future ocean
KIEL MARINE SCIENCES

2012/2013

FUTURE OCEAN RESEARCH

Focus on Mineral Resources
New concepts for sustainable marine resource management

Education and Careers
Opportunities for young scientists

Research in Marine Science
From acidification to coastal research

Dear Reader,

2012 marked the 20th anniversary of the Earth Summit on Sustainable Development in Rio de Janeiro, Brazil. Global awareness and concern about the future of our oceans and coasts featured prominently at the summit. Will there be an international coordinated effort to advocate sustainable development of the ocean and coasts? For us in Kiel, 2012 marked another important step in the course of the Future Ocean Cluster: our renewal proposal was successful and the second funding phase is now underway. We are excited about the opportunity to continue our successful work and at the same time implement new elements within the Cluster.

In the first phase we successfully recruited new faculty to Kiel. The hallmark of the second phase is to support excellent and strategic research projects at the postdoctoral and PhD levels. As a consequence, two-thirds of the cluster funding is proposal driven. Four calls for funding have been issued since the end of the first phase in 2011. Dozens of German and international scientists have engaged with us to share their ideas and are currently working on interdisciplinary Future Ocean science. We are experiencing rapid growth in our postdoc and PhD career development programs and providing a range of opportunities for these young colleagues to influence the course of the Cluster. Semester topics, special interdisciplinary marine science topics, have provided focus to our internal and external discussions. Each semester has been filled with public lectures, topical workshops and the production of thematic volumes in the World Ocean Review series. Visits to and from our international partners inspire our thinking and allow us to exchange our views and goals for a sustainable Future Ocean with other intellectual and cultural realms.

All these activities are important parts of our effort to chart the course for and sharpen the profile of Integrative Marine Sciences in Kiel. We envision a sustainable future of this precious and productive intellectual space between a broad range of disciplines, theoreticians and practitioners – even beyond the end of the Future Ocean Cluster project in 2017. We are actively engaged in discussions, consultations and strategic thinking to articulate what we think the marine research landscape in Kiel should look like for 2018 and beyond. We invite you to join us in this process and hope you enjoy reading this report.

Sincerely,

Martin Visbeck

Speaker of the Cluster of Excellence The Future Ocean

TABLE OF CONTENTS

PERSPECTIVES

If you can't explain it simply, you don't understand it well enough.

Albert Einstein

Securing Blue Wealth: The Need for a Sustainable Development Goal for Oceans and Coasts

A multidisciplinary research team of the Cluster has proposed a dedicated Sustainable Development Goal for Oceans and Coasts. In support of the Sustainable Development Goal (SDG), a Future Ocean Spatial Planning Initiative is in the planning stages to identify the opportunities and challenges facing our common future ocean.

The ocean regulates global climate, provides natural resources and is essential for international trade as well as recreational and cultural activities. However, human development, economic growth, and free access to ocean resources and services have exerted strong pressure on marine systems. Challenges range from overfishing, increased resource exploitation, and alteration of coastal zones to increased pollution. International cooperation and effective governance are required to balance the realization of new opportunities with the protection of the marine environment, and to promote the sustainable use of marine resources, emphasizing and respecting the environmental values of current generations and the needs of future generations. Developing and establishing a Sustainable Development Goal (SDG) focussed exclusively on oceans and coasts could prove to be an essential element in reaching these goals. This proposal is therefore a timely contribution to current intergovernmental discussions surrounding a number of targeted SDGs, building upon the momentum of the Millennium Development Goals (MDGs) and framing the post-2015 international agenda. A comprehensive set of ocean sustainability targets and effective indicators would help in assessing the current status of marine systems, in diagnosing any on-going trends, and in providing information for inclusive, forward-looking, and sustainable ocean governance.

An SDG Oceans and Coasts is needed

- to ensure a healthy and productive marine environment with all basic provisioning, support, regulation, and cultural services,
- to provide equitable access to ocean resources, and ensure that neither pollution nor the harvesting and extraction of living and non-living resources impair the basic functions of the ecosystem,
- to facilitate the development of sustainable and resilient coastal communities,
- to harmonize national and regional maritime policies,
- to encourage cooperation in coastal and global marine spatial planning, and
- to confirm the vital role of oceans and the subsequent rendering of ocean services in the Earth system.

Paper

Visbeck, M., U. Krohnfeld-Goharani, B. Neumann, W. Rickels, J. Schmidt, E. van Doorn, N. Matz-Lück, K. Ott, M. F. Quaas: Securing Blue Wealth: The need for an Ocean and Coast Sustainable Development Goal and Future Ocean Spatial Planning. Submitted to Marine Policy; under review.

"Fisheries are a prime example of an activity that originates in the coastal environment but whose focus typically extends well into the ocean. The major impediments for sustainable fisheries are non-existent or weak management, along with poor compliance and enforcement. We need to improve scientific input and develop ocean literacy in the general public in order to facilitate the involvement of an informed society in the decision-making process." Dr. Jörn Schmidt, Social Ecologist and Member of the Working Group "Sustainable Fisheries", Department of Economics, Kiel University

„Climate change and coastal hazards raise risk levels for coastal communities while coastal development and human interventions frequently increase their vulnerability. Together these changes and activities have noticeable and often serious effects at the coastal interface between the terrestrial and marine environments. At the same time, the growing population is increasingly dependent on coastal resources. This situation becomes even more challenging due to the unequal distribution of supply and demand. Thus, there is an urgent need to address these challenges by designing development scenarios that are able to increase the resilience and adaptive capacity of both the human and the natural coastal sub-systems. To foster a range of options for sustainable coastal development, we need to clearly identify the key issues and identify appropriate measures and governance strategies to to best address them." Dr. Barbara Neumann, Institute of Geography, Research Group Coastal Risks and Sea-Level Rise, Kiel University

"The international law community is trying to understand if existing international law is sufficient to reach the goal of sustainable oceans and coasts or if new legal instruments are required to fill existing or perceived gaps. A particularly challenging topic is whether governments view existing and possibly extended law as binding upon states/parties or merely as guidelines or recommendations. Beyond these challenges lies the task of effectively implementing the agreed-upon measures, binding or not." Erik van Doorn, Walther Schücking Institute for International Law, Kiel University

"Since the classical definition provided by the Brundtland Commission in 1987, the term 'sustainability' has become the dominant leitmotif for shaping international environmental and developmental relations. Notwithstanding these efforts, there is still no commonly accepted definition of the term and it often remains unclear what sustainability actually means. This holds particularly true in the conservation, development and international environmental law communities. What we need is a more complete understanding of the meaning of sustainability and how it is perceived by various actors. A good starting point would be the international conventions applicable to marine spaces. How have they dealt with the sustainability principle and which institutions are involved in implementing it? The central challenge is: How can sustainability be conceptualized in the context of a limited understanding of ocean change?" Dr. Ulrike Kronfeld-Goharani, Institute of Social Sciences, Research Group on International Political Sociology (IPS), Kiel University

Our Common Future Ocean

Venturing into new fields of research: How can sustainability of the uncertain future ocean be conceptualized in an acceptable way to provide guidance for responsible decision-making?

The research topic "Our Common Future Ocean" brings together researchers in the disciplines of ethics, economics, arts, political science, geography, law and the marine sciences to develop a concept of ocean sustainability. This conceptual approach is complemented by analysing and actively participating in the societal and scientific discourse on ocean sustainability in different cultures, and by experimentally eliciting sustainability views held by society. The researchers apply the sustainability concept to a range of coastal and oceanic issues, such as the use of ocean resources as well as sustainable governance and the management of marine fish stocks.

Sustainability has been a key element of societal and scientific discourse on the relationship between human societies and nature since the UN report 'Our Common Future' (WCED 1987). Although sustainability has been widely accepted as a general and abstract objective, the practical effects of the concept have remained relatively small. A major problem is that it is often unclear what sustainability actually means in the concrete context of decision-making. In particular, the large uncertainties surrounding the future development of the oceans and inevitable ocean changes challenge simple concepts of sustainability. A sustainability concept can only be of practical relevance if it is shared and supported by a large part of society. To this end, it is necessary to increase public and cultural awareness of the effects of ocean change and to take into account normative views on sustainability held by society. The objectives of the research group "Our Common Future Ocean" are, therefore,

- to develop a concept of ocean sustainability that transforms societal as well as scientific discourse;
- to elicit normative views held by society to empirically scrutinize the concept;
- to explore and advance the artistic perception and interpretation of the cultural impacts of ocean change; and,
- to apply the concept of ocean sustainability to specific issues.

One of the tasks of scientists in the research field "Our Common Future Ocean" is to make marine scientists aware that there are norms and fundamental values implied in how humans perceive, utilize, pollute and protect the oceans and marine systems. A focused reflection on these values and norms is the domain of ethics. We need to demonstrate how normative topics can become an integral part of the marine sciences.

"Our Common Future Ocean" will be the main topic of the winter semester 2014/2015.

"Environmental ethics and theories of sustainability explore the normative dimension of human interference with nature. Without ethical reasoning there is no clear guidance with respect to the future of mankind's role in the Anthropocene. Concepts such as ecosystem services also have a background in environmental ethics. The task of ethics is both reflection and application. In its more reflective dimension, it clarifies concepts, principles, values, and obligations. In its more applied dimension, it cooperates with scientists, lawyers, and economists in finding sustainable solutions for environmental problems on different scales. The problem-solving agenda in the marine sciences is extensive. A theoretical interest is an emerging "philosophy of the marine sciences" which integrates both epistemology and ethics. A special practical interest of research is to transform the idea of organic multi-trophic aquaculture into viable concepts."

Konrad Ott is Professor for Philosophy and Environmental Ethics. He works trans- and interdisciplinarily and develops theoretical concepts for sustainability as a background for practical conservation. In 2000-2008 he was a member of the German Advisory Council on the environment (SRU). Ott is the founding director of the "Gustav Radbruch Network for Environmental Philosophy and Ethics" at Kiel University, established by the faculties of Art and Humanities, Medicine, Law, Agricultural and Nutritional Science, Theology and Business, Economics and Social Sciences.

Professor Dr. Martin Visbeck, Speaker of the Cluster of Excellence "The Future Ocean" and Oceanograph at GEOMAR Helmholtz Center for Ocean Research Kiel and Professor Dr. Martin Quaas, Professor of Environmental, Resource-, and Ecological Economics, Department of Economics, Kiel University

"Our research aims at improving the scientific basis necessary for more sustainable development of the global future ocean. These aims include the development of a fully negotiable SDG text and a concept for Future Ocean Spatial Planning (FOSP). Therefore, we will build working groups of experts from inside the research group and including external key experts to bring forward a proposal for an SDG Oceans and Coasts. We further aim to develop a concept for global ocean spatial planning and to bring forward the scientific basis for the establishment of a global FOSP process to foster sustainable ocean development. This scientific basis will include a comprehensive set of ocean sustainability indicators for the assessment of marine systems, referencing safe minimum standards. We will thus provide scientific information for inclusive, forward-looking and sustainable ocean governance."

FOCUS ON

An expert is a person who has made all the mistakes that can be made in a very narrow field.

Niels Bohr

WORKSHOP SEAFLOOR MINERAL RESOURCES

Has the Race for Ores from the Deep Sea Begun? International Experts from Science, Economics and Civil Society Meet in Kiel

Whether smart phones, solar panels or electricity cables – nearly every technology uses metals. Up until now they have mainly been mined on the continents. Yet the world population is growing and the demand for raw materials is increasing. Thus deposits in the ocean are gaining in interest. Leading experts on deep sea geology, deep sea biology, marine law and deep sea mining were invited by the Cluster of Excellence "The Future Ocean" in Kiel (Germany) to discuss scientific, technical, ecological and judicial questions surrounding possible ore mining.

It began at least 7,000 years ago. Back then humans began using tools made of stone and later bronze to mine ores. Since then a culture without metals is unimaginable. This is also very true for the digital age. Whether smart phone, tablet computer or server – metals play a vital role. In addition there is a fast growing world population that needs not only mobile phones but also houses, cars and refrigerators. The mineral raw materials required for these are currently mined almost exclusively on the continents. The continents, however, account for less than a third of the earth's total surface. "With growing demand and rising prices, deposits in the remaining two thirds, the ocean, come to the attention of industry," explains the marine geologist Professor Dr. Colin Devey from GEOMAR Helmholtz Centre for Ocean Research Kiel, one of the scientific organizers of the workshop. Whether, when and under what circumstances deep sea mining will take place was discussed by about 150 national and international experts and students during the workshop "Seafloor Mineral Resources: scientific, environmental, and societal issues" in Kiel.

The focus of the current discussion particularly focuses on three types of mineral raw materials: manganese nodules usually found on the sea bed at 5,000 meters depth, cobalt crusts that form at the slopes of underwater mountain ranges at depths between 1,000 and 2,500 meters, as well as massive sulfides that develop in areas of volcanic activity along plate boundaries in the ocean between 500 and 5,000 meters depth. They all contain elements that are of particular importance for the high-tech industry such as cobalt, nickel, and copper. "As most of these deposits lie in the hardly explored deep sea and lie moreover in international waters, not only economic and technical aspects but also the civil aspects must be clarified before possible mining," Prof. Devey emphasized.

Therefore the workshop in Kiel aimed to inform participants not only about the scientific fundamentals and technical developments in marine mining, but also about the legal conditions for mining licenses as well as the effects on biodiversity and habitat in the deep sea. Some of the most renowned deep sea geologists travelled to Kiel, together with representatives of industry, specialists for deep sea biology and civil and marine law, representatives of different UN organizations and delegates from non-governmental organizations such as the World Wide Fund for Nature (WWF).

