Cluster of Excellence
The Future Ocean
1. Annual Report
Nov 2006 - Sep 2007

Cluster of Excellence
„The Future Ocean“

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Contents

1. General Information

1.1 Cluster Concept

The oceans host our planet's largest ecosystem, help regulate the composition of the atmosphere and global climate, and provide us with essential living and non-living resources. Coastal regions are home to the majority of the world's population and the open seas are key to global trade and security and a source of major natural hazards. In short, the oceans are vital for human welfare now and in the future. But mankind is altering the oceans in both direct and indirect ways and on a global scale. The alteration started with fishing which has already drastically changed the global marine ecosystem. Human impacts now extend from regional changes, such as alterations of coastal and deep sea habitats, to global scale impacts on marine life, ocean circulation and carbon cycling through emissions of CO_2 and other pollutants. The motivation for the Future Ocean Cluster is the recognition of mankind's increasing dependency on the oceans in the context of our increasing power to alter it. These two factors imply a need to *understand* in order to be able to *predict* and *manage*. They also imply a need to *educate*, in order that the next generation is aware of the need for responsible and sustainable use of the ocean and is prepared to adapt to the changes that we have already set in motion.

The Future Ocean Cluster at the Christian-Albrechts-University in Kiel (CAU) aims to (1) improve our understanding of ocean changes in response to human activities, (2) provide the scientific basis to develop, implement and assess sound global and regional ocean management options (3) build our capacity to reliably predict the risks associated with ocean change and natural hazards and (4) explore new marine resources and develop strategies for their sustainable use. This will be achieved by a multidisciplinary research strategy on the pathways, impacts and feedbacks of ocean change and their interaction with society in terms of ocean resources, services and risks.

1.2 Structural Aims and Strategy

Rather than forming a separate research unit, the Cluster will be fully integrated into the University and will function as a virtual institute to strengthen multidisciplinary cooperation between several faculties and research institutes of CAU and the participating Leibniz Institutes (IFM-GEOMAR: Leibniz Institute of Marine Sciences, IfW: Institute for the World Economy). It will augment, focus and enhance marine-oriented research and education in Kiel and will provide additional interfaces to the general public, stakeholders, non-governmental and scientific organizations as well as marine-oriented industries. A strategic instrument of the Cluster will be the establishment of 14 new Junior Research Groups (JRG's) in key interdisciplinary research areas (A1 - B6 in Fig. 1).

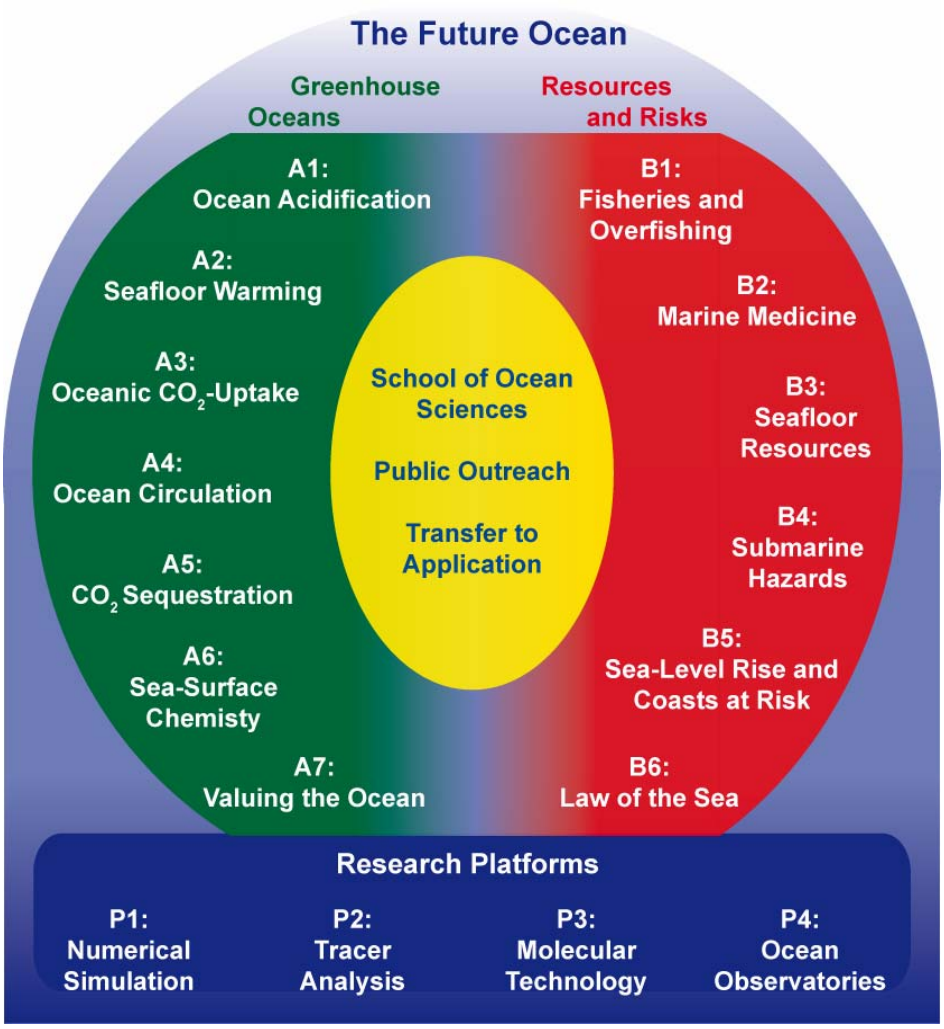


Figure 1: Elements of the Future Ocean Cluster (www.uni-kiel.de/future-ocean) consisting of the research topics under Themes A. Greenhouse Oceans (green) and B. Resources and Risks (red), overarching activities (yellow) and research platforms (blue)

The JRG's will augment the expertise provided by the well-established research groups of the proponents. The group leaders will be endowed with tenure-track positions which will be transferred to permanent positions (W2/W3) based on a review of merit. The Cluster will provide the JRG's with resources and personnel as well as scientific support through the established research groups of the proponents. The commitment of CAU and IFM-GEOMAR to offer permanent faculty positions to up to nine of the new junior professors ensures a long-term strategic impact on the fabric of the University.

Four general strategies are followed at CAU for its structural development: (1) the University is in the process of concentrating its infrastructural resources into centers, (2) the University has developed a concept to establish new JRG's at the interface between and at the forefront of various existing research fields; (3) new educational paths have been developed on the

Master's and Ph.D. levels to offer curricula with a wide disciplinary scope provided from various faculties; (4) multidisciplinary research themes are identified and supported by University funding to overcome the traditional boundaries between the faculties and to sharpen the University's scientific profile. The Cluster acts as a pilot project to implement these new structures at the University and is, hence, fully consistent with strategic planning at CAU.

The multidisciplinary approach of the Future Ocean Cluster will be complemented by an integrated educational program in ocean sciences. Core elements of the newly established Integrated School of Ocean Sciences (ISOS) are (1) coordinated Master`s programs in Marine Sciences, (2) a newly designed Ph.D. program, (3) a career-advancement program for professionals, covering the scientific, legal and economic management of marine resources and (4) support activities for early career development. The integration of six faculties of the CAU within the Cluster presents a challenging opportunity and the marine focus will sharpen the educational profile of the University nationally and internationally. The ISOS will provide an intellectually stimulating forum for exchange of ideas, information and educational services between the Cluster, CAU faculties, partners in the maritime industry, and policy-making bodies.

The Future Ocean Cluster will communicate with the broader scientific community, the general public and the political and economic audience through exhibitions designed by the Muthesius Academy of Fine Arts, Future Ocean conferences, workshops and other public outreach activities. The exhibitions and additional scientific contents will also be presented to the general public through the marine-oriented Kiel Science Center opening in 2011. The Future Ocean Cluster will closely cooperate with the "Maritime Cluster Schleswig-Holstein", a network of 1200 companies representing all branches of the maritime industry (www.maritimes-cluster.de), and additional partners to promote on-going, and develop new, technology transfer activities related to marine genetic resources, gas hydrates, CO_2 sequestration, and the use of other marine resources.

1.3 Scientific Aims and Perspectives

The Cluster will in its entirety address the Future Ocean with respect to climate, ecosystems, resources and hazards. The oceanic response to anthropogenic greenhouse gas emissions will be investigated under **Theme A "Oceans in the Greenhouse World".** The combined oceanic response to this forcing is complex and includes large-scale changes in ecosystem structure and ocean circulation. The internal cycling of carbon, nutrients and oxygen within the oceans and physical exchanges of greenhouse gases, heat, water and momentum

across the air-sea and ocean-seafloor interfaces are also affected by anthropogenic greenhouse gas emissions and global climate change. Internal oceanic feedbacks may amplify the external anthropogenic forcing with largely unknown consequences for oceans, global climate, and human society. Cluster Theme A encompasses basic and applied research into these roles and responses of the oceans in the Greenhouse World. The overarching questions for Theme A are:

- What are the biological and chemical responses of the ocean to changing atmospheric composition?
- How do ocean circulation and the ocean ecosystem interact with altered radiative forcing?
- What is the ocean's capacity for current and future mitigation of atmospheric CO_2 increase?
- What are the implications of these changes to the marine system for human welfare and greenhouse gas management?

Project A1 will establish new linkages between expertise in marine biology and geochemistry and related physiological and biochemical expertise at Kiel to improve the mechanistic understanding of the response of marine organisms to elevated CO_2 and decreased pH. Warming of intermediate-depth waters has the potential to drive major changes in seafloor processes, including accelerated decomposition of methane hydrates and as yet unknown effects on benthic ecosystems. Project A2 will address this issue by combining expertise in benthic ecology and geochemistry with new observational technologies. Project A3 will build on expertise in ocean modelling, marine carbon observations and synthesis, in a new partnership with advanced numerical techniques research. The goal is to improve our ability to quantify the current and future anthropogenic CO_2 uptake of the ocean. Project A4 will take advantage of the existing expertise in past ocean climate proxy research and use ocean and climate models in order to reconcile observational records from past climates with dynamically consistent climate scenarios. Project A5 addresses the potential and risks associated with CO_2 disposal in marine sediments. Specifically, expertise in marine geochemistry, inorganic and theoretical chemistry will collectively be focused on improving our understanding of the behaviour of CO_2 in marine sediments under the pressure and temperature conditions of the deep ocean. Project A6 will study physical chemical structures and interactions at and near the air-sea interface, including reactions important for understanding the ocean’s response to the changing composition of the surface ocean and troposphere. Here, new linkages between physical and theoretical chemistry and marine science are being established. The Future Ocean changes studied within projects A1 through

A6 have considerable implications for human welfare. Ocean carbon sequestration (on-going or deliberate) is important for an evaluation of carbon abatement strategies and global carbon management accounting. The economic and human welfare implications of Future Ocean change are the focus of project A7, which takes advantage of the existing economic expertise at IfW and the scientific insight provided by other parts of the Cluster. Project A7 is strategically placed at the interface between basic scientific insight, quantitative assessment, and socio-economic understanding to produce evaluations of the human-dimension implications of Future Ocean change.

Theme B "Marine Resources and Risks" focuses on the understanding and management of marine resources and the assessment of hazards. Oceans provide resources and services to humankind, such as fish and seafood, genetic resources for medical purposes, fossil fuels and minerals. However, the sea is also a source of hazards through tsunamis, storm surges and sea-level rise. These opportunities and risks pose several general questions:

- Which physical, chemical, biological, and geological mechanisms lead to the evolution of certain resources?
- What are the mechanisms that lead to marine hazards threatening coastal population?
- Are ocean organisms a model system for human diseases providing a new tool in medical research?
- How should ocean resources be managed in a sustainable manner and which institutional and legal frameworks are necessary for such endeavors?
- How can risks be assessed, how can damages from hazardous events be evaluated, and which countermeasures can be taken to mitigate these?

In project B1 fishery management will be studied with the special focus on multispecies interaction and the link between commercial species, non-commercial species, and the ecosystem. Marine life and fisheries are presently studied, but have not previously been linked to economic expertise at Kiel. Building on this expertise, a new JRG will be established to improve the management strategies of fish stocks and fisheries, incorporating economic, legal, and scientific aspects. Kiel-based scientists from medical and natural sciences will join for the first time to study marine organisms as a model system with the purpose of gaining a better understanding of the mechanisms which trigger human diseases (B2). The proponents and the new JRG will apply a genomics approach to investigate the evolution and function of orthologs to human susceptibility genes for barrier dysfunction in marine organisms from diverse phyla. This approach is possible because the genes which cause barrier disease have been conserved through evolution. As an ultimate goal, the knowledge required in the

marine model organisms will be applied to develop novel therapeutic or preventive strategies for human barrier disorders. The study of the occurrence and formation of marine resources, such as gas hydrates and hydrothermal deposits, is an important focus of research in Kiel. However, further expertise is needed in the area of fluid flow and coupled reactions, which are responsible for the formation of these deposits. This aspect will be addressed by a modeling-oriented new JRG in project B3 which will also serve to link existing research groups in this field. Despite growing concerns regarding submarine earthquakes, slumps and slides and their consequences, such as the triggering of tsunamis, marine seismology is not an established discipline in Germany. To close this gap, a JRG is being proposed in order to address the problems of submarine hazards at continental margins (B4). To strengthen the existing groups investigating sea-level change, coastal evolution and coastal zone management tasks, new expertise is needed to analyze physical-morphological changes in coastal seas and to develop new tools to assess the vulnerability and resilience of coastal zone communities. The socio-economic relevance of coastal change and risk assessment justifies the establishment of two new JRG's in project B5 covering this important field. Project B6 will strengthen expertise in maritime law and a JRG is proposed to contribute to the development of new laws for the sustainable use of marine resources based on a sound understanding of the oceanic ecosystem. The link between the topics of Theme B is the focus on marine resources and risks for human society. Therefore, the economic and legal aspects bridge the six topics and create a unique scientific network which is capable of developing innovative and comprehensive approaches in the investigation and management of marine resources and risks.

1.4 Scientific Infrastructure

The Cluster has established four overarching research platforms to provide infrastructure and resources for all scientists within the Cluster (Fig. 1). They offer a wide range of high-end instrumentation which was mostly acquired over the past few years. Many aspects of Cluster research require access to high performance computing facilities, and modern numerical techniques. Hence, numerical expertise and support will be offered by a network connecting the recently established Interdisciplinary Center for Numerical Simulation, the Seismic Processing Center and the ocean and climate modeling groups with the Computing Centers at Kiel (P1). Research into the ocean conditions of the past and its important role in guiding our understanding of the future ocean requires highly specialized and accurate isotope and trace metal analysis, both currently performed at Kiel. High-end instruments and advanced techniques will be integrated to establish the new virtual Tracer Analysis Center which will offer a comprehensive analytical support for the Cluster (P2). Improved understanding of human diseases by the study of marine organisms and mechanistic studies of pH-sensitive

processes in plankton at the molecular level will benefit from the recently established Center for Molecular Biosciences (ZMB). ZMB provides unique expertise in molecular biosciences and access to high throughput molecular techniques (P3). In-situ observations of current conditions and on-going trends in the ocean require an array of specialized oceanographic sampling and observing platforms. The Technology and Logistics Center for Ocean Observations at Kiel serves as the ideal nucleus for a new platform offering cutting edge technology to explore the ocean over space and time and in remote regions from the oceanic crust to the air-sea interface (P4). The novel platforms set up in the Cluster allow for a more efficient use of resources and will be further developed and strengthened according to the needs of the Cluster.

2. Structural Development

A number of organisational bodies have been established in the Cluster (Fig. 2) to ensure (1) effective cooperation between CAU, IFM-GEOMAR, IfW and the Muthesius Academy of Fine Arts in all Cluster-related activities; (2) influence on University policy-making towards strengthening ocean-related research; (3) the efficient exchange of information between the Cluster members; (4) the coordination of internal and external reporting, and planning activities; (5) an efficient monitoring system for research output; (6) an appropriate budget allocation system based on research success; (7) effective communication with external organizations; (8) the transfer of newly acquired knowledge for its application outside the Cluster; (9) public awareness for the Future Ocean themes; and (10) multidisciplinary educational offers for graduate students.

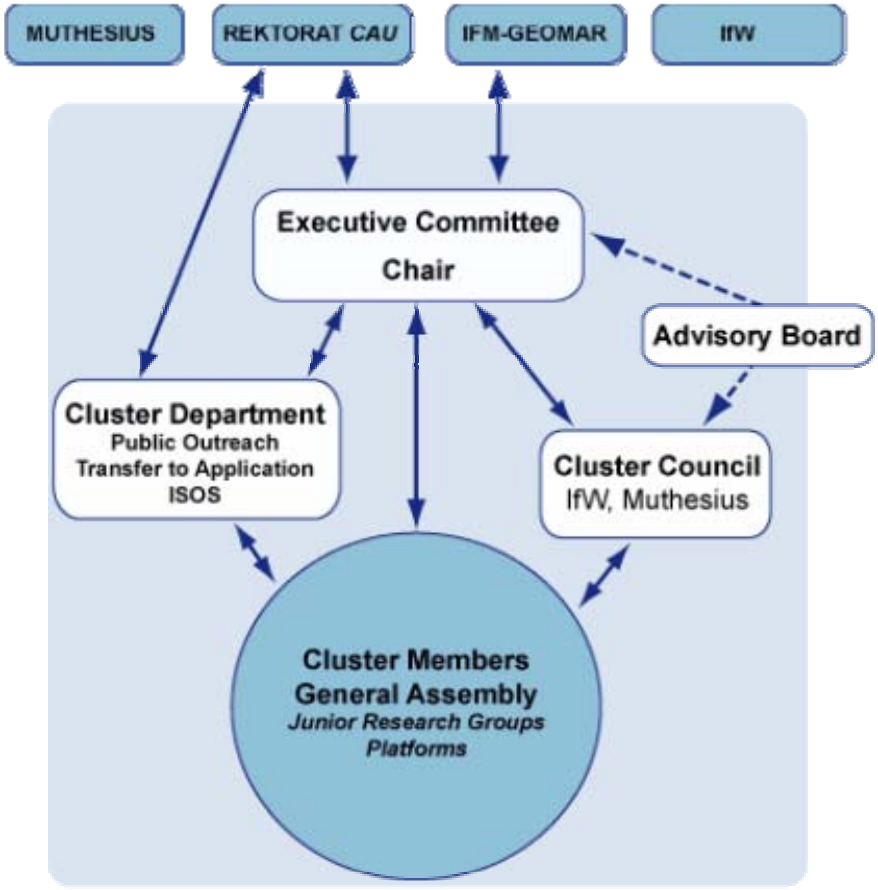


Figure 2 : Management scheme

The Cluster's ***Executive Committee*** is responsible for the overall management of the Cluster and is accountable to the Cluster Council and the General Assembly. It consists of the Chair, the Vice Chair, two speakers of the research platforms and two representatives from the research themes A and B. The Chair and the other representatives are elected by the Cluster members during the Cluster's annual General Assembly. Additional members of

the Executive Committee are the speaker of the new JRG's, the Head of the Integrated Ocean School of Sciences, the Rector of CAU, the Director of IFM-GEOMAR and one representative from regional maritime business. The ***Chair*** acts as intermediary to the DFG, CAU, IFM-GEOMAR and IfW and is authorized to execute project management. He is supported by a Vice Chair. The ***Cluster Department*** provides necessary support for project management and monitoring activities. It also supports the Cluster's public outreach and technology transfer activities and the Integrated School of Ocean Sciences (ISOS). The Chair, together with the Cluster Department, will be responsible for assuring that each party undertakes all reasonable endeavors to perform and fulfill, promptly, actively and on time, all of its obligations to the Cluster. The Cluster Department is particularly responsible for linking the activities of the Cluster and communicating the needs of the Cluster to the University and the participating institutes. It is based at the Division of Research and Technology Transfer at CAU to assure proper interrelations with the University. The Cluster Department provides project management in relation to the activities of the Cluster bodies on scientific, financial and dissemination issues, as applicable. It will review and propose budget transfers and the annual implementation plan to the Executive Committee. The ***Cluster Council*** is giving advice to the Executive Committee on all strategic decisions, such as scientific priorities, yearly budget planning and monitoring criteria. The Cluster Council comprises the two leading proponents of each research topic and research platform, the leader of each JRG, the Rector of CAU, the Directors of IFM-GEOMAR, IfW, and Muthesius Academy as well as the Chair and Vice Chair. The **General Assembly** of all Cluster members decides on the admission of new Cluster members and the exclusion of members and elects the Chair, the Vice Chair and other members of the Executive Committee. An external ***Advisory Board*** acts as an independent quality-control body to evaluate the progress of the Cluster. It consists of 10 leading scientists, both national and international, reflecting expertise of all Cluster-relevant research fields. Additional members are appointed to evaluate the Cluster's outreach to the general public, stake-holders and industries.

It is anticipated that the Cluster will evolve in four phases. Accordingly, the main focus of Cluster activities will shift from (A) an initial networking phase to (B) a scientific output phase, to (C) an increase in external funding phase, and to (D) a final structural consolidation phase. This implies that, during the initial phase, greater emphasis is placed on indicators related to success in achieving structural goals (implementation of new research groups, networking, interdisciplinary approaches), whereas pertinent scientific measures (publications, impact factors, Master's and doctoral theses, fund acquisition, transfer to application) will grow in importance with time. Annual reports are provided by the Cluster Department and the Executive Committee and are presented to the Cluster Council, the General Assembly, the Advisory Board and the DFG.

