Physikalische Ozeanographie II (2)	*U. Send*
Praktikum der Physikalischen Ozeanographie (für Hauptfächler) (2)	*U. Send*
Proseminar zum Praktikum der Physikalischen Ozeanographie (für Hauptfächler) (1)	*W. Zenk*
Praktikum der Physikalischen Ozeanographie (für Nebenfächler) (2)	*W. Zenk*
Proseminar zum Praktikum der Physikalischen Ozeanographie (für Nebenfächler)	*J. Reppin*
Physikalische Ozeanographie IV: Ozeanische Variabilität und Klima-schwankungen.(für Hauptfächler) (2)	*F. Schott*
Übungen zur Vorlesung Physikalische Ozeanographie IV: Ozeanische Variabilität und Klimaschwankungen (2)	*P. Brandt*
Physikalische Ozeanographie: Ozeanische Wassermassen und Klimarolle des Ozeans (für Nebenfächler nach dem Vordiplom) (1)	*F. Schott*
Übungen zur Vorlesung Physikalische Ozeanographie Ozeanische Wasser-massen und Klimarolle des Ozeans (für Nebenfächler nach dem Vordi-plom) (1)	
Einführung in die Theoretische Ozeanographie II: Dynamik großräumiger Bewegungen (2)	*J. Willebrand*
Übungen zur Vorlesung: Einführung in die Theoretische Ozeanographie II:	
Dynamik großräumiger Bewegungen (GFD) (2)	*A. Oschlies*
Numerische Methoden in Zirkulationsmodellen (2)	*C. Böning*
Aktuelle Fragen der Ozeanmodellierung (2)	*C. Böning*
Forschungs- und Literaturseminar: Ozean und Klima (1)	*C. Böning*
Arbeitsgemeinschaft Ozeanische Zirkulation (2)	*C. Böning, R.H. Käse, F. Schott, U. Send, J. Willebrand*
Seminar für Doktoranden der Physikalischen Ozeanographie (2)	*C. Böning, R.H. Käse, F. Schott, U. Send, J. Willebrand*
Ozeanographisch-Meteorologisches Seminar (2)	*C. Böning, R.H. Käse, P. Lemke, E. Ruprecht, F. Schott, U. Send, J. Willebrand*
Ozeanographisches Seminar für Fortgeschrittene (SFB 460) (2)	*C. Böning, R.H. Käse, P. Lemke, E. Ruprecht, F. Schott, U. Send, J. Willebrand*

Meteorologie	
Einführung in die Meteorologie II (2)	*P. Lemke*
Übungen zur Einführung in die Meteorologie I (2)	*M. Harder*
Theoretische Meteorologie IV: Allgemeine Zirkulation und Energetik (2)	*E. Ruprecht*
Übungen zur Theoretischen Meteorologie IV (2)	*A. Macke*
Statistische Methoden (2)	*P. Lemke*
Übungen zur Vorlesung: Statistische Methoden (2)	*A. Macke*
Chemie der Atmosphäre (2)	*E. Ruprecht*
Übungen zu Numerische Methoden der Meteorologie (2)	*M. Harder*
Arbeitsgemeinschaft Modellierung (2)	*P. Lemke*
Arbeitsgemeinschaft Fernerkundung (2)	*E. Ruprecht*
Seminar Wetteranalyse und -prognose ("Wetterbesprechung") (1)	*E. Ruprecht, K. Bumke*
Übung zur Wetteranalyse und -prognose (2)	*E. Ruprecht, K. Bumke*
Seminar für Diplomanden und Doktoranden der Meteorologie (3)	*P. Lemke, E. Ruprecht*
Proseminar: Meteorologische Instrumente (1)	*K. Bumke, K. Uhlig*
Meteorologisches Instrumentenpraktikum 14 Tage ganztägig	*K. Bumke, K. Uhlig*

Meereschemie	
Allgemeine Meereschemie II (1)	*D. Wallace*
Natürliche und anthropogene Halogenkohlenwasserstoffe im Ozean (1)	*D. Wallace, D. Schulz-Bull*
Einführung in meereschemische Arbeitsmethoden zum Meereschemischen Praktikum I (1)	*D. Schulz-Bull*
Meereschemisches Praktikum I (10 Tage halbtägig)	*D. Wallace, D. Schulz-Bull, mit T. Blanz, K. Friis, S. Utschakowski*
Meereschemisches Praktikum II und Seminar (für Nebenfächler) (4)	*D. Wallace, D. Schulz-Bull mit H.P. Hansen, K. Kremling, C. Osterroht*
Seminar für Diplomanden und Doktoranden der Meereschemie (2)	*D. Wallace, D. Schulz-Bull*
Einführung in die Marine Pharmakognosie II (2 Wochen ganztägig)	*L. Béress*

Biologisch-Meereskundliche Fächer	
Biologie der marinen Wirbellosen I (2)	*D. Adelung*
Ökophysiologie der Meerestiere (2)	*H. Theede*
Einführung in die Bestimmung mariner Wirbelloser und Fische (1)	*H. Theede*
Sonarortung bei Walen (1)	*B. Culik*
Statistik und graphische Datendarstellung für Meereszoologen (1)	*B. Culik*
Einführungsvorlesung zum Meereszoologischen Praktikum(1)	*D. Adelung*
Meereszoologisches Praktikum (Aufbaukurs) (4)	*B. Culik, H. Theede und Mitarbeiter*
Bestimmungsübungen an Meerestieren (A) mit Exkursionen (Aufbaukurs) (4)	*D. Adelung und Mitarbeiter*
Bestimmungsübungen an Meerestieren (B) mit Exkursionen (Aufbaukurs) (4)	*H. Theede und Mitarbeiter*
Meeresbiologisches Seminar (2)	*Dozenten und Mitarbeiter der Meeresbiologischen Abteilungen*
Meereszoologische Exkursionen	*D. Adelung, B. Culik, H. Theede*
Meeresökologie: Populationen und Lebensgemeinschaften (2)	*U. Sommer*
Ökologie freilebender Protisten für Meereskundler - Einführung (2)	*U.-G. Berninger*
Aktuelle Themen der aquatischen Ökologie - Diskussion neuer Forschungsergebnisse in Kombination mit didaktischen Übungen (2)	*U.-G. Berninger*
Seminar zum Praktikum: Lebensgemeinschaft des Mittelmeeres (2)	*J.-J. Rick*
Arbeitsgruppenseminar Meeresbotanik (2)	*U.-G- Berninger, U. Sommer mit J.-J. Rick*
Spezielle Fischereibiologie (2)	*D. Schnack*
Biologische Grundlagen der modernen Aquakultur (2)	*H. Rosenthal*
Fortpflanzung und Entwicklung bei Fischen	*H. Rosenthal*
Seminar für Diplomanden und Doktoranden der Fischereibiologie (2)	*H. Rosenthal, D. mit F.-W. Köster*
Praktikum: Parasiten und Krankheiten von aquatischen Organismen (5)	*H.W. Palm und Mitarbeiter*
Einführung in die Biologische Meereskunde II (3)	*U.-G. Berninger, H.-G. Hoppe, D. Piepenburg, U. Sommer, M. Spindler, B. Zeitzschel*
Methoden der Biologischen Meereskunde (2)	*B. Zeitzschel*
Biogeochemische Rückkopplungsmechanismen im Ozean und ihre Bedeutung für die Klimaentwicklung (1)	*A. Körtzinger, W. Koeve, A. Oschlies*
Die biologische Kohlenstoff-Pumpe des Ozeans: Räumliche und zeitliche Muster ihrer Steuerung (1)	*A.N. Antia*
Doktorandenseminar für Planktologen (2)	*B. Zeitzschel*
Planktologisch-Meereskundliches Praktikum auf See	*B. Zeitzschel mit A.N. Antia*
Biologie phototropher Prokaryonten (1)	*J.F. Imhoff*
Aktuelle Themen der marinen Mikrobiologie (2)	*H.-G. Hoppe*
Seminar der Marinen Mikrobiologie (2)	*J.F. Imhoff, H.-G. Hoppe*
Arbeitsgruppenseminar Bakterielle Aktivität und Diversität (2)	*H.-G. Hoppe*

Biologisch-Meereskundliche Fächer	
Aufbaukurs Marine Mikrobiologie	*J.F. Imhoff, J. Süling*
Biologisch-Meereskundliches Großpraktikum II (für Hauptfächler)	*U.-G. Berninger, H.-G. Hoppe, J.F. Imhoff, D. Piepenburg, H. Rosenthal, D. Schnack, U. Sommer, B. Zeitzschel mit A.N. Antia, C. Clemmesen, K. Gocke, F.-W. Köster, M. Meyerhöfer, A. Müller, R. Peinert, N. Rohlf, H. Rumohr, S. Schiel,W. Schramm, J. Süling, L. Thomsen, U. Waller*
Praktikum auf See	*Professoren und Dozenten des IfM*

Fächerübergreifend	
Meereskundliches Kolloquium (2)	*Professoren und Dozenten des IfM*
Anleitung zu selbständigen wissenschaftlichen Arbeiten	*Professoren und Dozenten des IfM*
Terrestrische und astronomische Ortsbestimmung auf See (2)	*V. Ohl*
Mariner radiochemischer Trainingskurs	*U. Rabsch*
Literaturerschließung in der Meereskunde und Einweisung in die Benutzung des ASFIS der IfM-Bibliothek (mit Übungen) (4)	*G. Kortum mit B. Schmidt*

Wintersemester 1999/2000

Physikalische Ozeanographie	
Einführung in die Physikalische Ozeanographie I (2)	*U. Send*
Praktikum der Physikalischen Ozeanographie I (für Hauptfächler) (2)	*U. Send*
Proseminar zum Praktikum der Physikalischen Ozeanographie (für Hauptfächler) (1)	*W. Zenk*
Physikalische Ozeanographie I: Physikalische Eigenschaften des Meerwassers (für Hauptfächler) (2)	*U. Send*
Übungen zur Vorlesung Physikalische Ozeanographie I: Physikalische Eigenschaften des Meerwassers (2)	*S. Harms*
Praktikum der Physikalischen Ozeanographie I (für Nebenfächler) (2)	*U. Send*
Proseminar zum Praktikum der Physikalischen Ozeanographie I (für Nebenfächler)	*J. Reppin*
Dynamik äquatorialer Bewegungen (2)	*J. Willebrand*
Inverse Modellierung und Datenassimilation (2)	*A. Oschlies, J. Willebrand*
Einführung in die Theoretische Ozeanographie und Meteorologie I: Hydrodynamik (2)	*E. Ruprecht*
Übungen zur Theoretischen Ozeanographie und Meteorologie I: Hydrodynamik (2)	*A. Macke*
Einführung in die Theoretische Ozeanographie und Meteorologie III: Numerische Methoden in Zirkulationsmodellen (2)	*C. Böning*
Übungen zur Vorlesung: Einführung in die Theoretische Ozeanographie und Meteorologie III: Numerische Methoden in Zirkulationsmodellen (2)	*A. Oschlies*
Grundlagen barotroper und barokliner Instabilität von Meeresströmungen (2)	*R.H. Käse*
Forschungs- und Literaturseminar: Ozean und Klima (2)	*C. Böning, A. Oschlies, J. Willebrand*
Arbeitsgemeinschaft Ozeanische Zirkulation (2)	*C. Böning, R.H. Käse, U. Send, J. Willebrand*
Seminar für Doktoranden der Physikalischen Ozeanographie (2)	*C. Böning, R.H. Käse, U. Send, J. Willebrand*
Seminar für Diplomanden der Physikalischen Ozeanographie (2)	*C. Böning, R.H. Käse, U. Send, J. Willebrand*
Ozeanographisch-Meteorologisches Seminar (2)	*C. Böning, R.H. Käse, P. Lemke, E. Ruprecht, F. Schott, U. Send, J. Willebrand*
Ozeanographisches Seminar für Fortgeschrittene (SFB 460) (2)	*C. Böning, R.H. Käse, P. Lemke, E. Ruprecht, F. Schott, U. Send, J. Willebrand*

Meteorologie	
Einführung in die Meteorologie I (2)	*P. Lemke*
Übungen zur Einführung in die Meteorologie I (2)	*A. Macke*
Einführung in die Theoretische Ozeanographie und Meteorologie I: Hydrodynamik (2)	*E. Ruprecht*
Übungen zur Theoretischen Ozeanographie und Meteorologie I: Hydrodynamik (2)	*A. Macke*
Einführung in die Theoretische Ozeanographie und Meteorologie III: Numerische Methoden in Zirkulationsmodellen (2)	*C. Böning*
Übungen zur Vorlesung: Einführung in die Theoretische Ozeanographie und Meteorologie III: Numerische Methoden in Zirkulationsmodellen (2)	*A. Oschlies*
Stadtmeteorologie (2)	*E. Ruprecht*
Klimamodellierung (2)	*M. Harder*
Übungen zu Klimamodellierung (2)	*M. Harder*
Arbeitsgemeinschaft Modellierung (2)	*P. Lemke*
Arbeitsgemeinschaft Fernerkundung (2)	*E. Ruprecht*
Seminar Wetteranalyse und -prognose ("Wetterbesprechung") (1)	*E. Ruprecht, K. Bumke*
Übung zur Wetteranalyse und -prognose (2)	*E. Ruprecht, K. Bumke*
Seminar für Diplomanden und Doktoranden der Meteorologie (3)	*P. Lemke, E. Ruprecht*
Meteorologisches Fortgeschrittenenpraktikum 14 Tage ganztägig	*K. Bumke, K. Uhlig*

Meereschemie	
Allgemeine Meereschemie I (1)	*D. Wallace*
Chemische Tracer im Ozean (1)	*D. Wallace, D. Schulz-Bull*
Ocean biogeochemistry present and past (2)	*D. Wallace, R. Zahn*
Einführung in meereschemische Arbeitsmethoden und Proseminar zum Meereschemischen Praktikum I (1)	*D. Schulz-Bull*
Meereschemisches Praktikum II und Seminar (für Nebenfächler)	*D. Wallace, D. Schulz-Bull mit K. Friis, S. Utschakowski, T. Blanz*
Seminar für Diplomanden und Doktoranden der Meereschemie (2)	*D. Wallace, D. Schulz-Bull*
Einführung in die Marine Pharmakognosie I (2 Wochen ganztägig)	*L. Béress*

Biologisch-Meereskundliche Fächer	
Biologie der marinen Wirbellosen II (2)	*D. Adelung*
Navigation und Orientierung bei Meerestieren (2)	*B. Culik*
Bestimmungsübungen an Meerestieren (mit Exkursionen) Aufbaukurs (4)	*D. Adelung, B. Culik mit H. Rumohr*
Vögel im Wattenmeer (1)	*H. Hötker*
Seminar: Ökophysiologie von Küstenvögeln	*H. Hötker*
Aufbaukurs: Ökologie der Vögel des Wattenmeeres	*H. Hötker*
Meeresbotanisch-Meereszoologisches Seminar (2)	*D. Adelung, U.-G. Berninger, B. Culik, A. Peters, U. Sommer mit H.-J. Rick*
Theoretische Ökologie: Diversität (2)	*U. Sommer*
Eutrophierung (1)	*U. Sommer*
Protisten als Modellorganismen in der Biologie (2)	*U.-G. Berninger*
Aktuelle Themen der aquatischen Ökologie - Diskussion neuer Forschungsergebnisse in Kombination mit didaktischen Übungen (2)	*U.-G. Berninger*
Seminar:Vergleichende Ökologie mariner und limnischer Systeme (2)	*U. Sommer mit M. Boersma, K. Wiltshire*
Arbeitsgruppenseminar Meeresbotanik (2)	*U. Sommer, U.-G. Berninger, A.F. Peters mit H.-J. Rick*
Darstellung wissenschaftlicher Ergebnisse in Wort, Schrift und Bild	*U. Sommer*
Fischbestandskunde (2)	*D. Schnack mit J. Gröger*
Aquakultur in den Tropen (2)	*H. Rosenthal*
Einführung in die Fischereibiologie (3)	*H. Rosenthal, D. Schnack*
Einführung in die biologische Statistik (3)	*D. Schnack*
Krankheiten und Parasiten von Meeresfischen (1)	*H. Palm, N. Reimann*
Seminar zur Biologischen Meereskunde und Fischereibiologie (2)	*A. Antia, U.-G. Berninger, H. Rosenthal, D. Schnack mit F.-W. Köster, U. Sommer*
Einführung in die Biologische Meereskunde I (3)	*U.-G. Berninger, J.F. Imhoff, U. Sommer, B. Zeitzschel*
Die Geschichte der biologischen Meeresforschung (2)	*B. Zeitzschel*
Seminar: Biogeochemische Rückkopplungsmechanismen im Ozean und ihre Bedeutung für die Klimaentwicklung (2)	*W. Koeve, L. Mintrop, A. Oschlies*
Stoffkreisläufe im Ozean (1)	*W. Koeve*
Arbeitsgruppenseminar für Planktologen (2)	*B. Zeitzschel*
Ökologie und Management von Küstensystemen, Ökologie des Wattenmeeres (2)	*F. Colijn*
Einführung in die Marine Mikrobiologie (1)	*J.F. Imhoff*
Gewässermikrobiologische Methoden mit Anwendungsbeispielen aus der ökologischen Forschung (2)	*H.-G. Hoppe*
Seminar der Marinen Mikrobiologie (2)	*J.F. Imhoff, H.-G. Hoppe*
Seminar für Diplomanden und Doktoranden (2)	*J.F. Imhoff*