"The demand for information from industry but also from policy makers and science on the topic is very great. It is our goal to discuss a sustainable solution for environmentally responsible mining of resources together with all the stakeholders," says Prof. Devey. "The scientifically based dialog is extremely important for us, before technology causes damage to nature and humans alike."

This workshop was part of a Future Ocean semester topic activity. As such, an issue of the World Ocean Review will summarize information and discussions on this topic. The Mineral Resources Issue of the World Ocen Review will be available in Spring 2014 from www.worldoceanreview.com.

Leading experts on deep sea geology, biology, marine law and mining came to Kiel to discuss the challenges of deep sea mining.

Semester Topics

Semester topics are one outreach measure of the Future Ocean to promote selected topics of interest to groups within and outside the Cluster of Excellence. Special activities illustrate the chosen scientific topics. These activities could include scientific workshops, summer schools, public lectures, seminars for certain stakeholder groups, conferences or other outreach activities. The topics already scheduled are Fisheries and Overfishing (summer semester 2012), Mineral Resources (winter semester 2012/13) and Ocean and Coastal Hazards (summer semester 2013). Each semester topic will contribute to an upcoming issue of the World Ocean Review.

ARENA – Virtual Fieldwork in the Ocean

Water is the basic motivation and simultaneously the biggest problem for deep sea research. It forces scientists to work from a distance, lowering sensors on cables and exploring the ocean floor with the help of remotely controlled robots. All too often it is, in the end, difficult to have a spatial conception of a world far below that is out of reach.

1 The bowl-shaped screen of ARENA fills the entire field of vission. In the middle there is enough space for up to four scientists. (Image T. Kwasnitschka)

A solution to this dilemma is offered by ARENA (Artificial Research Environment for Networked Analysis), a walk-in simulator which can reconstruct the world virtually. The central element of the installation developed at GEOMAR Helmholtz Centre for Ocean Research Kiel is the bowl-like projection surface (Fig. 1). It surrounds the viewer and fills the field of vision completely, from the ceiling to toes. A high performance computer system projects a global terrain model including the data to be considered in its correct geographical context. Up to four scientists at a time can dive down into their data and discuss what they see in situ. It is additionally possible to interconnect numerous installations as well as integrate other platforms such as laptops in order to allow spatially independent scientific cooperation.

The spectrum of applications ranges from the interpretation of bathymetric maps of the sea floor to biological habitat mapping and studies on the distribution of earthquakes along a subducted plate segment or even the spatial expansion of ocean currents or diffusion of volcanic ash particles in the atmosphere. For example, three dimensional photogrammetrically created models of complex rock formations on the sea floor can be portrayed and quantitatively analyzed. In this way Geologists can gain a better understanding of the spatial distribution and the regional context of their data sets – they carry out their field studies virtually, that is, independently of temporal and spatial limitations and are thus able to create an important added value to their precious time in the real terrain.

The goal is to create a laboratory that enables intuitive, unconstrained handling of data on the one hand, but on the other hand will result in the creation of new data sets. The result of an ARENA sitting should always be a concrete product in the sense of a data table, data map or at least field notes on the virtual fieldwork. The ARENA does not thus serve merely the visualization of complete research results in the sense of a presentation, but is rather a tool to expedite the work of the scientist and even make new research approaches possible.

Used in this way, visualization helps even in several stages of the scientific learning process from the formulation of questions in regard to robotic fieldwork and analysis to publication and presentation of results. The unification of these links in the scientific value-added chain including a strong focus on visualization of one single location is a novelty in marine science. Last but not least, with the help of the ARENA our enormous efforts at sea will be comprehensibly prepared.

Project team: Tom Kwasnitschka, Colin Devey, Warner Brückmann

2 In the ARENA a complete global terrain model can be loaded as a background. Here we are flying over the south island of New Zeeland. (Image T. Kwasnitschka)

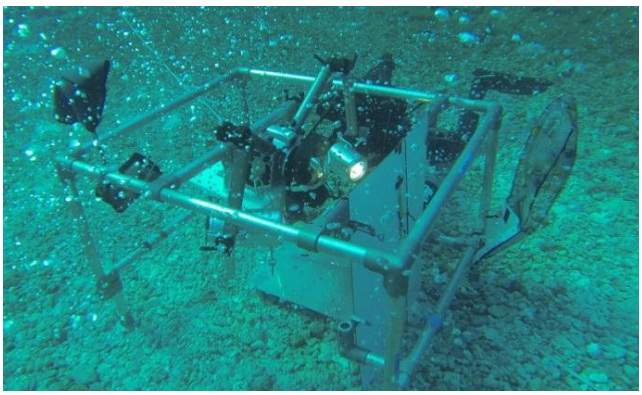
RESEARCH

Physics is like sex: sure, it may give some practical results, but that's not why we do it.

Richard P. Feynman

The Impact of Sub-Marine CO_2 Storage on the Marine Ecosystem: Reactive Transport of CO_2 in the Water Column

Investigating the pH in the water column is a key element for assessing the environmental risk of potential CO_2 leakage from offshore carbon dioxide storage sites. In the course of this project two numerical models have been developed to simulate the buoyant rise and dissolution of CO_2 bubbles in the water-column and to treat the subsequent near-field dispersion of dissolved CO_2 in seawater under ocean current and tidal forcing.



Deployment of the bubble box, equipped with a high resolution camera (Canon 5D Mark III) on the seafloor offshore Panarea.

The corresponding pH is predicted, considering solute transport and dissociation reactions at ambient pressure/temperature/salinity (PTS) conditions. In order to test and improve numerical models a comprehensive data set has been collected during campaigns to the storage site Sleipner off Norway in the North Sea and to a natural CO_2 seepage site offshore Panarea, Italy.

Experiments

In The North Sea, a gas release experiment at 80 m water-depth was conducted within the Sleipner area. CO_2 and Kr (used as inert tracer gas) were released on top of a benthic lander at varying gas flows (<140 kg/day) and bubble sizes (de: 1-6 mm). pCO_2 and pH were measured by in situ sensors to monitor the spread of the solute in different vertical heights and distances downstream of the artificial leak.

First results from our solute dispersion model indicate that the experimental setup likely influenced the local flow field by reducing the current velocities and by creating a pressure drop downstream of the gas source. This influenced the plume dispersion significantly. Current work is being done to solve the flow field affected by the lander in a sub-model and then to use the modeled data to fit the dispersion model to the experiment data. However, the experiment and numerical analysis show that the impact of such leakage rates is limited to bottom waters, due to the rapid dissolution of CO_2 bubbles in seawater (CO_2 is being stripped within the first two to five meters of bubble rise). In particular, small bubbles, which will dissolve close to the seafloor, may cause a dangerous low-pH environment for the marine benthos. However, on the larger scale, the advective transport by e.g. tidal currents, dominates the CO_2 dispersal in the North Sea and dilutes the CO_2 peak quickly.

For a complete understanding of a possible CO_2 sea bed leak, natural seepage sites like Panarea offer unique study opportunities. The gases are emitted at shallow water depth and have a high CO_2 content. Seepage has been active since ancient times and occurs at a wide range of gas flows. Thus, Panarea constitutes an ideal natural laboratory for investigating the impact of potential leakage. Data collection from two campaigns aims at understanding the dissolution behavior of the rising gas bubbles by measuring bubble sizes and rise velocities together with the gas composition. Furthermore, hydro-physical and geochemical data (pCO_2, TA, DIC, B, H_2S) of solute transport were investigated. The second campaign in 2013 was totally funded by the Future Ocean project and particularly aimed in filling parameterization gaps of the previous cruise (i.e. rise velocity and shrinkage rate). For that reason, a mobile bubble box (Fig. 1) was developed, which can be placed at the seafloor and allows to the initial bubble size spectra, shrinking rates of single gas bubbles and their rise velocities to be measured optically in a natural seepage setting and at various levels above ground (i.e. 0 - 100 cm). To study the horizontal and vertical distribution of the dissolved CO_2 plume a current meter, a Conductivity/Temperature/Depth sensor (CTD) and a pCO_2 sensor were deployed 20 m downstream of the main seepage site. It was also possible to perform a fluorescence tracer experiment to optically study CO_2 bubble plume dynamics in that area for the first time. Water and gas chemistry analysis, as well as HD-image and video analysis are still being processed and will enable testing and improvement of the parameterization of the bubble dissolution model. Parameterizations for gas bubble plumes, which occur at high leakage rates, will be implemented and tested using the fluorescence data.

Preliminary Results

Overall, preliminary results indicate that CO_2 leakage at a rate of 100 kg per day as in our experiment will only have a localized impact on the marine environment, thereby reducing pH substantially (by 0.4 units) within a diameter of less than 50 m (depending on the duration of leakage and the current velocities). Strong currents and tidal cycles significantly reduce the spreading of low-pH water masses into the far-field by efficiently diluting CO_2 in ambient seawater.

Outlook

Future work will focus on the numerical simulation of various leakage scenarios at Sleipner. Simulations will encompass different initial bubble sizes and gas fluxes to assess the spreading of the solute CO_2 plume into the near-field environment of a leak in the North Sea .

Project: CP1130
Project team: Lisa Vielstädte, Tina Treude
Research area: R5 Ocean Sinks

The Political Economy of the European Common Fisheries Policy

The failure of the European Common Fisheries Policy can be traced back to too high total allowable catches (TACs). To study why the minsters in the council choose to agree to such high TAC rates, we have developed a model which describes the annual voting on the TACs.

Within the model two types of ministers are considered, with one type favoring lower TACs more than the other. The model shows that the uncertainty about the future majority and its choice of TACs leads to an inefficiently high TAC level. A solution for this dilemma could be to agree on binding long-term management plans having the potential to overcome these high TAC levels instead of annually negotiated agreements on TAC rates.

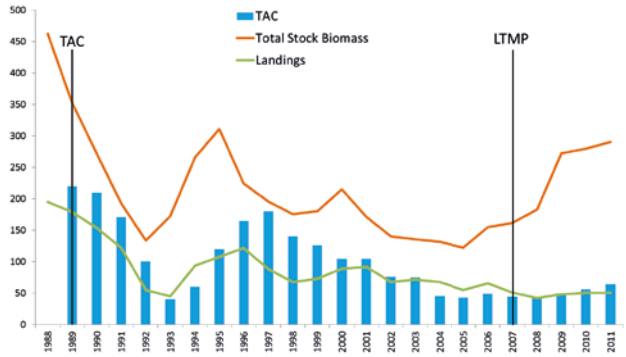
Introduction and Question

The Common Fisheries Policy (CFP) of the European Union was introduced to reduce the overfishing problem in European waters. Although the CFP has existed for several decades now it has only brought little success up to now. The main reason for this is, that TACs were often set too high to have any restrictive impact on fisheries. The ministers in the European Council are responsible for that failure because they passed the binding TACs. The goal of this project is to find out why ministers pass non-restrictive regulations for TACs and how an alternative management scheme, i.e. long-term management plans, which were brought into the CFP in 2003, but only implemented successively since 2007, can solve this problem.

Methods and Results

The first approach to answering this question is a dynamic game theoretic model that describes the situation in the council. The crucial assumption is that two groups of ministers exist. One prefers sustainable fishery and votes for low TACs (sustainable profit) while the other acts less sustainably and supports high TACs (short-term profit). TACs are fixed annually by the current majority in the Council and hold for one year. The annual update induces uncertainty about future fishing restrictions because the ministers do not know which majority will rule in the next period and how it will decide. The model shows that this uncertainty motivates an increase in TACs if the current majority is supporting short-term profits. Then, the possibility of a change in majority in the next period implies the risk of stronger fishing restrictions. Hence, the current majority tries to compensate potential losses due to potentially stronger fishing restrictions in the next period by allowing higher catches in the current period. This is what we refer to as the common pool problem in the Council of Ministers. The model can be applied to every country's fisheries management where decisions are made by majority voting in a council.

The uncertainty that drives the common pool problem could be reduced by substituting the short-term annual TAC management by binding long-term TAC management. Using the example of the Baltic Sea cod we can show that the long-term management plans implemented by the European Union have the potential to prevent the common pool problem and thereby increase the efficiency of fisheries management.



Deployment of the total stock biomass, landings and TACs (in 100 000 tons) for the Eastern Baltic cod from 1988 to 2011. TAC management started in 1989 and the long-term management plan (LTMP) was implemented in 2007. TAC levels and landings decreased with the implementation of LTMP (including an anticipation phase from 2004 to 2007). This allowed the stock to recover, which is reflected in an increasing total stock biomass from 2005 on.

Outlook

The next step will be to examine the conditions under which the ministers are willing to accept a change from the annual TAC management to long-term management, which usually implies stronger fishing restrictions.

An alternative approach will be to focus on lobbies at the national level and their impact on the decisions in the Council. I will build my modelling analysis on previous models that explain the influence of lobbying in other political fields.

Finally, using the insights of the approaches described above we will study how a modified institutional set-up could promote a more successful CFP and more sustainable fisheries. Specifically, I will consider the recent proposal of the Commission for more regionalized decision-making.

Project: CP1139
Project team: Julia Hoffmann, Martin Quaas
Research area: **R2** Ocean Governance

The Sea Surface Microlayer

The study is focused on the sea surface microlayer (SML) – a unique environment of the upper 1 mm of the ocean different from that of the subsurface water, important due to its role in air – sea interactions.