2.1 Junior Research Groups

A strategic instrument of the Cluster is the establishment of 14 new Junior Research Groups (JRG's) in key interdisciplinary research areas. These JRG's augment the expertise provided by the well-established research groups of the proponents. The positions of the group leaders are endowed with "tenure-track" positions and thus have the option of being converted to permanent positions (W2/W3) based on a review of merit. The Cluster will provide the JRG's with resources and personnel as well as scientific support through the established research groups of the proponents. The JRG leaders will be members of the Cluster and the Cluster Council. A JRG speaker to be elected by the JRG leaders will be member of the Cluster's Executive Committee. The JRG leaders will be eligible to benefit from Cluster resources and will address the emerging new research topics of The Future Ocean as identified in the Cluster proposal. About 50 % of the total Cluster funding will be used to set up the new JRG's. The scientific progress of the JRG's will be presented to the Cluster and the Cluster's Advisory Board by the JRG leaders during the annual Cluster evaluations.

2.1.1 State of Recruitment and Appointment Processes

Namely 14 JRGs are currently established at ten different institutes at CAU and at the Leibniz Institute of Marine Sciences (IFM-GEOMAR). (Table 1).

JRG	Host Institute	Appointee	Appointment
A1 Ocean acidification, W1	IFM-GEOMAR, Marine biogeochemistry	Frank Melzner, AWI Bremerhaven	confirmed, start in October
A2 Seafloor warming, W2	IFM-GEOMAR, Marine biogeochemistry	Gisela Winckler, Columbia University	pending
A3 CO_2-take-up in the ocean, W2	Interdisciplinary Center for Numerical Simulation	Thomas Slawig, FU Berlin	start in September
A4 Ocean circulation, W1	Geosciences	Birgit Schneider, CNRS Gif sur Yvette	pending
A5 CO_2-Sequestration, W2	Physical Chemistry	Oleg Souleimenov, ETH Zürich	pending
A6 Chemistry of the ocean surface, W1	Physical Chemistry	Gernot Friedrichs, University of Kiel	start in August
A7 Environmental and Ressource Economics, W1	The Kiel Institute for the World Economy (IFW)	Kathrin Rehdanz, University of Hamburg	pending
B1 Living resources and overfishing, W1	Department of Economics	Martin Quaas, University of Leibzig	confirmed, start in October
B2 Molecular marine medicine, W2	Center for Molecular Biosciences	Philip Rosenstiel MPI for Molecular Genetics, Berlin	confirmed, start in October
B3 Seafloor resources, W2	IFM-GEOMAR, Dynamics of the Ocean Floor	Lars Rüpke, University of Oslo	confirmed, start in October
B4 Natural hazards, W2	IFM-GEOMAR, Dynamics of the Ocean Floor	Sebastian Krastel, University of Bremen	pending

B5(1) Sea level rise and coastal erosion, W1	Geosciences	Kerstin Schrottke, RCOM, Bremen	pending
B5(2) Risk management in the coastal zone, W1	Geography	Annegret Thieken, GFZ Potsdam	pending
B6 Law of the Sea, W2	Walther Schücking Institute of International Law	Alexander Proelß, University of Tübingen	start in September

Tab.1 Allocation of new JRGs, appointed JRG leaders, and state of appointment procedure

Positions were openly announced as W1 or W2 professorships and endowed with a true tenure track option, both novelties in the university recruitment scheme. The positions were moreover endowed with exceptional funding for additional personnel and research equipment so that the new professors should quickly be able to set up excellent research groups.

A total of 148 applications was received, 60% from Germany, 22% from other European countries, 13.5% from the US, and 4% from others. The position A7 for Ocean Economics was re-announced more broadly as Environmental and Resource Economics to draw a larger number of applications. In January a total of 65 young researchers were invited to present their research plans with respect to Future Ocean related topics at a joint symposium held at Kiel. Based on the faculty evaluation procedures finally 33 candidates were short-listed by 12 appointment committees of the corresponding faculties. To ensure an appointment policy in accordance with the Cluster´s scientific and structural aims principal investigators of the Cluster as well as representatives of the Cluster´s Executive Committee participated in the individual committees. In compliance with personal and legal qualification requirements finally seven candidates were appointed at the W1 and seven at the W2 level. Appointment negotiations are still in progress, however it is anticipated that the majority of the positions will be filled prior to the end of the year. Three new professors have already taken up their positions in Kiel and four more confirmed their appointments (Tab. 1).

2.1.2 Promotion of Gender Equality

It is a declared aim of the Cluster to attract more women to a career in sciences and to increase the number of female professors at the university. Women are currently still severely underrepresented at the full professor level (9%), however with encouraging numbers at the junior professor level (25%). The particular target of the Cluster was to fill at least half of the 14 new W1/W2 professor positions with female candidates. Despite of initially low numbers of female applications where only 35 out of 148 total applications (24%) were submitted by women, numbers were stepwise increased during the recruitment process (Fig. 3).

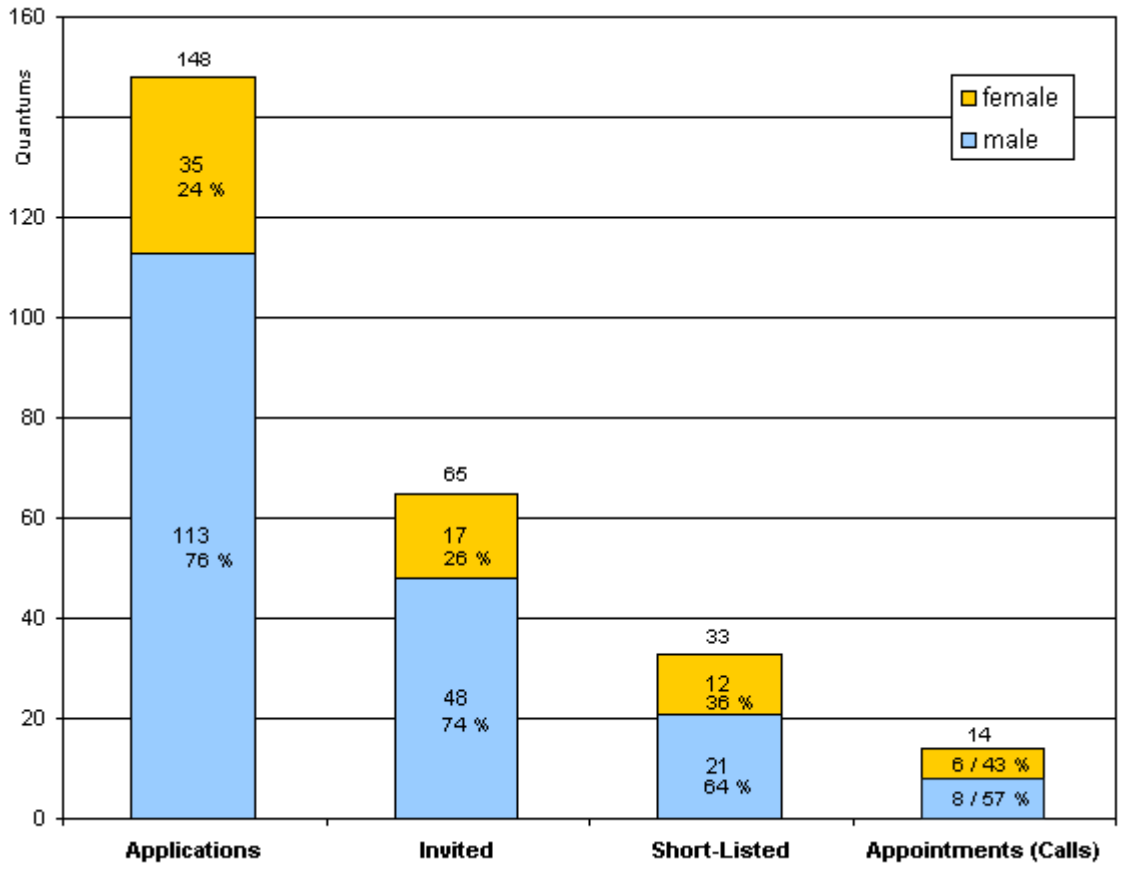


Fig. 3 Numbers of female candidates over the appointment process.

Only one out of the 14 positions, namely (b4) “natural hazards” could not attract any female candidates. The committees pre-selected a total of 17 (out of 65,= 26%), short-listed 12 female applicants and finally appointed 5 women scientists (out of 14;= 36%). Ongoing appointment negotiations do not yet allow final conclusions with respect to the initial target. Nevertheless it may be anticipated that the initial target will not be fully reached, still at least more than a third of the positions will be occupied by women, a number which compares favourably to both, the number of applications and the current situation at the University.

2.1.3 Tenure Track

The CAU will provide seven faculty positions augmented by two additional professor positions at IFM-GEOMAR that will be offered to successful JRG leaders till the end of the first Cluster funding period. The commitment of CAU to establish additional permanent faculty positions in key Cluster research areas implies that the Cluster will have a long-term strategic impact on the fabric of the University.

In 2010, each JRG leader will be evaluated by an appointments committee set-up by the corresponding faculty at CAU. Scientific members of the committees are the dean of the faculty, the proponents of the respective JRG, a representative of the Cluster’s Executive

Committee and additional faculty members. The JRG leaders will be evaluated by external reviewers appointed by the committee and by members of the Cluster's Advisory Board. Based on these external reviews, the committee will either approve or not recommend the appointment of the JRG leader as a permanent faculty member. The decision of the appointments committee will be presented to the Faculty Convention. Based on the advice given by the committee and the Faculty Convention, the CAU Senate will appoint the new faculty members.

2.2 Cluster Proposal System

About 50 % of the total Cluster funding is distribution among Cluster members through an internal proposal system. All Cluster members as well as scientists of their working groups holding a PhD are eligible to apply for Cluster funding. The individual funding schemes implemented in the Cluster are outlined below.

2.2.1 Research Projects

The Cluster provides grants for projects with clearly defined topics related to the research themes of the Future Ocean Cluster. Calls for proposals including guidelines, assessment criteria, and deadlines are published twice a year by the Cluster Office. Proposals have a maximum length of 3 pages and are written in English. The project's duration must not exceed 3 years and the total funding requested by the proponents is limited to 100 k€. The principal cost categories include personnel, investments, and consumables. Assessment criteria for the review process are: (1) Scientific significance with regard to the Cluster themes; (2) Contribution to networking within the Cluster; (3) Multi-disciplinary approach; (4) Clear working hypotheses and reasonable limitation of the topic; (5) Originality; (6) Quality of previous work. Proposals submitted to the Cluster Office are sent to all proponents for internal review. The proponents are asked to evaluate the proposals of all other Cluster members according to the assessment criteria listed above. Each proposal is also sent to external reviewers appointed by the Cluster Office. Based on internal and external reviews, proposals are either approved or rejected by a decision-making panel set-up by the Cluster's Executive Committee.

2.2.2 Development of Scientific Infrastructure

The Cluster provides grants to strengthen the scientific infrastructure through investments and technical personnel. Calls for proposals including guidelines and deadlines are published at least once a year by the Cluster Office. The submitted proposals are compiled by the Cluster Office and are sent to the corresponding Cluster Platforms (P1: Numerical Simulation, P2: Tracer Analysis, P3: Molecular Technology, P4: Ocean Observatories).

The individual proposals are reviewed and evaluated in the Platforms and each Platform defines the investments and technical personnel that should be granted to cover the infrastructural needs of the Cluster. These Platform proposals are presented to the Cluster Council by the Platform speakers. Based on the advice given by the Cluster Council, the Cluster's Executive Committee decides on the final allocation of resources.

2.2.3 Seed Money

The Cluster provides seed money to attract further third-party funding to Kiel. Requests for seed money can be submitted to the Cluster Office at any time. Cluster scientists planning to submit a large scale proposal related to the research themes of the Cluster are allowed to request up to 10 k€ from the Cluster to cover printing costs, technical support, and other costs arising during the development of a new proposal. The new projects should be coordinated at Kiel and should have a minimum financial volume of 500 k€. As a general rule, seed money should be refunded to the Cluster from the project's overhead. Requests for seed money are evaluated and approved by the Cluster's Executive Committee.

2.2.4 Support for Conferences, Workshops and Symposia

Conferences and other scientific meetings held at Kiel are supported by the Cluster if they are related to the Cluster's research themes. Calls for proposals requesting Cluster funding for scientific meetings are published twice a year by the Cluster's Integrated School of Ocean Sciences (ISOS). The amount of funding that may be requests by the organizers to cover costs related to scientific meetings depends on the number of participants. Organizers of conferences with at least 200 participants may request up to 15 k€. Proposals for the support of scientific meetings are evaluated and approved by the ISOS.

2.2.5 Visiting Scientists

The Cluster provides funding for scientists from abroad who are working in scientific fields relevant for the Cluster and who would like to stay at Kiel for at least 14 days. Calls for proposals requesting Cluster funding for visiting scientists are published twice a year by the ISOS. Cluster scientists may request funding to fully cover all costs for the visiting scientists including travel and accommodation. Proposals for guest scientists are evaluated and approved by the ISOS.

2.2.6 Travel Support

The Cluster provides funding for PhD students and Postdocs to present their scientific results at national and international workshops, symposia and conferences. PhD students who are members of the ISOS and Postdocs who are working in the Cluster or in the research groups

of the Cluster members are eligible to apply for travel support. Requests for travel support can be submitted to the ISOS at any time and are evaluated and approved by the ISOS.

2.3 Establishment of the Cluster Department

In order to achieve the administrative goals of the Cluster, a Cluster Department has been established at CAU to manage the Cluster, to offer the services of the Integrated School of Ocean Sciences (ISOS), as well as to coordinate the Cluster´s Public-Outreach and Transfer-to-Application programmes.

The Department is fully embedded in the existing structures of research management at CAU to ensure the use of pertinent expertise and to interlink the structural planning of the Cluster and the University. It makes use of the existing administrative structures at CAU with regard to fund administration and personnel management. New paths are implemented for quality management, administration of structured graduate education, as well as for the coordination of public outreach and Transfer-to-Application programmes. The department holds a staff of 11 new positions as organised in three functional subunits (Table 2).

Cluster Department		
ISOS	**Cluster Office**	**Public Outreach**
Coordination ISOS	Coordination Cluster Department	Coordination and press relations
Coordination E-learning	Budget management and Controlling	Coordination school programmes
Project assistance	Administrative secretary	Exhibition and event management
	Coordination Transfer-to-Application / Technology Transfer	Web-Administration

Table 2. Organisational structure and functions of the Cluster Department at CAU

2.3.1. Cluster Office

The Cluster Office supports the Executive Committee and the Council of the Cluster in the realization of their scientific goals and will bring into agreement the goals of structural development of the Cluster and those of the CAU. Moreover, coordination with the various funding bodies of the Cluster (DFG, University, other third parties) takes place through the Office. To ensure the successful realization of the Cluster's scientific aims, a scientific controlling system is established for the purpose of monitoring the scientific, educational, and exploitation/dissemination outputs of the Cluster. A financial controlling has been implemented to ensure the efficient use of the Cluster's resources in accordance with Cluster

aims and annual implementation plans as well as with funding party regulations. Moreover, the office is coordinating procedures and policies for the dissemination of knowledge from the project.

During the first year the Cluster's funding allocation and financial controlling systems have been developed to support the appointment procedures and the installation of the new JRG's (section 2.1), to organize and carry out calls for Cluster and Platform proposals (section 2.2), to develop pertinent review procedures for the internal proposal system (section 2.2), and to set-up the Cluster Department itself.

In accordance with the annual implementation plan funds were used for Cluster research projects, platform development, the set-up of the new JRG's and the Cluster Department. Additional funds were used to strengthen the general research infrastructure for the Cluster (i.e. online access to Nature, Elsevier through the University Library). Symposia were organized to further networking within the Cluster as well as in the frame of the transfer-to-application forum. A summary of fund allocation in the Cluster (2006 - 2007) is reported in Figure 4.

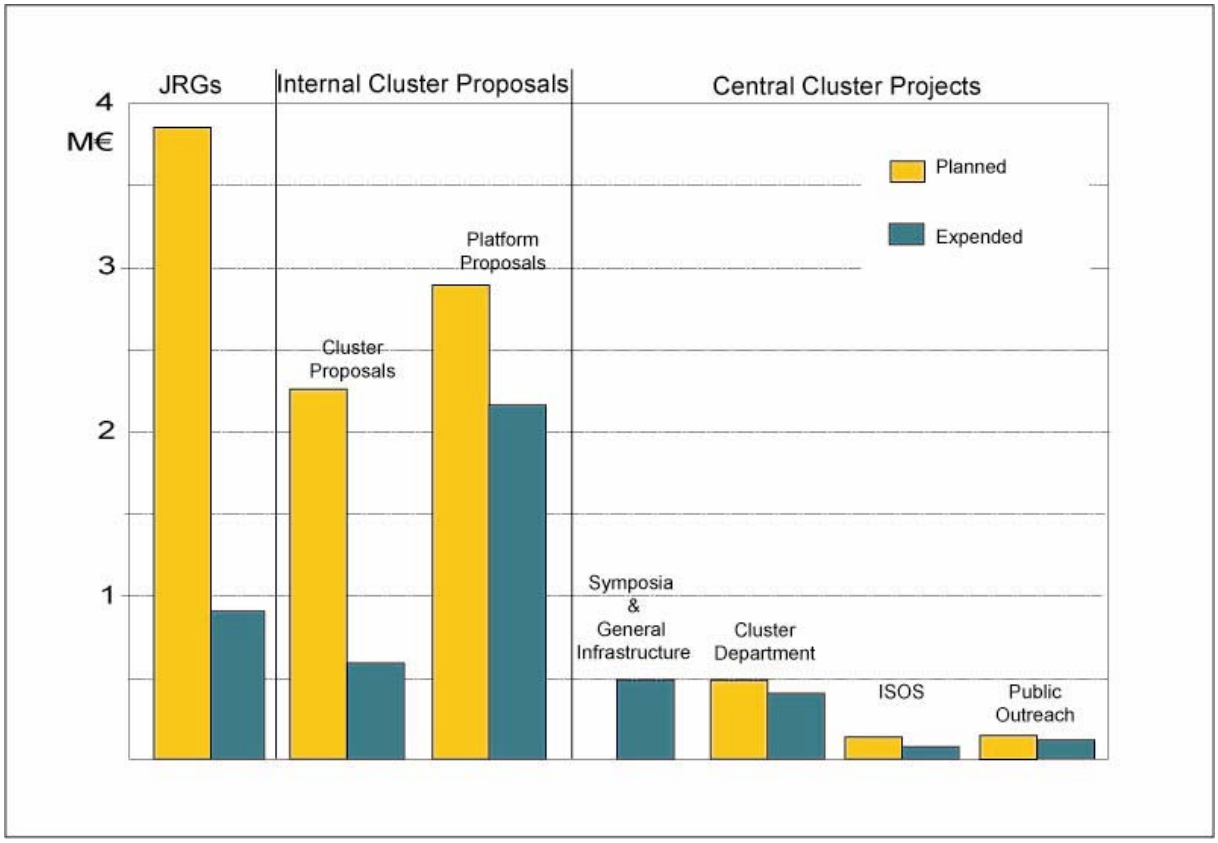


Fig. 4. Summary of fund allocation in the Cluster (2006-2007)

The financial controlling as realized through an existing data bank system for fund administration at CAU has been fully established in the Office and guarantees the efficient use of the financial resources of the Cluster at all operation levels. Reports are presented to the Executive Committee regularly as a basis for further fund allocation decisions. As a next step a data bank will be implemented as an efficient scientific controlling system for monitoring the structural evolution and performance of the Cluster. It will be based on the existing UNIVIS data bank system at CAU. The data bank will contain measurable quantities of scientific, educational, and transfer-to-application outputs of the Cluster. Annual reports will be provided to the Executive Committee and the Advisory Board through this databank.

2.3.2 Integrated School of Ocean Sciences (ISOS; http://isos.uni-kiel.de)

The Integrated School of Ocean Sciences (ISOS) is currently established to consolidate in structure, and enhance in scope, multidisciplinary and research-driven marine education at Kiel University.

ISOS is on plan in the establishment of a central platform that can initiate and develop multidisciplinary educational offers and provide exciting opportunities for graduate students to gain excellent qualifications in the multidisciplinary Cluster/ University setting. Implementation will largely depend on the rapid recruitment of new research groups in the Cluster, followed by recruitment of a cohort of ISOS PhD students whose themes lie at the intersection of the disciplines represented in the Cluster. An important aspect will be improving the flow of information within the Cluster, and disseminating this information to the larger circle of involved scientists and students. To this end ISOS is responding with an up-to-date website that is managed by the ISOS office and by building personal ties with the PIs and students involved.

During conception of a structured graduate programme ISOS seeks to exploit synergies, find potential partners and explore strengths and weaknesses in the existing structures contributing to graduate education at CAU. The University aims to establish a new Graduate Center to join its initiatives for structured graduate education and to bundle infrastructural resources. In this, ISOS is a test-bed and forerunner of a wider thrust to provide excellence in graduate education at the CAU.