Biologisch-Meereskundliche Fächer

Arbeitsgruppenseminar Struktur und Funktion bakterieller Gemeinschaften (2)	*H.-G. Hoppe*

Biologisch-Meereskundliches Großpraktikum I (für Hauptfächler):

D. Adelung, U.-G. Berninger, B. Culik, H.-G. Hoppe, J.F. Imhoff, A.F. Peters, H. Rosenthal, D. Schnack, D. Schulz-Bull, U. Sommer, M. Spindler, D. Wallace, B. Zeitzschel mit K. Gocke, F.-W. Köster, A. Kohly, A. Müller, H. Palm, R. Peinert, U. Piatkowski, N. Reimann, H.-J. Rick, H. Rumohr, S. Schiel, W. Schramm, J. Süling, U. Waller, R. Wilson

Biologisch-Meereskundliches Großpraktikum (für Nebenfächler):

D. Adelung, U.-G. Berninger, B. Culik, A.F. Peters, H. Rosenthal, D. Schnack, D. Schulz-Bull, U. Sommer, D. Wallace, B. Zeitzschel mit K. v. Bröckel, K. Friis, J.-J. Knaack, F.-W. Köster, M. Meyerhöfer, A. Müller, H. Palm, U. Piatkowski, N. Reimann, H.-J. Rick, H. Rumohr, W. Schramm, S. Utschakowski, U. Waller, R. Wilson

Meereskundliches Kolloquium (2)	*Professoren und Dozenten des IfM*
Anleitung zu selbständigen wissenschaftlichen Arbeiten	*Professoren und Dozenten des IfM*

Somersemester 2000

Physikalische Ozeanographie	
Meßmethoden der Physikalischen Ozeanographie (2)	*U. Send*
Einführung in die Physikalische Ozeanographie II (2)	*U. Send*
Praktikum der Physikalischen Ozeanographie (für Hauptfächler) (2)	*U. Send*
Proseminar zum Praktikum der Physikalischen Ozeanographie (für Hauptfächler) (1)	*W. Zenk*
Praktikum der Physikalischen Ozeanographie (für Nebenfächler) (2)	*S. Harms*
Proseminar zum Praktikum der Physikalischen Ozeanographie (für Nebenfächler)	*S. Harms*
Physikalische Ozeanographie II: Ozeanströmungen und Zirkulationssysteme (für Hauptfächler) (2)	*F. Schott*
Übungen zur Vorlesung Physikalische Ozeanographie II: Ozeanische Variabilität und Klimaschwankungen (2)	*P. Brandt*
Physikalische Ozeanographie: Strömungen und Deckschichtprozesse (1)	*F. Schott*
Übungen zur Vorlesung Physikalische Ozeanographie: Strömungen und Deckschichtprozesse (1)	*P. Brandt*
Einführung in die Theoretische Ozeanographie IV: Wellen im Ozean (2)	*J. Willebrand*
Übungen zur Vorlesung Einführung in die Theoretische Ozeanographie IV: Wellen im Ozean (2)	*A. Oschlies*
Modellierung der ozeanischen Zirkulation (2)	*C. Böning*
Aktuelle Fragen der Ozeanmodellierung (2)	*C. Böning*
Forschungs- und Literaturseminar: Ozean und Klima (1)	*C. Böning*
Arbeitsgemeinschaft Ozeanische Zirkulation (2)	*C. Böning, R.H. Käse, F. Schott, U. Send, J. Willebrand*
Seminar für Doktoranden der Physikalischen Ozeanographie (2)	*C. Böning, R.H. Käse, F. Schott, U. Send, J. Willebrand*
Seminar für Diplomanden der Physikalischen Ozeanographie (2)	*C. Böning, R.H. Käse, F. Schott, U. Send, J. Willebrand*
Ozeanographisch-Meteorologisches Seminar (2)	*C. Böning, R.H. Käse, P. Lemke, E. Ruprecht, F. Schott, U. Send, J. Willebrand*
Ozeanographisches Seminar für Fortgeschrittene (SFB 460) (2)	*C. Böning, R.H. Käse, P. Lemke, E. Ruprecht, F. Schott, U. Send, J. Willebrand*

Meteorologie	
Einführung in die Meteorologie II (2)	*P. Lemke*
Übungen zur Einführung in die Meteorologie I (2)	*M. Harder*
Theoretische Meteorologie II: Atmosphärische Dynamik (2)	*E. Ruprecht*
Übungen zur Theoretischen Meteorologie IV (2)	*M. Harder*
Strahlung (2)	*A. Macke*
Übungen zur Vorlesung: Strahlung (2)	*H. Mehrtens*
Wolkenphysik (2)	*E. Ruprecht*
Übungen zur Vorlesung: Wolkenphysik (2)	*A. Macke*
Arbeitsgemeinschaft Modellierung (2)	*P. Lemke*
Arbeitsgemeinschaft Fernerkundung (2)	*E. Ruprecht*
Seminar Wetteranalyse und -prognose ("Wetterbesprechung") (1)	*E. Ruprecht, K. Bumke*
Übung zur Wetteranalyse und -prognose (2)	*E. Ruprecht, K. Bumke*
Seminar für Diplomanden und Doktoranden der Meteorologie (3)	*P. Lemke, E. Ruprecht*
Proseminar: Meteorologische Instrumente (1)	*K. Bumke, K. Uhlig*
Meteorologisches Instrumentenpraktikum 14 Tage ganztägig	*K. Bumke, K. Uhlig*

Meereschemie	
Allgemeine Meereschemie II (1)	*D. Wallace*
Natürliche und anthropogene Halogenkohlenwasserstoffe im Ozean (1)	*D. Wallace, D. Schulz-Bull*
Einführung in meereschemische Arbeitsmethoden zum Meereschemischen Praktikum I (1)	*D. Schulz-Bull*
Meereschemisches Praktikum I (10 Tage halbtägig)	*D. Wallace, D. Schulz-Bull, mit T. Blanz, K. Friis, S. Utschakowski*
Meereschemisches Praktikum II und Seminar (für Nebenfächler) (4)	*D. Wallace, D. Schulz-Bull mit H.P. Hansen, K. Kremling, C. Osterroht*
Seminar für Diplomanden und Doktoranden der Meereschemie (2)	*D. Wallace, D. Schulz-Bull*
Einführung in die Marine Pharmakognosie II (2 Wochen ganztägig)	*L. Béress*

Biologisch-Meereskundliche Fächer	
Biologie der marinen Wirbellosen I (2)	*D. Adelung*
Von der Hypothese bis zur Diplomarbeit:Meereszoologische Forschung (2)	*B. Culik*
Einführungsvorlesung zum Meereszoologischen Praktikum(1)	*D. Adelung*
Meereszoologisches Praktikum (Aufbaukurs) (4)	*B. Culik, H. Theede und Mitarbeiter*
Meeresbiologisches Seminar (2)	*Dozenten und Mitarbeiter der Meeresbiologischen Abteilungen*
Meereszoologische Exkursionen	*D. Adelung, B. Culik, H. Theede*
Vorlesung: Vögel des Wattenmeeres (1)	*H. Hötker*
Seminar: Ökophysiologie von Küstenvögeln (2)	*H. Hötker mit S. Garthe*
Meeresökologie: Populationen und Lebensgemeinschaften (2)	*U. Sommer*
Ökologie freilebender Protisten für Meereskundler - Einführung (2)	*U.-G. Berninger*
Aktuelle Themen der aquatischen Ökologie - Diskussion neuer Forschungsergebnisse in Kombination mit didaktischen Übungen (2)	*U.-G. Berninger*
Seminar zum Praktikum: Lebensgemeinschaft des Mittelmeeres (2)	*J.-J. Rick*
Arbeitsgruppenseminar Meeresbotanik (2)	*U.-G- Berninger, U. Sommer mit J.-J. Rick*
Spezielle Fischereibiologie (2)	*D. Schnack*
Aquakultur in den Tropen (2)	*H. Rosenthal*
Biologische Grundlagen der modernen Aquakultur (2)	*H. Rosenthal*
Fortpflanzung und Entwicklung bei Fischen	*H. Rosenthal*
Seminar für Diplomanden und Doktoranden der Fischereibiologie (2)	*H. Rosenthal, D. Schnack mit F.-W. Köster*
Einführung in die Biologische Meereskunde II (3)	*U.-G. Berninger, H.-G. Hoppe, D. Piepenburg, U. Sommer, M. Spindler, B. Zeitzschel*
Neue Produktion des Phytoplanktons - Physiologie, Fallstudien und großräumige Abschätzungen (1)	*W. Koeve*
Biogeochemische Rückkopplungsmechanismen im Ozean und ihre Bedeutung für die Klimaentwicklung (1)	*A. Körtzinger, W. Koeve, A. Oschlies*
Doktorandenseminar für Planktologen (2)	*B. Zeitzschel*
Ökologie und Management von Küstensystemen, Ökologie des Wattenmeeres (2)	*F. Colijn*
Planktologisch-Meereskundliches Praktikum auf See	*B. Zeitzschel mit A.N. Antia*
Biologie phototropher Prokaryonten (1)	*J.F. Imhoff*
Aktuelle Themen der marinen Mikrobiologie (2)	*H.-G. Hoppe*
Seminar der Marinen Mikrobiologie (2)	*J.F. Imhoff, H.-G. Hoppe*
Biologisch-Meereskundliches Großpraktikum II (für Hauptfächler):	
	U.-G. Berninger, H.-G. Hoppe, J.F. Imhoff, D. Piepenburg, H. Rosenthal, D. Schnack, U. Sommer, B. Zeitzschel mit A.N. Antia, C. Clemmesen, K. Gocke, F.-W. Köster, M. Meyerhöfer, A. Müller, R. Peinert, N. Rohlf, H. Rumohr, S. Schiel,W. Schramm, J. Süling, L. Thomsen, U. Waller
Praktikum auf See	*Professoren und Dozenten des IfM*

Wintersemester 2000/2001

Physikalische Ozeanographie	
Einführung in die Physikalische Ozeanographie I (2)	*U. Send*
Physikalische Ozeanographie III: Schichtung und Zirkulation (für Hauptfächler) (2)	*F. Schott*
Übungen zur Vorlesung Physikalische Ozeanographie III (2)	*P. Brandt*
Praktikum der Physikalischen Ozeanographie I (für Nebenfächler) (2)	*S. Harms*
Proseminar zum Praktikum der Physikalischen Ozeanographie I (für Nebenfächler)	*S. Harms*
Einführung in die Theoretische Ozeanographie und Meteorologie I: Hydrodynamik (2)	*J. Willebrand*
Übungen zur Vorlesung: Einführung in die Theoretische Ozeanographie und Meteorologie I: Hydrodynamik (2)	*A. Macke*
Einführung in die Theoretische Ozeanographie und Meteorologie III: - Numerische Methoden in Zirkulationsmodellen (2)	*C. Böning*
Übungen zur Theoretischen Meteorologie III (2)	*A. Oschlies*
Autoregressive Prozesse (2)	*R.H. Käse*
Forschungs- und Literaturseminar: Ozean und Klima (2)	*C. Böning, A. Oschlies, J. Willebrand*
Arbeitsgemeinschaft Ozeanische Zirkulation (2)	*C. Böning, R.H. Käse, U. Send, J. Willebrand*
Seminar für Doktoranden der Physikalischen Ozeanographie (2)	*C. Böning, R.H. Käse, U. Send, J. Willebrand*
Seminar für Diplomanden der Physikalischen Ozeanographie (2)	*C. Böning, R.H. Käse, U. Send, J. Willebrand*
Ozeanographisch-Meteorologisches Seminar (2)	*C. Böning, R.H. Käse, P. Lemke, E. Ruprecht, F. Schott, U. Send, J. Willebrand*
Ozeanographisches Seminar für Fortgeschrittene (SFB 460) (2)	*C. Böning, R.H. Käse, P. Lemke, E. Ruprecht, F. Schott, U. Send, J. Willebrand*

Meteorologie	
Einführung in die Meteorologie I (2)	*P. Lemke*
Übungen zur Einführung in die Meteorologie I (2)	*A. Macke*
Einführung in die Theoretische Ozeanographie und Meteorologie I: Hydrodynamik (2)	*J. Willebrand*
Übungen zur Vorlesung: Einführung in die Theoretische Ozeanographie und Meteorologie I: Hydrodynamik (2)	*A. Macke*
Einführung in die Theoretische Ozeanographie und Meteorologie III: - Numerische Methoden in Zirkulationsmodellen (2)	*C. Böning*
Übungen zur Theoretischen Meteorologie III (2)	*A. Oschlies*
Tropenmeteorologie (2)	*E. Ruprecht*
Physikalische Klimatologie (2)	*E. Ruprecht*
Übungen zur Physikalischen Klimatologie(2)	*M. Harder*
Arbeitsgemeinschaft Meteorologie (2)	*P. Lemke, E. Ruprecht*
Seminar Wetteranalyse und -prognose (“Wetterbesprechung”) (1)	*E. Ruprecht, K. Bumke*
Übung zur Wetteranalyse und -prognose (2)	*E. Ruprecht, K. Bumke*
Seminar für Diplomanden und Doktoranden der Meteorologie (3)	*P. Lemke, E. Ruprecht*
Meteorologisches Fortgeschrittenenpraktikum 14 Tage ganztägig	*K. Bumke, K. Uhlig*

Meereschemie	
Allgemeine Meereschemie I (1)	*D. Wallace*
Chemische Tracer im Ozean (1)	*D. Wallace, D. Schulz-Bull*
Ocean biogeochemistry present and past (2)	*D. Wallace, R. Zahn*
Einführung in meereschemische Arbeitsmethoden und Proseminar zum Meereschemischen Praktikum I (1)	*D. Schulz-Bull*
Meereschemisches Praktikum II und Seminar (für Nebenfächler)	*D. Wallace, D. Schulz-Bull mit K. Friis, S. Utschakowski, T. Blanz*
Seminar für Diplomanden und Doktoranden der Meereschemie (2)	*D. Wallace, D. Schulz-Bull, A. Anita, D. Wallace, D. Schulz-Bull*
Einführung in die Marine Pharmakognosie II (2 Wochen ganztägig)	*L. Béress*

Biologisch-Meereskundliche Fächer	
Biologie der marinen Säugetiere (2)	*D. Adelung*
Bestimmungsübungen an Meerestieren (mit Exkursionen) Aufbaukurs (4)	*D. Adelung, B. Culik mit H. Rumohr*
Naturschutzprobleme im Küstenraum (1)	*H. Hötker*
Seminar: Aktuelle Arbeiten zur Biologie von See- und Küstenvögeln (2)	*S. Garthe, H. Hötker*
Ökologie der Vögel des Wattenmeeres (4-std., Blockseminar und -praktikum)	*H. Hötker*
Seevögel auf See: Fischerei und Hydrographie (7Tage)	*S. Garthe, H. Hötker*
Meeresbotanisch-Meereszoologisches Seminar (2)	*D. Adelung, U.-G. Berninger, B. Culik, A. Peters, U. Sommer mit H.-J. Rick*
Theoretische Ökologie: Diversität (2)	*U. Sommer*
Protisten als Modellorganismen in der Biologie (2)	*U.-G. Berninger*
Aktuelle Themen der aquatischen Ökologie - Diskussion neuer Forschungsergebnisse in Kombination mit didaktischen Übungen (2)	*U.-G. Berninger*
Seminar:Vergleichende Ökologie mariner und limnischer Systeme (2)	*U. Sommer mit M. Boersma, K. Wiltshire*
Arbeitsgruppenseminar Meeresbotanik (2)	*U. Sommer, U.-G. Berninger, A.F. Peters mit H.-J. Rick*
Seminar zur Benthosökologie und Meeresbiologie (2)	*U.-G. Berninger, U. Sommer mit R. Karez*
PCR-Kurs	*A.F. Peters*
Seminar zum PCR-Kurs	*A.F. Peters*
Literature Seminar: Molecular Techniques in Marine Research (14-tägig)	*H.-G. Hoppe, A.F. Peters, J. LaRoche*
Fischbestandskunde (2)	*D. Schnack mit J. Gröger*
Aquakultur in den Tropen (2)	*H. Rosenthal*
Einführung in die Fischereibiologie (3)	*H. Rosenthal, D. Schnack*
Einführung in die biologische Statistik (3)	*D. Schnack*
Fortpflanzung und Entwicklung bei Fischen (Blockkurs)	*H. Rosenthal*
Krankheiten und Parasiten von Meeresfischen (1)	*H. Palm, N. Reimann*
Seminar zur Biologischen Meereskunde und Fischereibiologie (2)	*A. Antia, U.-G. Berninger, H. Rosenthal, D. Schnack mit F.-W. Köster, U. Sommer*
Einführung in die Biologische Meereskunde I (3)	*U.-G. Berninger, J.F. Imhoff, U. Sommer, K. Lochte*
Ökologie und Management von Küstensystemen, Ökologie des Wattenmeeres (2)	*F. Colijn*
Molekularbiologie und Ökologie	*H.-G. Hoppe, J. LaRoche*
Einführung in die Marine Mikrobiologie (1)	*J.F. Imhoff*
Gewässermikrobiologische Methoden mit Anwendungsbeispielen aus der ökologischen Forschung (2)	*H.-G. Hoppe*
Seminar der Marinen Mikrobiologie (2)	*J.F. Imhoff, H.-G. Hoppe*