SML is thought to be a gelatinous film rich in transparent exopolymer particles (TEP) and acidic polysaccharides. TEP are the highly abundant and ubiquitous gel particles in the seawater. They can be produced directly by different aquatic organisms, mostly within the euphotic layer, or generated by coagulation from dissolved acidic polysaccharides. Phytoplankton is considered the major source of both TEP and their precursors, therefore TEP concentrations generally coincide with phytoplankton abundance.
Besides carbohydrates, a small fraction of lipids, proteins and humic organic matter as well as anthropogenic pollutants also contribute to the SML. The presence of these substances in the surface layer affects its properties that, consequently, may be important for air – sea gas exchange.

Roughly, the processes of air – sea gas exchange may be divided into three parts regarding their intensity and driven mechanisms. The molecular diffusion through SML acting as a barrier resistant to gas transport into the bulk of water exerts the weakest effect on gas exchange. A more effective mechanism is turbulent diffusion which is related to capillary wave formation on the water surface. And, lastly, air bubbles formed during strong turbulent regimes may penetrate deep into water cardinally affecting gas transport across the interface.

Open questions

Despite the progress in the understanding of the SML phenomenon and its role in nature, some questions still remain open.

How is polysaccharides (and TEP) production related to SML formation over the annual cycle of pelagic production? How do reduced polysaccharide (and TEP) concentrations during non-productive seasons affect the SML? Is TEP in the SML degraded or refractory and does it persist in the SML over a long time period?

Beyond this, there is evidence that proteinaceous gel – like particles, Coomassie stained particles (CSP), are enriched in SML similarly to TEP. However, the contribution of CSP to SML is not well studied.

1 Location (red point) of the time series station Boknis Eck in the Eckernförde Bay, SW Baltic Sea

Finally, since the role of SML in the processes of gas exchange is suggested, the dynamics of transformations in SML related to these exchange processes is still unknown.

Goals to be met by the end of the thesis:

a) To study how the abundance and composition of gelatinous material in the sea surface microlayer depends on plankton productivity and changes seasonally; probably, there are less gel particles in the surface microlayer during winter seasons and their chemical composition (sugar content, for instance) is changing as well.
b) To study how the formation of a gelatinous sea surface microlayer affects the air-sea gas exchange; the changes in the surface microlayer composition during non-productive seasons should increase gas transport.

Methods

To study the SML and its seasonal dynamics, the samples of SML were collected monthly in Boknis Eck (Fig. 1) from RV Littorina in the period of summer 2012 - autumn 2013.

The following parameters of SML are measured:

- Phytoplankton and bacteria abundance,
- Gel particles (TEP and CSP)
- Total lipids content,
- Total and dissolved amino acids
- Total and dissolved carbohydrates
- Total alkalinity
- Total and dissolved organic carbon concentrations

Two experiments are being conducted to study the relationship between chemical characterization of SML and air-sea gas exchange.

The first one is being used to investigate the effect that is solely driven by molecular diffusion; it is being carried out in a series of tank experiments. The main idea of such experiments concerns the dynamics of tracer gas concentrations (we use N_2O) in a gas-tight closed tank where the SML sample is before. The gas concentrations in the tank are measured by gas chromatography.

The second experiment deals with capillary wave damping by SML. Briefly, the damping coefficient and the wavelength of the capillary waves simulated by a thin glass wire in the small Teflon trough (16x40x2 cm) may be measured by means of an electromechanical device, using a capacity wave probe or laser beam reflection. Capillary waves in the trough are attenuated according to the SML content. These measurements are being carried out 4 times every second month since April, 2013 at the Chemical department of Saint Petersburg State University (Russia) in the laboratory of Prof. Noskov.

Preliminary results

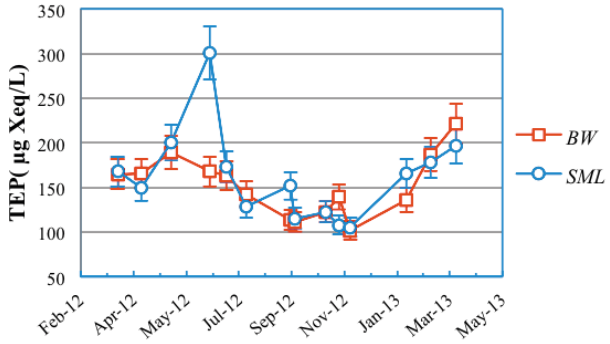
The chemical analysis of the samples is in progress. Some results including concentrations of TEP in the seawater have demonstrated seasonal dependence, reflected the processes of accumulation of organic matter in SML during productive seasons (Fig. 2).

The tank experiment and the experiment on capillary wave damping have both shown SML effects. Fig. 3 represents how gas transfer velocity changes over time in water covered by SML compared to a control with artificial seawater. The decreasing velocity indicates the slowing of molecular diffusion of gas across the boundary layer in the presence of SML. The damping coefficient (Fig. 4) of the SML samples is approximately two times higher than that of the artificial seawater, however, not as significant as was detected for artificial surfactants (not shown). Generally, it may be concluded that the SML samples collected in Boknis Eck demonstrate less retardation of air-sea gas exchange than was earlier reported, however, in accordance with the literature (see for example Brockman et al., 1982; Goldman et al., 1988; Saylor and Handler, 1999, and others).

What the components of SML are, where they come from, what seasonal changes take place in SML and how they contribute to air-sea gas transport will be shown by the further results.

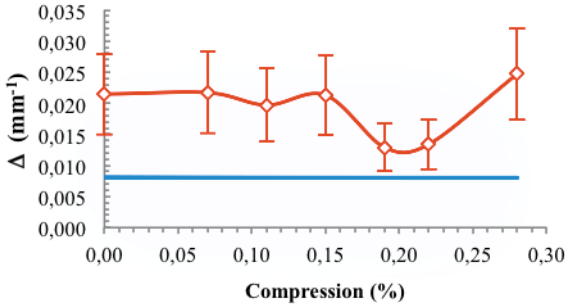
Project: CP1146
Project team: Alexander Dreshchinskii, Anja Engel, Gernot Friedrichs
Research area: R7 Ocean Interfaces

TEP concentrations in SML and BW



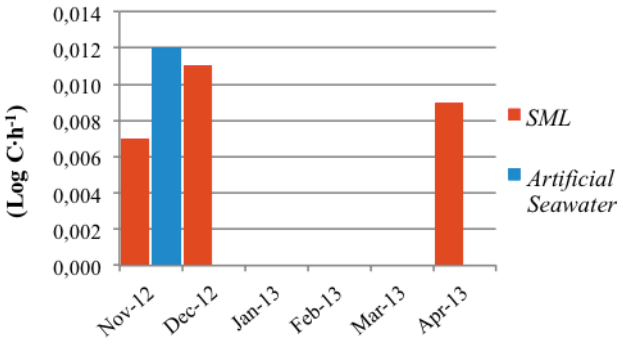
2 Seasonal variations of TEP concentrations detected in the SML and in the bulk water (BW) taken at 1m depth.

Damping coef. vs compression



3 Effect of SML on gas transfer velocity. Gas transfer velocity is expressed as Log of N_2O concentrations/hours (Log C•h^{-1}).

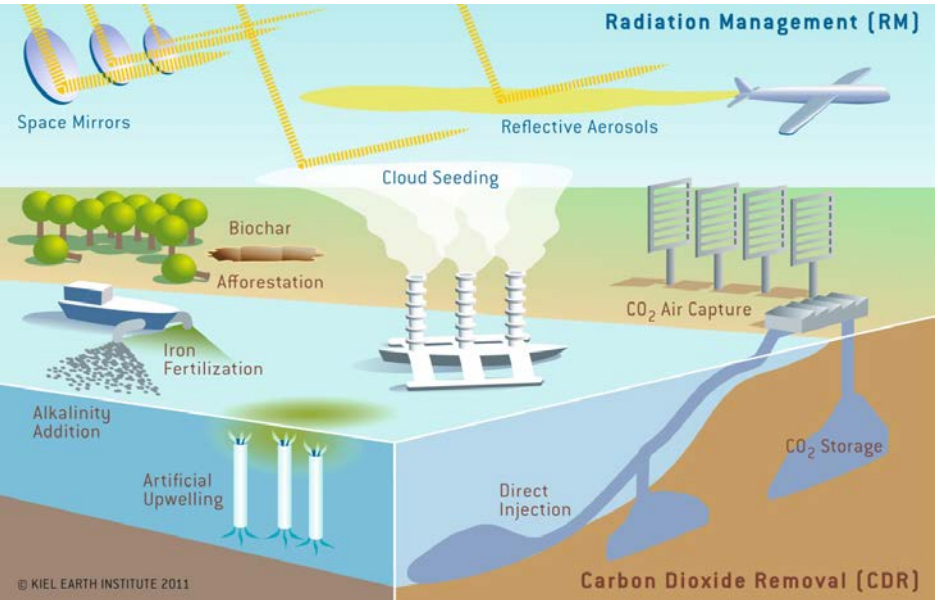
Variations of gas transfer velocity over time



4 Influence of the damping coefficient, Δ on the sample's compression. Colors are the same as in Fig. 2.

Carbon Sinks – Carbon Leakage

Even though the various carbon dioxide removal (CDR) measures are too limited in potential to relieve society from the necessity of significant emission control, their inclusion in the climate change reaction portfolio could allow for more cost-efficient and flexible emission paths which in turn would allow for a smoother transition of our energy system. Assessing the potential of CDR in general and the comparison of the various CDR measures requires the application of the same accounting rules to all measures and also consideration of carbon cycle feedbacks. However, carbon emissions represent only one threat humanity exerts on the ocean. For that reason comprehensive measures are needed that reflect the aggregate changes taking place in all relevant resources, allowing a profound assessment of sustainable development for the human-ocean system.



1 Overview of the various climate engineering measures

The aim of the research proposal "Carbon Sinks – Carbon Leakage" was to investigate the physical and the economic storage potential of the ocean and the seabed for different marine carbon sequestration technologies with a particular focus on the backflow of CO_2 into the atmosphere. However, in contrast to the rather theoretical approach outlined in the research project description, the research focus has been shifted to a rather empirical and more descriptive approach. The reason is the strong involvement of the Kiel Earth Institute and the GEOMAR in climate engineering (CE) research and assessment. Accordingly, the various CDR measures were not only compared among each other, but also compared to radiation management (RM) measures. Figure 1 provides an overview of the various measures. Furthermore, during the course of the project, the research focus was expanded to consider also other ocean related aspects in addition to carbon uptake and to investigate how the various aspects can be integrated in a comprehensive manner. Accordingly, the research project addressed the questions i) what is the role of CDR in the optimal climate change reaction portfolio, ii) how can carbon uptake be properly accounted for, and iii) how can the various anthropogenic induced changes in the ocean be comprehensively assessed?

Methods

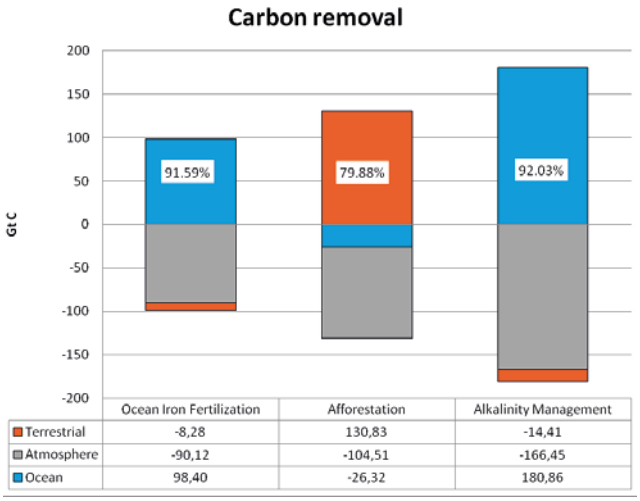
To address the research questions outlined above various methods were applied. As research on CE is still in its infancy, the assessment of the various CE measures was based on a literature review. In particular the reports for the German Ministry of Education and Research, for the Office of Technology Assessment at the German Bundestag, and for the European Commission involved an extensive literature review and assessment. To address the question of comprehensive carbon accounting, existing carbon accounting approaches were compared based on simulations with the University of Victoria Earth system climate model (UVic) which were conducted by David Keller and Andreas Oschlies at GEOMAR. To address the question of how the various anthropogenic induced oceanic changes can assessed, a comprehensive wealth measure was developed.

Results

Climate engineering brings new options to the climate change reaction portfolio of mitigation and adaptation. Yet these cannot relieve society of the necessity of controlling its greenhouse gas emission. CDR measures can indeed remove carbon from the atmosphere but most likely only in relatively small amounts. In other words, the leverage of CDR measures is too low. RM measures can exert a more immediate influence on the climate system but cannot control all climate variables equally. In short, the symptomatic approach addresses only a subset of the problems associated with global warming.

In principle, CDR measures are perfect substitutes for emission control. Leaving aside practical concerns and governance or legal constraints, the inclusion of CDR in a climate change reaction strategy would mean that CDR measures and emission control are used until their marginal (social) costs are equalized. Hence, some more expensive emission control measures would be replaced by CDR measures. This substitution would lower the social cost of climate mitigation or further reduce carbon concentrations in the atmosphere at existing costs.