Since its inception in May/June 2007, ISOS has concentrated on the following core activities:

- developing a structured PhD programme within the Cluster
- establishing an e-learning base in marine sciences
- providing a platform for exchange of Cluster science within and outside of the University
- co-funding of workshops, conferences and guest scientists through Cluster proposals

2.3.3 Public Outreach

The Public Outreach Project aims to raise public awareness for the Future Ocean themes. To meet this target and to reach the public, both, locally and nation-wide three different approaches were chosen each tailored to specific target groups:

- A special programme addressing teachers and students in schools
- Future Ocean exhibitions and events addressing the general public
- A Science-Economy-Politics forum addressing stakeholders in politics and industries

The Public Outreach group, moreover, supports the internal communication within the Cluster via pertinent communication instruments (web-page, newsletter).

2.3.4 Transfer-to-Application

The Cluster Department and the Cluster members will ensure the transfer of newly acquired knowledge for its application outside the Cluster on four different levels:

- **Scientific level**: The purpose is to disseminate the results to advanced researchers by publication in international peer-reviewed journals, organization of thematic workshops, attendance at international conferences, and through the activities of Cluster scientists as committee members or chairs in international scientific organizations. A further aim is to open up new areas of education and training on methodologies, models, and novel concepts developed within the Cluster (Section 2.3.2).
- **Public level:** School students and the general public should immediately benefit from Cluster results in a suitable manner. This will be ensured through Cluster public outreach activities (Section 2.3.3).
- **Stakeholder level**: Transfer of basic research results and recommendations for further actions to political bodies, non-governmental organizations and corporations is one major objective of the Cluster. Cluster scientists now currently advise stakeholders on marine and global change issues regionally, nationally and internationally. In addition a Science-Economy-Politics forum will be established as a public outreach activity (Section 2.3.3).
- **Economic level**: To foster the transfer of technology and competence from academic research into economic use, the Cluster will be embedded in the technology transfer network already established between research institutions, trade and industry. The Cluster will closely cooperate with the “Maritime Cluster Schleswig-Holstein“, a local network of 1200 companies in all branches of the maritime industry (www.maritimes-cluster.de), to support on-going activities and to develop new concepts and ideas for

a successful technology transfer. A representative of this network is a member of the Executive Committee of the Future Ocean Cluster to guarantee the active participation of the marine economy (Section 2). The valorization of applicable results, products, or patents emerging from Cluster research is carried out by the Patent and Evaluation Agency for Scientific Institutions in Schleswig-Holstein GmbH (PVA SH). PVA SH will implement measures for sensitizing researchers to patents and technology transfer. The Kiel Center of Innovation and Technology (Kitz) provides individual support in order to establish, finance, promote and thus ensure the success of research-driven start-ups in business. The Seed und Start-Up Fund Schleswig-Holstein, the Kiel Capital Fund and the local science park will provide space for enterprises that will emerge from the Cluster and complement the multi-faceted approach to enhance the transfer from science to application. Direct communication between industry partners and science will be institutionalized in a series of workshops and information events.

3. Cluster Activities in 2006 - 2007

3.1 Cluster Research

In the frame of the Cluster´s internal proposal system (Section 2.2) so far three calls for research projects have been published in autumn 2006 and in spring 2007, respectively. A third call published in autumn 2007 is currently still open. In response, a total of 50 research proposals were submitted by Cluster members and by members of their working groups (Fig. 5). Each proposal has been subjected to a two-stage review procedure (Section 2.2).

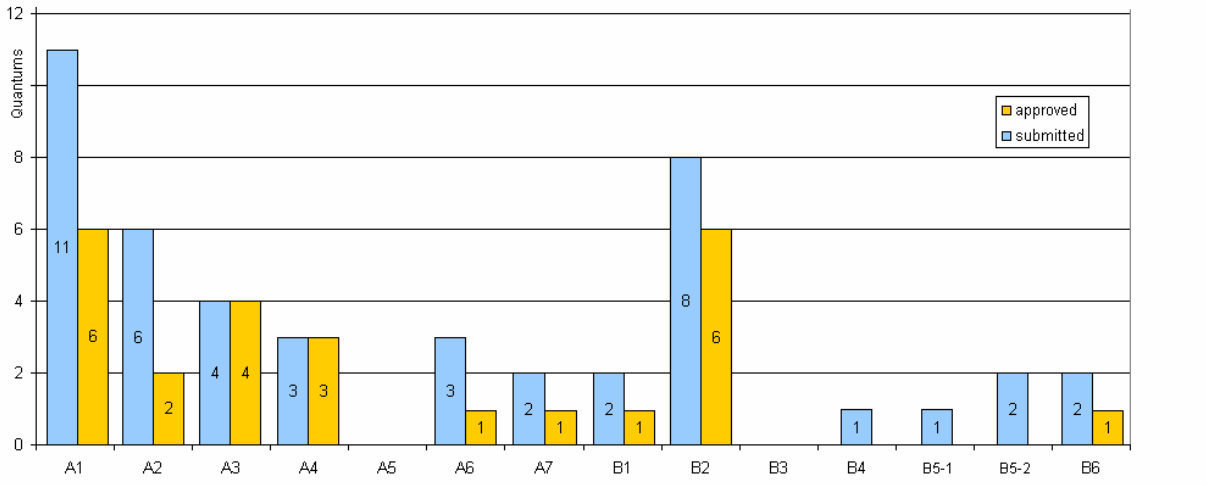


Fig. 5. Submitted and approved research proposals as assigned to single research topics of the Cluster.

Based on the review procedure, 25 proposals (11 in 2006 and 14 in 2007, respectively) were selected and are currently funded. The number of submissions has increased notably in the second call reflecting an increase in research activity and in cross-disciplinary networking within the Cluster. Generally, higher numbers of both, submissions and approvals were registered under theme A. Outstanding numbers were registered for the “Ocean Acidification” and “Marine Medicine” topics with six funded research projects each. Since autumn 2006, 13 doctorate students have started a PhD in the frame of Cluster projects.

3.1.1 *Theme A: Oceans in the greenhouse world*

Rising atmospheric CO_2 and the resulting climate change cause the ocean to undergo two major alterations: sea surface warming and ocean acidification. These changes may in turn trigger major shifts in ocean circulation, ecosystem structure, marine carbon and nutrient cycling, and exchanges with the atmosphere. These issues together with an evaluation of carbon abatement strategies are being assessed under Theme A through a multidisciplinary

approach integrating climate sciences, oceanography, biogeochemistry, marine biology, geosciences and economy.

In the spirit of the Excellence Cluster, first-year activities under Theme A focused on further strengthening the interaction and collaboration between the existing groups and disciplines within Theme A and cross-cutting to Theme B. These activities have led to a series of **research projects** related to Cluster themes and following innovative and multi-disciplinary approaches (see Appendix for detailed list of projects and project descriptions):

The effects of ocean acidification and ocean warming on marine biota are extensively explored under a variety of aspects and using novel approaches (Bleich and Riebesell, Macke et al., Piepenburg et al.). Appealing new results as based on combined molecular, organismal, physiological, and isotope geochemical approaches shed new light on the response of coccolithophores (unicellular calcifying marine algae) to changes in seawater pH. Bleich et al. were able for the first time to identify the ion transport pathways across the plasma membrane that regulate the cytosolic pH of those model organisms. The regulation of carbon transport in coccolithophores in response to increasing CO_2 levels and thus their potential for biological adaptation is also being explored at the molecular level (Schulz-Friedrich and Riebesell) and traced by trace element fluxes (Eisenhauer et al.).

At the same time methodical approaches are developed, improved, and tested to reconstruct past oceanic pH and pCO_2 scenarios (Eisenhauer et al.) and to trace past circulation patterns by their radiocarbon signatures in fossil biogenic carbon (Schneider et al.).

A further set of projects concentrates on developing and improving modelling approaches to simulate oceanic biochemical cycles aiming to improve the estimation of present and future oceanic CO_2. In particular, the refinement of the individual components of the Kiel Climate Model System (KCMS) is addressed here (e.g. Srivastav et al., Biastoch et al./Motif et al, Oschlies et al.).. Forthcoming projects as recently initiated focus on concepts for the efficient integration of biogeochemical models from seasonal to multi-millenial timescales (Oschlies), 3-d simulation of thermohaline convection in the ocean´s crust with adaptive filters (Braack et al), parametrization of near surface vertical mixing processes (Braack and Schneider).

Research topic A5 will address the reactions of the CO_2-seawater-sediment interfaces down to the molecular level. As a first step global optimization algorithms of molecular clusters have been established as a tool to better understand the transition from single molecules to bulk phases (Hartke et al., in prep.). Here the appointment process of the new JRG leader was delayed because of the declination of the candidate.

In the frame of research topic A 6 exploring the chemical structures and processes at and near the seawater-air interface, activities focus currently on improving the methods for nitrogene Isotope studies (Wallace et al.).

Moreover, general concepts and infrastructure for data exchange, archiving and retrieval are developed to strengthen multidisciplinary co-operations across the Cluster (Luttenberger et al.).

Under the topic “Valuing the Ocean” Klepper et al. in a highly multidisciplinary approach seek to improve economy-climate modelling with respect to the role of the ocean, here including for the first time the most relevant aspects of the oceanic carbon cycle.

Other networking activities include a regular monthly seminar organized by the Institute of World Economy (IfW) and attended by members of all Theme A topics, which provided the opportunity to learn the different languages in natural, engineering, and economic sciences from each other, become familiar with state-of-the-art research questions and tools in the neighboring fields and lay the foundation for topic A7 *Valuing the Ocean*.

The cross-disciplinary networking and research collaborations established during this first phase of the Excellence Cluster will provide fertile grounds for the JRGs to get a head-start in developing their research programs and build their scientific profiles.

3.1.2 Theme B: Marine Resources and Risks

As has been outlined above Theme B focuses on the understanding and management of marine resources and the assessment of hazards. Oceans provide resources and services to humankind, such as fish and seafood, genetic resources for medical purposes, fossil fuels and minerals.

To investigate the topics set out in the initial proposal, besides building the JRG’s, the different groups of Theme B have initiated the proposed research projects by applying for mini-proposals or through carrying out research by alternative funding. Within the Theme B, altogether 16 mini-proposals have been submitted, and 8 have been accepted. In the first round 4 mini-proposals have been accepted and funded, one from theme B1 and B2 each, and 2 from B6.

The subject of group B1 is to develop integrated multi-species fish population models in order to improve traditional fishery management systems. The aim of the first Cluster project was therefore to develop a bio-economic approach towards an alternative fishery

management for the Baltic Sea focussing on cod and sprat, the biologically and commercially most important fish species in the Baltic ecosystem. The work builds on the ISIS MSVPA-model focusing on the Baltic sea subdivisions 25-32. The work can be split into two parts. Within the marine biologic aspects the model has been further specified, important parameters such as stock size, natural morality and recruitment have been estimated from different data sets. The economists in the group have made progress in understanding the biological models and adapting alternative versions of Lesley-matrix models into economic models. First simulation runs have been carried out. There is need however for further investigations. A further proposal will therefore be submitted. Fortunately the candidate for the junior professorship, Dr. Martin Quaas, has confirmed his appointment now and will take up his position on November 1st.

Group B2 has launched a proposal on complex barriers and microbiota in the ocean and their implications for humans. The goal of that project was to study microbial consortia on marine multicellular host organisms as attractive model system to understand the complex interplay of challenge that is also relevant to the human barrier organs and its microbiota. In order to study the interactions between microorganisms and copepods, which are known to be carriers of human pathogens in costal areas the group developed sampling protocols and adapted molecular methods to copepods. Five new projects by the B2 group have just started. The B2 group can therefore be considered as the most successful and active group within theme B.

In group B3 the candidate for the junior professorship, Dr. Lars Rüpke, has also confirmed his appointment and will start his research soon. The main focus of his JRG will be to develop reactive transport models of deep sea resources and apply them to different geological settings. The initial scientific objectives of the new JRG include studies of how mid-ocean ridge dynamics affect hydrothermal activity and vice versa, studies on feedbacks between hydrothermal flow and chemical reactions, and investigations on the transition from continental rifting to steady-state seafloor spreading as well as on affects of fluid and melt migration on passive margin dynamics.

With respect to group B5, Dr. Kerstin Schrottke has accepted the offer of the CAU and will head research group B5-1. Her research activities cover nearshore sediment dynamics and coastal processes in relation to environmental changes and sea-level rise.

Current research activities of the Coastal Geology group at the Institute of Geosciences comprise the reconstruction of deglacial and Holocene sea-level histories, the hydro-

morpho- and sediment dynamics of coastal seas and river mouth systems combined with the evolution and migration of shorelines due to changes in sea level and anthropogenic impacts. Relevant projects focus on the reconstruction of major sea-level jumps during the last deglaciation. The group was able to prove evidence on the magnitude of initial deglacial sea-level jump at the end of the Last Glacial Maximum. The group further focused on Holocene evolution and modern sediment dynamics of the Mekong Delta and succeeded in a detailed reconstruction of the landward retreat of the Mekong river during last deglaciation's sea-level rise. Further projects focus on the evolution of mangrove forests, on river impacts on the northern Brazilian coast, on high-resolution seafloor and habitat mapping of selected areas of the North Sea and the south-western Baltic Sea, on anthropogenic impact, sediment transport and risk assessment in Luebeck Bight (Baltic Sea), and finally on tracing impacts of tsunami waves and sediment loaded backflow on the eastern continental shelf of the Andaman Sea (Thailand).

Group B6 has been successful with two funded research projects. The first proposal focus on the international legal and regulation of New Uses of the Deep Seabed. The research undertaken in that project has so far identified four groups of uses that are either already under way or become more feasible as resource costs increase and technology advances: the deep sea as deposit of vast amounts of mineral resources; the deep sea as source of genetic resources, the vicinity of hydrothermal vents as a source of a large variety of chemical substances and processes data for the development of industrial application, and finally the deep sea as storage for carobone dioxide captured from fossile fuel power plants. First analyses on which uses are covered by the UNCLOS regime *ratione materiae* have been carried out.

The second research project of the B6 group is an interdisciplinary proposal with the research platform P4 on ocean observations. Since gliders and drifters are important tools for ocean observations, questions concerning their use in waters subject to the jurisdiction of other states are crucial. This project investigates the legal status of the use of such gliders and drifters. First results and proposals how to solve the problem of using gliders in the above mentioned areas have been made.

As a further success of the B6 project, the candidate of the junior professor, Dr. Alexander Proelß has been appointed and has taken up his position in September.

3.1.3 Platform development

A first call of Platform proposals was launched in spring 2007. The goal of this call was to close analytical and instrumental gaps in order to provide a broad range of tools and techniques for the cluster. Based on suggestions by the Cluster Council, the Cluster's Executive Committee decided on grants for high-priority investments of the four platforms (2.9 Mio €) in a first step. However, the call will be closed in autumn to enable the participation of the new JRG leaders. All equipment purchased after the first call is summarized in the appendix.

Platform P1: Numerical Simulation and Data Management

The scientific activities of the research group of theme A will be based on extensive numerical simulation of the CO_2-cycle and climate variability of the Kiel Ocean Climate Model-system. The model computation together with data assimilation for the global ocean and atmospheric circulation and biogeochemistry plays a fundamental role in many Cluster activities, e.g. for the CO_2 uptake or, more generally, for regional developments of physical and biogeochemical parameters.

In order to account for extra computational resources Platform 1 decided on investments to extend the local vector computer system NEC SX-8 (with 5 knots) at the data processing center of the CAU with 8 CPUs and corresponding storage capacities. This concept is best compatible with existing facilities and will be maintained by available staff. Expected date of delivery is September 2007, installation is scheduled for October 2007. The increasing demand on computational power also requests additional personnel to maintain complex software and databases. A highly qualified data manager will start in October 2007.

To discuss the recent developments in the field of mathematical modelling and simulation of flow problems in geosciences the platform organized the "3rd Scientific Computing Seminar" about Mathematical Modelling and Simulation of Flow Problems in Geosciences held at the "Kunsthalle Kiel" in summer 2007. Topics included: mathematical models, numerical schemes, algorithms, simulation techniques, parameter estimation and data assimilation, coupled processes, reactive transport and free surfaces and partial differential equations with stochastic parameters. The conference with about 55 participants was supported by the DFG-cluster together with the GAMM and the "Innovationsfond des Landes SH" (total cost about 2 500 Euro).

Platform P2: Isotope and Tracer Analysis

Within the excellence cluster a large demand on analytic and in particular on isotope and trace element analysis will be requested. However, the available old mass-spectrometers will

not be able to meet the increasing demand on high sample throughput and precision. Therefore, highest priority was given on replacement of old machines by new equipment. Some analytical weakness was also identified in the field of organic geochemistry. Furthermore, Platform 2 also identified lacks of instrumentation for micro-analytical studies. Accordingly, the Platform council decided to emphasize the replacement of old equipment and the establishing of new capacities for organic geochemistry. Second priority was given to the improvement of micro-analytical capacities.

Following the above approach as decided by the Executive Committee two stable mass-spectrometers were advertised and are purchased via the DFG (Finnigan MAT253). Both machines will be allocated at the Leibniz Laboratory at CAU providing competent staff for service and maintenance. Both machines have already been ordered and will be installed within the next months.

Platform 2 members continue to discuss the role, management structure and performance of the TAC (Tracer Analytical Center) in order to provide effective analytical support for the excellence cluster, university and the attached institutions.

Platform P3: High-Throughput Molecular Bioscience Technologies

Platform P3 is devoted to strengthen the high-throughput analyses of genetic diversity, systematic expression profiling, robot-assisted cell-based assays, competitive proteome analysis techniques and the availability of a population-representative biobank (PopGen).

In order to fill instrumental gaps a Capillary Sequencer (Applied Biosystems, 3730 xL) and a Qiagen Robot for Large-Scale Plasmid Preparation are currently purchased.

A position for an expert in biogeochemical analytics and instrumentation will be installed at the Institute of Zoology.

Platform P4: Ocean observatories

Major tools for the excellence cluster to achieve information about future ocean change are ocean observatories. There is general consensus in the platform council that the already existing capacities have to be completed and extended by new approaches such as enhanced four dimensional ocean observation (glider swarm) and seafloor or open-ocean laboratories for manipulative biogeochemical studies (bottom landers, free-drifting mesocosms, etc.).

Therefore the following new systems and modules are currently purchased: mesocom, Lander, OTIS device, FlowCam, CO_2 manipulation, Shallow Seismic device, Streamer and a CTD. On the Cap Verde basic equipment was purchased for the local long term observatory. To maintain the new instruments a position for a technician is installed at IFM-GEOMAR.

3.2. Integrated School of Ocean Sciences

A structured, interdisciplinary PhD programme (details available on the ISOS Website: http://isos.uni-kiel.de) has been developed that allows flexibility in detail while defining the qualifying attributes that a doctoral candidate within the Cluster is expected to achieve: the ability to apply *in-depth scientific expertise* in their own field, be versant with the *multidisciplinary aspects* of scientific, economic and legal aspects of The Future Ocean, and possess appropriate *transferable skill*s to achieve pre-defined career goals within and outside of the University. The approach used is a combination of tailored course offers, access to funding for travel and mini-research-proposals, a strong PhD network with self-organised Symposia, and exposure of PhDs to science-industry-policy forums outside the University.

Formally, PhD candidates will be enrolled in their respective faculties; ISOS forms a structural framework within the Cluster to enhance all aspects of multidisciplinary science at the graduate level; in this it supports PhD students, the new research groups, and cluster PIs.

ISOS is responsible, together with Cluster PIs, for defining **core courses** and identifying both detailed, expert training courses as well as developing new, **multi-disciplinary teaching modules** for graduate and post-graduate students (as an example: “Scientific, economic and legal aspects of marine resources”, supported by PIs from the faculties of law, economics and science). Where courses e.g. for transferable skills are already available, these will be used, in other cases these may need to be imported or created after identifying the needs of graduate students. There is no rigid curricular demand on PhDs; training to be taken in all three main areas will be chosen solely according to the relevance for the candidate pertaining to their research and career goals.

The PhD programme does not rely solely on a curricular frame. To exploit the full potential of young researchers in the Cluster, a strong scientific and social **network** of PhDs will be formed – it is expected that by enabling this network to go on retreats, organise their own symposia, be offered a science-industry-policy forum and be encouraged to apply for independent, competitive funding through mini-proposals, ISOS PhDs will bring in innovative aspects to advance interdisciplinary discourse within the Cluster. PhDs can apply for **financial support** for participation in conferences training courses, and other scientific meetings.

Where appropriate and advantageous PhD candidates will be encouraged to engage themselves outside of the University by giving short scientific talks at gatherings of industry / policy makers, thereby identifying the aspects of their work of relevance to society. Although initial opportunities have already been opened through contacts with political and industrial

bodies, the exposure of PhDs as "***ambassadors of the University***" presumes a high level of expertise, confidence and backing by senior scientists that is still to be proven.

3.2.1 E-Learning

Web-based information and teaching platforms are indispensable to unite the diverse teaching contents and traditions of the marine science disciplines within the Cluster. E-learning presents an efficient, effective and innovative method for knowledge and teaching transfer within the Cluster that is also to be used to develop exportable units e.g. for courses aimed at maritime professionals. Recognizing the impossibility of producing a comprehensive e-learning system with the ISOS resources, we concentrate on i) identifying a few key themes in which excellent, widely applicable teaching units can be produced using e-tools, ii) networking with e-expertise within the university and thus exploiting synergies, iii) establishing a central platform for teaching in the core oceanographic disciplines and iv) providing intensive professional support to Cluster members to develop their own e-learning units.