Biologisch-Meereskundliche Fächer

Seminar für Diplomanden und Doktoranden (2)	*J.F. Imhoff*
Arbeitsgruppenseminar Struktur und Funktion bakterieller Gemeinschaften (2)	*H.-G. Hoppe*
Biologisch-Meereskundliches Großpraktikum I (für Hauptfächler):	
D. Adelung, U.-G. Berninger, B. Culik, H.-G. Hoppe, J.F. Imhoff, A.F. Peters, H. Rosenthal, D. Schnack, D. Schulz-Bull, U. Sommer, M. Spindler, D. Wallace, K. Lochte mit K. Gocke, F.-W. Köster, A. Kohly, A. Müller, H. Palm, R. Peinert, U. Piatkowski, N. Reimann, H.-J. Rick, H. Rumohr, S. Schiel, W. Schramm, J. Süling, U. Waller, R. Wilson	
Biologisch-Meereskundliches Großpraktikum (für Nebenfächler):	
D. Adelung, U.-G. Berninger, B. Culik, A.F. Peters, H. Rosenthal, D. Schnack, D. Schulz-Bull, U. Sommer, D. Wallace, K. Lochte mit K. v. Bröckel, K. Friis, J.-J. Knaack, F.-W. Köster, M. Meyerhöfer, A. Müller, H. Palm, U. Piatkowski, N. Reimann, H.-J. Rick, H. Rumohr, W. Schramm, S. Utschakowski, U. Waller, R. Wilson	
Meereskundliches Kolloquium (2)	*Professoren und Dozenten des IfM*
Anleitung zu selbständigen wissenschaftlichen Arbeiten	*Professoren und Dozenten des IfM*

Sommersemester 2001

Physikalische Ozeanographie	
Einführung in die Physikalische Ozeanographie II (2)	*U. Send*
Praktikum der Physikalischen Ozeanographie (für Hauptfächler) (2)	*T.J. Müller*
Proseminar zum Praktikum der Physikalischen Ozeanographie (für Hauptfächler) (1)	*U. Send*
Praktikum der Physikalischen Ozeanographie (für Nebenfächler) (2)	*U. Send*
Proseminar zum Praktikum der Physikalischen Ozeanographie (für Nebenfächler)	*S. Harms*
Angewandte Programmierübungen UNIX/Fortran/Matlab (für Haupt- und Nebenfächler) (2)	*S. Harms, A. Macke, A. Oschlies*
Physikalische Ozeanographie IV: Lange Wellen und ozeanische Klima-schwankungen (für Hauptfächler) (2)	*F. Schott*
Übungen zur Vorlesung Physikalische Ozeanographie IV: Lange Wellen und ozeanische Klimaschwankungen (2)	*P. Brandt*
Physikalische Ozeanographie: Ozeanische Wassermassen und Klimarolle des Ozeans (für Nebenfächler nach dem Vordiplom) (1)	*F. Schott*
Übungen zur Vorlesung Physikalische Ozeanographie Ozeanische Wasser-massen und Klimarolle des Ozeans (für Nebenfächler nach dem Vordiplom) (1)	*P. Brandt*
Statistik und Datenanalyse für Meteorologen und Ozeanographen (2)	*J. Willebrand*
Übungen zur Vorlesung Statistik und Datenanalyse für Meteorologen und Ozeanographen (2)	*A. Oschlies*
Einführung in die Theoretische Ozeanographie II: Dynamik großräumiger Bewegungen (2)	*C. Böning*
Übungen zur Vorlesung Einführung in die Theoretische Ozeanographie II: Dynamik großräumiger Bewegungen (GFD) (2)	*A. Oschlies*
Aktuelle Fragen der Ozeanmodellierung (2)	*C. Böning*
Forschungs- und Literaturseminar: Ozean und Klima (1)	*C. Böning*
Arbeitsgemeinschaft Ozeanische Zirkulation (2)	*C. Böning, R.H. Käse, F. Schott, U. Send, J. Willebrand*
Seminar für Doktoranden der physikalischen Ozeanographie (2)	*C. Böning, R.H. Käse, F. Schott, U. Send, J. Willebrand*
Ozeanographisch-Meteorologisches Seminar (2)	*C. Böning, R.H. Käse, P. Lemke, E. Ruprecht, F. Schott, U. Send, J. Willebrand*
Ozeanographisches Seminar für Fortgeschrittene (SFB 460) (2)	*C. Böning, R.H. Käse, P. Lemke, E. Ruprecht, F. Schott, U. Send, J. Willebrand*

Meteorologie	
Einführung in die Meteorologie II (2)	*A. Macke*
Übungen zur Einführung in die Meteorologie I (2)	*H. Mehrtens*
Theoretische Meteorologie IV: Allgemeine Zirkulation und Energetik (2)	*E. Ruprecht*
Übungen zur Theoretischen Meteorologie IV (2)	*A. Macke*
Chemie der Atmosphäre (2)	*E. Ruprecht*
Statistik und Datenanalyse für Meteorologen und Ozeanographen (2)	*J. Willebrand*
Übungen zur Vorlesung Statistik und Datenanalyse für Meteorologen und Ozeanographen (2)	*A. Oschlies*
Angewandte Programmierübungen UNIX/Fortran/Matlab (für Haupt- und Nebenfächler) (2)	*S. Harms, A. Macke, A. Oschlies*
Arbeitsgemeinschaft Meteorologie (2)	*E. Ruprecht*
Seminar Wetteranalyse und -prognose ("Wetterbesprechung") (1)	*E. Ruprecht, K. Bumke*
Übung zur Wetteranalyse und -prognose (2)	*E. Ruprecht, K. Bumke*
Seminar für Diplomanden und Doktoranden der Meteorologie (3)	*E. Ruprecht*
Proseminar zum Instrumentenpraktikum (1)	*K. Bumke, K. Uhlig, T. Martin*
Meteorologisches Instrumentenpraktikum 14 Tage ganztägig	*K. Bumke, K. Uhlig, T. Martin*
Lehrexkursion	*A. Macke*

Meereschemie	
Allgemeine Meereschemie II (1)	*D. Wallace*
Tracer im Ozean (1)	*D. Wallace*
Einführung in meereschemische Arbeitsmethoden zum Meereschemischen Praktikum I (1)	*D. Schulz-Bull*
Meereschemisches Praktikum I (10 Tage halbtägig)	*D. Wallace, D. Schulz-Bull, mit T. Blanz, K. Friis, S. Utschakowski*
Meereschemisches Praktikum II und Seminar (für Nebenfächler) (4)	*D. Wallace, D. Schulz-Bull mit H.P. Hansen, K. Kremling, C. Osterroht*
Seminar für Diplomanden und Doktoranden der Meereschemie (2)	*D. Wallace, D. Schulz-Bull*
Ocean biogeochemistry present, past and future (2)	*D. Wallace, A. Eisenhauer, K. Lochte, E. Suess*

Biologisch-Meereskundliche Fächer	
Grundlagen der Ökologie für Meereskundler I (2)	*U. Sommer*
Arbeitsgruppenseminar "Experimentelle Ökologie" (2)	*U. Sommer mit R. Karez*
Seminar zur Benthosökologie und Meeresbiologie (2)	*R. Karez, U. Sommer, H. Brendelberger*
Aktuelle Themen der Ökologie des Hartboden-Benthos. Seminar zur Diskussion neuer Forschungsergebnisse mit didaktischen Übungen (2)	*R. Karez*
Bestimmungsübungen an Meerestieren mit Exkursionen (Aufbaukurs) (4)	*U. Sommer mit H. Rumohr, H. Gonschior*
Ökophysiologie von Küstenvögeln (4-std., Blockpraktikum)	*H. Hötker*
Spezielle Fischereibiologie (2)	*D. Schnack*
Biologische Grundlagen der modernen Aquakultur (2)	*H. Rosenthal*
Seminar für Diplomanden und Doktoranden der Fischereibiologie (2)	*H. Rosenthal, D. Schnack mit F.-W. Köster*
Einführung in die Biologische Meereskunde II (3)	*H.-G. Hoppe, J.F. Imhoff, K. Lochte, U. Sommer, M. Spindler mit R. Karez*
Mikrobielle Stoffflüsse im Meer (2)	*K. Lochte*
Die biologische Pumpe im Ozeans: (1)	*A.N. Antia*
Planktologisch-Meereskundliches Praktikum auf See	*K. Lochte mit A.N. Antia*
Seminar für Diplomanden und Doktoranden der Chemischen und Biologischen Ozeanographie (2)	*D. Wallace, K. Lochte, D. Schulz-Bull*
Ocean biogeochemistry present, past and future (2)	*D. Wallace, T. Eisenhauer, K. Lochte, E. Suess*
Ökologie und Management von Küstensystemen, Ökologie des Wattenmeeres	*F. Colijn*
Biologie phototropher Prokaryonten (1)	*J.F. Imhoff*
Vorlesung und Seminar Ökologie der Mikroorganismen in limnischen und marinen Systemen (2)	*H.-G. Hoppe, K. Jürgens*
Vögel, Fischerei und Landwirtschaft (2) Blockseminar	*S. Garthe, H. Hötker*
Seminar der Marinen Mikrobiologie (2)	*J.F. Imhoff, H.-G. Hoppe*
Ergänzungskurs Molekulare Mikrobenökologie	*J.F. Imhoff mit J. Süling*
Seminar Molekulare Mikrobenökologie (für Diplomanden und Doktoranden) (2)	*J.F. Imhoff*
Ergänzungsveranstaltung für Hauptfächler: Biologische Meereskunde:	*H.-G. Hoppe, J.F. Imhoff, K. Lochte, D. Piepenburg, U. Sommer mit A.N. Antia, K. Gocke, R. Karez, M. Meyerhöfer, H. Rumohr, S. Schiel, W. Schramm, J. Süling, U. Zeller*

Biologisch-Meereskundliche Fächer	
Forschungsveranstaltung für Hauptfächler: Biologische Meereskunde:	*H.-G. Hoppe, J.F. Imhoff, K. Lochte, D. Piepenburg, U. Sommer mit A.N. Antia, K. Gocke, R. Karez, M. Meyerhöfer, H. Rumohr, S. Schiel, W. Schramm, J. Süling, U. Zeller*
Ergänzungsveranstaltung für Hauptfächler: Fischereibiologie	*D. Schnack mit C. Clemmesen, F.-W. Köster, U. Piatkowski, U. Waller*
Forschungsveranstaltung für Hauptfächler: Fischereibiologie	*D. Schnack mit C. Clemmesen, F.-W. Köster, U. Piatkowski, U. Waller*
Praktikum auf See	*Professoren und Dozenten des IfM*

Fächerübergreifend	
Meereskundliches Kolloquium (2)	*Professoren und Dozenten des IfM*
Anleitung zu selbständigen wissenschaftlichen Arbeiten	*Professoren und Dozenten des IfM*
Terrestrische und astronomische Ortsbestimmung auf See (2)	*V. Ohl*

10. Public Relations

10.1 Overview

Marine research issues are of great interest for the public. The Institute has established a Public Relation working group in 2001 to meet the growing demand for information about climate change, carbon Cycle in the ocean, sea level changes, environmental issue, effects of oil spills, toxic algae blooms, endangered species, fisheries resources etc. only to mention a few of the major questions being raised again and again.

The IfM-Internet pages were reviewed and updated and are now a first guide to the main research topics covered by the Institute. Links to other institution and to the sites of international programmes were established. Thus the IfM Homepage now serves as a portal to the marine science networks worldwide. (http://www.ifm.uni-kiel.de)

On a local basis PR activities were expanded by regular press releases, numerous interviews, contributions to media features and popular publications as well as public lecture series in the Aquarium, especially during the "Kieler Woche" event.

One means to foster relation of the Institute with local marine companies and the public in general is the "Gesellschaft zur Förderung des Instituts für Meereskunde e.V.". This non-profit organization has sponsored several public events, student sport activities etc.. By merchandising caps, cups, T-shirts etc. with the IfM-Logo the corporate identity became much clearer for the public.

In 2001 the Maasholm Centre for Environmental Education ("Naturerlebnisraum"), which started as a marine biology outpost of the IfM in the Schlei Lagoon in 1999, was formally inaugurated. The conversion of this facility, which was a NATO missile complex before, into an educational site was sponsored by local and state agencies. In Maasholm the Institute cooperates with GEOMAR and other organizations. In the EXPO-year 2000 the IfM participated in organizing the exhibition "The Blue Ocean" in the Kiel Norway Terminal. This joint effort of all institutions in the city with interests in marine research was very successful and attracted more than 15.000 paying visitors. Besides the IfM and GEOMAR, the Navy Research Centre and several University departments contributed to the exhibition, which was co-sponsored by the Federal Ministry of Research.

An new focus for PR activities of the Institute addressed schools, younger students and kids. There is a programme for school students to work at the institute for 2 weeks to get first insights into research work ("Schülerpraktikum"). There were more than 50 visits of school classes to the institute.

Furthermore the Institute organized special events to inform the general public about its research activities. Once a year, usually on Friday of Kieler Woche, the "Open Ship Day" at the IfM-Pier attracted thousands of visitors.

Since 1999 the IfM has participated in the "Schleswig-Holstein Kids' Festival" with a number of scientific games, a marine life touch-zoo, drawing competitions and other programmes for kids. Getting the kids means getting the parents interested as well, and all age groups welcome this effort.

A special service was set up for younger students interested in marine sciences by developing the "Ozean Online" pages.

In January 2000, this new project was started as a supplement to IfM's two-week professional training courses: for a week, high school students are given the opportunity to explore various aspects of ocean sciences by participating in practical work. In the second week, the students create a web page on an oceanographic topic of their choice under the guidance of IfM staff. By now (November 2001), 12 web pages are available on the internet:

http://www.OzeanOnline.de/

covering a wide range of topics in marine science from "Penguins" to "Climate Change". In spite of initial doubts with respect to the feasibility of this project, "Ozean Online" has been very well received both by the students and the public.

The Institute's Aquarium remains one focus of PR work throughout the year. There have been around 100.000 visitors each year (cp. special report of Aquarium).

In the next year, which is earmarked as "Year of Geosciences", the Institute will be a partner for organizing a number of events in cooperation with other institutions and the city of Kiel.

10.2 Presentations to public audience

Culik, B.M.: Humboldtpinguine und das Klimaphänomen El Niño. Zoologisches Museum der Christian- Albrechts-Universität Kiel, 14.3.1999.

Culik, B.M.: Pinguine: Berufstaucher mit speziellen Anpassungen. Schleswig-Holsteinische Universitätsgesellschaft, Verein Jordsand, Ahrensburg, 30.3.1999.

Culik, B.M.: Humboldtpinguine und ihr Lebensraum vor der Küste Chile's. Aquariumsvortrag, Institut für Meereskunde, Kiel, 11.5.1999.

Culik, B.M.: Plankton-Plantagen-Paradise: Wie vielfältig ist unser Zukunftsleben? Pinguinforschung in Deutschland. Jugendforum der Hypobank, München, 23.10.1999.

Culik, B.M.: Pinguine und Wale: Ein Leben unter Wasser. Schleswig-Holsteinische Universitätsgesellschaft, Sektion Heikendorf, Kiel, 18.11.1999.

Culik, B.M.: Antarktische Pinguine. Geographischer Klub, Madrid, Spain, 11.4.2000.

Culik, B.M.: Pinguine und Wale - ein Leben unter Wasser. Vortragsreihe "Maasholmer Meereskundliche Vorträge", Maasholm, 6.6.2000.

Culik, B.M.: Schweinswale und Pieper: Chancen und Risiken. Zoologisches Museum und Naturwissenschaftlicher Verein Kiel, 18.10.2000.

Culik, B.M.: Pinguine. Vier Präsentationen im Rahmen der Internationalen Kinder-und Jugendbuchaustellung "IKIBU" mit dem Motto "Winde weh'n, Schiffe geh'n" der Stadtbibliothek Duisburg, 14.11.2000.

Garthe, S.: Vorkommen und Gefährdung von Vögeln auf hoher See. Jahresversammlung der Ornithologischen Arbeitsgemeinschaft für Schleswig-Holstein und Hamburg. Rendsburg, 5.3.2000.

Garthe, S.: Auswirkungen von Offshore-Windkraftanlagen auf Vögel: Aktueller Kenntnisstand und notwendiger Forschungsbedarf. Fachtagung Offshore-Windparks. Alfred Töpfer Akademie für Naturschutz, Schneverdingen, 30.5.2000.

Garthe, S.: Untersuchungen zur Lebensweise des Basstölpels im Nord-Atlantik. Ortsgruppe Kiel der Ornithologischen Arbeitsgemeinschaft für Schleswig-Holstein & Hamburg, Kiel, 4.4.2001.

Imhoff, J.F.: Die Vielfalt mikrobieller Lebensformen in der Tiefsee. Leben ist Vielfalt. Woche der Biodiversität, Senckenberg Museum, Frankfurt, 27.11.2001.

Körtzinger, A.: "Rettet das Meer unser Klima?". Vortragsreihe "Maasholmer Meereskundliche Vorträge", Maasholm, 18.5.1999.