However, to fulfill this purpose fair accounting approaches are necessary which consider all CDR measures. Despite the looming conflict about using land that would otherwise be available for food production, current analyses predominantly concentrate on land-based measures like Bioenergy with Carbon Capture and Storage (BECCS) and afforestation, while ocean-based measures get less attention. Assessing the potential of CDR in general and the comparison of the various CDR measures requires the application of the same accounting rules to all measures and also consideration of carbon cycle feedbacks. The common practice of assessing land-based CDR based on local stored amounts of carbon produces biased results — in particular in comparison to ocean-based measures which are usually assessed based on global carbon uptake. The effect is even more amplified if accounted from a global carbon cycle perspective. Accounting for non-atmospheric carbon removal results in a stronger reduction of effectiveness for land-based than for ocean-based measures. This is shown for afforestation, ocean iron fertilization, and alkalinity management in Figure 2.



2 Carbon Fluxes for Ocean Iron Fertilization, Afforestation, and Alkalinity Management from 2020 until 2100. / Source: Keller et al. (2013).

Finally, continuously increasing carbon emissions are not the only threat humanity exerts on the environment and therefore on the ocean. Free access to and availability of ocean resources and services, together with human development and economic growth, have put strong pressures on the ocean, ranging from overfishing and increasing resource extraction to various channels of careless pollution and alterations of coastal zones leading often to the degradation of marine ecosystems. For that reason comprehensive measures are needed that reflect the aggregate changes taking place in all relevant resources. Using capital theory, a comprehensive wealth index has been derived which, under certain conditions on social preferences and technologie , allows us to capture the substitutability between the various man-made and natural capital stocks in a single parameter. The index obtained under these conditions is a constant-elasticity-of-substitution (CES) function of the various capital stocks which can also be applied if the resource dynamics are influenced by uncertainty. The index therefore allows the measurement of various degrees of sustainability ranging from strong to weak.

Outlook

The overall aim and the addressed questions will be the main research focus for the future. While in the first phase the research on CE was basically intended to describe the field and the research file, the following phases will address more specific questions related to CE. For example, the question of an appropriate research strategy will be investigated. For that purpose, the intention is to investigate whether field experiments should be included in such a research strategy or not. With respect to carbon accounting,an intensification of the research with respect to carbon cycle feedbacks and a comparison of causative CDR measures to symptomatic RM measures is planned. The working hypothesis is that under consideration of carbon cycle feedbacks symptomatic measures might even be more effective in controlling the causative source than causative CDR measures would be. However, attention will be paid to whether the simulated carbon removals are realistic once limitations on nutrients supply are factored in. Furthermore, the comprehensive wealth index developed will be used to assess the oceanic status at a global and a local level. Currently, only a few indices for this purpose exist and none of them properly captures the limited substitution possibilities among the various services and resources or properly reflects the role of uncertainty. Accordingly, the aim is to develop a profound index as an element of a prudent ocean management strategy for sustaining blue wealth.

Publications

Klepper, G. and Rickels, W. (2012): The Real Economics of Climate Engineering, Economics Research International, doi:10.1155/2012/316564.

Rickels, W., Rehdanz, K., Oschlies, A. (2012): Economics prospects of ocean iron fertilization in an international carbon market, Resource and Energy Economics 34, 129-150.

Rickels, W., Lontzek, T. (2012): Optimal global carbon management with ocean sequestration, Oxford Economic Papers, 64 (2), 323-349.

Project: CP1108

Project team: Wilfried Rickels

Research area: **R5** Ocean Sinks

Large-Scale Methane Seepage in the North Atlantic

The project "Large-Scale Methane Seepage in the North Atlantic" focuses on two study areas: the Giant Gjallar Vent (GGV) on the Vøring Plateau off mid-Norway and the continental slope off West Spitsbergen. This report will deal with recent findings from the GGV.

Introduction

The GGV is a hydrothermal vent complex that was initiated during the opening of the North Atlantic at about 55 Ma. Sill intrusions into organic-rich sediments led to the production of methane and subsequent vigorous fluid venting at the seafloor. A later phase of fluid escape occurred in the Oligocene. The GGV is characterized by two pipes of 440 m and 480 m in diameter that reach up to the Base Late Pliocene Unconformity (BLPU) (Fig. 1). The BLPU separates the ooze-dominated Kai formation from the Naust formation which consists of glacigenic sediments. Over an area of 18,000 km² across the vent, the unconformity is strongly deformed, with the Naust formation sediments conformally draping this deformation, leading to a smoother relief at seafloor level.

Motivation and objectives

Prior to this study, the present activity status of the GGV was largely unclear. Hansen et al. (2005) interpreted the vent as a buried system, which seemed to be supported by the sediment drape above the BLPU, whereas Gay et al. (2012) proposed reactivation of the GGV after deposition of the BLPU, and possibly ongoing venting activity. Therefore, the first objective was to find out whether the GGV is still active at the surface. The second objective was to constrain the evolution of the GGV since the BLPU, i.e. since the last 2.5 Myr.

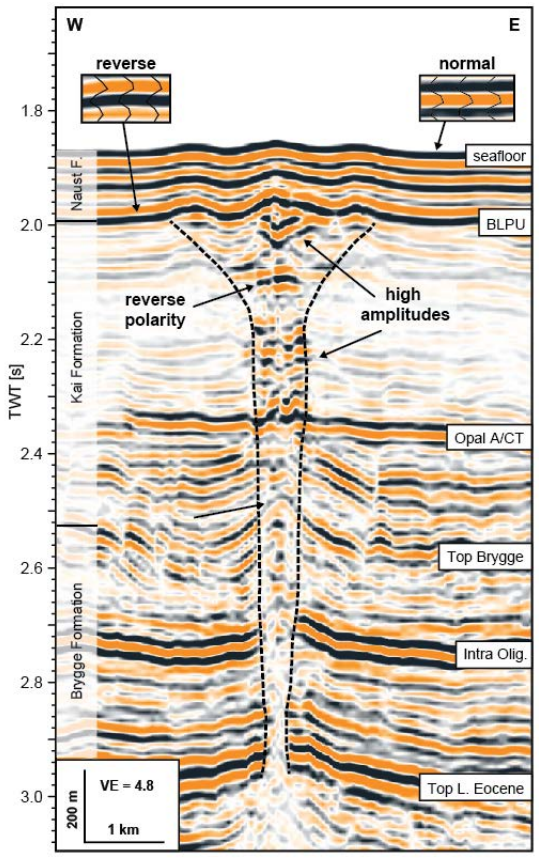
Data

In addition to exploration-type 3D seismic data from Saga Petroleum (now Statoil), which had so far been the only geophysical data of the GGV, we used a multidisciplinary dataset acquired during cruise M87-2 in 2012. These data include high-resolution 2D seismic and Parasound profiles, multibeam bathymetry, and water column imaging (WCI) data.

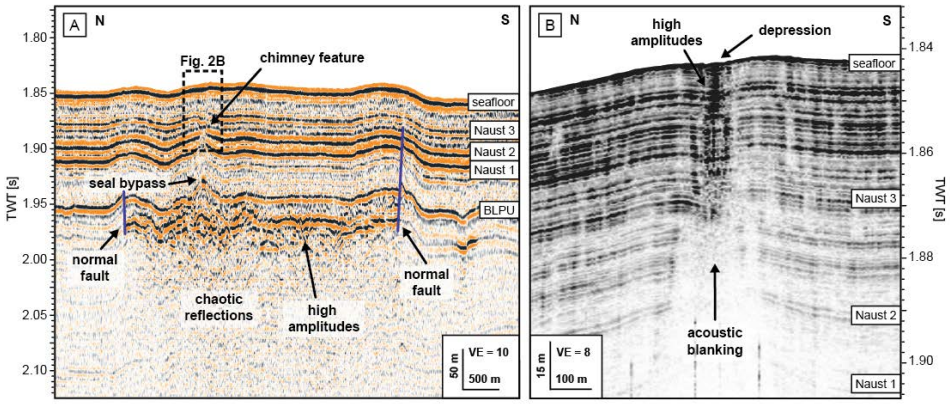
Results and interpretation

Although indications for active fluid escape into the water column were not observed during the cruise, we found several other indications for recent to ongoing activity at the GGV. Beneath the BLPU, various seismic anomalies (high amplitudes, reverse polarity, chaotic reflections, amplitude blanking) strongly suggest the presence of free gas (Fig. 1 and 2). The anomalies are confined to the Kai formation beneath the BLPU, except at a location 800 m northeast of the pipes where a 100 m wide chimney feature extends from the BLPU up to the seafloor (Fig. 2). At the edges of the pipes, subvertical faults cut the BLPU as well as horizons of the lower and middle Naust formation, indicating tectonic activity after deposition of these horizons. Neotectonic activity is further suggested by the extensive occurrence of shallow faults apparent in Parasound records, both in the immediate vicinity of the vent and up to 15 km away.

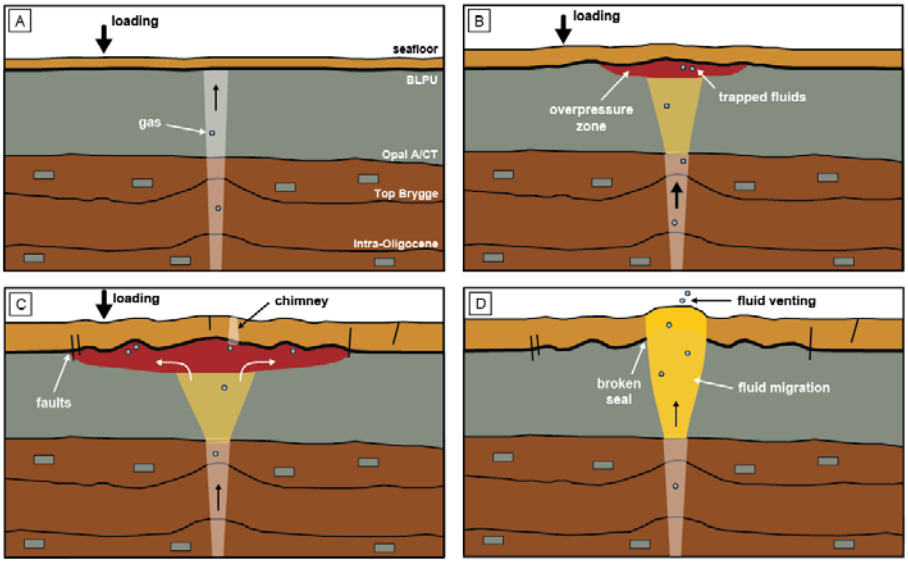
We interpret the observed deformation and faults as the result of fluids accumulating beneath the BLPU. Because of the lower permeability of the Naust formation, the BLPU acts as a seal to fluids migrating upwards from greater depths. Fluids are also produced within the Kai formation as the increased loading of the Kai formation by Naust sediments leads to dewatering. As the fluids cannot migrate further than the BLPU, overpressure builds up and causes deformation of the overlying strata (Fig. 3A and 3B). At present, it appears that the BLPU seal is still intact above the two pipes, but it has been penetrated in at least one location, as indicated by the chimney feature northeast of the pipes (Fig. 3C). We propose that further loading, gas ascent and overpressure build-up will eventually breach the BLPU seal (Fig. 3D) and start a new phase of venting at the GGV.



1 Exploration-type 3D seismic inline across one of the two pipes. Stippled lines indicate pipe extent. BLPU = Base Late Pliocene Unconformity, VE = vertical exaggeration.



2 (A) 2D seismic line showing faults and gas-associated chaotic reflections and high amplitudes above the pipe. A narrow chimney feature indicates a bypass of the BLPU seal. (B) A Parasound line at the same location shows that the chimney feature extends up to the seabed. BLPU = Base Late Pliocene Unconformity, VE = vertical exaggeration.



3 Proposed evolution of the GGV during last 2.5 Myr. (A) Early Naust period. BLPU acts as seal to upward fluid migration due to loading by dense Naust sediments. (B) Middle/ Late Naust period. Increased loading and trapping leads to overpressure build-up and deformation of the BLPU. (C) Present. Deformation and updoming continues, faults develop, the BLPU seal is breach in at least one location. (D) Future. Eventually, the seal fails completely, enabling renewed fluid venting at the GGV.

References

Gay, A., Mourgues, R., Berndt, C., Bureau, D., Planke, S., Laurent, D., Gautier, S., Lauer, C., Loggia, D., 2012. Anatomy of a fluid pipe in the Norway Basin: Initiation, propagation and 3D shape. Marine Geology 332–334, 75-88.

Hansen, J.P.V., Cartwright, J.A., Huuse, M., Clausen, O.R., 2005. 3D seismic expression of fluid migration and mud remobilization on the Gjallar Ridge, offshore mid-Norway. Basin Research 17, 123-139.

Publications /conference participations

Dumke, I., Berndt, C., Crutchley, G., Couillard, M., Gay, A., 2013. Neotectonic activity at the Giant Gjallar Vent (Norwegian Sea) indicates a future phase of active fluid venting. Abstract EGU2013-4729, EGU General Assembly 2013, 07.-12.04.2013, Vienna, Austria.

Project: CP1134

Project team: Ines Dumke, Christian Berndt and Volker Liebetrau in collaboration with GNS Science (Lower Hutt, New Zealand) and the University of Montpellier 2 (Montpellier, France).