Core e-learning activities since June 2007 are:

- *Implementation of an information platform:* A re-launched and extended version of the ISOS website serves as an information platform on ISOS activities. It includes information for cluster members and PhDs, provides a public site for announcements of lecture series, current events etc. and will be a portal for PhD candidates.
- *Establishment of an e-learning system:* The open-source e-learning platform *Nickels* has been adopted and is currently being customized for the ISOS e-learning concept.
- *Implementation of e-learning support and development of modules:* Individual e-learning support structures are being established, to support scientists in development of teaching units. These include an online tutorial, training seminars and personalized individual support for cluster scientists. Since the production of such e-learning modules is complex and time-consuming, first results are expected in spring 2008.
- *Mapping of several master study programmes into the e-learning system* as an information and download platform for students and teachers, enriched with e-learning content for specific topics and online assignments. This activity is underway for the Masters Programmes of the core oceanographic disciplines and will be expanded to include all basic courses in Cluster science.
- *Networking on an institutional level* for information exchange and competence sharing in e-learning technologies, content production and e-teaching experiences. The networking

process is expected to have a positive impact on the coordination of e-content production.

3.2.2 ISOS Events

ISOS sees itself as a platform for scientific exchange of Cluster issues within the Cluster, throughout the University and to the public, industry and policy-makers. Several forums have been established, others are to be started.

- **ISOS Lecture Series** (Winter Semester) are 2-hourly lectures held by Cluster members giving an insight into their work thus showing the variety of research done in the Cluster. Currently, the lecture series offers an opportunity to introduce principle investigators, junior professors and new cluster members to the cluster community and University at large. Additional, interdisciplinary topics augment the lecture series, an entire list of which is available on the ISOS Website.
- **ISOS Summer lecture evenings**, initiated in the Summer Semester 2007, consisted of individual lectures held by high-level scientists from other universities. The lectures were announced not only on the campus but also in the local media in order to attract a wide audience. To underline the public approach, two of these lectures took place outside the campus, one in the City art museum, the other at the house of the Schleswig-Holstein State Parliament.

3.2.3 Funding of Cluster Events

To enable academic exchange at all levels, ISOS invites cluster scientists to actively organise symposia, workshops and conferences and invite guest scientists in cluster-related themes. Funding for these events can be applied for on a competitive basis; the proposals are judged by 2 cluster proponents from within and outside of the discipline of the applicant (Section 2.2). Criteria for eligibility include provision of some form of student interaction during the event in question.

A complete list of the events funded so far is available in the appendix. Since the first call in April this year four international conferences which took place in Kiel received co-funding by ISOS. A side effect of this funding is an enormous public outreach for ISOS and the entire Cluster as well since it has to be mentioned as sponsor. Additionally, conferences usually provide an opportunity to inform an international expert public about ISOS and the cluster by showing posters, distributing flyers etc.

3.3 Public Outreach

3.3.1 School Program

To address the next generation of science students, the Cluster participates in "NaT-Working Marine Research" (http://nat-meer.ifm-geomar.de), a competence network comprising secondary schools and scientists. One major project in the Cluster's first year was a six-month course for gifted secondary level students (grade 9-11) on “The Science in Schätzing's 'The Swarm'”. Results of this course were highlighted to the public in student presentations at the “Enrichment Day” at the Kieler Gelehrtenschule in May and at IFM-GEOMAR's Open Day in September. A second major activity was a two-day NaT-Working-Marine-Science-Symposium in Bad Segeberg in February, in which 120 students and 18 teachers from 7 schools presented the results of their science projects together with 15 Cluster scientists. More than 120 guided tours through the Cluster exhibition “Ozean der Zukunft” were organized for school classes from Schleswig-Holstein and other parts of Germany (c.f. report on exhibition). As a contribution to the project “Forscherferien” by IPN – Leibniz Institute for Science Education a one-day excursion to Kiel Beach “Falckensteiner Strand” was carried out for 3rd grade students.

Forthcoming projects include an 8-day-expedition to Gdansk/Poland with RV ALKOR in October 2007 with students, scientists and a teacher, a one-year-course on iron fertilization and CO_2 uptake in grade 13 with various Cluster scientists, as well as a cooperation with Bundesumweltwettbewerb (coordinated by IPN). Further perspectives for outreach work addressing students at school aim to:

- extend the activities by involving more Cluster institutes, and thus encompassing a broader range of themes,
- raise national and international visibility of the school activities,
- address younger students (grades 5 to 8).

3.3.2 Exhibition Activities and Events

The exhibition “Ozean der Zukunft” introduces the visitor to the main topics of the Cluster, new challenges in marine research, research methods and equipment as well as to the latest scientific results. The exhibition was developed by a joint approach of science (CAU, IFM-GEOMAR) and art (Muthesius Academy of fine Arts): Interactive and reactive simulations, genuine instruments and models suggest at present “a dive to the deep sea” and enable the visitor to experience different scenarios. The audience is guided by qualified staff and the exhibition is accompanied by lectures, thematic movies and discussions forums. The modular system of the exhibition allows for a successive integration of new modules to keep track

with the development of Cluster themes. This concept permits moreover to adjust the presentation of the exhibition (as a whole as well as of individual parts) to the particular need and focus of the event (setting). Up to now the exhibition was presented two times (October 2006 and June 2007). It will travel to Berlin in October 2007 and further presentations are planned for 2008.

For the further development of the modular concept a series of workshops will be required to ensure the exchange between all relevant scientists and the exhibition designing crew. For the future the focus lies on interactive modules, for example sensitive projection screens which allow the presentation and linkage of different topics as well as the interaction with the visitors. The concept aims at compact modules to enable an easy and low cost transport for short-term events. Additionally, an individual use of exhibition parts will be required for special events like conferences, fairs or un-staffed locations. In view of determining factors of finance, space, or time, a concept allowing a multifunctional presentation of the exhibition at any time and any location will be created.

A co-operation has been initiated between the Cluster and the marine-oriented Kiel Science Centre (opening planned for 2011). Presently the “Future Ocean” exhibition team is contributing to the conceptual development. In the Science Centre the public will be offered the opportunity to keep track with Future-Ocean topics in the long term.

Fig. 6. Impressions from the Exhibition “The Future Ocean” as presented 2007 at Kiel.
Left: 3d-globe, Right: sidescan sonar.

3.3.3 Internal and external communication

Last year´s activities have focussed on

- implementation of a database providing specialists on all the themes relevant to the Cluster. This list is continuously updated. This database is online since April 2007 and was visited by more than 6.000 persons. Over 50.000 search requests have been registered.
- the close collaboration with print, electronic and online media was supported by a number of press events (including a two-day media workshop in spring 2006) and 27 press releases in 2006 and 2007.
- the presence of the Cluster in the media is continuously monitored and evaluated. An increase has indeed been registered over the last few months. The rise in student registrations in Cluster disciplines (e.g. marine biology, geosciences, etc.) observed over the last month may be related to the Cluster's media presence.
- as an internal and external communication tool of the Cluster its web site is continuously updated.
- a corporate design was developed for the Cluster and is applied to all publications, such as leaflets, posters, press kits, and the web presence of the Cluster. The latter is permanently growing and delivers detailed information about activities, projects and news of the Cluster members.

Forthcoming activities aim to

- enhance the internal information flow within the Cluster. An internal newsletter is presently under development in order to communicate important news to all cluster members.
- produce a cooperate film for the Cluster in cooperation with the Muthesius Academy of Fine Arts.

3.4 Transfer-to-Application

Cluster members now advise stakeholders on marine and global change issues regionally, nationally and internationally. They hold important functions and provide essential input in an array of international boards (e.g. WCRP, IGBP, IHDP, SCOR, IODP). Various scientists of the Cluster participate to the National Climate Consortium recently launched in Hamburg. A Kiel Earth Institute is currently established by Cluster members through financial support of the State of Schleswig-Holstein. This center will address the socio-economic implications of climate change for Schleswig-Holstein on a regional scale and will be imbedded in the National Climate Consortium.

A number of large-scale projects have been initiated in 2007 to enhance the cooperation between Cluster members and industries. Thus, submarine mud volcanoes in the Mediterranean at the continental slope of Egypt are investigated by Cluster scientists through a project financed by RWE/DEA (total funding: 6.5 Mio.€, funding period: 2007 – 2011). The active mud volcanoes are located within oil and gas fields to be exploited by an international consortium of energy companies and are threatening the projected seafloor installations. The Cluster's expertise in modes and pathways of eruptive mud volcanism is here applied to enhance risk assessment and reservoir characterization.

Gas venting sites located in the North Sea are investigated in a project funded by BASF/Wintershall (total funding: ~4 Mio€; funding period: 2007 – 2011). Off-shore drilling performed by oil & gas industries over the last decades showed that many North Sea gas reservoirs contain molecular nitrogen rather than methane. The Cluster's expertise in off-shore gas venting is here applied to enhance the exploration and characterization of natural gas fields through the chemical analysis of natural gas seeping from deep reservoirs.

CO_2 sequestration in marine sediments will be investigated in a project funded by RWE/DEA and BASF/Wintershall (total funding: ~4 Mio€; funding period: 2007 – 2011). Pressure laboratories will be established at Kiel to investigate the formation and behaviour of CO_2 gas hydrates in marine sediments. The project aims to develop new technology for the save disposal of CO_2 drawing on the Cluster's expertise on natural gas hydrates and sediment-CO_2 interactions.

Clean technologies for the production of natural gas from marine methane hydrates will be developed in large-scale national projects funded by the Federal Ministries of Economics and Science (total funding: ~15 Mio€; projected funding period: 2007 – 2011). The projects are coordinated at Kiel by Cluster members and include a large number of industrial partners from various sectors (off-shore exploration, ship building, chemistry, gas technology, energy). New technologies will be developed to convert natural methane hydrate into CO_2 hydrates. The projects aim to combine the production of natural gas from methane hydrates with the save disposal of CO_2 applying again the Cluster's expertise in marine gas hydrates.

The valorization of applicable results, products, or patents emerging from the cluster research is carried out by the Patent Evaluation Agency for Scientific Institutions Schleswig-Holstein GmbH (PVA SH). An informative meeting addressing Cluster scientists has been invited by the PVA for autumn. Currently, the Cluster´s four research platforms joining high-end technology are screened by a PVA scout.

APPENDIX

Appendix

I. **Funded Cluster-Proposals 2006**
   1. **List**
   2. **Reports**

II. **Cluster-Proposal started in 2007 – List**

III. **Platform Investments 2007 – List**

IV. **Integrated School of Ocean Sciences – Report**
   1. **Lectures**
   2. **Financial Support**

V. **Presentations of Professorship candidates – List**

VI. **Public Outreach Activities**
   1. **Press Resonance to the Cluster**
   2. **Press Monitoring Service (Selection)**
   3. **NaT-Working Activity Report**
   4. **Exhibition “Ozean der Zukunft / The Future Ocean”**

I. Funded Cluster-Proposals 2006

1. **Effect of increased CO2 on cellular ion transport mechanisms - CO2-induced Ocean Acidification: Biological Responses and Adaptations**
   Bleich

2. **Boron Isotopes as a Proxy for pH decrease and pCo2 increase**
   Eisenhauer, Liebetrau, Fietzke, Riebesell, Dullo, Kuhnt, Schönfeld, R. Schneider, Frank

3. **Managing Cod and Sprat in the Central Baltic Sea - A bio-economic multi-species approach with stochastic regeneration functions**
   Froese, Kraus, Requate

4. **dearX - XML Technology for marine Data Exchange, Archiving and Retrieval**
   Luttenberger, Visbeck, Grevemeyer, Karstensen, Linke

5. **The role of light fluctuations on ocean heating and photosynthesis**
   Macke, Eden, Wahl, Croot, Zimmer

6. **Synergetic effects of temperature, pH and salinity on the metabolism of benthic organism**
   Piepenburg, Spindler, Linke, Riebesell

7. **Complex Barriers and Microbiota in the Ocean: implications for human barrier disorders**
   Schmitz-Streit, LaRoche, Rosenstiel

8. **Radiocarbon dating of fossil biogenic as an indicator of age differences in surface and subsurface water masses in the past ocean**
   Ralph Schneider, Blanz, Grootes, Nadeau, Andersen

9. **Mathematical and Algorithmic Challenges in Modelling Marine Biogeochemical Cycles**
   Srivastav, Böning, Oschlies, Schneider, Schneider

10. **Beyond Mineral Resources - The International Legal Regime and Regulation of New Uses of the Deep Sea Bed**
    Zimmermann, Giegerich, Jenisch

11. **Development of a Coupled Climate/Ocean Biogeochemistry Model**
    Latif, Böning

12. **Miniproposal: The Legal Regime of Drifters and Gliders in International Law**
    Zimmermann, Visbeck

Project title: „Effect of increased CO_2 on cellular ion transport mechanisms”

Funding period: 08.11.2006 – 07.11.2008
Project period: 15.3.2007 – 15.3.2009

Aims:
The project aims are to investigate the effects of changes in ambient pH and pCO_2 on marine model organisms at the cellular level. Membrane transport and compensatory mechanisms for cellular pH homeostasis are investigated by electrophysiological and microfluorimetric techniques.

Progress:
According to the work plan and schedule we recruited Dipl. Biol. Kerstin Suffrian as a doctoral fellow under supervision of Profs. Markus Bleich and Ulf Riebesell. She is associated to the integrated school of ocean sciences (ISOS) within the cluster of excellence and started in March 2007, training physiology and specifically techniques of electrophysiology and microfluorimetry.
We selected two marine calcifying organisms (*E. huxleyi* and *C. pelagicus*) and set up the respective culture conditions.
Cell preparation for measurement of cytosolic pH (pH_i) has been established. After decalcification, cells are loaded with the dye BCECF-AM and fluorescence intensities are recorded by video imaging. The first data set provides insight in H^+ transport pathways of the two coccolithophorids and their dependence on Cl^- and K^+ concentrations. In addition we investigated the feasibility of the use of diffusible weak acid base buffers to experimentally influence pH_i.
Adaptation of cell preparation to investigate membrane electrophysiology by patch clamp techniques is still ongoing. To solve technical problems in cell handling to obtain a clean plasma membrane, we established a collaboration with Dr. Alison Taylor, Department of Biology and Marine Biology, The University of North Carolina, Wilmington, who was the first to publish patch clamp data on the coccolithophorid *C. pelagicus* in 2003.

Results:
To correlate fluorescence ratio values with pH_i we permeabilized the plasma membrane of *C. pelagicus* by the K^+/H^+ exchanger and ionophore nigericin. In the presence of nigericin extracellular pH and pH_i equilibrate. Figure 1 shows the changes in fluorescence ratio as a result of different extracellular pH values under these conditions. The changes in pH are proportional to the changes in fluorescence ratio. Calibration and dye loading will be optimized for time constancy.

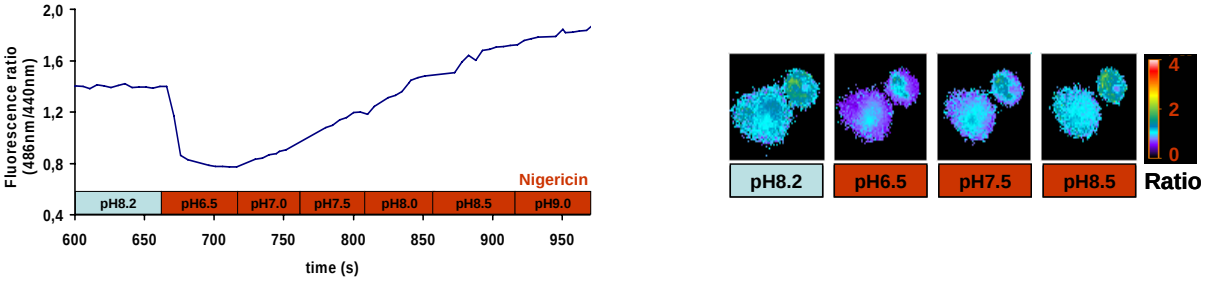


Figure 1. Calibration of fluorescence ratio versus pH_i after membrane permeabilization for K^+ and H^+. Left: Fluorescence ratio vs. time. Right: Pseudocolour image of C. pelagicus fluorescence ratio.

Environmental conditions change ambient CO_2 and H^+ concentrations. In this context we first measured the influence of different ambient H^+ concentrations on pH_i. Ambient changes in pH directly influence pH_i values significantly as shown in fig. 2. Data is comparable for both *C. pelagicus* and *E. huxleyi* and in the investigated time frame no obvious compensation by cellular mechanisms could be observed.

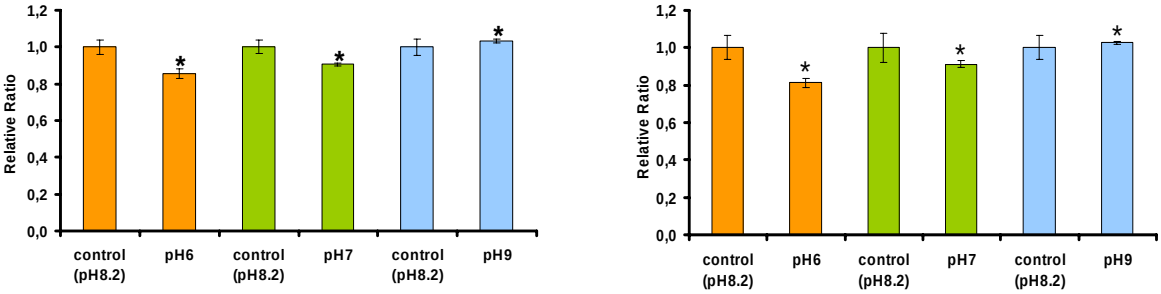


Figure 2. pH_i depends on ambient H^+ concentrations. Relative changes in fluorescence ratio in C. pelagicus (left) and E. huxleyi (right).

The data shown in figure 2 strongly suggests the existence of a H^+ transport pathway across the plasma membrane. In the next experimental series we investigated whether this pathway is depending on extracellular Cl^- or K^+ concentration. Changes in pH_i were most prominent for Cl^- in *C. pelagicus*. Figure 3 shows the summary of the respective experiments in *C. pelagicus* and *E. huxleyi*.

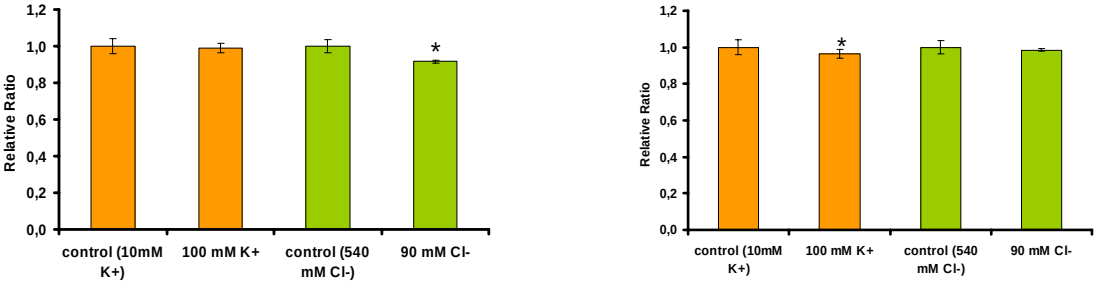


Figure 3. Effects of changes in ambient Cl^- and K^+ concentrations on pH_i in C. pelagicus (left) and E. huxleyi (right). C. pelagicus shows the strongest response to $\Delta[Cl^-]$.

In further experiments we validate different diffusible buffer systems to experimentally influence pH_i and thereby challenge cellular pH regulatory mechanisms. NH_3/NH_4^+ and acetate/acetic acid show only weak effects on pH_i in *E. huxleyi* indicating similar permeability for both buffer components.

Perspectives:

The results from microfluorimetric measurements are encouraging and will be expanded to characterize the properties of these model organisms with respect to CO_2 and HCO_3^- permeability. In addition, pharmacological tools will be included into the investigations to identify transport proteins involved. To get an insight into compartmentalization of the dye within the cell and the respective pH differences within cellular compartments we will use confocal imaging. As soon as the plasma membrane preparation technique is acquired from the Taylor lab, the fluorescence data will be complemented by measurements of membrane voltage and conductance.

Together with the new JRG in A1 we will select another species (most likely larvae from Echinoidea) and set up an additional lab to expand work space.

Status report on the cluster project:

Boron Isotopes as a Proxy for pH decrease and pCO_2 increase

By: Anton Eisenhauer, Leibniz-Institut für Meeresforschung, IFM-GEOMAR, Dienstgebäude Ostufer, Wischhofstr. 1-3, 24148 Kiel.