Körtzinger, A.: "Mensch und Klima - Rettet uns der Ozean?". Aquariumsvortrag, Institut für Meereskunde, Kiel, 19.6.1999.

Körtzinger, A.: Chemische und Biologische Sensoren im Zeitalter des globalen Wandels. InWater-Tec Konferenz, Kiel, 31.8.2001.

Lehmann, A.: Klima und Zirkulation der Ostsee. Zoologisches Museum der CAU, Naturwissenschaftlicher Verein für Schleswig-Holstein e.V., Kiel, 15.3.2000.

Lochte, K.: Von der Meeresoberfläche in die Tiefsee. Aquariumsvortrag, Kiel, 20.6.2001.

Lochte, K.: Die Produktivität des Ozeans. Zoologisches Museum der Universität Heidelberg, Heidelberg, 16.12.2001.

Oschlies, A.: Strömungen, Plankton, CO_2 - Klimaänderungen aus dem Meer. Aquariumsvortrag, Institut für Meereskunde, Kiel, 20.6.1999.

Oschlies, A.: Strömungen, Plankton, CO_2 - Klimaänderungen aus dem Meer. Naturwissenschaftlicher Verein Schleswig-Holstein, 10.11.1999.

Oschlies, A.: Klimawandel aus dem Meer - kann der Golfstrom versiegen? Vortragsreihe "Maasholmer Meereskundliche Vorträge", Maasholm, 14.8.2001.

Piatkowski, U.: Kalmare und Kraken: Giganten der Tiefsee. Aquariumsvortrag, Institut für Meereskunde, Kiel, 27.6.1999.

Piatkowski, U.: Kraken und Kalmare: Athleten der Hochsee. Zoologisches Museum, Universität Kiel, 28.1.2001.

Rumohr, H.: Die Bodenfauna des Fehmarn Belt – Leben im Windfang der Ostsee. Aquariumsvortrag, Institut für Meereskunde, Kiel, 14.2.2000.

Rumohr, H.: Bildgebende Verfahren in Benthosuntersuchungen. Sylter Sommerseminar im Alfred-Wegener-Institut, Wattenmeerstation List, Sylt, 14.8.2000.

Rumohr, H.: Leben und Sterben in der Ostsee. Rotary Club, Kappeln, 5.3.2001.

Ruprecht, E.: Das Ostseeprojekt BALTEX. Aquariumsvortrag, Institut für Meereskunde, Kiel, 18.6.2001.

Schramm, W.: Wozu sind Meeresalgen gut? Neuere Forschungsergebnisse aus der angewandten Meeresbotanik. Vortragsreihe "Maasholmer Meereskundliche Vorträge", Maasholm, 29.6.1999.

Stramma, L.: Die Meeresströmungen im tropischen Atlantik und ihre Rolle in der globalen Ozeanzirkulation. EXPO-Projekt "Der blaue Ozean", Kiel, 7.9.2000.

Send, U.: Technologien zur Erforschung des tiefen Ozeans. Aquariumsvortrag, Institut für Meereskunde Kiel, 25.6.2000.

Theede, H.: Schwefelwasserstoff im Meeresboden – wie gehen Tiere damit um? Vortragsreihe "Maasholmer Meereskundliche Vorträge", Maasholm, 23.5.2000.

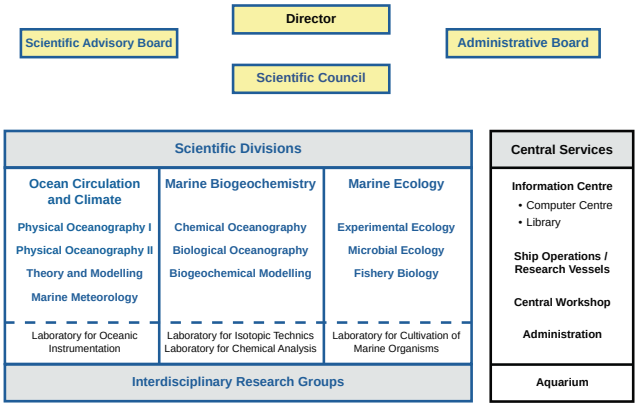
Waller, U.: Stand und Chancen der Aquakultur. Bundesverband der deutschen Fischindustrie, Frankfurt, 5.7.2001.

Willebrand, J.: Was macht eigentlich ein theoretischer Ozeanograph? Physikalisches Kolloquium, Universität Würzburg, Würzburg, 21.12.1999.

Wilson, R.P.: Einblicke in das geheime Leben von Schildkröten, Seevögeln und Meeressäugern: Was hi-tech Augen möglich machen. Nordwestdeutsche Universitätsgesellschaft, Wilhelmshaven, 31.8.2000.

Appendix A: Organisation[1]

A.1 Management[1]



Organizational Structure of the IfM

A.1.1 Director

Prof. Dr. J. Willebrand
Head FB1: Prof. Dr. C. Boening
Head FB2: Prof. Dr. D.W.R. Wallace
Head FB3: Prof. Dr. U. Sommer
Provost: Prof. Dr. G. Kortum

A.1.2 Scientific Council

Chair: Prof. Dr. E. Ruprecht
Deputy: Prof. Dr. D. Schnack

Members:

Dr. A. Antia (FB2) (Dr. I. Kriest)
Prof. Dr. C. Böning (FB1)
Dr. J. Dengg (FB1) (Dr. T. Martin)
Prof. Dr. J.F. Imhoff (FB2)
Prof. Dr. K. Lochte (FB2)
Dr. U. Piatkowski (Dr. C. Clemmesen-Bockelmann)
Prof. Dr. E. Ruprecht (FB1)
Prof. Dr. D. Schnack (FB2)
Prof. Dr. F. Schott (FB1)
Prof. Dr. U. Send (FB1)
Prof. Dr. U. Sommer (FB2)
Prof. Dr. D. Wallace (FB2)

A.1.3 Administrative Board (Kuratorium)

During the reporting period 1999-2001 the Administrative Board of the IfM met 14.9.2000, 25.1.2001 and 29.11.2001.

The members of the Administrative Board are:

Dr. B. Hendriks (Chair)
Ministerium für Bildung, Wissenschaft, Forschung und Kultur des Landes Schleswig-Holstein
Kiel

D. Deneke
Bundesministerium für Bildung und Forschung
-Referat 425-
Bonn

Dr. H. Eggers
Bundesministerium für Bildung und Forschung
-Referat 425-
Bonn

M. Wagner
Ministerium für Bildung, Wissenschaft, Forschung und Kultur des Landes Schleswig-Holstein
Kiel

Prof. Dr. T. Bauer
Math.- Nat. Fakultät der CAU Kiel
Kiel

Prof. Dr. C. Dullo
Forschungszentrum für Marine Geowissenschaften "GEOMAR" der CAU Kiel
Kiel

Prof. Dr. B. B. Jørgensen
Max-Planck-Institut für Marine Mikrobiologie
Bremen

1. Note: all details of this section are effective: Dec. 31, 2001

A.1.4 Scientific Advisory Board

During the reporting period 1999-2001 the Scientific Advisory Board of the IfM met 12.9.-13.9.2000 and 27.11.-28.11.2001.

The members of the Scientific Advisory Board are:

Prof. Dr. B. B. Jørgensen (Chair)
Max-Planck-Institut für Marine Mikrobiologie
Bremen
(8.8.1995-30.6.2003)

Prof. Dr. D. L. T. Anderson
ECMWF
Reading, UK
(1.11.2001-31.10.2005)

Prof. Dr. Y. Desaubies
IFREMER
Plouzane, France
(30.10.1996-1.11.2000)

Prof. Dr. H. Graßl
Max-Planck-Institut für Meteorologie
Hamburg
(1.6.2000-31.5.2004)

Prof. Dr. M. Heimann
Max-Planck-Institut für Biogeochemie
Jena
(1.6.2000-31.5.2004)

Prof. Dr. W. Lampert
Max-Planck-Institut für Limnologie
Plön
(9.9.1997-31.10.2005)

Prof. Dr. P. S. Liss
University of East Anglia, School of
Environmental Sciences
Norwich, UK
(30.11.1995-30.11.2003)

Prof. Dr. W. de Ruijter
Institute of Marine and Atmospheric Research
Utrecht, The Netherlands
(8.8.1995-30.6.2003)

Prof. Dr. E. Sakshaug
NTNU, Trondkeim Biol. Station
Trondheim Norway
(1.6.2000-31.5.2004)

Prof. Dr. J. G. Shepherd
School of Ocean and Earth Science
Southampton Oceanography Centre
Southampton, UK
(1.6.2000-31.5.2004)

Appendix B: Staff (31. December 2001)

B.1 Research Division 1: Ocean Circulation and Climate

Division Head: Prof. Dr. C. Böning
Deputy: Prof. Dr. F. Schott

(For abbreviations, see section B.7 or Appendix D).

B.1.1 Permanent Positions

Scientific Staff

Prof. Dr. C. Böning (TM)
Dr. P. Brandt (PO1)
Dr. K. Bumke (ME)
Dr. J. Dengg (TM)
Dr. J. Fischer (PO1)
Prof. Dr. R. Käse (TM)
Dr. J. Kielmann (TM)
Dr. A. Macke (ME)
Dr. T. Müller (PO2)
Dr. A. Oschlies (TM)
Prof. Dr. E. Ruprecht (ME)
Prof. Dr. F. Schott (PO1)
Prof. Dr. U. Send (PO2)
Dr. L. Stramma (PO1)
Dr. K. Uhlig (ME)
Prof. Dr. J. Willebrand (TM)
Dr. W. Zenk (PO2)

Secretaries and Technical Staff

B. Binger (TM)
S. Braun-Schroeder (TM)
H. Carlsen (PO2)
T. Csernok (PO2)
G. Dorn (TM)
K. Grunau (TM)
U. Hecht (ME)
A. Kipping (PO2)
S. Komander-Hoepner (PO1)
H.J. Langhof (PO1)
R. Link (PO2)
N. Mahmud (PO1)
C.-H. Meinke (PO1)
A. Meyer (ME)
P. Meyer (PO2)
M. Müller (PO1)
F. Nevoigt (ME)
G. Niehus (PO2)
U. Papenburg (PO1)
C. Schuster (PO2)
A. Schurbohm (TM)
P. Timm (ME)

B.1.2 Externally funded staff

Scientist/Technicans	Project
Dr. J. Abshagen	SFB 460 B4
Dipl.-Oz. T. Avisc	EU ANIMATE
Dr. J.-O. Beismann	SFB 460 A6
Dr. A. Biastoch	DEKLIM
Dr. L. v. Bremen	GKSS, DFG, DWD
Dr. M. Dengler	SFB 460 A4
U. Dombrowsky	CLIVAR
Dr. J. Hauser	SFB 460 A1/A3
Dr. M. Kawamiya	JGOFS Indik
Dr. H. Klindt	BMBF
U. Koy	CLIVAR, SFB 460
Dipl.-Oz. U. Krebs	CLIVAR marin
Dr. J. Kröger	CLIVAR marin
Dr. A. Lehmann	BMBF
Dipl.-Geogr. M. Lüning	CLIVAR marin Project Office
Dr. T. Martin	EU-SEALION
Dr. H. Mehrtens	DFG
M. Nielsen	EU
A. Pinck	SFB 460
Dr. R. Scheirer	EU-CIRAMOSA
M. Schütt	SFB 460
Dr. A. Timmermann	SFB 460 B4
Dr. A. Villwock	International CLIVAR Project Office

Ph.D. Students	Project
Dipl.-Met. H. Berndt	SFB 460 B2
Dipl.-Met. B. Brodersen	SFB 460 B1
Dipl.-Met. M. Clemens	EU-JOULE, SFB
Dipl.-Oz. L. Czeschel	SFB 460 A6
Dipl.-Oz. C. Dieterich	CLIVAR
Dipl.-Oz. H. Dietze	Subtropen-DOM, DFG
Dipl.-Met. W. Frerichs	DWD, CM-SAF
Dipl.-Oz. M. Hamann	CLIVAR
Dipl.-Met. H. Hauschildt	EU-CLIWANET
Dipl.-Oz. F. Justino	SFB B4
Dipl.-Oz. T. Kanzow	CLIVAR
Dipl.-Oz. D. Kindler	SFB 460 A2, GYROSCOPE
Dipl.-Met. U. Löhnert	Microwelle
Dipl.-Math. U. Löptien	SFB 460 B2
Dipl.-Oz. A. Macrander	SFB 460 A1
Dipl.-Met. S. Meyer	4 D-Wolken
Dipl.-Met. M. Schewski	4 D-Wolken
Dipl.-Oz. R. Schoenefeldt	SFB 460 A4
Dipl.-Met. S. Schröder	SFB 460 B1
Dipl.-Oz. U. Schwecken-diek	SFB 460 B3
Dipl.-Met. O. Timm	SFB 460 B1

B.2 Research Division 2: Marine Biogeochemistry

Division Head: Prof. Dr. D.W.R. Wallace
Deputy: Prof. Dr. K. Lochte

B.2.1 Permanent Positions

Scientific Staff

Dr. A. Antia (BI)
Dr. H. Bange (CH)
Dr. K. v. Broeckel (BI)
Dr. H. Hansen (CH)
Dr. U. Horstmann (BI)
Prof. Dr. A. Körtzinger (CH)
Prof. Dr. J. LaRoche (BI)
Prof. Dr. K. Lochte (BI)
Dr. I. Peeken (BI)
Dipl. Biol. A. Stuhr (BI)
Prof. Dr. D.W.R. Wallace (CH)

Secretaries and Technical Staff

M. Bartlomiej (BI)
P. Fritsche (BI)
H. Johannsen (CH)
P. Krischker (CH)
K. Nachtigall (BI)
G. Petrick (CH)
U. Rabsch (LI)
F. Malien (CH)
B. Sehlke (BI)
K. Stange (CH)
P. Streu (CH)
U. Weidinger (CH)
N. Winter (BI)

B.2.2 Externally funded staff

Scientist/Technicans	Project
Dr. G. M. Berg	Humboldt
Dr. K. Friis	SFB 460 A5
Dipl. Biol. J. Herrmann	JGFOS
Dr. P. Kähler	
Dr. I. Kriest	JGOFS
Dr. M. Mills	
Dr. B. Quack	DFG
Dipl. Chem. U. Richter	BMBF-Tracerzirkel

Ph.D. Students	Project
E. Breitbarth	BMBF
Dipl. Chem. G. Cziudaj	DFG
Dipl. Biol. A. Davidov	BMBF
W. Gaul	DFG
A. Kirch	DFG
V. Kuhnhenn	BMBF
H. Lüger	EU (CAVASSOO)
S. Nissen	DFG
Dipl. Biol. S. Walter	DFG

B.3 Research Division 3: Marine Ecology

Division Head: Prof. Dr. U. Sommer
Deputy: Prof. Dr. D. Schnack

B.3.1 Permanent Positions

Scientific Staff

Dr. K. Gocke (MI)
Prof. Dr. H.-G. Hoppe (MI)
Prof. Dr. J.F. Imhoff (MI)
Dr. R. Karez (EX)
Dr. F.W. Köster (FI)
Dr. U. Piatkowski (FI)
Dr. H. Rumohr (EX/FI)
Prof. Dr. D. Schnack (FI)
Prof. Dr. U. Sommer (EX)
Dr. W. Schramm (EX)
Dr. J. Süling (MI)
Dr. E.A. Trippel (FI)
Dr. U. Waller (FI)
Dr. R. Wilson (EX2)

Secretaries and Technical Staff

M. Bruhn (FI)
H. Gonschior (EX2)
R. Koppe (MI)
F. Lappe (MI)
R. Lüthje (FI)
V. Martens (EX)
S.-O. Mees (FI)
H. Mempel (FI)
B. Reuter (MI)
B. Rohloff (FI)
R. Schütt (EX2)
C. Stielau (EX)
M. Strasdas (EX)
R. Wicher (MI)

B.3.2 Externally funded staff

Scientist/Technicans	Project
P. Boyer	
A. Burmeister	
Dr. C. Clemmesen-Bockelmann	EU - MACOM
Dr. R. Froese	BMBF - FishBase
Dipl.-Biol. V. Grabowski	BMBF - Schwämme
T. Hansen	
Dr. J. Hennicke	DFG
Dr. M. Holzmann	DFG GATEWAYS
D. Jarosch	
Dipl.-Biol. S. Jaschinski	DFG
Dipl.-Biol. S. Ludwig	
Dipl.-Biol. S. Moorthii	
Dipl.-Biol. R. Ptacnik	DFG
Dipl.-Ing. C. Rautenstrauch	
Dipl.-Biol. M. Sandow	BMBF
Dr. R. Schmaljohann	BMBF
Dipl.-Biol. F. Sommer	DFG
Dr. R. Stöhr	BMBF-Schwämme
Dr. H. Thetmeyer	EU - MERAMEO
Dipl.-Biol. B. Weitzel	BMBF