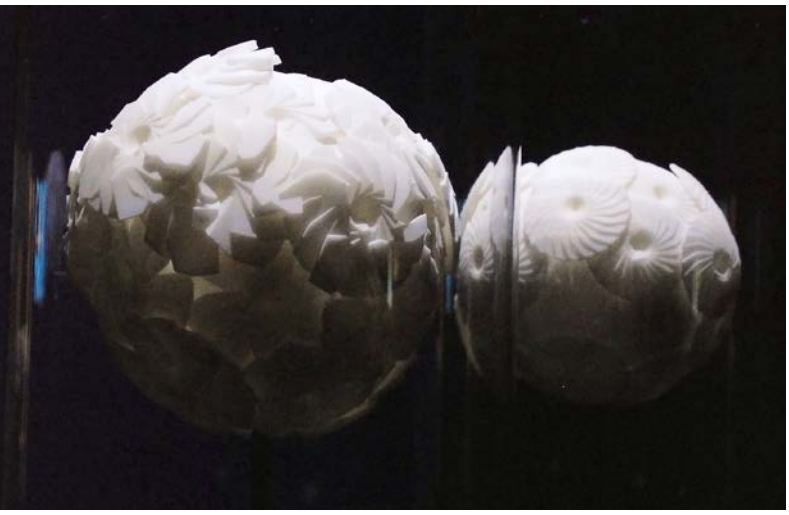
Research area: **R9** Ocean Controls

Is Evolution Constrained by Previous Adaptation of *Emiliania huxleyi*?

The coccolithophore *Emiliania huxleyi* is a globally distributed phytoplankton species with a key role in global primary production and biogeochemical cycles. Predicted future responses have long been exclusively based on short-term studies. While adaptation to a single selection pressure (CO_2) has recently been demonstrated by Lohbeck et al. (2012), knowledge on adaptation to multiple selection regimes, for example ocean acidification and rising temperatures is still lacking.

After 1500 generations of CO_2-adaptation a second evolutionary pressure will be added on the selection system. The temperature will be increased until the algae show responses of temperature stress. Further a new selection line will be introduced with both selection pressures starting at the same time (co-occurring vs. time-shifted). After approximately 500 additional generations under a double-selection regime a reciprocal approach will test for evolutionary adaptation.

We predict the outcome to be influenced on three major factors: sign epistasis, pleiotropy and standing genetic variation. We will develop different test scenarios to disentangle these factors.



Introduction

In times of global change and an increasing CO_2 concentration in the atmosphere and the sea there is a need for knowledge about key species which may affect the global carbon cycle. Coccolithophores are globally distributed calcifying algae estimated to contribute up to half of the current $CaCO_3$ production (Milliman 1993), and therefore regarded as a key species for the global carbon cycle. Calcite scales known as coccoliths cover the surface of the cells. Depending on seasonal and geographical location the contribution of coccolithophores to the pelagic $CaCO_3$ flux is estimated from less than 20 % to over 90 %. Hence, atmospheric pCO_2 is significant influenced by the increase und decrease of coccolithophore $CaCO_3$ formation, which can occur through variation in coccolithophore numbers or change in $CaCO_3$ production levels (Marsh 2003, Archer et al. 2000).

Predictions about adaptive evolution in coccolithophores are mainly based on short-term experiments. In the study of Lohbeck et al. (2012), one of the first long-term studies on marine calcifying organisms, the authors showed that *Emiliania huxleyi*, a unicellular coccolithophore, has the evolutionary potential to adapt to high CO_2 conditions by partly restored calcification and growth rate. However, it is believed that global change will not be only increasing CO_2. Hence, there is a need for multiple selection regimes. In this study we concentrate on temperature as a secondary selection pressure additionally to CO_2, since temperature affects a broad spectrum of metabolic pathways, because all enzymatic reactions are temperature dependent. Additionally temperature is easy to control and therefore appropriate for lab experiments. Moreover, we investigate consecutive versus simultaneous adaptation to two of the most important novel selection regimes, ocean acidification and temperature.

Questions

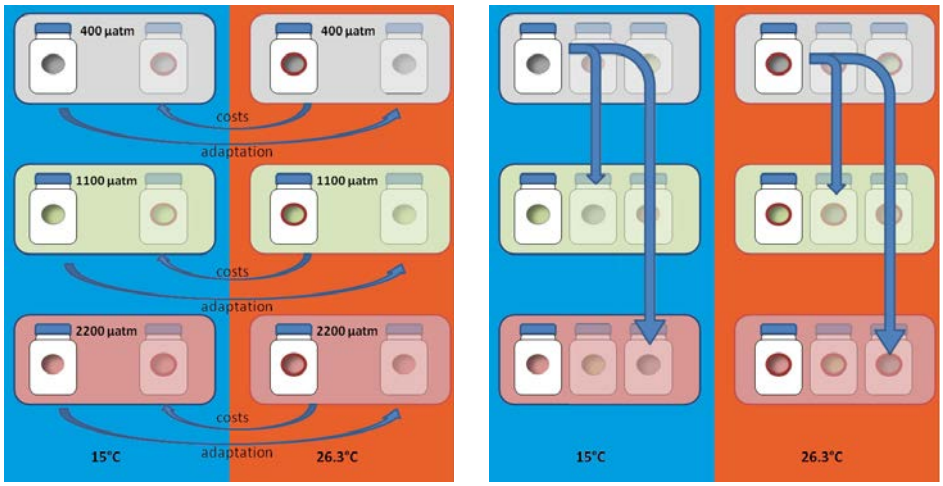
Will *E. huxleyi* be able to adapt to high temperatures and does CO_2 affect the adaptive potential? Why would previous or simultaneous selection regimes differ? Why would one regime constrain, the other maybe enhance adaptive evolution? How do we know whether CO_2 and temperature stress affect the same or different metabolic pathways? What is the pool of mutations we expect in the CO_2 adapted populations? Will the beneficial mutations be in genes influencing multiple phenotypic traits (pleiotropy)? Beneficial mutations may be dependent on the genetic background (sign epistasis), hence will standing genetic variation be the main driver of evolution?

Methods

The study starts with a genotypic lineage of *E. huxleyi* already adapted to different CO_2. This lineage has been kept under 400, 1100 and 2200 µatm pCO_2 and 15°C 1500 generations, while 400 µatm pCO_2 serves as control, 1100 pCO_2 is predicted to be reached by the end of the century. 2200 µatm pCO_2 is the proof of principal. The replicates (five each) for each pCO_2-level have been duplicated and the duplicates put at 26.3°C, a temperature were the algae show signs of temperature stress. Additionally replicated asexual populations of the control (400 µatm pCO_2) were put under high CO_2 (2200 µatm pCO_2) and high temperature at the same time (Treatment 400 ->2200 = 422).

The experiment will be run for at least another 500 generations (approx. Oct. 2013). Then the adaptive response will be tested in a reciprocal approach were the control is put under selection conditions and compared to the evolved cells and vice versa. Owing to the large combinatorial treatment combinations, the experiment will be divided into several sub-experiments (Fig. 1).

Several biological parameters will serve about actual status of the cells. Growthrate will be the main indicator of evolution, while calcification, lipid production and the transcriptome analysis will serve as phenotype description.



1 Principal scheme of the reciprocal experiments. A) testing for temperature adaptation. 15°C treatments (control) will be duplicated and raised to 26.3°C and vice versa (costs for adaptation). B) testing for CO_2 adaptation. The CO_2 control treatment (400 µatm CO_2) will be triplicated and set on selection conditions (1100 and 2200 µatm CO_2), while the selection lines will be set to control conditions (no arrows in the scheme).

Preliminary results

The evolutionary response as a response to increased CO_2 (without temperature), a continuation of the Lohbeck et al. experiment increases with time (600 generations ≈ 1 year) (Fig. 2). The difference in growth rate is at the same time an estimate for relative fitness differences in the asexual phase. (relative fitness = adapted – non-adapted growthrate). Since the error bars at 1100 µatm pCO_2 selection regime overlap with zero, yet no significant fitness improvement could be measured in this regime.

In case of the temperature treatments, so far, the strains develop with a slight increase in growthrate over time (Fig. 3). However, first the reciprocal test experiment has to be done to give a clear answer to the questions.

Outlook

From October to December 2013 will be a huge reciprocal test experiment upon temperature and CO_2 adaptation. In the following month the samples taken in the experiment will be analyzed on calcification, lipid production and transcriptomics. All these variables will help disentangle the relevant metabolic pathways that are under selection.

Further we plan to compare the transcriptome of the evolved strains to transcriptomes of different wild life morphotypes of *E. huxleyi*.

References

Archer, D, Winguth, A, Lea, D, Mahowald, N, 2000. What Caused The Glacial/Interglacial Atmospheric pCO_2 Cycles? Rev. Geophys. 38, 159-189.

Marsh, ME, 2003. Regulation of CaCo3 formation in coccolithophores. Compar. Biochem. Physiol. Part B. Biochem Mol Biol 136, 743-754.

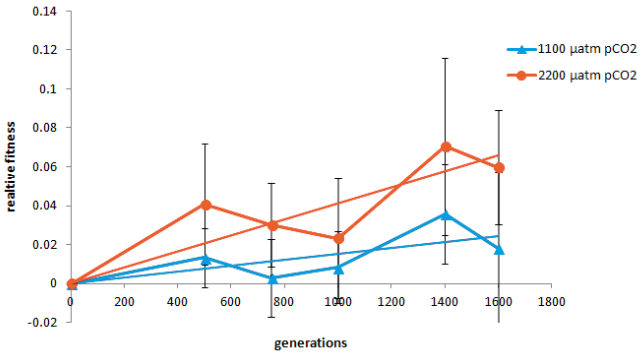
Milliman, JD, 1993. Production and accumulation of calcium carbonate in the ocean: Budget of nonsteady state. Glob. Biogeochem. Cycles 7, 927-957.

Lohbeck KT, Riebesell U, Reusch TBH. 2012. Adaptive evolution of a key phytoplankton species to ocean acidification. Nat Geosci 5: 346– 51.

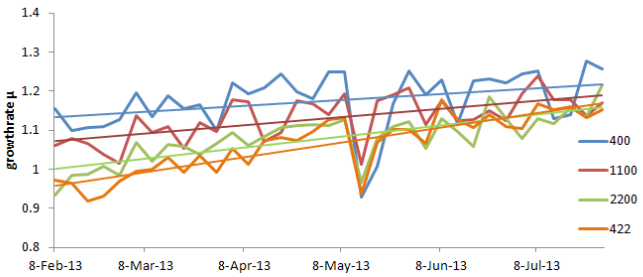
Project: CP1150

Project team: Lothar Miersch, Ulf Riebesell and Thorsten B. Reusch in collaboration with Magdalena Gutowska, Jorge Rafael Bermúdez Monsalve (all GEOMAR), Sinead Collins (Edinburgh University)

Research area: R8 Evolving Ocean



2 Time-course of relative fitness (growth rate of adapted relative to non-adapted control populations) in the single-clone experiment that is currently continued over more than 1600 generations.



3 Growthrates µ over time at 26.3 °C. The treatments are 400 µatm pCO_2 (blue), 1100 µatm pCO_2 (red) and 2200 µatm pCO_2 (green) before and after temperature increase. The orange treatment was 400 µatm pCO_2 before and 2200 µatm pCO_2 after temperature increase. Each treatment shows a clear trend towards higher growthrates with time. The drop around the 14-May-13 was due to a failure of the climate chamber.

The Sustainability Approach on the High Seas: How can Sustainability be Conceptualized Regarding the Great Uncertainty of Ocean Change?

While in the past decades various measures and initiatives on an international and regional level have been taken, there is still a lack of governance structures on the high seas where more than 60 per cent are still not under sovereign jurisdiction. These parts that belong to the global commons of humankind provide an 'open access' resource. In the past decades, several global commons regimes and conventions have established a framework of rules to conserve the marine ecosystems and to manage the use of renewable and non-renewable resources. In this context, the term 'sustainability' has become a leitmotif.

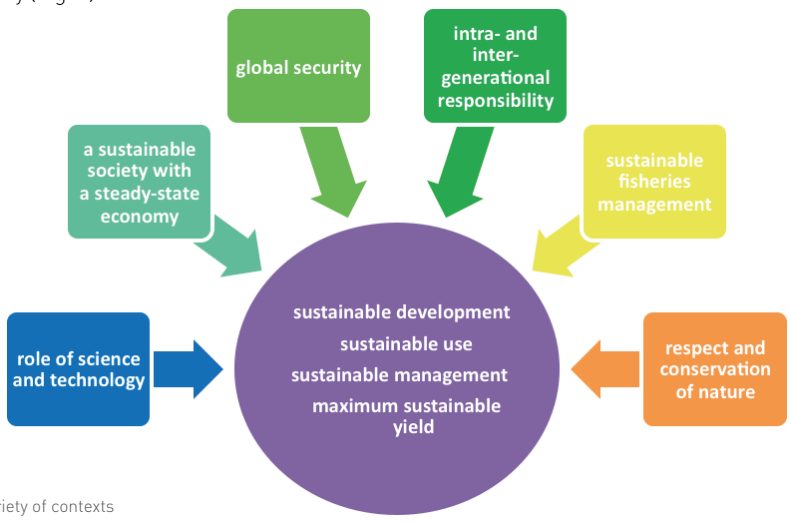
This project investigates how the concept of sustainability has been developing in maritime affairs in the last ten years. Based on a constructivist approach, data that refer to sustainability in international conventions, institutional and decision-making processes will be collected. Applying a corpus linguistic method the data set will be analyzed to find out how sustainability goals are formulated within these texts and how they are passed on to a variety of actors.