Although $\delta^{11}B$ is routinely measured at the mass-spectrometer facilities of the IFM-GEOMAR by TIMS and has contributed significant scientific results the chemical procedures for Boron purification is not sufficient for small samples amounts because of blank and contamination problems. Boron isotope studies require unique clean-lab conditions for sample treatment and element separation because borax and boric acid are widely used as flame retardant in air handling systems in reason of legislative regulations. As a consequence in the lab atmosphere Boron is present in high abundance and may eventually contaminate the sample boron to an unknown and not reproducible quantity. Contamination problems for the Boron isotope system are unique because laboratories that were originally designed for the analysis of Pb, Nd, Sr, U and Th are optimized for low particle flux and not for problems related to highly volatile elements like boron and boron bearing filter material. The excellence cluster will require the measurement of even smaller sample sizes for time series analysis by using TIMS and later "Laser Ablation Systems" linked to our MC-ICPMS (Axiom). Latter down sizing of the amount of sample material in combination with the anticipated higher precision may cause further problems which have to be solved.
In order to overcome this contamination and blank problems a separate low level boron workspace should be provided by an active laminar flow workstation with integrated safety hotplate and independent air supply. The desired workspace (*Filter Table FT-1500; PicoTrace*®) is specially designed for the work on Boron and its isotopes and is based on the combination of chemical-active and boron-free PTFE filter elements. Boron chemistry can completely be performed in this workspace because an additional hot plate is integrated.
Such optimized laboratory conditions are especially favouring multi-element-isotope-approaches as they are required in the excellence cluster and provide the high quality base for conventional element separation accompanying laser ablation isotope techniques.

Status of the project

In order to prepare for the delivery and installation of the desired workspace the laboratory located in 8D/119 in the first floor of the east shore building was redesigned. In the already existing lab, Boron free PTFE filters were built in for an extra cleaning of the laboratory air. In addition, in the already existing laboratory 8D/119 an extra laboratory was built in (see Fig. 1 to 3). Furthermore, in order to create extra air pressure in the room the air exchange rate was increased to about 1600 m^3/hour. Latter exchange rate guarantees that the air pressure in the lab is always considerably higher than the outside air.
The remodelling of the laboratory 8D/119, the air conditioning system and the extra laboratory are finished.
The workspace has been delivered in mid september´2007 and will finally be installed in October´2007.
First blank tests and sample preparation will be performed end of October´2007.

Fig 1: This picture shows room 8D/119 of the east shore building with the built-in laboratory specially designed for the chemical preparation of Boron isotopes. Before installation of this built-in laboratory the air conditioning system was improved with Boron free air filters. In addition the air exchange rate was increased in order to guarantee high air pressure in the room.

Fig 2: In order to reduce contamination with outside air the built-in laboratory was equipped with a 2-door entrance.

Fig 3: The recently delivered and still wrapped workspace for contamination free Boron preparation can be seen. Installation will be finished in mid september´2007. First chemical preparation and Boron measurements are scheduled to be performed at the end of October´2007.

B1-Project: Living Resources and Over-Fishing

Managing Cod and Sprat in the Central Baltic Sea - A Bio-Economic Multi-Species Approach with Stochastic Regeneration Functions

Rainer Froese, IfM GEOMAR; Till Requate, CAU, Institut für Volkswirtschaftslehre

Modelling fisheries needs a strong foundation in both biology and economics. The subject of this cluster proposal is a bio-economic approach towards an alternative fishery management for the Baltic Sea focussing on cod and sprat, the biologically and commercially most important fish species in the Baltic ecosystem.
Present fishing practises in the Central Baltic Sea (ICES Subdivisions 25-32) not only exert an enormous direct influence on the population development of both species, but also indirectly, e.g. via the removal of food for top predators affecting reproduction, and growth. In addition, climate change effects on hydrographic regimes strongly impact the recruitment success and stock development of cod and sprat with unfavourable hydrographic conditions plus heavy harvesting of cod leading to changes in the predator-prey and thus the entire trophic cascade.
In fishery-biology, an area disaggregated, multi-species virtual population analyses constitutes the presently most advanced assessment model for Baltic Sea upper trophic levels that however only allows for longer term projections under certain assumptions on future reproduction, growth and mortality. In fishery economics surplus production models, which depict fish population size and growth as aggregate fish biomass have predominantly been applied. However, as both commercial value and population parameters are size-dependent, biologically more realistic size- or stage-structured and disaggregated management models must be applied in bio-economic modeling.
Therefore, the interdisciplinary work of fishery-biologists and economists within this proposal strives for the development of environmentally sensitive optimal fishery management which takes into account size- or stage-structured populations, multi-species interactions, and different stochastic influences.

The biological part

It is still common practice in fisheries assessment and management to use long term average recruitment in medium or long term forecasts of catch and biomass, although the expected level of recruitment will change in relation changes to spawning and predator stock sizes as well as predominant environmental conditions. In the Baltic Sea, the frequency of inflow events of highly saline, oxygenated North Sea water favouring cod reproduction decreased drastically during the last three decades with major events only occurring in 1993 and 2003 (ICES 2004). In the light of future climate change, favorable conditions for cod recruitment may further deteriorate. In addition, due to multispecies effects, recruitment of cod may be impacted by sprat predation on cod eggs. On the contrary, recruitment of sprat as a truly

lusitanic species may benefit from global warming and the decrease in predation pressure by cod with density dependent processes likely becoming the major control mechanisms of sprat population dynamics.

To establish a coupled bio-economic model of the Baltic, first step of the biological module was thus to generate historic multispecies stock and spawning stock sizes as well as estimates of recruitment for Baltic cod and sprat under different environmental regimes and perform initial stock projections based on classical stock recruit-relationships (Fig. 1). For this step we had to review and update the existing biological input data base and perform a series of retrospective stock assessments, which formed the basis for the stock projections. Additionally, biological stock parameters, e.g. fecundity data and environmental information were collected during he first phase of the project, which will be used to develop alternative recruitment models that account for changes in stock reproductive potential, multispecies effects and environmental forcing.

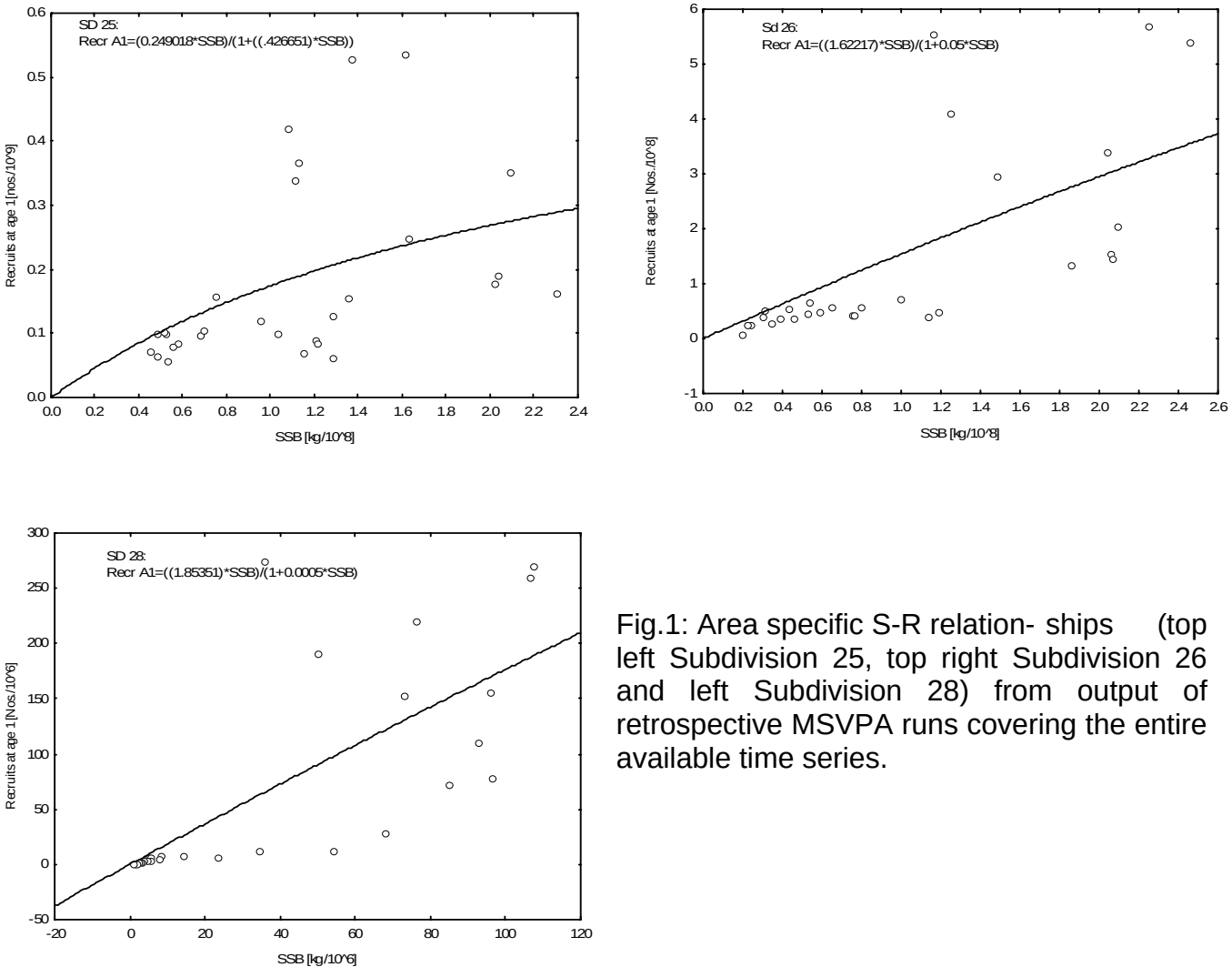


Fig.1: Area specific S-R relation- ships (top left Subdivision 25, top right Subdivision 26 and left Subdivision 28) from output of retrospective MSVPA runs covering the entire available time series.

We chose to develop stage-based matrix recruitment models as an alternative way to account for the different variables and processes acting on production, growth and survival of the various life stages from egg production until recruitment, rather than establishing e.g., multi-parameter S-R relationships. Such Lesley type or life table models are frequently applied in terrestrial ecology, but have rarely been in studies of fish population dynamics. The conceptual model is shown in Fig.2 and will be incorporated into the existing multispecies projection model to generate the long term projections of Baltic cod and sprat stock development under different environmentally driven recruitment scenarios required as upper trophic level ecosystem / population model in the bioeconomic approach.

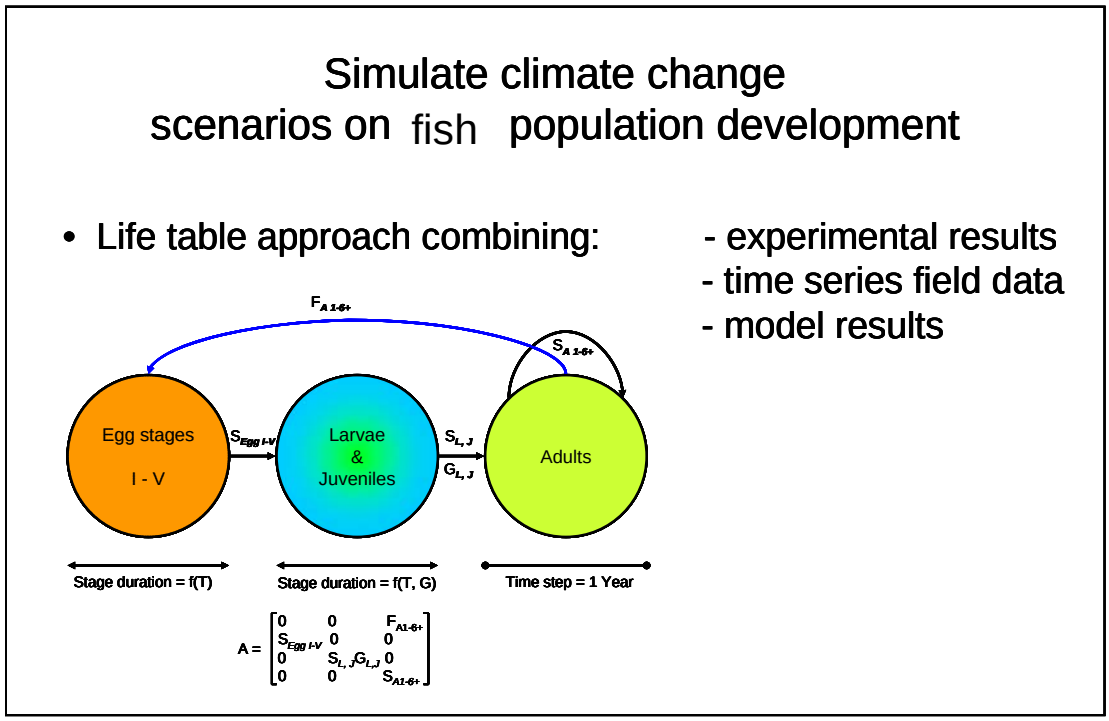


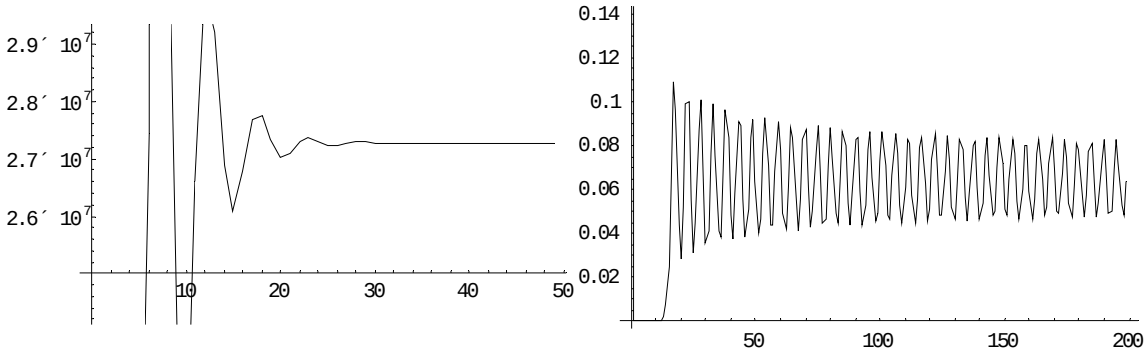
Fig.2: Conceptual life cycle diagram and matrix model to investigate population dynamics of Baltic cod and sprat populations.

The economic part

The economic issue is to study optimal harvesting strategies consistent with the biological approach. Biologic models usually work with exogenously given mortality of the fish stock. This mortality is decomposed into a natural motratility rate and man made mortaility rate wich depends on the fishing effort. In an economic model this man made mortality rate is to be endogenized, either by considering optimal harvesting or harvesting as a result of fishery policy

To achieve optimal harvesting strategies, the first step was to increase the understanding of the biological modelling approaches in particular age-structured population models. In

addition, both deterministic and stochastic multi-species and spatial optimization models were surveyed. The economic module further analysed the incorporation of measurement errors, economic disturbances, and implementation uncertainty in stochastic models as most economic literature has only focused on modelling random stock-recruitment functions. A further step of the economic module was the coupling of profit and welfare optimization models with a stage-based Lesley-Matrix as biological constraint which both couples environmental regimes with life cycle stages and integrates the predator-prey relationships between cod and sprat. As an important result it turned out that population dynamics with constant mortality rates either leads to exploding stock or a stock going to extinction. This is not satisfactory. We therefore set up a model where mortality rates were stock dependent. If the mortality rate has the functional form αS^{β}, where S is the total stock of fish, and $0 < \beta < 1$ but sufficiently bounded away from 0 and 1, simulations showed that fish stocks stabilize (at least for constant harvest rates). Typical behaviour of the fishing stock is displayed in the following Figures:



We see that depending on the parameters, fishing stocks may monotonically grow and converge, the may converge after some oscillations, or they may oscillate forever. This even happens in models with one species only. Further research has to calibrate the parameters and to extend this model to a several species. The economic module will also cover stochastic models on marine protected areas (MPAs). The failure of extant management to cope with uncertain fisheries has led to increased MPA modelling in economics, however, predominantly in a deterministic setting. Further investigation of MPAs will in particular incorporate the findings of the biological part to account for both the ecological and economic implications of the implementation of MPAs in the Central Baltic Sea.

dearX — XML Technology for Marine Data Exchange, Archiving and Retrieval

Progress report for the period: 2007, March 15, until 2007, August 15

Prof. Dr.-Ing. Norbert Luttenberger, Dept. for Computer Science, CAU Kiel
Prof. Dr. Martin Visbeck, Ocean Circulation and Climate Dynamics, IFM-GEOMAR

1 Formal

The dearX project did not start before 2007, March 15, when Dipl.-Inf. Jesper Zedlitz took up his job in the Communication Systems Research Group of CAU's Dept. for Computer Science. Thus, this progress report covers the work of five months. The proposed work on implementation of some of the structures into a new data logger will happen this fall.

2 Project Goals

As outlined in the dearX proposal, the goals of the dearX project are the following:

- Develop a consensual ***Marine XML-related roadmap*** for the Future Ocean research network.
- Set up a working ***demonstrator*** to illustrate the capabilities of an XML-based framework for marine data exchange, archiving and retrieval.
- Get in touch with the ***international standardization bodies*** to provide input concerning special Future Ocean requirements

During the report period, contributions were made to the first and the second goal.

3 Achievements

3.1 Roadmap Development

During the report period, it became obvious that exchange, archiving, and retrieval of marine data must be seen in the context of a elaborate and complex information and processing model for geospatial data, for which the Technical Committee 211 of the International Organization for Standardization (ISO/TC 211) and the Open Geospatial Consortium (OGC) until now have published approx. fifty standards ("geo-standards"). These stan-

dards do not only describe data formats for geospatial data, but also, e.g., related information services, metadata formats, and methods for the development of application-specific standard subsets.

We developed a process-chain model for marine data acquisition as applied by IFM-GEOMAR, and identified those standards from the set of geo-standards that neatly relate to the different sub-processes in this model. The Sensor Markup Language (SensorML) with its process-oriented view supports our modeling approach very well. It turned out that especially the sub-processes for data logging and for measurement data adjustment need a more careful inspection and a more formal description. It was agreed upon to concentrate on these area during the next dearX working period.

3.2 Demonstrator

Jesper Zedlitz developed an initial dearX demonstration program that illustrates how the proposed XML technology supports

- data management
- sensor management, and
- quality management

The dearX demonstrator e.g. automatically stores information on measurement data provenance, on algorithms applied to measurement data, and on sensor state.

4 Next Steps

During the next dearX working period, we will concentrate on

- the definition of formally described, XML-based interfaces between sub-processes in the IFM-GEOMAR data acquisition process.
- the integration of further components into the dearX demonstrator.
- A pilot implementation of XML-based data output in a newly developed data logger for temperature and dissolved oxygen.

It is planned to publish a paper on the adaptation of the mentioned geo-standards to marine data acquisition and processing. This paper should help us to get in contact with the mentioned standards bodies.

First Progress Report:

The role of light fluctuations on ocean heting and photosynthesis (CP0609)

Internal Project
in the Excellence Cluster “The Future Ocean”

Andreas Macke, Carsten Eden, Martin Wahl, Peter Croot (all IFM-GEOMAR),
and Martin Zimmer (Zoologisches Institut der CAU Kiel)

with contributions by Katharina Grosser, Christine Lentz and Martin Hieronymi.

1) Introduction

The solar heating of the ocean as well as the marine photobiological and photochemical processes react in a non-linear way on the intensity of the solar downwelling radiation. Therefore, the response to irradiation fluctuating in time and space is different to that from a homogeneous irradiation with equal mean intensity. The aim of this project is to quantify these differences in theory and in observations under realistic environmental conditions

2) Radiative transfer modelling

Based on a Monte-Carlo model the radiative transfer from the atmosphere into the ocean can be simulated with full account of complex sea surface structures. To this end an ocean/atmosphere interface needs to be build into the model. Because of the late employment of Martin Hieronymi in the modelling position in July 2007, no results exist for this part of the project. However, Martin Hieronymie performed important preliminary work for the reconstruction of sea surface tilts from swell statistics.

In principal an arbitrary irregular swell in a specific sea area can be described by means of short term statistics of a energy power spectrum. Initial values to construct a swell spectrum are either wind speed or the following two parameters: the significant wave height and the so-called zero-upcrossing period. The spectrum according to Pierson-Moskowitz (PM-spectrum) for a mild wind sea corresponding to wind speeds of up to 3.3 m/s (2 Bft) is shown in Fig. 1 (top).

By means of linear wave theory a random swell in space and time can be generated from the spectrum (Fig. 1, bottom). Here, a number of individual waves with distinct frequency and wavelength are simply superimposed. The results can be used to generate the statistical distributions of the wave tilts.

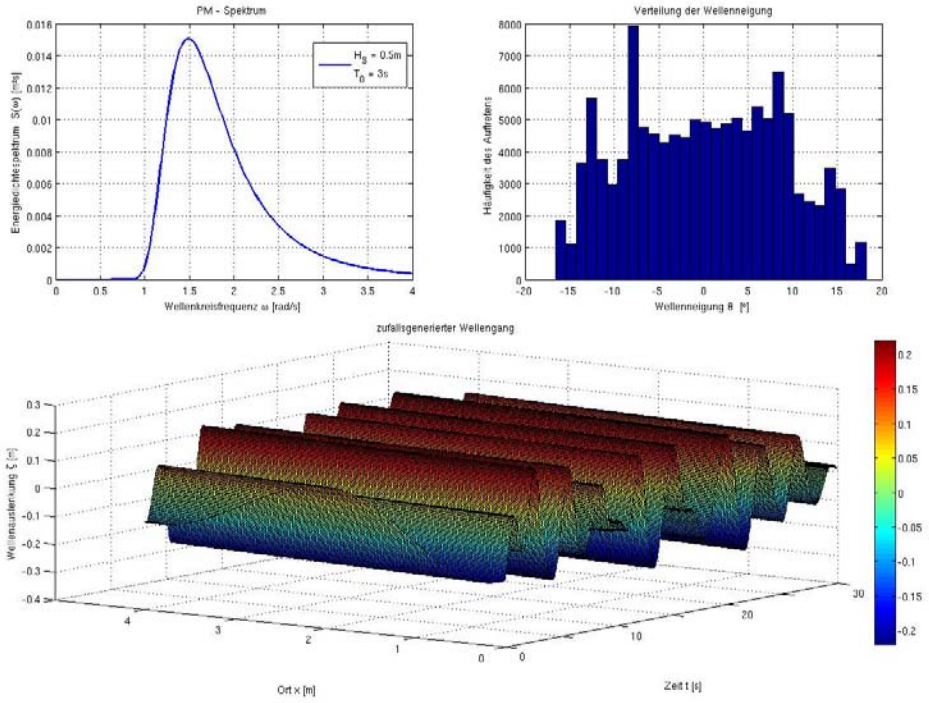


Fig. 1: Given probability density function of swell (top, left), reconstructed frequency distribution of wave tilts (top, right)m and reconstructed spatial wave pattern (bottom).