Ph.D. Students	Project
Dipl.-Biol. K. Abt	
Dipl.-Biol. A. Bamberger	
Dipl.-Biol. I. Beserra Galvao	
Dipl.-Biol. D. Brepohl	
Dipl.-Biol. C. Bucher	
Dipl.-Biol. V. Bühler	EU - MACOM
Dipl.-Biol. R. Diekmann	EU - LIFECO
Dipl.-Biol. A. Drossou	
Dipl.-Biol. M. Kamal	
Dipl.-Biol. S.-K. Kim	
Dipl.-Biol. S. Klimpel	EU - Hersur II
Dipl.-Biol. M. Kock	
Dipl.-Biol. G. Kraus	EU - STORE
Dipl.-Biol. U. Kubetzki	
M.Sc. S. Kupschus	
Dipl.-Biol. A. Malzahn	
Dipl.-Biol. B. Meusel	
Dipl.-Biol. H. Möhlig	
Dipl.-Biol. C. Möllmann	EU - FishBase
Dipl.-Biol. B. Munkes	
Dipl.-Biol. J. Orellana	
Dipl.-Biol. J. Schmidt	
Dipl.-Biol. A. Simeone	
Dipl.-Biol. A. Steinfurth	
Dipl.-Biol. S. Storch	DFG
Dipl.-Biol. R. Voss	EU - LIFECO
Dipl.-Biol. B. Willert	EU - MACOM

B.4 Central Facilities:

B.4.1 Adminstration

Head: J. Wittmaack
Deputy: H. Vogt

G. Bauer
U. Frank-Scholz
M. Gebert
S. Genrich
C. Hansen
M. Holtmeier
A. Jakobi
K. Jaekel
T. Jahn
R. Klotz
T. Lentfer
S. Manikowski
B. Moll
M. Roeske
K. Schäfer
H. Schomann
A. Schweder
H.-G. Seemann
P. Wehrhahn
W. Westendorf
U. Ziemus-Kroll

B.4.2 Aquarium

Scientific Head: Dr. U. Waller
Technical Head: M. Gruber

V. Bundtzen
E. Glapa
M. Gruber
M. Rohmann
H. Schröder
A. Stein

B.4.3 Central Workshop

Head: U. Lentz

P. Krüger
H. Langmaack
P. Marquardt
G. Peters
O. Rechner
U. Stephan
D. Wehrend
Electronic-Lab.: M. Steen

B.4.4 Information Centre

Computer Centre
Head: Dr. J. Kielmann

K. Grunau
B. Kisjeloff
D. Richter

Library
Scientific Head: Prof. Dr. G. Kortum
Mangaging Head: B. Schmidt

Library Assistant: M. Lembke

Darkroom: I. Oelrichs
Cartography: M. Heinitz; R. Hellwig

B.4.5 IfM Staff of Research Vessels

Research Vessel Coordination and Planning:
Prof. Dr. G. Kortum

H.-J. Böhnke (Alkor)
F. Herzam (Littorina)
V. Ohl (Littorina)
D. Rauch (Littorina)
H. Schramm (Polarfuchs)
R. Wontorra (Littorina)

B.4.6 Other Facilities

Laboratory for Isotopic Technics (FB2, FB3):
U. Rabsch (Head)

Laboratory for Chemical Analysis (FB2, FB3):
Prof. Dr. D.W.R. Wallace (Head)

Laboratory for Cultivation of Marine Organisms (FB3, FB2):
Dr. U. Waller (Head)

Laboratory for Oceanic Instrumentation (FB1):
Dr. T.J. Müller (Head)

B.5 Emeritus Professors

Prof. Dr. D. Adelung
Prof. Dr. H. Flügel
Prof. Dr. S. Gerlach
Prof. Dr. L. Hasse
Prof. Dr. W. Krauß
Prof. Dr. G. Rheinheimer
Prof. Dr. H. Rosenthal
Prof. Dr. G. Siedler
Prof. Dr. B. Zeitzschel

B.6 Staff Changes

During the reporting period 1999-2001 the following employees left the institute:

Name	Unit	employed until
Prof. Dr. D. Adelung	ZO	31.03.2001
Dipl. Biol. B. Alexander	MI	31.05.2001
B. Altenscheidt	ZV	30.11.2001
K. Bahrenfuß	PO1	13.04.1999
B. Baschek	PO2	31.08.1999
E. Becker	PO2	30.06.1999
Dipl. Oz. S. Becker	PO2	30.06.1999
Dipl. Biol. G. Behrends	FI	30.06.1999
PD. Dr. U.-G. Berninger	EX	30.11.2000
Dr. T. Blanz	CH	31.03.2000
Dr. R. Boje	BI	31.10.1999
A. Borck	ZV	31.01.1999
Dr. C. Borowski	MI	31.08.2000
Dr. L. Bremen, von	ME	30.09.2001
K. Burkert	FI	22.02.1999
O. Chinnow	PO1	30.04.2001
Prof. Dr. B. Culik	ZO	11.10.2000
H. Drews	ZV	30.06.2001
Dipl. Biol. M. Drews	MI	31.10.1999
M. Drews	ZV	31.05.1999
Dr. C. Eden	TM	31.12.2000
Dipl. Oz. U. Ernst	TM	30.06.2000
Dipl. Biol. U. Fehner	BI	30.06.1999
Prof. Dr. H. Flügel	EX	31.03.1999
D. Friese	FI	30.06.1999
Dr. S. Garthe	EX	14.06.2001
Dipl. Biol. S. Gollasch	FI	31.12.1999
D. Gutberlet	AQ	31.12.2000
Dr. R. Hagedorn	ME	30.06.2000
D. Hahn	ZSL	31.01.2000
Dr. M. Harder	ME	31.07.2000
Dr. J. Hauser	TM	30.09.2001
Dipl. Biol. J.C. Hennicke	EX	07.12.2000
Dr. H. Hillebrand	EX	14.09.1999
Dr. M. Hilmer	ME	31.07.2001
D. Hoffmann	MI	31.10.1999
Dr. H. Holfeld	EX	31.07.1999
Dr. J. Holfort	PO2	30.06.1999
Dr. T. Jung	ME	31.12.2000
U. Junghans	BI	31.12.2000
Dr. R. Jürrens	ME	31.01.1999
Dr. N. Kannan	CH	31.05.1999
Dipl. Met. U. Karger	ME	30.06.1999
Dr. G. Karsten	MI	31.03.2001
Dr. T. Kath	MI	30.11.2000
Dipl. Oz. D. Kieke	PO1	31.12.2000
Dr. W. Koeve	BI	24.08.2000
R. Krehl	BI	30.04.2000
Dr. K. Kremling	CH	30.09.2000
A. v. Kruijssen-Koch	ZV	31.08.1999
Dr. J. Kuß	CH	31.03.1999
Dipl. Biol. A. Lauer	MI	30.09.1999
Prof. Dr. P. Lemke	ME	31.01.2001
Dipl. Oz. B. Lenz	PO2	31.03.2000
Dipl. Phys. C. Lichtenberg	PO1	30.06.1999
Dr. R. Lindau	ME	31.03.2000
Dipl. Oz. J. Lippmann	TM	30.09.1999
Dipl. Met. U.W. Löhnert	ME	31.08.2001
K. Maaß	PO1	30.06.2001
W. Marwedel	AQ	30.11.1999
Dipl. Biol. J.F. Meißner	EX	28.02.1999
Dr. C. Mertens	PO1	30.06.1999
Dipl. Oz. T. Mitzka	BI	30.06.1999
Dr. A. Müller	FI	31.12.2000
B. Müller	PO1	10.06.2001
Dipl. Biol. M. Nolting	FI	30.11.1999
Dipl. Biol. U. Ohlendieck	BI	31.12.1999
Dr. C. Osterroht	CH	31.08.2001
Dr. H. Palm	FI	31.05.1999
A. Paulsen	CH	31.03.2000
PD. Dr. A. Peters	EX	31.07.2001
Dr. G. Peters	EX	11.05.1999
Dipl. Chem. R. Petri	MI	30.09.1999
Dipl. Oz. K. Petuhov	BI	31.03.2000
Dr. O. Plähn	PO1	15.03.1999
M. Plikshs	FI	14.08.1999
Dr. L. Podgorsek	MI	31.08.2000
G. Porsch	ZW	30.04.1999
A. Prang	CH	31.03.1999
Dr. R.-A. Redler	TM	30.06.1999
Dipl. Oz. J. Reppin	PO2	31.01.2001
PD. Dr. J.-J.Rick	EX	31.05.2000
Dipl. Oz. N. Rix	TM	31.01.1999
Dipl. Biol. N. Rohlf	FI	30.11.2000

Name	Unit	employed until
Prof. Dr. H. Rosenthal	FI	31.03.2001
Dr. M. Schartau	TM	31.05.2001
Prof. Dr. D. Schulz-Bull	CH	31.03.2001
S. Schweinsberg	CH	30.06.1999
K. Sommer	ZSL	31.03.2001
Dr. N. Steiner	ME	31.10.2000
R. Stöhr	MI	31.12.2001
Dr. S. Stutzer	TM	30.06.1999
Prof. Dr. H. Theede	MI	30.09.1999
Dipl. Biol. R. Thomas	FI	14.09.2001
Dr. R. Tyler	TM	30.06.1999
Dr. B. Ueberschär	FI	28.02.1999
Dipl. Oz. M. Vanicek	PO2	14.03.1999
Dr. C. Völker	TM	31.12.2000
Dipl. Oz. M. Walter	PO1	31.10.2000
J. Waniek	BI	31.08.2000
H. Wessel	ZV	31.03.2001
Dipl. Oz. D. Wilhelm	PO1	31.07.2000
G. Wilhelm	CH	04.09.2001
H. Wilker	ME	30.06.1999
Dr. B. Worm	EX	04.03.2000
H. Worthmann	FI	31.07.2001
Prof. Dr. B. Zeitzschel	BI	30.09.2000
Dr. U. Zeller	BI	14.05.2000

B.7 Abbreviations of Research Units and Central Facilities

AQ	Aquarium
BI	Biological Oceanography
BM	Beogeochemical Modelling
CH	Chemical Oceanography
EX	Experimental Ecology
EX2	Experimental Ecology II
FI	Fischery Biology
ME	Marine Meteorology
MI	Micobial Ecology
PO1	Physical Oceanography I: Large-scale Circulation
PO2	Physical Oceanography II; Processes and Observing Systems
TM	Theory and Modelling
ZO	Zoology
ZSL	Research Vessel: Littorina
ZV	Administration
ZW	Central Workshop

Appendix C: Budgets

C.1: Budget Statement

Note: all details are in 1000 German Marks (DM))

	1999	%	2000	%	2001	%
Total volume	33.016.0		32.654.5		34.679.3	
Personnel	14.768.0	44,73	14.949.0	45,78	14.495.0	41,8
Materials	18.248.0	55,27	17.705.5	54,22	20.184.3	58,2
External funds (Projects)	9.468.0		12.389.0		10.554.0	
Federal part (BMBF)	3.273.0	34,57	5.803.0	46,84	3.750.0	35,53
DFG part	3.211.0	33,91	3.567.0	28,79	3.881.0	36,77
SFB 460 part	*2.536.4*		*2.609.0*		*2.589.3*	
Other project budgets	2.984.0	31,52	3.019.0	24,37	2.923.0	27,70
EU part	*2.219.0*		*2.079.0*		*2.170.0*	

More details on the externally funded projects can be found in the following section.

Appendix C.2: Project Themes and Budgets

Table 1: Forschungsbereich 1: Project themes and budgets

No.	Shorttitle/ Framework	Research theme	Region	Funding Agency	Lead PI	Funding period	Budget (DM)
1	SFB460/A1	Overflow und Vermischungsprozesse in der Irmingersee	Nordatlantik	DFG	Käse/Krauß	01.07.96 - 30.06.99	654.800,--
2	SFB460/A2	Tiefe Konvektion: Prozesse, integrale Effekte und Variabilität	Nordatlantik	DFG	Send/Schott	01.07.96 - 30.06.99	1.036.500,--
3	SFB460/A3	Wassermassentransformation im östlichen Becken	Nordatlantik	DFG	Zenk/Siedler	01.07.96 - 30.06.99	933.900,--
4	SFB460/A4	Schwankungen von Wassermassenverteilung und Zirkulation im westlichen Becken	Nordatlantik	DFG	Schott/Rhein	01.07.96 - 30.06.99	886.900,--
5	SFB460/A6	Simulation des subpolaren Nordatlantiks mit hochauflösenden Modellen	Nordatlantik	DFG	Böning/ Willebrand	01.07.96 - 30.06.99	581.800,--
6	SFB460/B1	Variabilität der Flüsse an der Meeresoberfläche	Atlantik	DFG	Ruprecht/Simmer	01.07.96 - 30.06.99	557.000,--
7	SFB460/B2	Rolle der Meereisvariabilität für den Wasser- und Energieaustausch Ozean-Atmosphäre	Arktis	DFG	Lemke/Ruprecht	01.07.96 - 30.06.99	410.800,--
8	SFB460/B3	Längerperiodische Schwankungen im System Ozean / Atmosphäre über dem Nordatlantik	Nordatlantik	DFG	Willebrand/Lemke	01.07.96 - 30.06.99	713.100,--
9	SFB460/Z	Koordination		DFG	Schott/Willebrand	01.07.96 - 30.06.99	497.600,--
10	SFB460	Meteor 45, Koordination	Nordatlantik	DFG	Schott	01.05.99 - 30.06.00	365.729,--
11	SFB460/A1	Overflow und Vermischungsprozesse in der Irmingersee	Nordatlantik	DFG	Käse/Send	01.07.99 - 31.12.02	805.400,--
12	SFB460/A2	Tiefe Konvektion: Prozesse, integrale Effekte und Variabilität	Nordatlantik	DFG	Send/Schott	01.07.99 - 31.12.02	895.800,--
13	SFB460/A3	Wassermassentransformation im östlichen Becken	Nordatlantik	DFG	Zenk/Käse	01.07.99 - 31.12.02	768.400,--

Table 1: Forschungsbereich 1: Project themes and budgets

No.	Shorttitle/ Framework	Research theme	Region	Funding Agency	Lead PI	Funding period	Budget (DM)
14	SFB460/A4	Schwankungen von Wassermassenverteilung und Zirkulation im westlichen Becken	Nordatlantik	DFG	Schott/Rhein	01.07.99 - 31.12.02	1.346.100,--
15	SFB460/A6	Modellierung der Zirkulation und Wassermassentransformation im subpolaren Nordatlantik	Nordatlantik	DFG	Böning/ Willebrand	01.07.99 - 31.12.02	577.000,--
16	SFB460/B1	Wechselwirkung zwischen Ozean und Atmosphäre in verschiedenen Zeitskalen	Atlantik	DFG	Ruprecht/Dullo	01.07.99 - 31.12.02	536.300,--
17	SFB460/B2	Rolle der Meereisvariabilität für den Wasser- und Energieaustausch Ozean-Atmosphäre	Arktis	DFG	Lemke/Ruprecht	01.07.99 - 31.12.02	570.200,--
18	SFB460/B3	Längerperiodische Schwankungen im System Ozean / Atmosphäre über dem Nordatlantik	Nordatlantik	DFG	Willebrand/ Wallace	01.07.99 - 31.12.02	565.000,--
19	SFB460/B4	Dynamik thermohaliner Zirkulationsschwankungen	Nordatlantik	DFG	Timmermann	01.04.01 - 31.12.02	668.200,--
20	SFB460/Z	Koordination		DFG	Schott/Willebrand	01.07.99 - 31.12.02	1.570.400,--
21	SFB460	Meteor 50, Koordination	Nordatlantik	DFG	Schott	03/2000- 04/2001	317.732,--
22		Anwendung neuronaler Netze zur Ableitung hydrometeorologischer Parameter	Global	DFG	Ruprecht	09/1999 - 08/2000	58.100,--
23		Datenorientierte Modellierung der biologischen Produktion im Atlantik: Assimilation in ein gekoppeltes physikalisch-biologisches Modell	Nordatlantik	DFG	Willebrand/ Oschlies	10/1999 - 09/2001	143.800,--
24		Sensitivitätsstudien zur Satellitenfernerkundung von Chlorophyll im vertikal geschichteten offenen Ozean	Nordatlantik	DFG	Ruprecht/Martin	10/1999 - 09/2002	165.000,--
25	Subtropen-DOM	Modellgestützte Untersuchungen zur Bedeutung von gelöstem organischen Material (DOM) für Abschätzungen neuer Produktion und Exportproduktion im oligotrophen subtropischen Atlantik	Nordatlantik	DFG	Oschlies/ Willebrand	10/2000 - 09/2002	100.200,--