Introduction

The conservation and protection of marine ecosystems and their aesthetic, cultural and spiritual values demand a more careful use of renewable and non-renewable marine resources to ensure that the needs of the present are met without compromising the ability of future generations to meet their own needs. In this context, the concept of 'sustainability' provides a conceptual basis for integrating these requirements. Since its classical definition provided by the Brundtland Commission in 1987, the term 'sustainability' has received much international attention and has become the globally dominating leitmotif for shaping international environmental and developmental relations. However, the holistic approach of the concept in implying everything is somewhat imprecise as it can be used to cover very divergent ideas. There is still no common definition of the term which has been used in a variety of contexts, ranging from questions of security to sustainable fisheries management, a sustainable society with a steady-state economy, the distribution of resources and intra- and intergenerational responsibility (Fig. 1).

Against this background, the project focuses on a detailed analysis of the term 'sustainability'.

- How has it been defined and what does it exactly mean in ocean affairs?
- Who is concerned with sustainability in the maritime context and what do different actors understand by it?
- Which international maritime conventions have taken the sustainability principle into account?
- Which institutions are involved in implementing it?
- How can sustainability be conceptualized regarding the great uncertainty of ocean change?
- What does the process of sustainability mean for institutionalization?



1 The term 'sustainability' is used in a variety of contexts

Methods

The investigation is based on a constructivist approach. Constructivism describes the dynamic, contingent and culturally based condition of the social world, understanding the world as a project under construction i.e. as becoming rather than being. Hence, the study of change is central to a constructivist approach.

The analysis covers the last ten years after the World Summit in 2002 in a diachronic analysis of documents looking at how the sustainability concept has been developing in maritime affairs since then. The study will be divided into two sequential parts. In the first part, data that refer to sustainability in international conventions, institutional and decision-making processes will be collected through lexicometric analysis. Following Ferdinand de Saussure, language is regarded as central to our understanding of the world where interests and behavior of political agents are socially constructed by collective meanings, interpretations and assumptions about the world. The use of language plays a significant role for the diffusion and internationalization of ideas between and within communities. The term 'sustainability' , for example, is employed in political discourse as an empty signifier designating all kinds of ocean-related problems. Drawing on linguistic insights, it is possible to generate broader meanings of what is said in texts by referring to methods such as intertextual and contextual analysis.

Once central signifiers, their frequency and co-occurences have been classified, in the second part the lexicometric analysis will be followed by qualitative scrutiny. To substantiate the results of the lexicometric analysis, the second part will be based on the evaluation of expert interviews to be taken with personnel from selected international institutions, government agencies, intergovernmental (IGO), nongovernmental (NGO) and marine research organizations.

Current status and outlook

The project has started with a thorough literature research on theoretical approaches to sustainability and viewing of selected text material (inter alia annual reports, official documents, statements, speeches, scientific publications). For the linguistic analysisthe generation of the text corpus has been started. Currently, more than 900 documents (July 2013) have been chosen, downloaded and converted into pure text files. The procedure has not been concluded and is an ongoing process. First test calculations on texts processed using the software WordSmith have been made (Fig. 2). When the corpus is completed a statistical analysis will be conducted to specify central signifiers, their frequency and co-occurrences designating ocean-related problems within the texts.

2 First calculation of a word cloud (yet unprocessed) for the search word *sustain* based on a corpus of 900 text files

Relevant Publications

Kronfeld-Goharani, Ulrike (2013): Bedrohungen und Herausforderungen im maritimen Bereich – Dimensionen der menschlichen Sicherheit, in: Jäger, T., Bruns, S., Petretto, K., Petrovic, D. (Hrsg.), Die maritimen Dimensionen von Sicherheit, Reihe „Globale Gesellschaft und Internationale Beziehungen", Wiesbaden: Springer VS, 83-97.

Visbeck, Martin; Kronfeld-Goharani, Ulrike; Neumann, Barbara; Rickels, Wilfried; Schmidt, Jörn; van Doorn, Erik (2013): Establishing a Sustainable Development Goal for Oceans and Coasts to Face the Challenges of our Future Ocean, Kiel Working Papers, Kiel Institute for the World Economy, No. 1847, June 2013, www.ifw-kiel.de.

Visbeck, Martin; Kronfeld-Goharani, Ulrike; Matz-Lück, Nele; Neumann, Barbara; Ott, Konrad; Rickels, Wilfried; Schmidt, Jörn; van Doorn, Erik, Quaas, Martin F.: Sustaining Blue Wealth: The need for a Sustainable Development Goal for the Ocean; paper is prepared to be submitted to the journal Marine Policy.

Project: CP1203

Project team: Ulrike Kronfeld-Goharani, Dirk Nabers

Research area: R1 Our Common Future Ocean

Coastal Sustainability and Governance

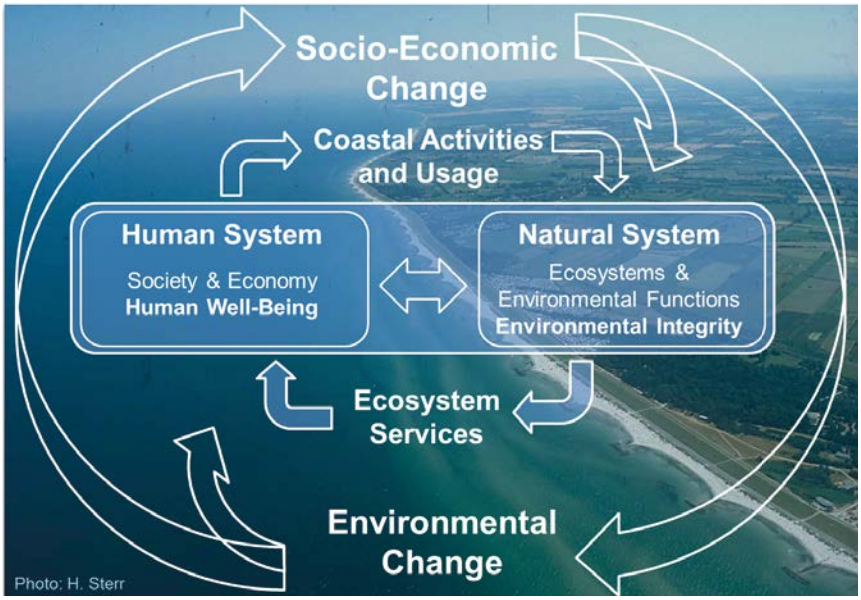
This project takes a socio-ecological systems approach to assessing coastal sustainability and governance at regional to global scales. The aim is to develop a transferable and adaptive analytical framework to identify hotspots and deficits of sustainability and governance in coastal zones, building upon the Ecosystem Services approach. The concept includes methods of participatory knowledge production in order to understand the issues at stake, provide a well-grounded conceptualization of coastal sustainability, and develop meaningful indicators as well as future scenarios. The project will contribute to the scientific and public discourse on sustainability and sustainable development and connect terrestrial and marine issues of sustainability and governance.

Introduction

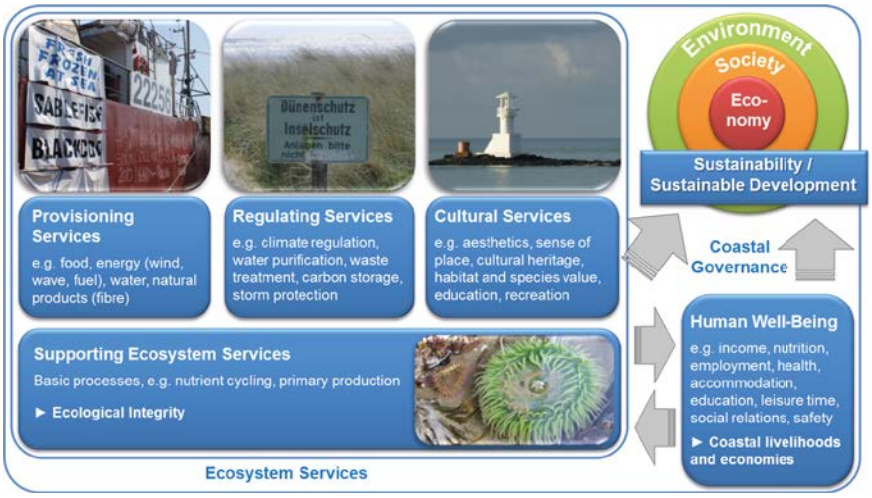
Coastal zones[1] can be conceptualized as complex and dynamic socio-ecological systems (SES) or coupled human-environmental systems (CHES) that are composed of two closely interlinked subsystems: a human system and a natural system (cp. Figure 1). Both subsystems are coupled through various interactions and interdependencies that stretch from the coastal hinterland far into the marine environment, with some linkages of supra-regional or even global nature. The natural subsystem provides various resources and benefits which keep attracting humans to settle, develop and utilize coastal zones (Visbeck et al., 2013, Brown et al., 2013). This special attractiveness and the resulting utilisation of coastal zones has led to significant human interventions and caused serious impacts on the natural coastal system (cp. Figure 2) and cultural assets in addition (Nicholls and Cazenave, 2010). Natural hazards such as storm surges pose further risks to the coastal SES. However, there is large uncertainty with regard to the future development of human societies and economies and to environmental changes such as climate change and the resulting pressures, impacts and responses.

This complexity of pressures and impacts and the interconnectedness of the subsystems, as outlined above, challenge the sustainable management of coastal zones with their resources, communities and environments. In order to build sustainable and resilient coastal communities, coastal governance and management must be aware of and responsive to the complexity and dynamics of coastal SES and the key issues at stake.

[1] Commonly, coastal zones are understood as the interface or transitional area between terrestrial and marine environments and their mutual influences (Woodroffe, 2002). In this project, "coastal zones" are defined by the key functional linkages and interactions of the coastal SES and its subsystems, stretching from the coastal hinterland (as landward extent) into the EEZ and continental shelf (as seaward extent); significant administrative or natural boundaries are taken into account as well.



1 Coastal zones as complex and dynamic socio-ecological systems (SES) of coupled human and natural subsystems that are exposed to changes of local, regional and global nature and the resulting impacts and responses.



2 The Ecosystem Services approach and indicators for Human Well-Being as basic concepts to develop a framework for assessing sustainability and governance of coastal zones (Griggs et al., 2013, Millennium Ecosystem Assessment, 2005, Lange et al., 2010, World Business Council for Sustainable Development, 2012)

Project goals, research questions and methods

The core of the project is the development of a transferable and adaptive analytical framework to identify and assess hotspots and deficits of sustainability and governance in coastal zones. Through this, the project contributes to the scientific and public discourse on sustainability and sustainable development and connects terrestrial and marine issues of sustainability and governance. This work is strongly linked to the current discourse on sustainable development and governance of the ocean (Visbeck et al., in progress).

The research questions addressed in this project can be summarized as follows:

- CONCEPTUAL: (How) can we assess or "measure" sustainability of coastal socio-ecological systems? How can we account for uncertainties of future developments and change?
- DIALOGUE & PARTICIPATION: What notions and concepts of (coastal) sustainability have scientists, experts, stakeholders and the public? (How) can we make use of public knowledge in order to identify key issues, define suitable indicators and thresholds?
- PROBLEM SOLVING: What is needed in terms of sustainable management and governance? Where are the gaps?

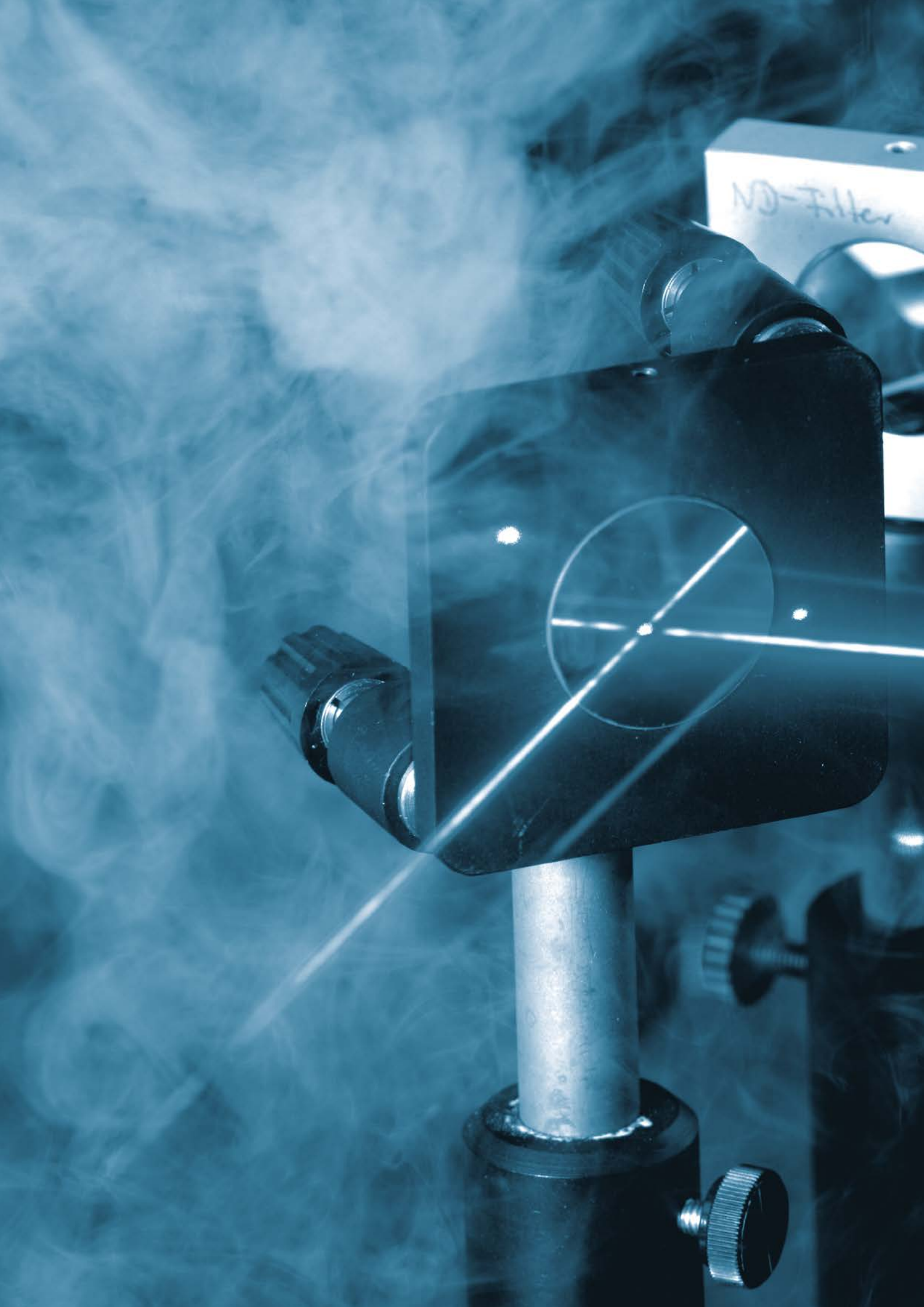
Fundamental to the envisaged framework of coastal sustainability and governance is a well-grounded conceptualization of "coastal sustainability" which accounts for the complexity of coastal SES and aspects of uncertainty. Cummins and McKenna (2010) and Stirling (2010) strongly advocate that co-production of knowledge through participatory and deliberative procedures is essential for deriving useful answers to complex and uncertain issues in sustainability science. Therefore, this work takes a multi-dimensional and multi-actor perspective by conducting stakeholder analyses and including stakeholders' views and judgements at several steps of the project. The framework is developed upon the Ecosystem Services approach (Millennium Ecosystem Assessment, 2005, Costanza, 1999, Burkhard et al., 2012) in conjunction with concepts of human well-being, which are adapted to the specific characteristics and key issues of coastal SES in order to derive meaningful indicators and benchmarks/thresholds of sustainability (cp. Figure 2). The framework is implemented and tested at case study level through GIS-based multi-criteria analysis and later on will be up-scaled for regional to global assessments. Further, socio-economic and environmental scenarios as well as a cross-cutting analysis of the governance system will be included.