The waves constructed in this manner do not yet show any small scale pattern which are caused by capillary waves, foam, and trochoid wave shapes. It is planned to establish a cooperation with the Technical University Berlin and to use the local wave channel (see picture to the right) in order to generate and to monitor realistic wave pattern under various swell conditions.

In the near future the spatial and temporal wave pattern will be build into the Monte-Carlo radiative transfer model.

3) Experimental investigations on the effect of light fluctuations on macro algae

Surface waves on waters affect the light properties at those depths where macro algae exist. Within a fraction of a second the algae receives light with extreme large or extreme low intensities. Experiments have been set up (Katharina Grosser) to study the biological reactions (photosynthesis, growth, defence) of algae that are exposed to light fluctuations compared to those which are exposed to homogeneous light.
Light fluctuations visible on a white plate below the water have been filmed with a underwater camera. The resulting movie is projected on an aquarium with four algae (*Fucus serratus*) by means of a LCD projector (see picture below). A control

experiment is performed with homogeneous light of the same mean intensity (80-85 µmol cm^{-2} s^{-1}), which is sufficient for growth of *F. serratus*.

For a period of four weeks both the control and the fluctuation movie are projected onto the algae (sampled at Bülk) 12 hours per day.
At the beginning of the experiment the weight and length of the individual algae are determined. Swabs are taken for the microbiological analysis and photographs are taken. During the first 2 weeks O2- measurements will be performed to determine the net photosynthesis. Subsequently, isopods (*Idotea baltica*) are added to the algae for another 14 days under the same fluctuating/homogeneous light regimes. After a total of 4 weeks the analysis of the algae is repeated to determine the consumption and to compare the capacity for defense induction between treatments.

Aiming at long-term cultivation of *Fucus* in climate-controlled culture rooms, Christine Lentz –accompanied by lab students– has started early this year to figure out light conditions that make possible growth rates sufficient to compensate for consumption by *Idotea*. In order to be able to simulate the above-mentioned fluctuation-free light fluxes over an entire annual cycle, weather data obtained by IFM-GEOMAR at Kiel lighthouse. As a result Christine Lentz now has a series of average fluctuation-free diurnal cycles over an entire year at hand that simulate the light conditions in 2m depth under an undisturbed water surface. This simulation will be implemented in climate chambers to cultivate *Fucus* and *Idotea* jointly. On the long run, light fluctuations as used by Katharina Grosser could be superimposed on the annual light cycle determined by Christine Lentz.

4) Modelling the effects of light fluctuations on photochemical processes in the ocean – Photochemical model and database construction

A photochemical model for H_2O_2 was constructed using a simple 1D mixing model (used previously for modelling Fe(II) mixing during iron enrichment experiments). The model uses a prescribed light input (real or simulated data) which drives the photochemical production of superoxide (O_2^-) which rapidly reacts with metal species or itself to produce the more stable H_2O_2. Instantaneous concentrations of O_2^- were found to respond rapidly to light fluctuations, while the slower reacting H_2O_2 was related more to the total light absorbed. The present model system includes the rapid reactions of superoxide with trace metals (requiring a short time step to ensure model stability) and simple mixing physics. Currently the model has no spectral dependence and this will be added in the 2nd phase of model development.

Sandra Treydte was employed as a student worker to construct a database of critical reaction kinetics for the key photochemical and chemical reactions in seawater. She also ran the model code under different simulation conditions (mixed layer depth, light attenuation coefficients etc) using both observed light data from M68-3 (Jul-Aug 2006 Mauritanian Upwelling) and synthetic data.

(2) **Observations of light spectrum under high clouds in Cape Verde.**
In conjunction with work performed as part of the BMBF project SOPRAN, field observations were recently carried (July 2007) out in Mindelo, Cape Verde in order to obtain more high quality data for use in the photochemical modelling. High quality spectral data was recorded (full solar spectrum) using an Ocean Optics USB4000 spectrophotometer over the course of several days while undertaking photochemical measurements at the INDP in Mindelo. The spectral response of the spectrophotometer was checked daily with a calibrated light source. This data will now be used for implementing the 2nd phase of the modelling in which a spectral response is included (see above).

Report Cluster Project
CP0610:

Synergetic effects of temperature, pH and sainity on the metabolism of benthic organisms

Dr. Michael K. Schmid
Prof. Dr. Dieter Piepenburg

Institut für Polarökologie der Universität Kiel

30.08.2007

Table of Contents

Introduction

The project CP0610 is strongly associated with research topic A2 by directly addressing objective 4 (consequences of seafloor warming on the structure and metabolic activity of the benthic ecosystem) and also tackles a main issue of research topic A1 (biological responses of to ocean acidification), as in a later phase the synergetic effects of temperature and pH changes will be studied in an experimental approach. In this project, we address the issues of (i) how benthic organisms respond in terms of their metabolic performance to changes in environmental key factors (temperature, pH, salinity, and food availability) and (ii) whether there are synergetic effects of temperature, pH and salinity on benthic metabolic rates. In an integrated approach, we have started to investigate (a) the oxygen consumption of selected macrobenthic organisms in laboratory experiments in relation to varying temperature and pH, and (b) the total sediment community oxygen consumption (SCOC) in small-scale field measurements in relation to ambient temperatures and salinities. For the oxygen measurements, we employed a device consisting of a combination of a CTD and a high-precision high-resolution fibre-optical oxygen sensitive sensor (optode).

Work Progress

After accepted for being funded at the end of November 2006, the project started in January 2007. At first, the respiration measurement system, which had been used to investigate the in-situ oxygen consumption of individual organisms as well as the total sediment community oxygen consumption in the Arctic deep sea during a 'Polarstern' cruise in 2003, was modified for (a) the deployment by divers in shallow waters and (b) the measurements in the laboratory. Several dives and laboratory measurements, respectively, took place in January, February and March to optimize the equipment prior to starting the actual measurements.

Field Deployments

For the field study, a site near the "Seebadeanstalt Düsternbrook" at 3-4 m water depth was selected, as it is well suited for our research for different reasons.

After the setup phase field measurements started at the beginning of June. The deployments lasted for approximately one day each (Tab.1).

Tab.1: Field study: sampling dates

Date	Time Start	Time End	Duration
05.-06.06.07	10:36	10:48	24:12 h
12.-13.06.07	11:36	10:16	22:40 h
19.-20.06.07	11:00	08:57	21:57 h
03.-04.07.07	10:03	08:50	22:47 h

In addition to measuring the decreasing oxygen concentration in the incubation chamber, the CTD component of the system also records ambient temperature and salinity in order to relate the measured rates to environmental characteristics. In addition, after the deployments, the sediment under the incubation chamber was sampled and analyzed for sediment parameters (Tab.2, Tab.3). In the course of the project, the biomass and composition of the sediment community in the incubation cores will be determined.

Tab.2: Field study: sediment parameters measured

Abbreviation	Parameter and Unit
WC	Water content (%)
TOC	Organic carbon content (g/g DW)
Chla	Chlorophyll a concentration (µg/cm^3)
Phaeo	Phaeopigment concentration (µg/cm^3)
Phaeo/Chla	Phaeopigment to Chlorophyll a Ratio

Laboratory Measurements

In close collaboration with Armin Form (IFM-GEOMAR), the laboratory measurements of oxygen consumption rates focussed on cold-water corals (*Lophelia pertusa*) collected from the Norwegian Trench. A slightly modified respiration chamber was used for conducting the measurements conducted in the aquarium facilities of the IFM-GEOMAR. After the setup period (which lasted longer than expected due to technical and logistical problems) and several tests, the first successful incubation of a single coral stock was made on July 25-27, 2007.

First Results

The oxygen consumption rates determined in the field study (Tab. 3) lie all within the same order of magnitude and are consistent over the experiments. So far highest oxygen consumption rates were found during the deployment on the July 3-4, lowest on the 19-20 July deployment.

Tab.3: Field deployments: first results - sediment parameters, water temperatures and mean oxygen consumptions.

Date	**WC** [%]	**TOC** [g/g DW]	**Chl** a [µg/cm^3]	**Phaeo** [µg/cm^3]	**Phaeo/ Chla**	**Mean Temperature** [°C]	**Mean O_2 Consumption** [µmol O_2 l^{-1} h^{-1}]
05.-06.06.07	30.55	0.089	12.74	30.81	2.42	15.4	18.45
12.-13.06.07	32.60	0.011	7.70	19.85	2.58	17.2	14.85
19.-20.06.07	50.83	0.031	8.49	36.24	4.27	17.5	6.15
25.-26.06.07	31.49	0.012	6.64	28.91	4.36	n.a.	n.a.
03.-04.07.07	53.74	0.032	9.82	27.38	2.79	15.7	22.50
10.-11.07.07	53.41	0.034	7.96	21.70	2.73	n.a.	n.a.

The respiration of cold water corals was very low (mean oxygen consumption of 0.72 µmol O_2 l^{-1} h^{-1} at 5.4 °C). The experiment lasted for > 40 hours and O_2 saturation in the chamber was still at over 80%. Further experiments have be be conducted to validate this result.

Outlook

The present data are promising and show the general success of the chosen observational and experimental setup. The oxygen optode in combination with the CTD is now reliably working. With more data being analyzed and more results becoming available, we will get a better picture of the benthic community respiration at the "Seebadeanstalt". Differences in SCOC over time will have to be discussed in relation to the environmental setting (primarily temperature, but also sediment parameters and food availability) and the benthic organisms found in the sediment underlying the incubation chamber.

Unfortunately, we could so far only get one measurement with the cold-water corals. But this one experiment showed already that with a simple experimental setup good results can be obtained. In the future, the ambient temperature and pH of the test animals will be manipulated and the acute and medium-scale metabolic reaction will be monitored. With a modified respiration chamber it should also be possible to measure cold-water coral respiration *in-situ*. This modification is necessary because in case of corals we would have to place the chamber over biogenic hard substrate rather then push the core into soft sediment.

Intermediate report 17.08.2007

R. Schmitz-Streit, Rebekka Metzger

Titel: Complex Barriers and Microbiota in the Ocean: Implications for human barrier disorders (CP0611)
Scientific position Rebekka Metzger (PhD student, engagement 5/2007)
Output (publications): -

Summary of Scientific Results

The goal of this project is to study microbial consortia on marine multicellular host organisms as attractive model system to understand the complex interplay of challenge that is also relevant to the human barrier organs and its microbiota. In order to study the interactions between microorganisms and copepods, which are known to be carriers of human pathogens - as *Vibrio cholera* - in coastal areas we developed sampling protocols and adapted molecular methods to copepods. The following essential steps have been performed or are currently in progress:

Field sampling and analysis of the microbial diversity on copepods:
1) Copepods were sampled in the Kieler Förde using a plankton net (mesh size 200 µm) from 18 m depth to surface (vertical). Water from the catch was filtered through 500 µm to keep larger copepods and avoid too much organic material. Samples were kept on ice and subsequently sorted and stored at -70 °C. As controls 1 l surrounding water was filtered (8 µm followed by 0.2 µm).
2) Copepods were thawn at 65°C and frozen at -70°C for 4 cycles and DNA was extracted by direct cell lysis at high temperatures in the presence of 1.5 M NaCl, 1% CTAB (Henne et al. 1999, modified). High molecular DNA (E (260/280) = ~2.0) between approx. 50 – 180 µg was isolated depending on the number of copepods (varying between 70 and 300) (see Fig. 1). 16S rDNA was amplified using universal primers (bacterial and archaeal). No archaeal 16S rDNA was detected, the obtained bacterial PCR product was purified by gel extraction and TOPO-TA-cloned into pCRII (Invitrogen). Plasmids inserts from 48 independent clones were purified and sequenced at the sequence facility of the Research platform of the excellence cluster for 'high throughput molecular biosience technology' (headed by Prof. Schreiber). The phylogenetic analysis demonstrated that the species identified belong to α-Proteobacteria (13 %), γ-Proteobacteria (39 %), Sphingobacteria (2 %), Flavobacteria (19 %); 27 % turned out to be non-classified, uncultered bacteria. 6 % of the α-Proteobacteria were uncultured; the only identified α-Proteobacteria was *Roseobacter* sp. (6 %). The species found within the group of γ–Proteobbacteria were *Marinomonas* sp. (13 %), *Psychromonas* sp. (4 %), *Serratia marcescens* (17 %) and *Alteromonas* sp. (2 %); 4 % were identified as uncultured. Furthermore, 2 % uncultured Bacterioidetes were found (Figs 2 + 3). Interestingly no *Vibrio* species was identified within the microbial consortium. The diversity of the surrounding waters is currently under investigation. This analysis will demonstrate which of those bacteria identified on the copepods are specifically associated.

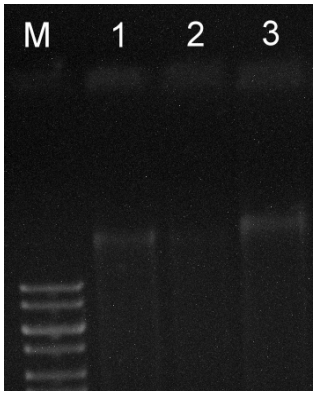


Fig. 1 Gel electrophoretic analysis of extracted DNA from copepods (lane 1) and surrounding water (lane 3); M = Marker (1 µg)

Next steps:

- 18S rDNA analysis will follow in order to identify the copepods and potential associated fungi.
- Field sampling at different locations (oligotrophic and eutrophic marine environment) followed by

phylogenetic analysis of the specifically associated microorganisms. This will allow us to compare the microbiota on copepods at different locations.

- In order to screen for selected orthologs of human disease genes in different copepods by PCR and sequence analysis primers will be designed and optimized.

Duration of the project:

The PhD student, Rebekka Metzger started the project in May 2007. In order to further succeed in the goals of this project, Ms. Metzger has to continue her work at least for the next 30 months (see attached letter).

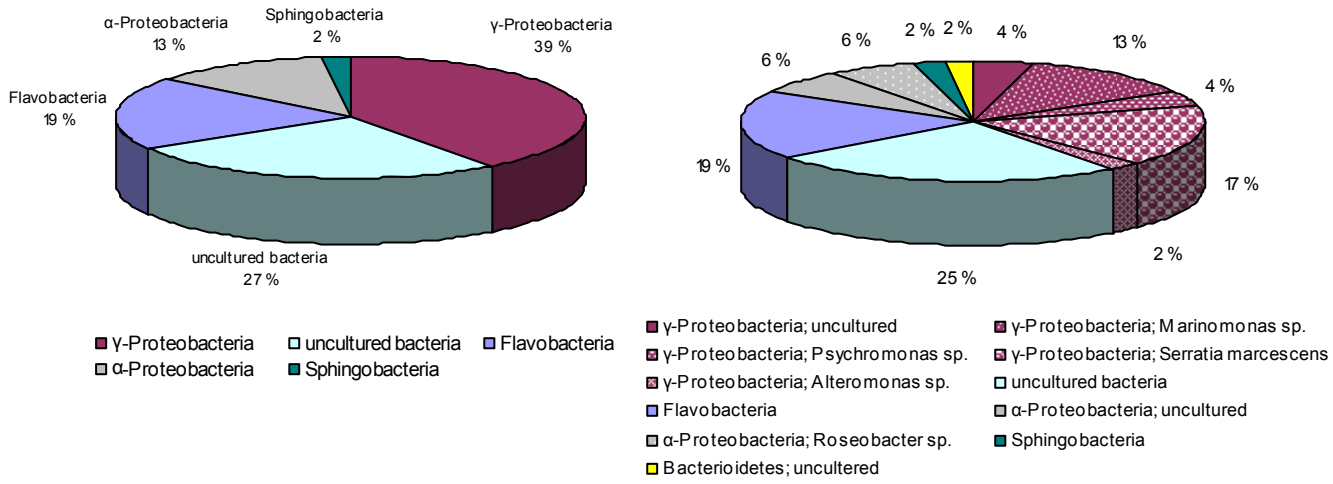


Fig. 2 Phylogenetic 16S rRNA analysis of bacteria isolated from copepods

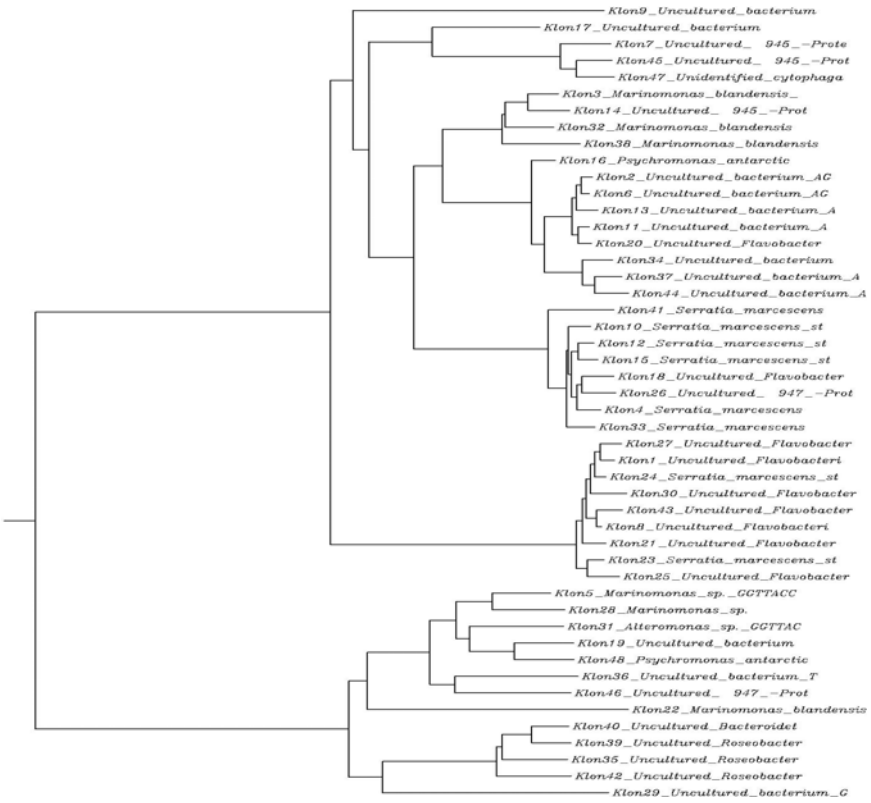


Fig. 3 Phylogenetic tree of microbial consortium isolated from copepods based on 16S rRNA analysis

Reference

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First Report of ExCluster Proposal (CP0612), 22. August 2007

Radiocarbon dating of fossil biogenic carbon as an indicator of age differences in surface and subsurface water masses in the past ocean

Prof. Dr. R. Schneider (A4), Dr. T. Blanz, Dr. E. Schefuß, Institut für Geowissenschaften, CAU Kiel
Prof. Dr. P. Grootes, Dr. N. Andersen, Dr. M.-J. Nadeau, (P2), Leibniz Labor für Altersbestimmung und Isotopenforschung, CAU Kiel

This project aims to test the use of differences in the radiocarbon age of different fossil organic (alkenones) and inorganic (calcitic skeletons of coccoliths and planktonic foraminifera) carbon in marine sediments as an indicator for changes in the dissolved carbon inventory of surface, subsurface and deep-water masses (or mixing of them) over the last 30.000 years. Within 12 months we intend to set up a routine method using preparatory gas chromatography and the SPLITT system (both purchased through Cluster start-up funding) for the extraction of biomarker carbon and coccolithophore calcite, respectively. The project started by February 1, 2007 with the hiring of Dr. Enno Schefuß on a postdoctoral position, who worked before at the Woods Hole Oceanographic Institution, MA, USA on a similar theme. As radiocarbon dating of individual organic compounds by AMS is laborious and cost-intensive, we used the first 6 months of the project to intensively test and optimise the system of preparatory capillary gas chromatography before starting the dating of real samples. The major purpose of this technical work is to ensure that routine dating of organic biomarkers can be ensured without contamination of the samples by GC capillary column bleeding or incomplete recovery of specific compounds due to leakage of the GC and trapping system.

As column bleed, the thermal degradation product outgassing from the chromatographic stationary phase, includes a significant amount of ^{14}C-free carbon, an incomplete removal of this carbon contamination from the sampled extracts will produce erroneously high ages (Eglinton et al. 1996). Therefore, column bleeding has to be removed by separation on a SiO_2 gel column prior to AMS-dating (Pearson et al. 2001). However, this preparation step might be incomplete and its sample-by-sample efficiency is difficult to check. In order to minimize the column bleeding already beforehand, we installed in our system a special high temperature column (XTI-5 from Restek), which is characterised by extremely low bleeding.