Table 1: Forschungsbereich 1: Project themes and budgets

No.	Shorttitle/ Framework	Research theme	Region	Funding Agency	Lead PI	Funding period	Budget (DM)
26		Änderung der Sturmhäufigkeit auf dem Weltmeer, untersucht anhand von Luftdruckbeobachtungen	Global	DFG	Hasse/Bumke	03/2001 - 02/2003	100.000,--
27	TIEFBIT	Tiefenwasserzirkulation in Äquatornähe und interhemisphärische Transporte	Äquatorialer Atlantik	BMBF	Schott/Stramma/ Fischer	07/1996 - 07/1999	341.100,--
28	TIEFBIT	Tiefenwasserzirkulation in niederen Breiten und interhemisphärische Transporte	Äquatorialer Atlantik	BMBF	Käse	07/1996 - 06/1999	402.500,--
29	TIEFBIT	Tiefe Zirkulationssysteme in Schlüsselregionen des Westpazifiks	Pazifik	BMBF	Siedler	07/1996 - 06/1999	469.100,--
30	TIEFBIT	Interhemisphärischer Transport von Wassermassen und Spurenstoffen im äquatorialen Atlantik	Äquatorialer Atlantik	BMBF	Böning	07/1996 - 07/1999	260.900,--
31	APG FLOATS	Untersuchungen der Tiefenwasserkonvektion im westlichen Mittelmeer "Autonom Profilierenden Geräteträger - Tiefendriftern"	Mittelmeer	BMBF	Send	09/1997 - 05/2001	323.475,--
31	ESTOC/JGOFS IV	Langzeitstudien bei den Kanarischen Inseln (ESTOC) - Physikalische Ozeanographie und Partikelfluß	Nordatlantik	BMBF	Siedler/Wefer	10/1997 - 03/2000	303.960,--
33	BALTEX: LWC	Kombinierte Mikrowellenradiometer- und Wolkenradarfernerkundung zur Bestimmung der Vertikalverteilung des Wassergehaltes in der Atmosphäre	Ostsee	BMBF	Macke	05/1998 - 08/2001	194.502,--
34	BALTEX: Energie	Energiezyklus im BALTEX-Gebiet	Ostsee	BMBF	Ruprecht	10/1998 - 03/2000	274.000,--
35	CLIVAR marin	Synthese der Monsunzirkulation des Indischen Ozeans	Indik	BMBF	Willebrand/ Schott/ Quadfasel	03/1999 - 02/2002	563.479,--
36	CLIVAR marin	Integrale Erfassung der Intensität der thermohalinen Zirkulation	Nordatlantik	BMBF	Send/Rhein/Zenk	03/1999 - 02/2002	1.456.713,--
37	CLIVAR marin	Hochauflösende Modellierung der Zirkulation des Atlantischen Ozeans	Atlantik	BMBF	Böning	03/1999 - 02/2002	566.232,--
38	CLIVAR marin	Koordination	Atlantik / Indik	BMBF	Schott	seit März 1999	233.499,--

Table 1: Forschungsbereich 1: Project themes and budgets

No.	Shorttitle/ Framework	Research theme	Region	Funding Agency	Lead PI	Funding period	Budget (DM)
39	CLIVAR marin	Tropisch-subtropische Wechselwirkung im Atlantik	Atlantik	BMBF	Schott/Stramma/ Fischer	08/1999 - 02/2002	861.163,--
40	CLIVAR	Unterstützung des internationalen Programms zur Klimavariabilität und -vorhersage	Global	BMBF	Willebrand	01/2001 - 12/2003	175.224,--
41	JGOFS-Indik	Raum-zeitliche Strukturen der biologischen Produktion im Arabischen Meer: Synthese von in-situ Beobachtungen, Fernerkundungsdaten u. Modellergebnissen	Indik	BMBF	Willebrand/ Oschlies/Lochte	03/2001 - 02/2003	693.168,--
42	4D Wolken (AFO2000)	Parametrisierung der Strahlungsfelder inhomogener Bewölkung		BMBF	Macke	03/2001 - 03/2004	418.006,--
43	DEKLIM	Einfluß der Ostsee und des Jahresganges der Eisbedeckung auf den Wasser- und Energiehaushalt der BALTEX-Region	Ostsee	BMBF	Krauß/Send/ Harms	05/2001 - 04/2004	354.466,--
44		Klimasensitivität der biologischen Pumpe	Nordatlantik	BMBF	Oschlies/Antia/ Lochte	07/2001 - 06/2003	311.859,--
45	DEKLIM	Ozeanische Aufnahme anthropogener Spurengase: Realistische Darstellung des Effekts mesoskaliger Prozesse in Zirkulationsmodellen	Atlantik	BMBF	Böning	09/2001 - 08/2004	607.777,--
46	CANIGO	Canary Islands Azores Gibraltar Observations	Nordatlantik	EU	Send	08/1996 - 09/1999	401.700,--
47	CANIGO	Canary Islands Azores Gibraltar Observations	Nordatlantik	EU	Siedler	08/1996 - 09/1999	916.500,--
48	CANIGO	Canary Islands Azores Gibraltar Observations	Nordatlantik	EU	Käse	08/1996 - 09/1999	257.400,--
49	MATER 201	Mediterranean Targeted Project-Mass Transfer and Ecosystem Response	Mittelmeer	EU	Send/Rhein	08/1996 - 12/1999	565.500,--
50	INTAS	A new, full-field approach to acoustic tomography of ocean currents in the coastal zone		EU	Send	03/1997 - 02/1999	10.000,--

Table 1: Forschungsbereich 1: Project themes and budgets

No.	Shorttitle/ Framework	Research theme	Region	Funding Agency	Lead PI	Funding period	Budget (DM)
51	BALTEX:PEP	Pilot study of evaporation and precipitation in BALTEX	Ostsee	EU	Bumke	11/1997 - 10/2000	156.500,--
52	OCTOPUS	Ocean Tomography Operational Package and Utilization Support		EU	Send	02/1998 - 04/2001	507.700,--
53	DOMINOE / INTAS	Dissolved organic matter as a component of ocean ecosystem and carbon cycle		EU	Willebrand/ Oschlies	03/1998 - 02/2001	11.735,--
54	CARTUM	Comparative analysis and rationalization of second-moment turbulence models		EU	Willebrand/ Oschlies	01/1999 - 12/2001	19.558,30
55	BALTEX: CLIWA-NET	Satellite remote sensing of cloud liquid water and integration of ground-based observations	CLIWA-NET	EU	Macke	03/2000 - 02/2003	181.986,07
56	Gyroscope	Development of a real time *in situ* observing system in the North Atlantic Ocean, by an array of Lagrangian Profiling floats	Nordatlantik	EU	Send/Zenk	01/2001 - 12/2003	1.725.550,59
57	Str.-Cirrus CIRAMOSA	Compilation of regional cirrus macro- and microphysical properties		EU	Macke	02/2001 - 02/2004	234.081,58
58	ANIMATE	Atlantic Network of Interdisciplinary Moorings and Timeseries for Europe	Nordatlantik	EU	Send/Wallace		1.724.800,--
59	NOCES	Northern Ocean-Atmosphere Carbon Exchange Study		EU	Oschlies	12/2001 - 12/2003	333.351,--
60	SAT:LWP /Climate - SAT	Cloud liquid water path from NOAA16 AVHRR data	Europa	EUMETSAT /DWD	Macke	01/2001 - 12/2001	
61	Str.-Wolken/ GKSS	Entwicklung eines 3D Strahlungstransportmodells für die inhomogen bewölkte Atmosphäre			Macke/Stuhlmann	02/1998 - 01/2001	167.196,93
62	Str.-Param./ GKSS	Parametrisierung der Strahlungsbilanz im Regionalmodell			Macke/Rockel	01/2001 - 12/2002	118.000,--
63	NAO: Europa	Die Nordatlantische Oszillation: Regionale Auswirkungen auf das Wetter und Klima Europas	Nordatlantik/ Europa	VW	Ruprecht	12/1999 - 11/2002	177.300,--

Table 2: Forschungsbereich 2: Project themes and budgets

No.	Short title/ Framework	Research Theme	Region	Funding Agency	Lead PI	Funding Period	Budget (DM)
1		Untersuchungen zur Produktion von DMSP des marinen Phytoplankton unter Stickstofflimitation und zum Umsatz von DMSP durch Mikrozooplankton	Nordatlantik	DFG	Antia	01.01.00 - 31.12.01	135.830,--
2		Auswertung der Meteor-Expedition: Der Einfluß der Großen Meteorbank auf die klein- und mittelskalige Verteilung des Phytoplanktons	Nordatlantik	DFG	v. Broeckel	01.09.99 - 31.07.01	36.050,--
3		Die Rolle von TEP in marinen Systemen: I. Vorkommen und Verbreitung, II. Entstehung, III. Rolle bei der Aggregation, IV. Rolle für die Sedimentation		DFG	Passow	01.09.97 - 31.08.99	25.710,--
4		Reaktionen des Phytoplanktons auf eine Eisendüngung an der Antarktischen Polarfront Zone	Southern Ocean	DFG	Peeken	01.10.00 - 31.08.01	32.327,--
5		Flavodoxin and ferredoxin abundances as indicator of iron stress in natural populations of phytoplankton		DFG	La Roche	01.09.99 - 31.08.00	26.200,--
6		Bildung spezifischer Proteine unter Bedingungen von Stickstofflimitierung oder Aufnahme von gelöstem organischem Stickstoff: eine Methode, um alternative Strategie der Stickstoffaufnahme bei *Prymnestiophytae* zu untersuchen		DFG	La Roche	01.09.00 - 31.08.02	126.300,--
7		Auswertung der Meteor-Expeditionen: Verteilung von anthropogenen Spurenstoffen (PCB) im Oberflächenwasser und in der Wassersäule des Nordatlantiks	Nordatlantik	DFG	Schulz-Bull	01.10.00 - 01.09.01	28.000,--
8		Bestimmung der stabilen Kohlenstoffisotope von langkettigen ungesättigten Methylketonen (C37-Alkenone) im Verlauf von *Coccolithoriden*-Blüten im Nordatlantik	Nordatlantik	DFG	Schulz-Bull	01.04.01 - 31.03.03	140.688,--
9	SOLAS-Konferenz	Mittel für die Solas-Konferenz vom 20.-24. Februar 2000.		DFG	Wallace		12.000,--

Table 2: Forschungsbereich 2: Project themes and budgets

No.	Short title/ Framework	Research Theme	Region	Funding Agency	Lead PI	Funding Period	Budget (DM)
10		Bestimmung des Isotopenmusters von N_2O im Ozean	Nordatlantik Ostsee	DFG	Wallace / Bange	01.10.01 - 30.09.03	142.800,--
11		Bromoform im tiefen, tropischen Ozean: Verteilung, Transformationswege und -raten, Tracer Anwendungen. Auswertung von Meßdaten der METEOR-Reise M47/1 (3/2000)	Nordatlantik	DFG	Wallace	01.08.01 - 30.04.02	54.900,--
12	SFB460-A5	Dynamik thermohaliner Zirkulations-schwankungen, Kiel (Aufnahme und Transportwege von anthropogenem CO_2)	Nordatlantik	DFG-SFB460	Duinker/Wallace/ Grootes	01.07.96 - 31.12.02	916.700,--
13	JGOFS	JGOFS IV - Nordatlantik: Beiträge des Institutes für Meereskunde an der Universität Kiel, Synthese, TP 1	Nordatlantik	BMBF1	Schulz-Bull	01.10.97 - 31.03.00	404.500,--
14	JGOFS	JGOFS IV - Nordatlantik: Beiträge des Institutes für Meereskunde an der Universität Kiel, Synthese, TP 2	Nordatlantik	BMBF1	Kremling	01.10.97 - 31.03.00	318.600,--
15	JGOFS	JGOFS IV - Nordatlantik: Beiträge des Institutes für Meereskunde an der Universität Kiel, Synthese, TP 3	Nordatlantik	BMBF1	Zeitzschel	01.10.97 - 31.03.00	703.002,--
16	JGOFS	JGOFS - Arabisches Meer III: Bilanzierung der epipelagischen Prozesse im Arabischen Meer während des SW-Monsuns und Modellierung der raum-zeitl. Strukturen der biologischen Produktion	Arab. Meer	BMBF1	Zeitzschel	01.01.99 - 31.12.00	510.831,--
17		Projekt: AMAM - Vorhaben: Entwicklung eines autonomen hydrochemischen Analysenmoduls		BMBF1	Hansen	01.10.01 - 30.09.04	261.236,--
18		Koordination der wissenschaftlichen Baubetreuung des eisrandgängigen Forschungsschiffes; Vorhaben: Wissenschaftliche Baubetreuung als Koordinator des Wissenschaftlich-Technischen Fachausschusses (WTZ) des neuen mittelgroßen Eisrand-Forschungsschiffes		BMBF1	v. Broeckel	01.06.01 - 31.05.04	156.344,--

Table 2: Forschungsbereich 2: Project themes and budgets

No.	Short title/ Framework	Research Theme	Region	Funding Agency	Lead PI	Funding Period	Budget (DM)
19	JGOFS	Verbundprojekt: JGOFS/Atlantik/Synthese II - Joint Global Ocean Flux Studies: Leitantrag; Vorhaben: Die Klimasensitivität der biologischen Pumpe im Nordatlantik	Nordatlantik	BMBF1	Lochte	01.07.01 - 30.06.03	311.859,--
20		Projekt: SO 152 - TRACERZIRKEL; Vorhaben: Produktion und Ozean-Atmosphäre Fluss von Methyljodid im subtropischen Atlantik	subtr. Atlantik	BMBF1	Wallace	01.09.00 - 31.12.02	244.869,--
21		Analyse des Kohlenisotopenverhältnisses von Methan in Gasproben aus den Expeditionen SONNE 152 und METEOR 504	Nordatlantik	BMBF2	Wallace	01.11.01 - 31.12.01	13.003,21
22		Unterauftrag zum BMBF-Projekt d. IOW: Begleitforschung für die Meeresüberwachung: Erstellung einer Spurenmetallbilanz (Cd, Pb, Ca, Zn) für das Oberflächenwasser der östlichen Gotlandsee	Gotlandsee	BMBF2	Kremling	01.09.99 - 31.08.01	126.000,--
23		Bestimmung von Nährstoffen und Sauerstoffproben	Nordatlantik	BfSuH	Wallace	06.05.00 - 04.06.00	25.000,--
24		Untersuchung des Planktoneinflusses auf die Standzeit von Luftblasen im Meer	Nordsee/Ostsee	FWG	Horstmann	01.01.01 - 31.12.03	141.000,--
25		Algal Bloom Detection Monitoring and Prediction		EU	Horstmann	01.02.97 - 31.01.99	27.900,--
26	BASIC	Baltic Sea cyanobacteria	Ostsee	EU	v. Broeckel	01.12.97 - 31.12.99	243.500,--
27		Global mass balance of persistent semi - volatile organic compounds: An approach with PCB as an indicator-Global- Soc		EU	Schulz-Bull	01.02.98 - 31.01.01	405.500,--
28	DANUBS	Nutrient management in the danube basin and its impact on the black sea (DANUBS)	Westliches Schwarzes Meer	EU	Horstmann	01.02.01 - 31.01.04	331.043,74
29	IRONAGES	Iron Resources and Oceanic Nutrients-Advancement of Global Environment Simulations		EU	LaRoche	01.04.00 - 31.03.03	285.948,85

Table 2: Forschungsbereich 2: Project themes and budgets

No.	Short title/ Framework	Research Theme	Region	Funding Agency	Lead PI	Funding Period	Budget (DM)
30	CAVASSOO	Carbon variability studies by ships of opportunity	Nordatlantik	EU	Wallace/ Körtzinger	01.12.00 - 30.11.03	418.228,83
31	SOLAS	International SOLAS Conference, Damp		EU	Wallace	01.08.99 - 30.06.00	48.895,75
32	ARAL-KUM	Desertification in the Aral Sea Region: a Study of the Natural and Anthropogenic Impacts	Aral See	EU	Horstmann	01.11.00 - 31.10.03	55.750,95
33	CANIGO	CANIGO: Canary Island Azores Gibraltar Observation	Nordatlantik	EU	Duinker	01.08.96 - 31.07.99	87.700,--
34	OMEX II	OMEX II - Phase II: Ocean Margin Exchange II		EU	Peinert	01.06.97 - 30.11.00	858.000,--
35		Size spectral analysis of key biochemical and bioenergetixc parameters of micro-plankton. Biochemical and biophysical approaches to an ecosystems investigation	Schwarzes Meer, Ostsee	EU-INTAS	Horstmann	05.09.97 -	3.500,--
36	Volvo Ocean Adventure	Demonstration of Marine Science topics in the frame of the Volvo Ocean Race		Volvo	Horstmann	01.01.01 - 31.12.02	24.224,56
37	AvH-For-schungsstipen-diate 2000	Betreuungszuschuss an Gastinstitute von AvH-Forschungsstipendiaten 2000		AvH	Wallace	01.03.00 - 28.02.01	1.500,--
38	Humboldt-For-schungsstipen-dium	Sachmittelzuschuss für Humboldt-For-schungsstipendium		AvH	Wallace	01.03.01 - 28.03.03	24.000,--
39	MARE	"Photochemische Produktion von Methan im Meerwasser" - MARE Förderpreis für Meersforschung 1999		Dreivier-tel Verlag	Bange	01.01.01 - 31.12.02	12.216,70
40		GC-Analysen und Messungen von stabilen Kohlenstoffanalysen an Biomarkern	Nordatlantik	GEOMAR	Schulz-Bull	01.11.99 - 31.12.99	10.500,--
41	GEOMAR/Koh-lenstoff	Kohlenstoffisitopenuntersuchungen	Nord- und Süd-atlantik	GEOMAR	Schulz-Bull	01.01.00 - 31.12.00	4.050,--