Status of the project and upcoming activities

At this early stage the project is in a phase reviewing theories, key concepts and approaches in human-environmental research, sustainability science and ecosystem service approaches for coastal and marine environments as well as methods of participatory knowledge production; contacts are being established and cooperation with experts in the respective fields built; case study sites defined, and contacts to experts, stakeholders and related projects established; data is being collected and a basic analysis of the primary case studies conducted. The case studies will depict a choice of different socio-economic and environmental settings from Europe, Australia, South America and Asia:

- The Kiel Fjord (Schleswig-Holstein, Germany) and the coast of New-South Wales (Australia) have been selected as primary case study regions to develop, implement and test the conceptual framework. The actual case study site in Australia will be defined in September during a field survey and meetings with experts from the University of Wollongong, the Australian National Centre of Ocean Resources Security (ANCORS) and the Natural Resources Commission of NSW.
- Further collaboration projects are planned in Argentina (Buenos Aires Province) and Thailand (Gulf of Thailand and/or Andaman Sea coast) in order to cover selected research-questions in different socio-economic and environmental settings.

Project: CP1201
Project team: Dr. Barbara Neumann
Research area: **R1** Our Common Future Ocean


ND-Filter

SCIENCE NEWS

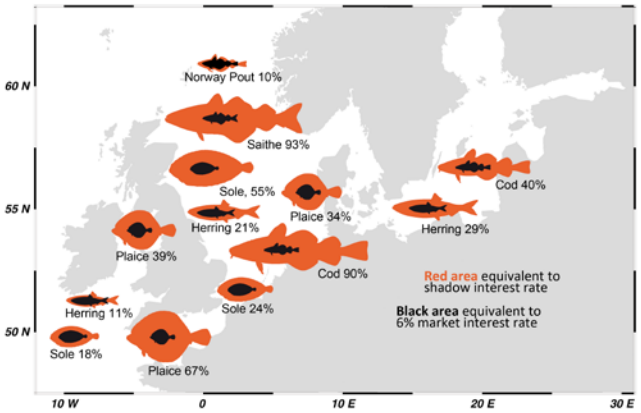
If we knew what it was we were doing, it would not be called research, would it?

Albert Einstein

Limiting Catches Results in Great Economic Benefits

Kiel Economists and Fisheries Biologists Develop a New Concept for the Common Evaluation of 13 Commercially Fully Utilized European Fish Species

More than two thirds of all fish stocks worldwide are considered overfished or utilized to the sustainability limit. Especially affected are the stocks of popular food fish in the North and Baltic Seas such as cod, pollock, sole or plaice. They recover only slowly – despite various attempts at sustainable fisheries management. Scientists from the Kiel Cluster of Excellence "The Future Ocean" have now developed a concept that allows for the first time the evaluation and comparison of the degree of overfishing of 13 commercially fully utilized European fish species both economically and biologically. The Kiel scientists presented their calculations recently in the international journal Ecological Economics.



Graphic on the Shadow Interest Rate Representation of the shadow interest rate for 13 species. The higher the percentage the more overfished the stock and the more an investment would equally benefit the fisher and the stock. Copyright: The Future Ocean, Graphic Jörn Schmidt.

Up to now either biological reference values such as stock density (BMSY) and mortality (FMSY) or economic valuations such as catch (MSY) and sustainable yield (MEY) have been used for the development of sustainable fisheries management concepts for single stocks. An alternative and new method is the calculation of so-called shadow interest rates (SIR). "For the first time we have been successful in combining biological and economic factors in a single indicator" says Professor Martin Quaas, Resource Economist at the Institute of Economics at Kiel University and first author of the study. "With the calculation of the shadow interest rate we can determine not only the degree of overfishing. We can now compare the individual stocks also."

The calculation of the shadow interest rate requires a complicated mathematical model. "This is comparable to the effort needed to determine the future earnings of a company. Our calculations are based on scientifically substantiated models and statistical methods" says Martin Quaas. The interpretation of the shadow interest rate is comparatively simple: It measures the future economic revenue which would result from a marginal lowering of the current fishing quotas.

Ocean fish stocks are still considered a common resource, whereas the caught fish belongs to the fisher, the fish in the sea belongs to everyone. The fisher borrows the natural resource fish – before any interest rate has been calculated. If it is assumed that the revenue will increase if fewer fish are caught, this represents an investment of the fisher in a growing fish stock. This growth has now been given a value by the Kiel fisheries biologists and economists, the so-called shadow interest rate. Shadow interest rates between 10 percent (Norwegian smelt) and 90 percent (North Sea cod) could be identified for 13 fish species (see graphic). The higher the percentage the more overfished the stock is and the more an investment would be worth equally for the fisher as for the stock.

Shadow interest rates provide stakeholders from politics and industry with a new means of evaluation for the development of sustainable fisheries management concepts. "Economic costs are often underestimated when determining quotas" says fisheries biologist Dr. Rainer Froese from GEOMAR Helmholtz Centre of Ocean Research Kiel and co-author of the study. "In Kiel we have long been researching integrated concepts that make sense from a biological and an economic point of view." adds Froese. Resource economist Martin Quaas comments:

> **"The new study demonstrates that a stock-sparing fishery represents an economically rewarding investment, since the rate of return lies well over the market interest rate."**

Original Paper

Martin F. Quaas, Rainer Froese, Helmut Herwartz, Till Requate, Jörn O. Schmidt, Rüdiger Voss, Fishing industry borrows from natural capital at high shadow interest rates, Ecological Economics, August 2012, http://dx.doi.org/10.1016/j.ecolecon.2012.08.002

Acidic Water Impacts Sea Urchins – Study Verifies Adverse Effects on Sea Urchin Larvae

Increasing ocean acidification can have negative effects on calcifying marine organisms. A new study of the GEOMAR Helmholtz Centre for Ocean Research Kiel, Kiel University and the University of Gothenburg demonstrates that sea urchin larvae grow and build up their calcium skeletons more slowly if their development has to take place in acidified sea water. In an article in the online edition of the journal Proceedings of the National Academy of the Sciences, the scientists point out potential mechanisms of effect. The study was carried out within the scope of the BMBF (Federal Ministry of Education and Research) coordinated project BIOACID (Biological Impacts of Ocean Acidification) and the Cluster of Excellence "The Future Ocean".

Pluteus larvae of the green sea urchin Strongylocentrotus droebachiensis are tiny, about 0.3 mm long "eating machines" which feed on algae for several weeks in plankton before they go through metamorphosis and begin their life on the sea bed. Thin skeletal elements support their transparent bodies. These spines are made of calcium carbonate and are formed by special cells. Only recently has it been discovered that pluteus larvae grow more slowly in acidified sea water and need more energy. An extended development period, however, increases the risk that the larvae will be eaten by the many predators in the open sea.

As part of the BMBF coordinated project BIOACID, scientists from GEOMAR Helmholtz Centre for Ocean Research Kiel and the Cluster of Excellence "The Future Ocean" at Kiel University examined which mechanisms lead to this decrease in growth rate. Using methods developed for research on mammals, the scientists were able to show that pluteus larvae cannot control the pH value in their cavities. These measurements were taken with tiny, 2 µm thin pH-electrodes. In contrast, measurements with pH sensitive colorants revealed that the cells in the bodies of larvae can control their internal pH value under the stress of acidification. This is important as the first skeletal elements are formed inside the cell itself – a process that only functions at very uniform conditions. Changes in the pH gradient between the calcifying cells and the cavities could be one of the reasons for the observed reduction in growth and calcification in an acidified sea environment. Under these conditions, more energy is necessary to control the pH value in the calcifying cells. This energy is thus missing for the growth process. "We need further studies on the cell biology of calcification processes in order to better understand the mechanisms of sensitivity" explains Prof. Dr. Frank Melzner, head of the research group for ecophysiology at GEOMAR. "The pH regulation abilities of tiny larval stages can only be researched with sophisticated optical and electric methods" continues Melzner. "That is why the cooperation with human physiologists at the faculty of medicine is so very important, as they have developed methods over decades that are very useful for us marine biologists." Prof. Dr. Markus Bleich, director of the Physiological Institute of Kiel University confirms this, "For the first time we can transfer techniques, which we have used successfully on mammals for a long time, to the cell processes of sea urchins. The interdisciplinary research for the coordinated project BIOACID and "The Future Ocean" allows us to examine the disturbances of the inner milieu of the cells of different organisms. Thus we can better understand the physiological processes necessary for vital functions."

The first co authors of the study, Dr. Meike Stumpp and Dr. Marian Hu, a former PhD student at GEOMAR and a former research assistant at Kiel University, are currently completing one-year postdoc positions at the University of Gothenburg. There they are continuing their research on sea urchin larvae. First results point towards further fundamental findings on the physiology of sea urchin larvae. "These studies show that our understanding of the functioning of early life stages of even the most common sea organisms is still in its infancy – exciting times for interdisciplinary marine research" sums up Prof. Melzner.

Original Paper

Stumpp, M., Hu, M.Y., Melzner, F., Gutowska, M.A., Dorey, N., Himmerkus, N., Holtmann, W., Dupont, S.T., Thorndyke, M.C., Bleich, M., 2012: Acidified seawater impacts sea urchin larvae pH regulatory systems relevant for calcification. Proceedings of the National Academy of Sciences, DOI: 10.1073/pnas.1209174109.

SHORT NOTICES

Everything must be made as simple as possible. But not simpler.

Albert Einstein

MATEP: The Maritime Technology Platform Fosters Project Based Industry Collaborations

Knowledge transfer between science and business is usually personnel or project based. In 2013 the Future Ocean started a MAritime TEchnology Platform MaTeP to enhance knowledge transfer and cooperation with European stakeholders from the private and public sectors. A series of stakeholder meetings is envisioned that will take place in Kiel and Brussels in cooperation with the Brussels-based Konsortium Deutsche Meeresforschung (KDM) office and other partner organizations. These workshops will identify possible fields of cooperation between the stakeholders and the Future Ocean. The Cluster will then publish a call for proposals to co-fund selected projects.

Building on existing, well established contacts to industry, the implementation of the MaTeP has already begun. A kick-off-meeting brought together nearly all relevant research groups, leading to the selection of two topics of particular interest for cooperation: 1) Industrial activities on the sea floor, including exploration, technology development, offshore foundations e.g. for wind parks, risk assessment, and raw material extraction, e.g. oil and gas-hydrates and 2) Marine Life Science including topics such as "blue" biotechnology, bioenergy, aquaculture and bionics. The related stakeholder meetings will be conducted in early 2014. Collaborative projects between science and stakeholders can already be submitted.

Interested parties can find information on MaTeP activities and the proposal calls and workshops at
www.futureocean.org/de/matep/
or contact Annette Preikschat apreikschat@uv.uni-kiel.de.