In addition, since oxygen introduced by leakages into the chromatographic system will significantly increase the column bleeding, we developed a system that permanently checks for leakages within the GC oven. Hereto, we installed a computer and software (developed by H. Cordt from the Leibniz Laboratory for Radiometric Dating and Isotope Research) to get every minute the readings of a H_2 sensor, which had been already installed in the GC oven for safety reasons, since we use hydrogen as carrier gas. Originally the H_2 sensor is used only for shutdown in case of massive leakages, with this improvement, we can also detect the occurrence of smaller leakages.

Furthermore, we tested the trapping efficiency with mixtures of specific organic compounds with different chain-lengths (e.g., n-C_{18} to n-C_{32}). By ensuring a leak-tight system, the trapping efficiency for all compounds can be above 90%, however, often with outliers below 70% for compounds with different carbon-chain length. By running several test samples over several weeks, we found that with standard length of the capillary and the original technical set up of the GC and trapping system, some material gets lost at the very end of the trapping capillary (visible as dark spots). This loss is due to the strong temperature gradient between the preparative fraction collector (PFC) oven at 320°C and the component trap at room temperature. To remove this temperature gradient from the capillary, we built an optional heating device (up to 350°C) for the metal nut at the connector next to the component trap. Hereby, a new type of ferrules (vespel) within the metal nut was used, since teflon is decomposing at such temperatures. In addition, by modifying the length of the trapping capillary which transfers the substances to the component trap (shortage of 4 mm compared to the standard length originally given by the instrument producer GERSTEL) we could improved the trapping efficiency close to 100%. Even for less efficient trapping there is no memory effect, which means that no material from previous samples will be incorporated in later samples.

After the successful technical improvement of the preparatory system, we will now start to analyse real samples and to set up the SPLITT system for purifying coccolithophore calcite from sediments samples. Unfortunately, Dr. Schefuß cancelled his contract after 6 months and left our department for private reasons (child care). Nonetheless, we will proceed with our intended work programme as intended for the next 6 months and are optimistic to reach a fully working set up for radiocarbon dating of specific organic compounds of marine algae and of the calcareous nanofossils delivering the inorganic carbon from phytoplankton.

References:

Eglinton T.I., L.I. Aluwihare, J.E. Bauer, E.R.M. Druffel, and A.P. McNichol (1996) Gas chromatographic isolation of individual compounds from complex matrices for radio carbon dating. *Analytical Chemistry* 68, 904-912.

Pearson A., A.P. McNichol, B.C. Benitez-Nelson, J.M. Hayes, and T.I. Eglinton (2001) Origins of lipid biomarkers in Santa Monica Basin surface sediment: A case study using compound-specific $\Delta^{14}C$ analysis. *Geochim. Cosmochim. Acta* 65, 3123-3137.

Mathematical and Algorithmic Challenges in Modelling Biochemical Cycles

Report: 1/2007 - 8/2007

Anand Srivastav
Institut für Informatik, Christian-Albrechts-Universität zu Kiel

Further Proponents: Prof's C. Böning, A. Oschlies, Ralph Schneider, Reinhold Schneider

The research project was started in January 2007.

Rationale and Goals. The goals of the project are, on the one hand, an evaluation of existing marine ecosystem models, in particular the predictive power of parameter optimization of ecosystems, and on the other hand, improvents of modelling underlying biogeochemical processes, e.g. the interaction of the components phytoplankton, zooplankton, nitrogen, and detritus, guided by results from optimization.
Until now, with existing optimization methods, it was possible to determine 10 to 15 parameters simultaneously, while already the simple NPZD model comprises up to 20 parameters. The data-fits currently known are clearly suboptimal, and deviate by several standard deviations from the measured data.

Algorithm design. In the past 8 months, a new *hybrid* evolutionary algorithm was developed in the research group of A. Srivastav in cooperation with Prof. C. Patvardhan (DEI University, Agra, India). The algorithm was tested on discrete problems. The special property of this algorithm is the integration of several randomized and deterministic local search methods, as well as a memory-efficient representation via so-called QUANTUM BITS. The algorithm hence can be regarded as a quantum-evolutionary method. The algorithm is promising: for the computation of hypergraph colorings, it delivers the best-known results, which is the first improvement in this research area since many years. At the moment we are extending the discrete prototype to capture continuous problems in order to invoke the objective function from the parameter optimization of marine ecosystems. In the research group of Prof. A. Oschlies, a method for the computation of the considered objective function for a *given* parameter configuration via the solution of a system of differential equations was developed. The code is available in FORTRAN.

Current research and perspectives. Until end of october 2007, both algorithms shall be combined to conduct the parameter optimization with the new evolutionary algorithm. To this end, the computation of the objective function by the FORTRAN code has to be integrated in a C program. Until end of december 2007, extensive tests will be conducted. The goal is to either achieve a much better data-fit, or to gain strong evidence, if not even proof, that the NPZD model is insufficient.
The evolutionary method is suitable for a wide range of different problems, and it is expected that it will, as an easy-to-use optimization software, be applied to other optimization problems arising in projects in the excellence cluster.

Staff. Currently, three scientific assistants are employed on a *part-time basis* financed by the granted fund for one **BAT IIa** position:
Dipl. Math. Volkmar Sauerland (since 4/2007),
Dipl. Math. Mourad El-Ouali (since 9/2007),
Dipl. Math. Lasse Kliemann (since 7/2007).

Intermediate report 21.08.2007

Till Müller, Andreas Zimmermann
Titel: Beyond Mineral Resources - The International Legal Regime and Regulation of New Uses of the Deep Seabed (CP618)
Scientific position Till Müller (PhD student, ½ position 7/2007 – 6/2009)

Summary of Scientific results:

Given that the research has only recently started, it has so far mainly focused on a general overview of the questions posed by the subject matter. A short survey of the results will be given below.

The prices for resources on the global market are higher than ever, at the same time possibilities of resource exploitation on land territory seem to drastically decline. This of course leads some states to view the deep sea and more specifically the deep sea bed as the new frontier. This new interest is very well illustrated by Russia's recent reiteration of its claim to parts of the deep seabed underlying the arctic. Traditionally the deep seabed was deemed to only supply mineral resources in the form of manganese nodules. The research undertaken here has now identified four groups of uses that are either already under way or become more feasible as resource costs increase and technology advances.

- As the global demand for energy increases and energy costs rise steadily, many states are eying the deep seabed for a solution for their energy problems. The deep seabed is deemed to hold vast deposits of petroleum, natural gas and methane hydrates, all of which could be used as energy sources. As energy prices go up and the costs decrease due to technology developments, actually accessing these sources might be economically feasible in the near future.
- Probably the most exciting prospect of new resources of the deep seabed however is the increased use of genetic resources that are primarily expected to be found around hydrothermal vents. The life forms found in the vicinity of hydrothermal vents consist mainly of bacteria which are highly adapted to life in very adverse circumstance and have unique attributes found in no other life form. Possible fields of exploitation are the isolation of Enzymes for use in industrial and manufacturing processes, the employment of DNA polymerases for use in research and diagnostics, Therapeutic and Pharmaceutical research, as well as the use of bacteria to treat different kinds of industrial or chemical waste.
- Furthermore the vicinity of hydrothermal vents not only promises a rich harvest for bio-prospectors but also seems to hold a large variety of chemical substances and processes that could be supply important material and data for the development of industrial application.
- At last there is also one use in today's discussion that is not directly linked to the exploitation of resources. The increasing change in global climate and its attribution to green house gas emission has led many scientists and politicians on a search for means to curb CO2 emission or at least to prevent its discharge into the atmosphere. One option recently discussed is the sequestration of CO2 into the deep seabed where it can be stored for longer periods of time.

Having identified these broad groups of new uses, it will now be necessary to seek out cooperation with scientists in the respective fields to assess the actual scientific state of these uses, the costs involved and possible prospects of these uses being conducted on a

commercial scale.

The next step has to be to analyse the legal framework applicable to these diverse uses of the deep seabed.

Here it will be important to asses *first* which uses are covered by the UNCLOS regime *ratione materiae*. For the energy related uses like exploitation of petroleum deposits this seems more likely than for bio-prospecting.

Secondly the analysis has to show how non state parties are fitting into the existing UNCLOS regime and its regulations.

Thirdly the new uses could also be affected by international and domestic law not belonging to the law of the sea, such as international environmental law or international law on intellectual property.

Development of a Coupled Climate/Ocean Biogeochemistry Model

Contributors: Arne Biastoch, Heiner Dietze, Angela Landolfi, Mojib Latif, Andreas Oschlies

1 Achievements

In order to explore the feasibility of the task at hand, the freon tracer module of the NEMO2.1 ocean circulation model was modified such that it holds five biotic tracer compartments. Those compartments (nitrate, phytoplankton, zooplankton, detritus and oxygen) are subject to the same mixing and advection processes that affect salinity (but, contrary to salinity and temperature, they have no influence on the dynamics of the circulation). The dynamics of the ecosystem model, i.e. the interaction of the five biotic tracer compartments with one another, is governed by a set of differential equations identical to the one outlined by [1]. The only difference is an additional oxygen compartment which is coupled linearly to fluxes to and from the nitrate compartment, using an nitrogen-to-oxygen ratio of 10. The following files of the NEMO DRAKKAR V2.1 (NEMO2.1) Fortran source code were modified:

- par_sms_cfc.h90: addition of tracer pointers for additional biotic tracers.
- par_trc_trp.F90: increase of number of passive tracers jptra to 5.
- trcctl.cfc.h90: change of names assigned to specific tracer compartments.
- trcfreons.F90: Three major modifications: (1) Addition of an Eularian (forward in time) solver such that the set of partial differential equations governing the interaction of the biotic tracers can be solved. (2) Hardwiring of a list containing all the biotic parameters. (3) Implementation of an upstream advection scheme in order to account for downward sinking of detritus.

Initial conditions of nitrate and oxygen were taken from the World Ocean Atlas [2, 3]. A MATLAB script was written to interpolate the initial data onto the model grid.

2 Preliminary results

The implementation of the biogeochemical module was tested within the framework of the "ORCA05-L46/Config new" setup developed by Arne Biastoch. This global setup is based on Drakkar Config Manager V2.1 (NEMO 2.1). It has 46 vertical levels and a horizontal resolution of 0.5°. Specific details can be obtained via http://wiki.ifm-geomar.de/wikiocdoc/index.php/Configuration/ORCA05-L46/Config_new. The physical circulation model was spun up for 20 years. Subsequently, the

biogeochemical module was switched on and integrated for an additional 10 years. Figure 1 shows that modeled phytoplankton concentrations at the surface is in many regions, like the equatorial Pacific and the Southern Ocean, much too high compared to satellite data. This is a common flaw of simple ecosystem models and comes along with an overestimated organic particle export from the surface to the deep ocean.

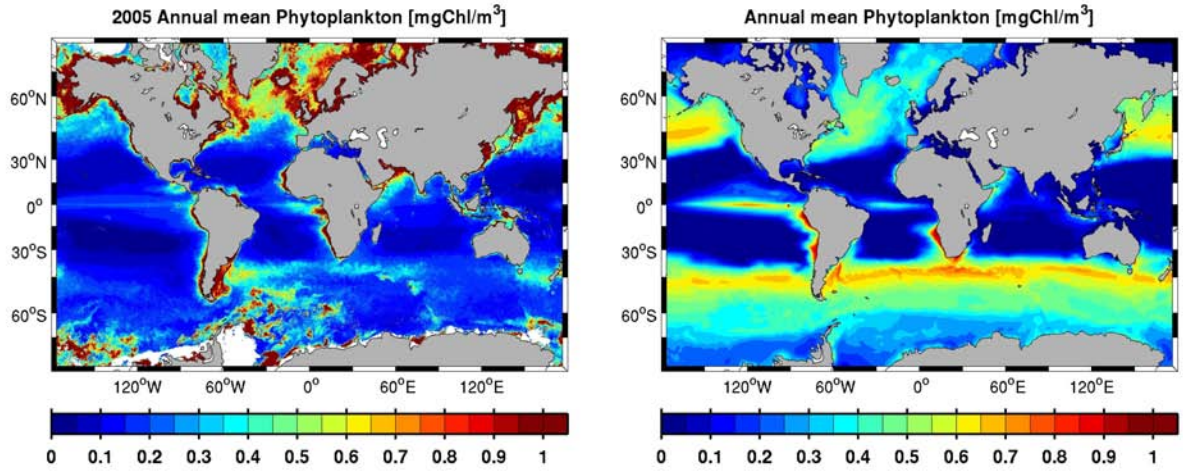

Figure 1: Left panel: Annual mean distribution of chlorophyll a as estimated from the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) satellite observations. This picture is based on a composite of data obtained during 2005. Right panel: Modeled annual mean phytoplankton concentration in the surface layer corresponding to the ORCA05 setup of the ocean circulation model. The modeled phytoplankton concentration in the surface layer were multiplied by 1.59 to convert from mmol Nitrogen to mg chlorophyll. Units in both panels are mg $\mathrm{Chl\,m^{-3}}$.

3 Roadmap

The group has put together the tools to implement biogeochemical models into the NEMO DRAKKAR framework. Preliminary results coincide with results we have obtained with global configurations of the Modular Ocean Model 4 (MOM4) (not shown). Hence, we are confident that the overestimated export of organic particulate material from the surface of the equatorial pacific to the depths of the oxygen minimum zones are the result of problems of the biogeochemical model. The general paradigm is, that growth of phytoplankton is limited by the availability of iron in the equatorial Pacific and in the Southern Ocean. However, a throrough model study exploring alternative explanations for the lower-than-elsewhere growth in the equatorial Pacific such as e.g. enhanced zooplanton grazing pressure is still missing in the literature. Since growth at the surface is so intimately connected with the oxygen deficit in the oxygen minimum zones we feel that we need such a study, also to better prepare for the work planned in the new SFB. Otherwise, we run into the risk of getting the right answer for the wrong reason.

References

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[3] M. Conkright, H. Garcia, T. O'Brian, R. Locarnini, T. Boyer, C. Stephens, J. Antonov World Ocean Atlas 2001, Volume 4: Nutrients In S. Levitus, editor, *NOAA Atlas NESDIS 52*. U.S. Government Printing Office, Wash., D.C., 2002.

Intermediate report 21.08.2007

Katharina Bork, Johannes Karstensen, Martin Visbeck, Andreas Zimmermann
Titel: The Legal Regime of Drifters and Gliders in International Law
(Miniproposal 2006)
Scientific position: Katharina Bork (PhD student, ¼ position 11/2006 – 10/2007)

Summary of Scientific results:

Drifters and Gliders are free floating platforms of a smaller size and are mainly used to collect data of the oceans. During the last years significant questions as to their international legal status have arisen, in particular questions concerning their use in waters subject to the jurisdiction of other states.

1. The first issue, the research project analyses is the question of possible rights of the respective coastal state in that regard, *i.e.* whether its consent forms a necessary precondition in order for such floats to enter the waters under its jurisdiction or in order for drifters and gliders to be deployed without the prior consent of the coastal state.

Having analysed relevant sources of international law and namely the United Nation Convention on the Law of the Sea (UNCLOS), the project reaches the conclusion that the answer to this problem depends, on the one hand, on their legal status (1.1.) and, on the other, on the intended purpose when used (1.2.), and finally third, on the area in which they are to be deployed (1.3.).

1.1. UNCLOS differentiates on the one hand between ships/vessels and installations, structures and equipment on the other, a definition of neither of which is however contained in the convention. An analysis of both, treaty and state practice was therefore undertaken in order to find a generally accepted definition of what can legally be considered, under UNCLOS, a ship/ vessel. The main elements found were the ability of navigation, transportation and self-propulsion. Drifters and gliders, however, do not meet any of these characteristics and are therefore not to be considered ships/vessels.

The need arose, therefore, to also define the notion of ‘installations’, ‘structures’ and ‘equipment’ as used in Art. 60 and 258 UNCLOS. On the whole, installations as well as structures are platforms located in a given area. They are also of a greater size. Given that drifters and gliders, as being of a smaller size and free floating, can therefore be characterized as equipment, rather than ‘installations’ or ‘structures’.

1.2. Being equipment, the second question which necessarily arose was which purpose is pursued by their deployment. This is due to the fact that UNCLOS contains a specific set of norms regulating marine research which also covers and regulates the legal status of scientific equipment. This led to the main question involved in this research project, namely whether the deployment of drifters and gliders constitutes marine scientific research for UNCLOS purposes.

The problems related to such qualification are first and foremost due to the fact that UNCLOS does not contain a definition of what may be considered “marine scientific research”. Hence, the project analysed UNCLOS, its *travaux préparatoires*, as well as legal writings which led to a generally accepted definition of ‘marine scientific research’. Under this definition, the deployment of drifters and gliders does represent marine scientific research, provided such research is indeed intended and no other purposes, such as *e.g.* the exploration of resources, or the undertaking of hydrographic or military surveys are being pursued.

This result is then applied *in concreto* to the deployment of drifters and gliders and their use within the framework of the so-called Argo Project where drifters are used to collect data over a long period of time in a routine and systematic manner, *i.e.* for so called operational purposes.

1.3. In a next step, the issue of a required consent of the coastal state, if ever, was examined. Depending of the area in which drifters and gliders are deployed, *i.e.* on the High Seas, within an EEZ or in territorial waters, the coastal state has either no jurisdiction whatsoever (which is the case with regard to the High Seas), or may clearly require its prior consent in its own territorial waters.

With regard to the EEZ, the legal regime is however less than clear. This is due to the fact that, with regard to the EEZ, the provisions of UNCLOS on marine scientific research differ from the general provisions governing the legal regime of the EEZ as such. If the deployment of drifters and gliders indeed represents marine scientific research, which in turn depends on the purpose pursued (see above 1.2.), the prior consent of the coastal state would be needed. If however, the use of the platforms does not represent marine scientific research, a prior consent of the coastal states is not a precondition of their deployment within their respective EEZ.

2. The analysis of the influence of the coastal state is then followed by an analysis of the rights and duties of coastal states versus the rights of states using drifters and gliders. This analysis came to the conclusion that the provisions in UNCLOS are not sufficient to protect the platforms from impacts by others such as accidental impacts by ships or intended destruction by private persons. Besides, UNCLOS does neither contain sufficient provisions concerning safety measures to be taken by States using floating devices. Furthermore, the application of some of the provisions of UNCLOS (mainly those dealing with marine scientific research) to the deployment of drifters and gliders leads to a disproportionate enhancement of the rights of the coastal state.

3. The third and final part of the project then undertakes an attempt to formulate, as a matter of legal policy, possible approaches in order to solve the problems arising whenever drifters and gliders are deployed, in particular with regard to their protection, safety measures and responsibility of states. In this part, the work of the Inter-governmental Oceanographic Commission (IOC) is scrutinized, namely the work of its Advisory Body of Experts on the Law Of the Sea (ABE-LOS) and its resolutions, practical guidelines, as well as a possible convention on ocean data acquisition systems.

4. At the present stage, it can be expected that the research project will be completed at the latest at the end of the year 2007.

II. Cluster Proposals started in 2007

1. **Transgenic Aurelia allow functional analysis of genes involved in control of tissue homeostasis and biological barriers**
   Thomas Bosch et al.

2. **Carbon acquisition in coccolithophores: molecular basis and adaptive potential**
   R. Schulz-Friedrich & U. Riebesell et al.

3. **Complex barriers: The biotic control of marine biofilms on algal surfaces**
   Martin Wahl & Ruth Schmitz-Streit

4. **Marine Steroid Pharmaceuticals to Control Human Diseases**
   Edmund Maser et al.

5. **Variations of Trace Element Fluxes induced by Ocean Acidification at Ca2+- Channels/ Ca2+-ATPases**
   Anton Eisenhauer et al.

6. **A new computational framework to efficiently integrate biogeochemical models from seasonal to multi-millennial time scales**
   Andreas Oschlies

7. **Complex barriers and microbiota in the Ocean**
   J. Thomsen et al.

8. **Economic valuation of the ocean's role in the carbon cycle and consequences for abatement and mitigation strategies**
   Gernot Klepper et al.

9. **Parameterization of near surface vertical mixing processes by multiscale methods**
   Malte Braack et al.

10. **Building up the capacity for δ34S measurements from organic samples by continuous flow isotope mass spectrometry**
    Ulrich Sommer et al.

11. **3-D Simulation of Thermohaline Convection in the Ocean's Crust with Adaptive Finite Elements**
    Malte Braack & Reinhold Schneider

12. **Changing habitats of calcareous plankton in the Greenhouse World**
    Joachim Schönfeld et al.

13. **Improved Methods for Nitrogen Isotope Studies with Specific Application at the Tropical Eastern North Atlantic Time-Series Observatory, Cape Verde**
    Douglas Wallace et al.

14. **Deciphering transcriptomal responses to environmental stimuli in simple aquatic model organisms by massive parallel sequencing technology**
    P. Rosenstiel & J. LaRoche et al.

15. **Modelling chemosensor-aided foraging in zooplankton**
    Andreas Oschlies et al.