Table 2: Forschungsbereich 2: Project themes and budgets

No.	Short title/ Framework	Research Theme	Region	Funding Agency	Lead PI	Funding Period	Budget (DM)
42		Sinkstofffallen: Kalibrierung und Reevaluation der Sinkstoffflüsse aus Trichterfallen unter Einsatz eines neuen Fallenprotokolls für verankerte und driftende Systeme sowie vertiefte numerische Analyse		TU HH	Schulz-Bull	01.02.01 - 31.01.03	67.171,--
43	Ökosystemdaten Kieler Bucht	Bearbeitung und Zusendung von Ökosystemdaten der Kieler Bucht	Kieler Bucht	Uni Greifswald	Hansen	01.12.00 - 31.12.00	960,--
44	Chelators in the sea	The role of bacterial siderophores for Fe-uptake by phytoplankton	Mittelmeer, Ostsee	CEEP	Horstmann	01.01.95 - 31.12.99	72.000,--

Table 3: Forschungsbereich 3: Project themes and budgets

No.	Short title/ Framework	Research theme	Region	Funding agency	Lead PI	Funding Period	Budget (DM)
1	METEOR - Auswertung	Auswertung der Metor-Expedition Nr. 44: Untersuchung der Planktondynamik eines oligotrophen marinen Gewässers (Golf v. Aqaba)	Rotes Meer	DFG	Berninger	01.10.99 - 30.09.01	64.400,--
2	AQUAWEB	Untersuchungen zur qualitativen und quantitativen Bedeutung mixotropher Protisten in ufernahen Sedimenten	Ostsee	DFG	Berninger	01.04.00 - 31.03.02	119.000,--
3	AQUAWEB	Untersuchungen zur Diversität und Funktion von benthischen Mikroalgen und Protozoen im Nahrungsnetz mariner und limnischer Sedimente	Ostsee/Labor	DFG	Berninger	01.09.00 - 31.08.02	129.360,--
4	METEOR - Auswertung	Auswertung der Meteor-Expedition: Der Einfluß der Großen Meteorbank auf das Wachstum und den Ernährungszustand von Ichthyoplanktonarten	Nordatlantik	DFG	Clemmesen-Bockelmann	01.09.00 - 31.08.01	23.000,--
5		Untersuchungen der Reproduktionsbiologie, des Nahrungsbedarfs und der Jagd- u. Wanderbewegungen des Humboldtpinguins *Spheniscus humboldti*	Pazifik/Chile	DFG	Culik	15.09.97 - 14.09.99	201.477,64
6		Untersuchungen zur Reproduktionsbiologie und Nahrungsökologie des Humboldtpinguins *Spheniscus humboldti*	Pazifik/Chile	DFG	Culik	08.12.99 - 07.12.00	46.800,--
7		Ernährungsökologie von Basstölpeln (*Sula bassana*) und Eissturmvögeln (*Fulmarus glacialis*)	Nordsee	DFG	Garthe	02.04.98 - 01.04.00	55.658,80
8		Ernährungsökologie und Verdauungsphysiologie von Basstölpeln	Nordsee	DFG	Garthe	15.08.00 - 31.12.00	8.594,--
9	METEOR - Auswertung	Auswertung der Meteor-Expedition: Bakteriengemeinschaften im oligotrophen östlichen Mittelmeer unter dem Einfluß des sich verändernden Tiefenwassersystems	Mittelmeer	DFG	Imhoff	01.09.00 - 28.02.01	56.200,--

Table 3: Forschungsbereich 3: Project themes and budgets

No.	Short title/ Framework	Research theme	Region	Funding agency	Lead PI	Funding Period	Budget (DM)
10	METEOR - Auswertung	Auswertung der Meteor-Expedition: Artenzusammensetzung und Verbreitung ozeanischer Tintenfische (*Mollusca, Cephalopoda*) im Bereich der Großen Meteorbank und bei Bermuda, Nordatlantik	Nordatlantik	DFG	Piatkowski	01.10.99 - 30.09.00	56.700,--
11	METEOR - Auswertung	Auswertung der Meteor-Expedition: Artenzusammensetzung und Verbreitung ozeanischer Tintenfische im Bereich der Großen Meteorbank und bei Bermuda, Nordatlantik	Nordatlantik	DFG	Piatkowski	01.10.00 - 30.09.01	57.000,--
12		Flavodoxin and ferredoxin abundances as indicator of iron stress in natural populations of phytoplankton	Südl.Ozean	DFG	LaRoche	01.09.99 - 31.08.00	26.200,--
13		Populationsdynamik mariner Ciliaten am Beispiel der Trichodinen (*Urceolariidae*)	Weltmeer	DFG	Rosenthal	01.09.99 - 31.08.00	72.800,--
14		Populationsdynamik mariner Ciliaten am Beispiel der Trichodinen (*Urceolariidae*)	Weltmeer	DFG	Rosenthal	21.09.00 - 20.12.00	12.000,--
15	METEOR - Auswertung	Auswertung der Meteor-Expedition Nr. 44: Untersuchungen zur Nahrungsökologie und Parasitierung von Fischen der Großen Meteorbank	Nordatlantik	DFG	Schnack	16.09.99 - 15.09.00	57.800,--
16		Bedeutung biotischer Interaktionen für die Struktur des Mikrophytobenthos auf Hartsubstraten	Ostsee	DFG	Sommer	15.09.98 - 14.09.99	56.787,01
17		Die relative Bedeutung von Nährstoffverfügbarkeit und Konsumption für die Struktur einer marinen Lebensgemeinschaft: ein transatlantischer Vergleich	Nordatlantik/ Ostsee	DFG	Sommer	01.06.98 - 31.03.99	4.395,--
18	AQUAWEB	Die Bedeutung von Omnivorie und Mixotrophie für Nahrungskettenlängen und Nahrungsnetzstruktur im marinen Pelagial	Labor	DFG	Sommer	01.05.00 - 30.04.02	142.930,--
19	AQUAWEB	Auswirkungen der Unterschiede zwischen Copepoden und Cladoceren auf das Phytopklankton	Nordatlantik/ Ostsee	DFG	Sommer	15.08.00 - 21.08.02	320.600,--

Table 3: Forschungsbereich 3: Project themes and budgets

No.	Short title/ Framework	Research theme	Region	Funding agency	Lead PI	Funding Period	Budget (DM)
20	AQUAWEB	Ernährungsökologische Nische und Habitatstruktur in benthischen Nahrungsnetzen	Nordatlantik/ Ostsee	DFG	Sommer	01.09.00 - 31.08.02	107.500,--
21	Ozeanpassagen	Einfluss sich ändernder Meerespassagen auf Ozeanzirkulation, Klima und Evolution.	Panama, Indonesien, Island	DFG	Süling	01.12.01 - 30.11.03	400.826,--
22		Lebensweise der Echten Karettschildkröte *Eretmochelys imbricata* im Karibischen Meer	Karibik	DFG	Wilson	01.07.98 - 30.06.00	154.792,85
23		Lebensweise der Echten Karettschildkröte *Eretmochelys imbricata* im Karibischen Meer	Karibik	DFG	Wilson	01.01.01 - 31.12.02	153.762,--
24	DIGENIT	Untersuchungen zur Biodiversität und Gentransfer bei denitrifizierenden Bakteriengemeinschaften	Ostsee	BMBF	Imhoff	01.06.96 - 30.09.99	351.885,--
25	TIEFBAK	Biologisch aktive Naturstoffe aus marinen Invertebraten der Tiefsee und ihren symbiontischen Bakterien	Pazifik	BMBF1	Imhoff	01.10.98 - 31.12.00	122.629,--
26	JGOFS	Arabisches Meer III: Bilanzierung der epipelagischen Prozesse im Arabischen Meer während des SW-Monsuns und Modellierung der raum-zeitlichen Strukturen der biologischen Produktion	Arab.Meer	BMBF1	Hoppe	01.01.99 - 31.12.00	113.711,--
27	FISHBASE	Neue Ansätze zur retrospektiven und interaktiven Auswertung wissenschaftlicher Datensätze innerhalb des globalen Informationssystems FishBase	Weltmeer	BMBF1	Rosenthal	01.01.01 - 31.12.03	434.772,--
28	Sonne 130 - MARKAN II	Tektonische Entwicklung und Fluidtransport im Makran-Akkretionskeil: Mikrobiologische und geochemische Untersuchungen in "cold seeps"	Arab.Meer	BMBF1	Imhoff	01.01.98 - 31.10.99	208.490,--
29	Sonne 134 - Hyfiflux II	Mikrobiologische und geochemische Untersuchung in Hydrothermalfeldern	Pazifik	BMBF1	Imhoff	01.07.98 - 31.08.00	399.868,--
30	Sonne 155 - HYDROARC	Diversität und Aktivität autotropher Bakteriengemeinschaften in den Sedimenten der Bransfield Straße (Antarktis)	Antarktis	BMBF1	Imhoff	01.11.00 - 31.03.03	179.750,--

Table 3: Forschungsbereich 3: Project themes and budgets

No.	Short title/ Framework	Research theme	Region	Funding agency	Lead PI	Funding Period	Budget (DM)
31	BIOTEC-Marin	Marine Naturstoffe II: Schwammassoziierte Bakterien: Molekulare Systematik und biotechnologisches Potential	Mittelmeer	BMBF1	Imhoff	01.09.01 - 31.08.04	491.543,92
32		Bioaktive Naturstoffe: Biologisch aktive Naturstoffe aus marinen Schwämmen und assoziierten Mikroorganismen	Ostsee/Nordsee	BMBF2	Imhoff	01.01.99 - 31.12.01	574.973,--
33	Meteor - RSP	Meeresforschung im Golf von Aqaba und dem Roten Meer - Ein multidisziplinäres regionales Forschungsprogramm - zweite Phase	Rotes Meer	BMBF2	Sommer	01.01.99 - 31.12.00	64.000,--
34	ICES - IHLS	Durchführung und Auswertung zweier Heringslarvensurveys in der Nordsee und im Englischen Kanal	Nordsee	BfaFi	Schnack	01.07.95 -	1.372.217,50
35	BFG	Untersuchung zur langfristigen Entwicklung des Makrozoobenthos im Fehmarnbelt	Westl. Ostsee	BfG	Rumohr	01.11.99 - 30.11.00	40.000,--
36		See- und Wasservögel in der deutschen Ostsee und ihr Schutz im Rahmen internationaler Vereinbarungen	Ostsee	BfN	Adelung	01.04.00 - 31.12.01	249.434,80
37		Forschungs- und Entwicklungsvorhaben: Bestimmung, Quantifizierung und Bewertung der Öleinträge in die Nordsee zur Beurteilung der Schiffsentsorgung in deutschen Nordseehäfen	Nordsee	UBA	Garthe	01.09.00 - 30.04.01	15.300,--
38	EU - PESCA	Werkvertrag im Rahmen der Mittel der EU aus der Gemeinschaftsinitiative für die Umstrukturierung des Fischereisektors	Nordsee	AfLR	Adelung	01.01.00 - 31.12.01	335.440,--
39	Kooperations Vertrag	Entwicklg. u. Anwendung v. Fahrtenschreibern u. Satellitentransm. an Robben u. Pinguinen im Bereich d. östl. Weddellmeeres, d. Antarkt. Halbinsel u. d. Halbinsel Valdez, um d. raum-zeitl.Verteilung d. Tiere in d. See u. ihre Rolle im ant.-u.subantarkt. Nahrungsnetz zu verstehen	Weddellmeer/ Antarktik	AWI	Wilson	01.08.99 - 31.01.00	61.000,--

Table 3: Forschungsbereich 3: Project themes and budgets

No.	Short title/ Framework	Research theme	Region	Funding agency	Lead PI	Funding Period	Budget (DM)
40	Monitoring d. Robbenvork. im Wattenm.	Monitoring der Robbenvorkommen im Wattenmeer. Die Untersuchung ist Bestandteil des Trilateralen Monitoring-u. Bewertungsprogrammes (TMAP)	Nordsee/ Wattenmeer	Land (NPA)	Adelung	01.01.00 - 31.12.00	60.000,--
41	Meeresenten	Notwendigkeit ungestörter Mauserplätze für Meeresenten in der Offshore-Zone	Nordsee	Land (NPA)	Garthe	20.07.00 - 15.11.00	10.000,--
42	Gehör von Fischen	Der Einfluss akustischer Signale auf marine Nutzfische	Ostsee	MLET	Culik	01.05.98 - 30.11.00	21.655,--
43	Biol. Mon. d. S-H.	Sortierungen für das Biologische Monitoring der schleswig-holsteinischen Küstengewässer	Nordsee Küstengewässer	MUNF	Rumohr	01.05.00 - 30.06.00	3.720,--
44	Seehunde im Schl.-Holst. Wattenmeer	Telemetrische Untersuchungen zur Erfassung der Aktivitäten von Seehunden im Schleswig-Holsteinischen Wattenmeer	Nordsee/ Wattenmeer	MUNF	Adelung	25.03.00 - 30.11.00	50.000,--
45		Training of development issues		EU	Rosenthal	01.06.98 - 30.11.99	103.700,--
46	EU-AEPM	Evaluation and development of spatio-temporal models and survey designs for efficient assessment of mackerel and horse mackerel	Nordatlantik	EU	Schnack	15.04.98 - 14.10.99	10.000,--
47	EU-BALLAST	Testing monitoring Systems for Risk Assessment of Harmful Introductions by Ships to European Waters (zum EG Contract MAST 3-CT 97-0111)	Nordatlantik	EU	Rosenthal	01.11.97 - 31.10.99	13.200,--
48	EU-HERSUR	Herring Surveys in the North Sea and West of Scotland	Nordsee	EU	Schnack	01.01.98 - 31.12.99	16.400,--
49		Iron Resources and Oceanic Nutrients-Advancement of Global Environment Simulations		EU	LaRoche	01.04.00 - 31.03.03	285.948,85
50	EU-PARS	Precision and accuracy of tools in recruitment studies		EU	Schnack	01.01.97 - 31.12.99	358.500,--

Table 3: Forschungsbereich 3: Project themes and budgets

No.	Short title/ Framework	Research theme	Region	Funding agency	Lead PI	Funding Period	Budget (DM)
51	EU-SAP	Sustainable fisheries. How can the scientific basis for fish stock assessments and predictions be improved?	Nordatlantik	EU	Schnack	01.01.98 - 30.04.01	30.000,--
52	EU-STORE	Environmental and fisheries influences on fish stock recruitment in the Baltic Sea	Ostsee	EU	Schnack	01.01.99 - 31.12.01	633.600,--
53	ONEDIN	Vertrag mit dem Institute of Marine Biology of Crete i. R. d. EG Leonardo da Vinci Programme- Pilotprojekt "ONEDIN"	Europa	EU	Rumohr	02.12.96 - 01.12.99	48.000,--
54	ICES-IHLS	Herring surveys in the North Sea and West Scotland	Nordsee	EU	Schnack	01.01.00 - 31.12.01	177.339,--
55	SIMCOAST	Interdisciplinary methodologies for the sustainable use and management of coastal resource systems: EU ASEAN Coastal transect applications (Unterver-trag mit der University of Warwick)	Weltmeer	EU	Rosenthal	01.09.96 - 31.08.00	29.500,--
56	EU-AQUATOXAL	Aquaculture management and ecological interaction of noctions phytoplankton development in the south of Latin America	Südatlantik	EU	Rosenthal	01.01.98 - 30.06.01	296.500,--
57	COMWEB/ ELOISE LOICZ	Comparative analysis of food webs based on flow networks: Effects of nutrient supply on structure and function of coastal plankton communities	Nordatlantik/ Nordsee/Ostsee/ Mittelmeer	EU	Sommer	01.05.96 - 31.07.99	780.000,--
58	EU-BASYS	Baltic Sea System Study	Ostsee	EU	Imhoff	01.08.96 - 31.10.99	250.000,--
59	EU-BASYS	Baltic Sea System Study	Ostsee	EU	Schnack	01.08.96 - 31.10.99	117.000,--
60	EU-BALLAST	Testing Monitoring Systems for Risk-Assessment of Harmful Introductions by Ships to European Waters	Weltmeere	EU	Rosenthal	01.11.97 - 31.12.99	408.000,--
61	EULIT/ELOISE LOICZ	Effect of Eutrophicated seawater on rocky shore ecosystems studied in large littoral mesocosms	Nordatlantik	EU	Sommer	01.04.98 - 31.03.01	341.000,--

Table 3: Forschungsbereich 3: Project themes and budgets

No.	Short title/ Framework	Research theme	Region	Funding agency	Lead PI	Funding Period	Budget (DM)
62		Long-term Changes in Baltic Algal Species and Ecosystems	Ostsee	EU	Peters	01.04.98 - 31.03.01	483.000,--
63	MEGBAS	INTERREG-Projekt: Forschung zur molekularen Ökologie grüner Schwefelbakterien in der Ostsee	Ostsee	EU	Imhoff	01.06.98 - 31.05.01	208.946,95
64	EU-LIFECO	Linking hydrographic frontal activity to ecosystem dynamics in the North Sea Skagerrak: Importance to fish stock recruitment	Nordsee	EU	Schnack	01.12.00 - 30.11.03	432.236,49
65	EU-MERAMED	Development of monitoring guide lines and modelling tools for environmental effects from Mediterranean aquaculture	Mittelmeer	EU	Rosenthal	01.12.00 - 30.11.03	395.897,15
66	EU-MACOM	Demonstration of maternal effects of Atlantic cod: combining the use of unique mesocosm and novel molecular techniques	Nordatlantik	EU	Schnack	01.01.00 - 31.12.02	508.101,--
67	BEQUALM	BEQUALM: Biological effects quality assurance in monitoring programmes	Europa	EU	Rumohr	01.11.98 - 31.10.01	136.900,--
68	Konzeptstudie F^3	Konzeptstudie F^3 = Forschung / Fakten / Fantasie	-	Technologiestift	Sommer	01.05.01 - 31.12.01	60.000,--
69	Stipendiaten-schwerpunkt Ostsee	Die südliche Ostsee und ihre Küsten im Wandel	Ostsee	Umwelt Stiftung	Sommer	01.04.01 - 31.03.03	250.000,--
70	VW I	Auswirkungen der Meeresumwelt auf die Verbreitung auf See, Ernährungsökologie, Reproduktion und Energetik von Seevögeln in Nord-Chile	Pazifik/Chile	VW	Adelung / Garthe	01.11.98 - 31.10.00	98.800,--
71	VW-Culik	Nutzung des Überwinterungshabitats durch Grauwale (*Eschrichtius robustus*) in Baja California, Mexico	Pazifik/Mexiko	VW	Culik	07.08.98 - 06.08.00	98.000,--
72		Wissenschaftl.-technologische Zusammenarbeit (WTZ) mit Griechenland: Bildgebende Verfahren zur Benthoskunde	Europa	DLR	Rumohr	01.09.99 - 31.08.01	1.380,--