III. Platform Investments 2007

P1: „Numerical Simulation and Data Management”

Array Processor NEC SX-8	470.000 EUR
Technician	80.000 EUR

P2: „Isotope and Tracer Analysis”

Isotope Ratio mass spectrometer and GC-interface	420.000 EUR
Isotope mass spectrometer and CarboPrep	450.000 EUR

P3: „High-Throughput Molecular Bioscience Technologies“

Capillary Sequencer (Applied Biosystems, 3730 xL)	350.000 EUR
Qiagen Robot for Large-Scale Plasmid Preparation	110.000 EUR
Technician	80.000 EUR

P4: „Ocean Observatories“

ROV/ Technician	85.000 EUR
Mesocom	24.000 EUR
Lander	132.000 EUR
OTIS	174.000 EUR
FlowCam	70.000 EUR
CO2 manipulation	50.000 EUR
Shallow Seismic	110.000 EUR
Streamer	100.000 EUR
CTD	174.200 EUR
C. Verde (long-term observatory)	58.000 EUR

IV. Integrated School of Ocean Sciences

1. Lectures

Lecture Series Winter Semester 06/07

Wallmann, K.[1:] “Research Network ‘The Future Ocean’"
[1] IfM-GEOMAR, FB2: Marine Biogeochemie

"Ocean Circulation and the Hydrological Cycle during the Holocene and Anthropocene"
M.Latif, [1], R.R. Schneider[2]
[1] IfM-GEOMAR, FB1: Ozeanzirkulation und Klimadynamik
[2] CAU, Geologie - Paläoozeanographie und Marine Paläoklimaforschung

„CO2-Induced Ocean Acidification: Biological Responses and Adaptations“
Riebesell, U. [1], Bleich, M. [2]
[1] IfM-GEOMAR, FB2: Marine Biogeochemie
[2] CAU, Physiologisches Institut

„Seafloor Resources“
Devey, C.[1], Schneider, R.[2], Hoernle, K.[3]
[1] IfM-GEOMAR, FB 4: Dynamik des Ozeanbodens
[2] CAU, Geologie - Paläoozeanographie und Marine Paläoklimaforschung
[3] IfM-GEOMAR, FB 4: Dynamik des Ozeanbodens

„Intentional Marine Storage of CO2“
Hartke, B.[1], Körtzinger, A.[2]
[1] Institut für Physikalische Chemie
[2] IfM-GEOMAR, FB2: Marine Biogeochemie

Ringvorlesung: „Present and Future CO2-Uptake“
Eden, C. [1], Srivastav, A.[2]
[1] IfM-GEOMAR, FB1: Ozeanzirkulation und Klimadynamik
[2] CAU, Diskrete Optimierung

„Marine Medicine: Interactions between Complex Barriers and Microbiota in the Ocean“
Schreiber, S. [1], LaRoche, J.[2]
[1] Institut für Klinische Molekularbiologie
[2] IfM-GEOMAR, FB2: Marine Biogeochemie

„Sea-Level Rise and Coasts at Risk“
Stattegger, K. [1], Rabbel, W.
[1] CAU, Geologie - Sedimentologie, Küsten- und Schelfgeologie
[2] CAU, Geophysik

"Towards a Global Ocean Observing System"
Visbeck, M.[1]., Körtzinger, A.
[1] IfM-GEOMAR, FB1: Ozeanzirkulation und Klimadynamik
[2] IfM-GEOMAR, FB2: Marine Biogeochemie

„Seafloor Warming Effects on Gas Hydrates and Benthic Biota“
Wallmann, K.[1], Wahl, M.
[1] IfM-GEOMAR, FB2: Marine Biogeochemie
[2] IfM-GEOMAR, FB3: Experimentelle Ökologie

“Vulnerability of coastal regions: from risk assessment to risk management"
Sterr, H. [1], Schmidt, U., Dombrowsky,, W.
[1] CAU, Geografisches Institut
[2] CAU, Finanzwissenschaft, Sozialpolitik und Gesundheitsökonomik

„ Results of the new IPCC Report“
Willebrand, J.[1]
[1] IfM-Geomar, FB 1: Ozeanzirkulation und Klimadynamik

Lectures in Summer 07

Dr. Carol Turley, Plymouth Marine Laboratory, Plymouth, U.K.
“Ocean Acidification: the Other CO2 Problem”

Prof. Dr. Jörn Piel, Kekulé-Institut für Organische Chemie und Biochemie, Universität Bonn
”Medicine from the Seas - Antitumor Polyketide Pathways of Symbiotic Bacteria”

Prof. Dr. Peter Lemke, Alfred Wegener Institut Bremerhaven, Helmholtz-Zentrum für Polar- und Meeresforschung
”Are we loosing the Ice of the Earth?“

Lecture Series Winter Semester 07/08 (preliminary)

“Dynamic optimisation in the presence of threshold effects – with an application to the disintegration of the western antarctic icesheet and the shutdown of the thermohaline circulation”
Eric Naevdal, Department of Economics, Universiy of Oslo:

„Health Costs of Climate Change“, Hübler, M., Klepper, G., Institut für Weltwirtschaft

n.n.
Requate, T., Institut für Volkswirtschaftslehre, Innovations-, Wettbewerbs- und Neue Institutionenökonomik

“Legal regime of the Arctic“, Proelß, A.
Walter-Schücking-Institut für Internationales Recht (JRG B3, Seafloor Resources)

n.n.
Melzner, F.,
IfM-Geomar, (JRG A1, Ocean Accidification)

2. Financial Support

2.1 Financial Support for the Organisation of Workshops, Conferences etc.

	Applicant	Title	Period	approved support
1.	Visbeck	Northatlantic Subpolar Gyre/CLIVAR	19. - 20.03.2007	10.000,00
2.	Weinrebe	Building a Global Data Network …	09. - 11.05.2007	5.000,00
3.	Bauer/Braack e.a.	Mathmat. Modelling	25. - 27.06.2007	5.000,00
4	Wahl	EMBS Tagung	27. - 31.08.2007	15.000,00
5	Clemmesen e.a.	Int. Annual Larval Fish Conference	04. - 07.08.2008	8.000,00
6	Fachschaft Geolog.	Geowissenschaftl. Berufskolloquium	May 2007	500,00

2.2 Financial Support for the Participation at Workshops, Conferences etc.

	Applicant	Title	Period	approved support
1	Suffrian (PhD Student)	PhD Workshop, Inst. f. Agrartechnik Potsdam	05. – 07.09.07	210,00
2	Rüggeberg	3rd Post Cruise Meeting on IOPD Expedition 307, Barcelona	07. – 09.11.07	1.000,00
3	Stramma	African Monsoon Multidisciplinary Analyses, Karlsruhe	26. – 30.11.07	720,00

2.3 Financial Support for Hosting of guest researchers

	Applicant	Name of Guest Researcher	Period	approved support
1.	Prof. Schneider	Antoni Rosell Melé	June 2007	1.200,00
2.	Pof. Srivastav	Patvardhan	1. – 31.08.07	1.800,00
3.	Prof. Thalheim	Oleg Selesnjev	1.11. - 1.12.07	2.020,00

V. „The Future Ocean“ - Presentations of Professorship candidates 29.01. – 02.02.2007, Steigenberger Hotel, Kiel

A1 “Ocean acidification”

Dr. Gisela Lannig, AWI für Polar- und Meeresforschung, Bremerhaven
„Thermal impact on energy metabolism & stress tolerance in marine animals”

Dr. Sebastian Meier, CEREGE, Aix en Provence, France
“From life cycle to carbon cycle: impact of ocean acidification on calcifying phytoplankton”

Dr. Philine Feulner, Universität Potsdam
“Speciation, adaptation, and ecology: Adaptive radiation in African weakly electric fish”

Dr. Haruko Kurihara, Nagasaki University, Japan
“Responses of marine animals to elevated pCO2

Dr. Birgit Schneider, Laboratoire des Sciences du Climat et de L'Environnement, Gifsur-Yvette, France
“Modeling the impact of ocean acidification on pelagic calcification”

Dr. Frank Melzner, AWI für Polar- und Meeresforschung, Bremerhaven
“Ecophysiology of marine invertebrates in a high CO2 world”

A2 “Seafloor warming”

Dr. Barbara Teichert, BA für Geowissenschaften & Rohstoffe (BGR), Hannover
“Controls and mechanisms of dynamic gas hydrate systems”

Dr. Tina Treude, University of Southern California, USA
"Microbial methane consumption in cold-seep environments"

Dr. Gisela Winkler, Lamont-Doherty Earth Observatory, USA
“Quantitative reconstruction of biogeochemical processes using isotope tracers: The Ocean's Past, Present and Future”

Dr. Martin Blumenberg, Institut für Biogeochemie und Meereschemie, Bremen
„Methanotrophic processes in the Black Sea – biogeochemical and lipid biomarker evidences“.

Dr. Frank Wenzhöfer, Max-Planck-Institut für marine Mikrobiologie, Bremen
"Benthic biogeochemical processes at seep and non-seep sites: How scale matters"

Helge Niemann, MPI Bremen
“Rates and signatures of methane turnover at cold seeps”

A3 “CO2-take-up in the ocean”

Prof. Dr. Arne Winguth, University of Wisconsin-Madison, USA
"Improvement of the Prediction of CO2-Uptake in the Ocean by Data Assimilation"

Dr. Sara Mikaloff-Fletcher, Princeton, USA
"Air-sea Fluxes of Natural, Anthropogenic, and Contemporary CO2"

Dr. Martin Losch, AWI Bremerhaven
"Estimating the Ocean State During EIFEX"

Dr. Lars Nerger, Greenbelt, USA
"Data assimilation into ocean-biogeochemical models"

Dr. Thomas Slawig, TU Berlin
"Data Assimilation in Climate Models from the Algorithmic and Mathematical Viewpoint"

A4 „Ocean circulation“

Dr. Birgit Schneider (CEA-CNRS-UVSQ, Gif-sur-Yvette Cedex)
“Impact of the Panama Closure (14-3 Ma BP) on ocean circulation, marine productivity and nutrient cycling”

Dr. André Paul (RCOM, Universität Bremen)
“What forces interglacial climate variations”

Dr. Holger Pohlmann (MPI für Meteorologie, Hamburg)
„Desertification During the Holocene and in Future Climate Scenarios”

Dr. Andreas Kleinen (University of East Anglia, Norwich)
“Improving our understanding of late Holocene climate”

Prof. Dr. Andreas Levermann (PIK Potsdam)
“Can models of intermediate complexity help understand climate?”

A5 „CO2-Sequestration“,

Prof. Dr. Gregor Rehder
„Deliberate Marine Carbon Dioxide Disposal: Scenarios, experimental investigations, and demands on future marine research”

Dr. Matthias Haeckel
"Assessing CO2 storage below the seafloor: A combined approach of highpressure experiments and numerical modelling"

Dr. Judith Schicks
"Interactions between CO2 , gas hydrates and sediments – fundamental knowledge for effective CO2 -storage"

Dr. Oleg M. Souleimenov
"Towards a molecular understanding of fluids in geochemical processes"

PD Dr. Michael Kühn
"Mineral trapping of CO2 in operated hydrogeothermal reservoirs"

A6 “Changing chemistry at the sea surface”

PD Dr. Martin Beyer (TU Berlin)
“Aqueous chemistry in water clusters”

Dr. Hans-Werner Jacobi (AWI Bremerhaven)
“Surface ocean chemistry in polar regions: The frozen ocean”

Dr. Paolo Barzaghi (IfT-Leipzig)
“Laser-based studies of aqueous phase radical reactions of relevance for tropospheric / environmental chemistry”

Dr. Gernot Friedrichs (Uni-Kiel)
“Quantitative Laser Spectroscopy: From gas phase kinetics to chemistry at the ocean surface”

Dr. Manuela Martino (Univ. East Anglia)
“Iodine chemistry at the air-sea interface”

Dr. Hendrik Nahler (Univ. California Santa Barbara)
“Photochemistry and dynamics at the air-sea interface”

B1/A7 ”Living resources and overfishing”/”Ocean economics”

PD Dr. Thomas Eichner, Uni Mainz (B1)
“Efficient Ecosystem Services and Naturalness in an Ecological/Economic Model”

Dr. Klaus Eisenack (B1), Potsdam, Institut für Klimafolgenforschung
“Marine Overexploitation: From Global Change to Model Based Viability Analysis of Fisheries Governance”

Dr. Martin Quass (B1), Leipzig, Helmholtz Zentrum für Umweltforschung
“Sustainable use of ecosystem services under uncertainty”

PD Dr. Susanne Soretz (B1), Uni Hannover
“Is uncertainty in environmental policy ecologically harmful?”

Dr. Karin Rehdanz (A7), Uni Hamburg und Centre for Marine and Atmospheric Science
“Climate and Happiness”

B2 “Molecular marine medicine”

Dr. Casimir Bamberger
“Evolution of the p53 Tumor Suppressor Family: Unexpected Guardians of the Germ Line from Sea Anemones to Humans”

PD Dr. Ute Henschel
„Towards a molecular understanding of human diseases using marine sponges as models“

Dr. Philip Rosenstiel
„Human Diseases of Barrier Organs: lessons from evolutionary ancient cellular pathways“

B3 “Seafloor resources”

Thomas Monecke
„Shallow marine massive sulfide deposits: The role of magmatic fluids”

Dr. Christian Schardt
"Computer simulations as a tool to investigate hydrothermal processes in submarine environments and the formation of seafloor resources"

Lars Rüpke
„From deep sea ore deposits to hydrocarbons in sedimentary basins - numerical modeling as a quantitative tool for studying the formation of ocean resources”

Dr. Klaus Gessner, Univ. of Western Australia
“A Multi-Scale 3D Approach to Understanding Sea-Floor Hydrothermal Systems”

B4 „Natural hazards“

Robert Weiss, NOAA Center for Tsunami Research, Seattle, USA
„Tsunamis: eine geowissenschaftliche Herausforderung“

Ingo Grevemeyer, IFM-GEOMAR, Kiel
„Observational constraints on seismic hazards in the Andaman-Sunda Subduction zone”

Gert Zoeller, Universität Potsdam
„Datenbasierte Erdbebensimulationen: ein Weg zu einem integrierten Konzept für Gefährdungsabschätzungen“

Sebastian Krastel, Universität Bremen
“Large scale mass wasting off NW-Africa: Is it a natural hazard and risk?”

David Hindle, IFM-GEOMAR, Kiel
“Some inferences on seismicity and hazard variation in time from geologic, geodetic and modelling data”

B5(1) “Sea level rise and coastal erosion”

Ch. Hübscher
„Shaping the Israeli shelf and slope – active oceanographic, sedimentary and tectonic processes”

Ch. Müller
“From 2D to 4D Marine Seismic Acquisition: The Present and Future of Coastal Geophysical Investigation”

Till Hanebuth, Univ. Bremen
“The shallow-water ruin landscape: Understanding the past from paleo-coastal remnants and temporary high-resolution archives”

Paul Liu, North Carolina State University
“Postglacial sea-level rise, and the Land-Ocean Interactions in Asia Pacific Marginal Seas”

Paul Kench, Univ. Auckland
“Coastal Landform Response to Sea Level Change: Refining the Science for Improved Predictions”

Kerstin Schrottke, Univ. Bremen
„Coastal dynamics on different time scales – research tasks for the future”

B5(2) “Risk management in the coastal zone”

Dr. Felix Morsdorf (Zürich)
“The Potential of High-Resolution Remote Sensing Data for the Assessment of Flooding Vulnerability”

Dr. Annegret Thieken (Potsdam)
„Neue Modellansätze zur Abschätzung von Hochwasserrisiken“

PD Dr. Gabriele Gönnert (Hamburg)
„Modernes Risikomanagement an Küsten und Ästuaren. Konzept und Beispiele“

Dr. Athanasios Vafeidis (Lesvos Griechenld)
“Spatially-Explicit Quantitative and Dynamic Assessment of Coastal-Zone Vulnerability to Climate-Induced Sea-Level Rise”

B6 “Law of the Sea”

Dr. Sabine Schlacke
„Rechtliche Probleme der CO2-Speicherung im Meeresboden“

Priv.-Doz. Dr. Volker Röben
“Das Recht der genetischen Meeresressourcen in der Hohen See und im Meeresboden“

Dr. Alexander Proelß:
“Bewirtschaftung der genetischen Ressourcen des Tiefseebodens – ein neues Seerechtsproblem?“

VI. Public Outreach

1. Press Resonance to the Cluster

media	quantums
Science magazines	3
Press, national	27
Press, local	38
Internet articles	45
Radio	3
Television	3

2. Press Monitoring Service (selection) / Start: 15.6.2007

titel	tv/radio/press/www	date
Ein Tauchgang auf Schatzsuche	Financial Times (national press)	20.6.2007
Wir sind Klimakiller	Rheinische Post (national press)	23.6.2007
Kieler Wissenschaftspreis Verleihung	shz (regional press)	24.6.2007
Ozean der Zukunft im Land der Ideen	Kieler Nachrichten (regional press)	25.6.2007
Das blaue Wunder	Funkuhr (national press)	22.6.2007
Campus in Kürze	Stuttgarter Zeitung (national press)	22.6.2007
Schüler Forschen an der Schwentine	Stadtwerke Kiel Magazin (regional press)	05.7.2007
Die Energie des Meeres	Wirtschaftsland SH (regional press)	01 7.2007
Ozean der Zukunft	Merian (national magazine)	01.7.2007
Neuer Hot-spot	Wirtschaftswoche (national press)	02.7.2007
Ozean der Zukunft platziert sich	Kieler Nachrichten (regional press)	04.7.2007
Große Publikumsresonanz bei Ausstellung	Kieler Nachrichten (regional press)	10.7.2007
Der Meeresboden - CO2-Depot der Zukunft?	Kieler Nachrichten (regional press)	11.7.2007
Der neue Kampfgeist auf dem Campus	FAZ (national press)	15.7.2007
Optimierte Klimaprognosen durch genaue Analyse der Vergangenheit	Idw-online (website)	18.7.2007
Hochtechnologie für Klimaforschung	Kieler Nachrichten (regional press)	19.7.2007
Ein Cluster wirkt sich auf die gesamte Uni aus.	Kieler Nachrichten (regional press)	02.8.2007
Maritime Koordinatorin der Bundesregierung besucht SH	shz (regional press)	27.8.2007
Klimawandel und der Ozean	umweltschutz-news (national press)	04.9.2007
Packeis der Arktis hat bereits im August den niedrigsten Stand seit Menschengedenken	extremnews.com (website)	04.9.2007
Alarmstufe rot für Ozeane	springer.com (website)	05.9.2007

3. NaT-Working Activity Report

School cooperations in the Cluster's first year were:

- a six-month course in the framework of Schleswig-Holstein's “Enrichment Program” for gifted students: 14 selected students from Kiel's secondary schools studied various topics of the Future Ocean under the title “Frank Schätzing's “Der Schwarm”/“The Swarm” – What is science, what is fiction?”. Results of this course were presented to the public in student presentations at the “Enrichment Day” at the Kieler Gelehrtenschule in May and at IFM-GEOMAR's Open Day in September.
- a two-day NaT-Working-Marine-Science-Symposium in Bad Segeberg in February, in which 120 students and 18 teachers from 7 schools participated together with Cluster scientists. In a rich program of students' and scientists' presentations and workshops, new cooperations between students and scientists were initiated.
- for guided tours through the Cluster exhibition “Ozean der Zukunft” from June 2 to July 6, more than 120 school classes from Schleswig-Holstein and other parts of Germany needed to be coordinated.
- as a contribution to the project “Forscherferien” by IPN – Leibniz Institute for Science Education a one-day excursion to Kiel Beach “Falckensteiner Strand” was carried out for 3rd grade students.
- 4 sets of literature on marine science, specifically selected to be suitable for school students, were provided in special boxes for teachers to borrow for use in their courses.
- a two week laboratory work during summer vacation 2007 (Marieke Goeser, Gymnasium Heikendorf and Prof. Ruth Schmitz-Streit, IFAM, CAU).
- development of a board game “Spiel rund um die Arktis” (Gymnasium Bad Segeberg and IPÖ, CAU).

NaT-Working in the news

title	tv/radio/press	date
Schüler erleben die "Faszination Naturwissenschaft"	Segeberger Zeitung (press)	3.2.2007
Schüler experimentierten rund ums Thema Wasser	Lübecker Nachrichten (press)	3.2.2007
Schüler erleben die "Faszination Naturwissenschaft"	Kieler Nachrichten (press)	3.2.2007
Kongress machte Schülern Lust aufs Forschen	Basses Blatt (press)	6.2.2007
Press echo on exhibition „Ozean der Zukunft“	cf. report on exhibitions (press)	
Forscherferien, Kurzinterview mit Prof. Demuth und Dr. Katrin Knickmeier	ZDF-heute nacht (TV)	27.7.2007

4. Exhibition “Ozean der Zukunft / The Future Ocean”

Previous presentations:
German Unity Day 2006, Halle400 in Kiel, Oct 2006
Kieler Woche, IFM-GEOMAR in Kiel, Jun 2007:

On schedule:
German Unity Day 2007, Schwerin, Oct 2007
Representation of the Land Schleswig-Holstein to the Federation, Berlin, Oct 2007
Kieler Woche, Kiel Jun 2008
Schleswig-Holstein-Tag, Neumünster, Aug 2008
German Unity Day 2008, Hamburg, Oct 2008
International Maritime Museum Hamburg, Hamburg, 2008

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the future ocean

CHANGES, RESOURCES AND RISKS