Table 3: Forschungsbereich 3: Project themes and budgets

No.	Short title/ Framework	Research theme	Region	Funding agency	Lead PI	Funding Period	Budget (DM)
73		Deutsch-griechische Zusammenarbeit. Projekt: Sediment Profile Photography	Europa	DLR	Rumohr	30.06.97 - 30.06.99	7.314,--
74	WTZ Brasilien und Kanada	Wissenschaftl.-technologische Zusammenarbeit (WTZ) mit Brasilien und Kanada, Tätigkeit als Fachbeauftragter	SW Atlantik/NW Atlantik	DLR	Rosenthal	01.10.99 - 30.09.00	15.600,--
75	Brookfield Zoo	Time-based utilization of Humboldt penguins (*Spheniscus humboldti*) during the non-breeding seasons	Südpazifik	Brookfield Zoological Society	Wilson / Simeone	01.11.99 - 31.12.00	12.698,35
76	CNRS-Wilson	The use of marine birds and mammals as monitors of changes in oceanographic conditions	Südatlantik	CNRS	Wilson	01.11.99 - 31.12.00	74.000,--
77	Taxonomischer Workshop	Taxonomischer Workshop in Hamburg	Hamburg	Helcom	Rumohr	01.02.00 - 31.12.00	3.300,--
78	Larval Base	Feasibility Study of LarvalBase	Weltmeer	ICLARM	Rosenthal	01.03.98 - 28.02.99	142.000,--
79	Larval Base	Larval Base: a Global Information System on Fish Larvae	Weltmeer	ICLARM	Rosenthal	01.07.99 - 30.06.02	429.942,--
80	EU-MACOM	Mittel für die Einstellung der Doktorandin Vivian Bühler i.R. einer Forschungsarbeit, die in Zusammenhang mit dem am IFM angesiedelten EG - Projekt "MACOM" steht	Nordatlantik	IfM	Schnack	01.02.00 - 31.01.03	160.650,--
81	SfP 978024	Implications of periodic Ecosystem Fluctuations to Fisheries Management in the Baltic Sea	Ostsee	NATO	Köster	01.08.01 - 31.12.02	16.969,32
82	BASECOEX	Capelin and Herring in the Barents Sea, Coexistence or Exclusion	Nordatlantik	Res. Council Norw.	Schnack	01.05.01 - 30.04.04	85.844,40
83	Riverbanks Zoo & Bontanical Garden	Timebased utilization of Humboldt penguins (*Spheniscus humboldt*) during the non-breeding seasons	Südpazifik	Riverbanks Zoo	Wilson / Simeone	01.11.99 - 31.12.99	1.500,--

Appendix D: Acronyms

AABW	Antarctic Bottom Water
AAIW	Antarctic Intermediate Water
ACCE	Atlantic Climate Change Experiment
ACSYS	Arctic Climate System Study
ADCP	Acoustic Doppler Current Profiler
AGU	American Geophysical Union
AMAM	Automated nutrient analysis
AMS	American Meteorological Society
AMSU	Advanced Microwave Sounding Unit
ANIMATE	Atlantic Network of Interdisciplinary Moorings and Timeseries for Europe
APEX	Autonomous Profiling Explorers
APG	Autonom Profilierenden Geräteträger - Tiefendriftern
AQUAWEB	DFG Project (Comparison of marine and limnetic food webs
ASFA	Aquatic Sciences and Fisheries Abstracts
ASLO	American Society of Limnology and Oceanography
AtlantNIRO	Atlantic Scientific Research Institute of Marine Fisheries and Oceanography, Russia, Kaliningrad, Russia
ATSAF	Arbeitsgruppe für tropische und subtropische Agrarforschung
AVHRR	Advanced Very High Resolution Radiometer
AWI	Alfred Wegener Institut für Polar- und Meeresforschung, Bremerhaven
BAHC	Biospheric Aspects of the Hydrological Cycle (IGBP)
BALTEX	Baltic Sea Experiment
BASECOEX	Capelin and herring in the Barents Sea - coexistence or exclusion (Norway)
BASEWECS	BAltic SEa Water and Energy Cycle Study
BASIC	Baltic Sea cyanobacteria
BASYS	Baltic Sea System Study
BATS	Bermuda Atlantic Time series Study
BEQUALM	Biological effects quality assurance in monitoring programmes
BfA	Bundesforschungsanstalt für Fischerei
BfN	Bundesamt für Naturschutz
BGR	Bundesanstalt für Geowissenschaften und Rohstoffe
BIO	Bedford Institute for Oceanography
BMBF	Bundesministerium für Bildung und Forschung
BMVEL	Bundesministerium für Verbraucherschutz, Ernährung und Landwirtschaft
BSH	Bundesanstalt für Seeschifffahrt und Hydrographie
BSIOM	Baltic Sea Ice Ocean Model
CACGP	Commission for Atmospheric Chemistry and Global Pollution
CANIGO	CANary Islands Azores Gibraltar Observations
CARINA	Carbon dioxide in the Atlantic Ocean
CAS	Commission on Atmospheric Sciences (WMO)
CAU	Christian-Albrechts-Universität zu Kiel
CAVASSOO	Carbon variability studies by ships of opportunity
CCC	Cod and Climate Change
CCCC	Climate Change and Carrying Capacity
CDIAC	Carbon Dioxide Information Analysis Center, Oak Ridge, USA
CEFAS	Centre for Environment, Fisheries and Aquaculture Science, Lowestoft, UK
CIMAS	Cooperative Institute for Marine and Atmospheric Studies, Miami, USA
CIRAMOSA	Compilation of regional cirrus macro- and microphysical properties
CliC	Climate and Cryosphere (WCRP)
CLIVAR	Climate Variability and Predictability Programme (WCRP)
CLIWA-Net	Cloud Liquid Water Network (BALTEX)
CMS	Commission on Moving Species
COADS	Comprehensive Ocean-Atmosphere Data Set
CoML	Census of Marine Life
COMWEB	Comparative analysis on coastal planktonic food webs

CORE	Cod recruitment in the Baltic (EU project)
CRIMP	Center of Research on Marine Introduced Pests (Australia)
CSIRO	Commonwealth Scientific & Industrial Research Organisation (Australia)
CTD	Conductivity-Temperature-Depth
DBE	Deep Basin Experiment (WOCE)
DCESS	Danish Centre for Earth System Science
DEKLIM	BMBF Climate Research Programme
DFG	Deutsche Forschungsgemeinschaft
DGHM	Deutsche Gesellschaft für Hygiene Mikrobiologie
DGL	Deutsche Gesellschaft für Limnologie
DGM	Deutsche Gesellschaft für Meeresforschung
DGP	Deutsche Gesellschaft für Protozoology
DIFRES	Danish Institute for Fisheries Research, Lyngby, Denmark
DIGENIT	Diversität nitratreduzierender Bakterien (BMBF Project)
DLR	Deutsche Gesellschaft für Luft- und Raumfahrt
DMG	Deutsche Meteorologische Gesellschaft
DMS	Dimethyl sulphide
DMSP	dimethyl sulfonium proprionate
DOMINOE	Dissolved organic matter as a component of ocean ecosystem and carbon cycle
DON	Dissolved organic nitrogen
DON	dissolved organic nitrogen
DSOW	Denmark Strait Overflow Water
DWBC	Deep Western Boundary Current
DWD	Deutscher Wetterdienst
DWK	Deutsche Wissenschaftliche Kommission für Meeresforschung
DYNAMO	Dynamics of North Atlantic Models
EASIZ	Ecology of the Antarctic Sea Ice Zone
ECMWF	European Centre for Medium Range Weather Forecasts
ECOSIM	Ecosystem Simulation
EEA	European Elasmobranch Association
EISENEX	The second iron enrichment experiment
ELOISE	European Land Ocean Interaction Analysis
ENBI	European Network of Biodiversity Information
ESTOC	European Station for Time-Series in the Ocean Canary Islands
EU	European Union
EUAC	European Union of Aquarium Curators
EUC	Equatorial Undercurrent
EULIT	Effects of eutrophicated seawater on rocky shore ecosystems studied in large littoral mesocosms
EURASLIC	European Association of Aquatic Libraries and Information Centres
FB	Forschungsbereich
FLAME	Family of Linked Atlantic Model Experiments
FTZ	Forschungs- und Technologiezentrum der CAU, Büsum
GBIF	Global Biodiversity Information Facility
GCOS	Global Climate Observing System
GeoB	Institut für Geowissenschaften, Univ. Bremen
GEWEX	Global Energy and Water Cycle Experiment
GfÖ	Gesellschaft für Ökologie
GFZ	Geoforschungszentrum Potsdam
GIN Sea	Greenland, Iceland and Norwegian Sea
GKSS	Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt (Forschungszentrum Geesthacht)
GLOBEC	Global Ocean Ecosystems Dynamics
GODAE	Global Ocean Data Assimilation Experiment
GOOS	Global Ocean Observing System
GPI	Geologisch-Paläontologisches Institut
GSF	Forschungszentrum für Umwelt und Gesundheit (BMBF Projekträger)
HELCOM	Helsinki Commission (Baltic Marine Environment Protection Commission)
HERSUR	Herring Survey Programme (EU)
HMW	high molecular weight
HYDROARC	Hydrothermale Prozesse an flachmarinen Vulkanen der Bransfield Strasse

Appendix D: Acronyms

HYFIFLUX	Hydrothermal fluid development, material balancing and special biological activity in the North Fiji Basin
IBM	Individual-based models
IABO	International Association for Biological Oceanography
IAMAP	International Association of Meteorology and Atmospheric Physics
IAPSO	International Association for the Physical Science of the Oceans
ICBM	Institut für Chemie und Biologie des Meeres, Universität Oldenburg
ICCM	Instituto Canario de Cencias Marinas, Las Palmas, Spain
ICES	International Council for the Exploration of the Seas
ICHCA	International Cargo Handling Co-ordination Association
IEO	Instituto Español de Oceanografía
IfM	Institut für Meereskunde
IFREMER	Institut Français de Recherche pour l'Exploitation de la Mer, Brest, France
IGBP	International Geosphere-Biosphere Programme
IGOOS	IOC-WMO-UNEP Committee for GOOS
IHF	Institut für Hydrobiologie und Fischereiwissenschaft, Hamburg
IHLS	International Herring Larvae Survey (ICES)
IMO	International Maritime Organization
INTAS	International Association (of EU)
IOC	Intergovernmental Oceanographic Commission
IOW	Institut für Osteeforschung, Warnemünde
IPCC	Intergovernmental Panel on Climate Change
IPRC	International Pacific Research Institute, Honolulu, USA
IRONAGES	Iron Resources and Oceanic Nutrients-Advancement of Global Environment Simulations
ISCCP	International Satellite Cloud Climatology Project
IUGG	International Union of Geodesy and Geophysics
JGOFS	Joint Global Ocean Flux Study
KAPEX	Cape of Good Hope Experiments
K.E.R.N.	Techologie Region: Kiel-Eckernförde-Rendsburg-Neumünster e.V.
KISS	Kiel Sea-Ice Simulation
KNMI	Koninklijk Nederlands Meteorologisch Instituut, de Bilt, The Netherlands
LATFRI	Latvian Fisheries Research Institute
LIFECO	Impact of frontal activities on fish recruitment in the North Sea (EU project)
LOICZ	Land Ocean Interactions in the Coastal Zone (IGBP component)
LSW	Labrador Sea Water
MACOM	Maternal effects on Atlantic cod recuitment and implications for management strategies (EU Project)
MAST	Marine Science and Technology Programme (EU)
MATER	Mediterranean Targeted Project-Mass Transfer and Ecosystem Response
MOC	Meridional Overturning Circulation
MOVE	Meridional Overturning Variability Experiment
MPI	Max-Planck Institut für Meteorologie
MRI	Marine Research Institute, Reykjavik, Iceland
MUNF	Ministerium für Umwelt, Natur und Forsten
NAC	North Atlantic Current
NADW	North Atlantic Deep Water
NAFO	Northwest Atlantic Fisheries Organization
NAO	North Atlantic Oscillation
NATO	North Atlantic Treaty Organization
NBUC	North Brazil Undercurrent
NCAR	National Center for Atmospheric Research, Boulder, USA
NCEP	National Center for Environmental Prediction (NOAA)
NERC	National Environmental Research Council
NOAA	National Ocean Atmosphere Administration
NOCES	Northern Ocean-Atmosphere Carbon Exchange Study
NOPEX	Northern Hemisphere Climate-Processes Land-Surface Experiment (BAHC comp.)
NSF	National Science Foundation (US)

OBIS	Ocean Biogeographic Information System
OCTOPUS	Ocean Tomography Operational Pakkage and Utilization Support
OMEX	Ocean Margin Exchange
OPAC	Online Public Access Catalogue
ORNL	Oak Ridge National Laboratory, Oak Ridge, USA
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic (**Os**lo-**Par**is)
PAH	Polycyclic Aromatic Hydrocarbons
PARS	Precision and accuracy of tools in recruitment studies (Eu-Project)
PEP	Pilot Study of Evaporation and Precipitation (BALTEX)
PESCA	Fisheries Programme (EU)
PCB	Polychlorinated biphenyl
PCR	Polymerasekettenreaktion
PIK	Potsdam Institute für Klimafolgenforschung, Potsdam
PJTT	Paleo-JGOFS Task Team
POC	Particulate Organic Carbon
POGO	Partnership for Observations of the Global Oceans
PON	Particulate Organic Nitrogen
PR	Public Relations
PTJ	Projektträger Jülich (BMBF)
RAFOS	Profiling Float
RIVO	Nederlands Instituut voor Visserijonderzoek, Ijmuiden, The Netherlands
RSMAS	Rosenstiel School of Marine and Atmospheric Sciences, Miami, USA
RSP	Red Sea Programme
SAB	Scientific Advisory Board
SAP	Sustainable Fisheries: Assessment and Prediction (EU project)
SCAR	Scientific Committee on Antarctic Research
SCOR	Scientific Committee on Oceanic Research
SDN	Schutzgemeinschaft Deutsche Nordseeküste
SETAC	Society of Environmental Toxicology and Chemistry
SFB	Sonderforschungsbereich
SIL	Societas Internationalis Limnologiae
SimCoast	Interdisciplinary methodologies for the sustainable use and management coastal resource systems: EU and ASEAN Coastal transect applications (EU Project)
SIO	Scripps Institution of Oceanography, La Jolla, USA
SMHI	Swedish Meteorological and Hydrological Institute
SOC	Southampton Oceanography Centre, UK
SOIREE	Southern Ocean Iron RElease Experiment
SOLAS	Surface Ocean Lower Atmosphere Study
SOMARE	Sampling, Observations & Modelling of Atlantic Regional Ecosystems
SPACC	Small Pelagic Fishes and Climate Changes
SSB	spawning stock biomass
STC	Subtropical Cell
STORE	Fish stock recruitment in the Baltic (EU project)
SV	Sverdrup (10^6 km^3/s)
TAR	Third Assessment Report (IPCC)
TAV	Tropical Atlantic Variability
TIEFBAK	Distribution pattern, geochemical and biological characterization of hydrothermal and cold seep communities (BMBF)
TIEFBIT	BMBF Tiefseeforschungsprogramm
TTO	Transient Tracers in the Ocean
UBA	Umweltbundesamt
VAAM	Vereinigung für Allgemeine und Angewandte Mikrobiologie e.V.
VOS	Voluntary Observing Ships
VW	Volkswagen
WCRP	World Climate Research Programme
WDC-MARE	World Data Center for Marine Environmental Data
WGL	Wissenschaftsgemeinschaft Gottfried Wilhelm Leibniz
WGNE	Working Group on Numerical Experimentation
WGOMD	Working Group on Ocean Modelling Development
WHOI	Woods Hole Oceanographic Institution, Woods Hole, USA

Appendix D: Acronyms

WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment
WTZ	Wissenschaftl.-Technische Zusammenarbeit (BMBF)
ZAM	Zentrum für Angewandte Meereswissenschaften
ZMK	Zentrum für Meeres- und Klimaforschung der Universität Hamburg
XBT	Expendable Bathythermograph