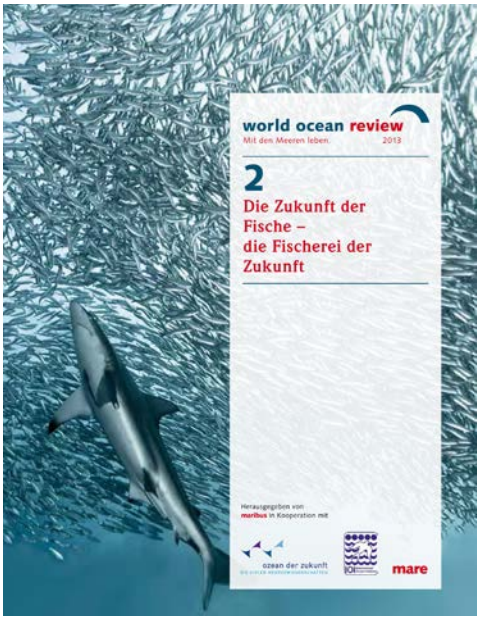
BIOACID: Second Phase of the German Research Project on Ocean Acidification

How do marine biocenoses react to increasing carbon dioxide concentrations in the water? What effect does the change in the ecosystem have on the exchange of substances in the sea? Which consequences must the economy and society expect? Within the BIOACID (Biological Impact of Ocean Acidification) project, over a hundred scientists are examining the effects of ocean acidification.

"In the second phase, BIOACID will study the complete chain from the fundamental biological mechanisms, to the reaction of single organisms, up to the consequences for the complete ecosystem and for us humans" announces Ulf Riebesell, professor for biological oceanography at the GEOMAR Helmholtz Centre for Ocean Research Kiel. Under his direction, 14 German institutes came together in September 2009 to answer the most urgent questions about ocean acidification. The second phase began in September 2012 and will last three years. The Federal Ministry of Education and Research (BMBF) supports the work with 8.77 million Euros. Various open-sea and laboratory experiments aim to show how biocenoses react when important key species are damaged by ocean acidification and how high their long term adaptation potential is. The focus lies especially on the interaction between different stress factors, such as ocean acidification, temperature rise, overfertilisation and decrease in oxygen levels. In this combination, the factors can cause stronger reactions than the sum of the single reactions. Economists and sociologists associated with the Cluster of Excellence "The Future Ocean" at Kiel University and University Bremen have now also joined BIOACID. "As important ocean 'services' we have chosen fisheries and carbon dioxide absorption" explains Riebesell. "With these examples we want to portray how ocean acidification affects the economy." Besides simulations and calculations, empirical

investigations are planned as well: A group of experts will present different future scenarios to fishermen and representatives of the fisheries market and together discuss approaches for improved fisheries management. Lead proponents of this new research field are Katrin Rehdanz, Kiel Insitute for the World Economy and Kiel University and Martin Quaas, Kiel University. They aim to investigate social and economic consequences of ocean acidification and to quantify them.
www.bioacid.de BIOACID-Homepage

Second Edition of the World Ocean Review Concentrates on Fisheries



On 21 February 2013, the "World Ocean Review 2 – The Future of Fish – The Fisheries of the Future" (WOR 2) was released. With the new report, published by the non-profit organization maribus GmbH with support from the magazine mare, the International Ocean Institute and the Cluster of Excellence "The Future Ocean", scientists from Kiel together with other leading international fisheries experts have produced one of the most comprehensive investigations into the state of worldwide fisheries.

Will we still be able to eat fish with a clear conscience in future? How great is the threat and which fish species are affected? What are the possible solutions, particularly on the European level, for the sustainable management of the most important edible fish species? And how can aquaculture contribute to securing the long-term supply of edible fish for the world's population? At present, more than one quarter of all edible fish are deemed to be overfished and a further 30 percent are considered endangered. The situation is even more drastic in Europe where almost half of all stocks are threatened by overfishing. Since 1950, the quantity of fish caught annually has increased fivefold to currently 78.9 million tons of fish and seafood. The ruthless exploitation of fish as a resource threatens not only the food supply for an increasing world population, but also particularly the sensitive ecological balance of the oceans.

The "World Ocean Review 2 – The Future of Fish – The Fisheries of the Future" is the first comprehensive analysis of the state of the world's fisheries, the consequences for the global food supply and the ocean ecosystem.

"With the 'World Ocean Review 2', we are presenting, for the first time, the interrelation between worldwide fishery and the threats and consequences posed by this interrelation in their full complexity," says Nikolaus Gelpke, mare publisher and founder of maribus gGmbH. "In so doing, we are not merely sounding the alarm, but are proposing concrete solutions." Thanks to the constructive co-operation between scientists and mare journalists, the report is easy to understand and can be read by anyone: It is a profound source of knowledge for decision makers and publicists who want to increase their awareness of the problem. The new report provides a comprehensive overview of the significance of fish as a part of the biocoenoses in the ocean, examines fish as a food source and as a livelihood for hundreds of thousands of fishermen and puts forth possible solutions for long-term and sustainable management. One chapter is devoted to the prospects for aquaculture – the fastest-growing food sector in the world today. The report also provides advice on what to buy at the fish counter:

> **"With the 'World Ocean Review 2', we are raising public awareness about buying fish on a sustainable basis,"**

says Professor Martin Visbeck, speaker of the Cluster of Excellence "The Future Ocean", during his presentation on the WOR 2 in Hamburg. One of the greatest problems today, according to Visbeck, is that individual fish species are currently often viewed in isolation, not in terms of their interaction with other species and their significance for the entire ocean ecosystem. "This must change quickly and fundamentally," says Visbeck. "There are now positive examples of sustainable management of the resource fish from around the world, both from an economic and a social perspective. We want to make these examples known with the 'World Ocean Review 2'."
The World Ocean Review is available free of charge as hardcopy or PDF file at www.worldoceanreview.com.

Panel discussion during the launch event ot the world ocean review in Hamburg.


Briese Schiffahrt
Research

TECHNOLOGY

Any sufficiently advanced technology is indistinguishable from magic.

Arthur C. Clarke

New High Purity Germanium Detectors Installed at Leibniz Laboratory for Radiometric Dating and Isotopes

Studies of oceanic and coastal hazards as foreseen in the Future Ocean research topic 6: "Dangerous Ocean" require an understanding of changes in subaqueous deltas and shorelines during the geological past. Such environmental changes are stored in marine archives. Age dating of the marine sediments is necessary for the reconstruction of the geological history. This allows determining the time when a certain process happened and how quickly sediments were formed. One important tool for age determinations are the natural radionuclides. The disequilibrium of Th-230 and U-238 in sediments and corals allows age determination over the past ~ 500.000 years. For age dating of young deposits (< 150 years) the isotopes Pb-210 (T½ = 22.3 years) and Cs-137 (T½ = 30.07 years) have proven to be the best method. Pb-210 is a decay product of Rn-222 (daughter of Ra-226) whereas Cs-137 is an anthropogenic radionuclide which was first released into the marine environment during atmospheric atomic tests in the 1960s. Considerable amounts of Cs-137 were further released during the Chernobyl accident in 1986. Based on characteristic concentration patterns of Pb-210 and Cs-137 information on the age of sediments can be obtained.

In order to strengthen and extend the capabilities of age dating young sediments in Kiel the "Future Ocean" purchased two high purity germanium detectors (Canberra BE3830P). Such detectors register the characteristic gamma ray photons released by radionuclides. The detectors are placed in 10 cm thick lead shielding to minimize ambient background radiation. The efficiency of the detectors can be quantified by using different standard reference materials for which the concentrations of radionuclides are known. For sample preparation, 5-20 g of sediments are ground and filled in appropriate plastic containers which are sealed with folio and tape. The measurement time of each sample is in between 3-5 days, depending on the amount of sample available, the activity of the radionuclides of interest and the required measurement precision.

Currently gamma measurements of sediment samples are being conducted for two projects in the Future Ocean: "Shoreline changes at Macaneta Peninsula, Mozambique and mitigation alternatives" (Prof. Dr. K. Stattegger) and "Salt marsh development under the influence of decadal and long-term climate variations (Dr. M. Schürch).

Project team: Jan Scholten, Karl Stattegger, Marie Nadeau, Ralph Schneider

Lab PI Jan Scholten setting up samples for measurement in the Germanium detector at CAU.

A New Versatile IR Laser Pushes CRDX into New Realms

Precise concentration measurements of the seasonal variations in abundance of environmental trace gases are key for understanding different global biogeochemical cycles.

For example, the role of the ocean as a source or sink within the carbon and nitrogen cycles can be investigated by detecting CO_2 and N_2O at high spatial and temporal resolution. Here, the difference of the partial pressures of the gas in the atmosphere and the gas dissolved in the surface ocean water largely determines the direction of the gas transport across the ocean-atmosphere interface . Beyond this flux assessment, more detailed information about the underlying physical and biological processes are obtained by further analysis of the isotopic composition of the particular trace gas.

Thanks to the outstanding sensitivity, reliability, and robustness of cavity-enhanced absorption spectroscopy (CEAS), recent years have seen an enormous upturn in the use of optical detection methods in environmental applications, in particular of the variant cavity-ringdown spectroscopy (CRDS). The detection sensitivity of CEAS based methods is primarily based on long absorption pathlengths of >10 km arising from multiple reflections of light in an optical resonator that is formed by highly reflective mirrors. The use of continuous wave lasers as light sources with narrow spectral bandwidths offers the required high resolution to spectrally separate the target species – including the differentiation of isotopologues – from possible interfering signal contributions stemming from other gases.

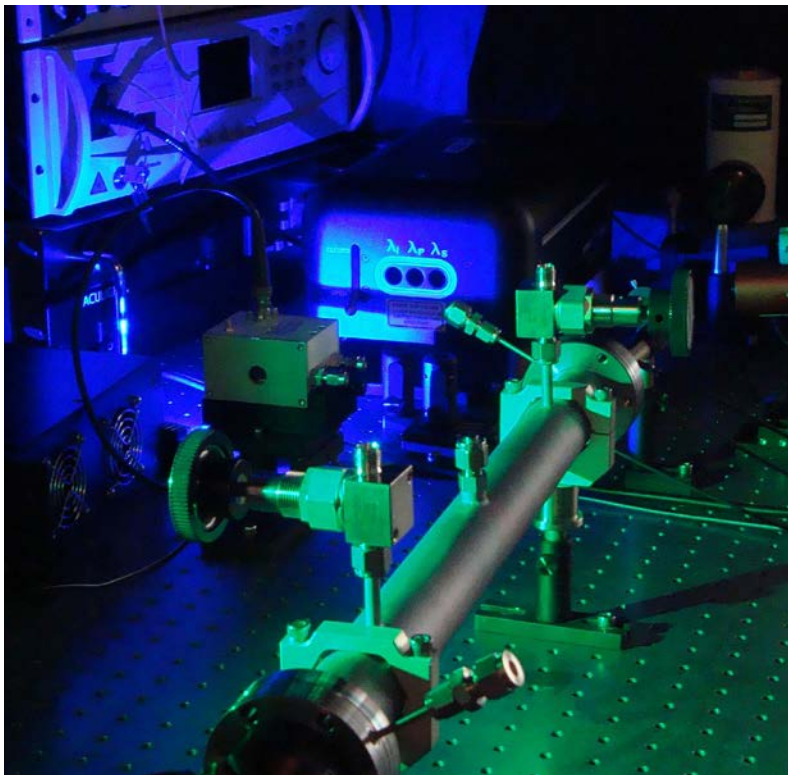
Building on the successful demonstration of quasi-continuous ship-based field monitoring applications of CO_2, $^{13}CO_2$, N_2O, CO, and CH_4 undertaken in previous projects of the Future Ocean (Becker

et al. 2012, Arévalo-Martinez et al. 2013) it is the purpose of future projects to bring CRDS-based detection to the next technology state. This includes the development of autonomous monitoring systems for use on container vessels as part of our research topic on Ocean Observation as well as the expanded use of commercially available CEAS and CRDS instruments to collect unique data on radiatively active trace gases in marine environments as conducted in the Cluster research topic Ocean Interfaces. To accomplish this the Future Ocean science platforms have invested into a continuous wave, high power, narrow bandwidth and widely tunable laser light source, which went into service in early summer 2013. This state-of-the-art laser system operates in the difficult to reach infrared, IR, spectral range and thus allows one to measure vibrational spectra of many molecules. For CEAS and CRDS instruments, IR detection holds the potential to further enhance the detection sensitivity due to a factor of 10 -1000 times higher absorption cross sections in the IR (fundamental vibration bands) compared to the conventionally used near infrared, NIR, spectral range (overtone and combination vibrations). Using the advanced saturation CRDS (Sat-CRDS) technique, IR detection of CO_2 on a ppq (parts per quadrillion) level has already been demonstrated by Galli et al.

Target species include oxygenated and halogenated volatile organic compounds. Although often present at merely ppt (parts per trillion) mixing ratio levels, the emission, photolytic degradation, and reactivity of these compounds are thought to exert significant influence on the concentrations and lifetimes of climatically active gases such as methane, ozone, and dimethylsulfide and influence aerosol particle formation in the marine boundary layer. More recently, it has been reported that the strong upwinds present in the inter-tropical convergence zone may even transport short-lived bromine compounds to high atmospheric layers, hence exhibiting high ozone destruction potential by significantly contributing to a so-far unidentified source of bromine in the stratosphere.

In the laboratory stage of the project, in close cooperation with the Helmholtz Research School for Ocean System Science and Technology (HOSST), possibilities of Sat-CRDS will be ranged, reachable detection limits will be determined, and spectroscopic detection schemes taking into account limitations arising from interfering absorbers and cross-sensitivities will be worked out. Strategies for pretreatment and trace gas isolation of environmental samples will be assessed and first on-site field measurements will be performed.

The new versatile IR laser system as a key investment of the cluster enables the Future Ocean Optical Detection activities to keep pace with the rapid technological developments in the field of fundamental and applied environmental laser spectroscopy. It is envisioned to serve as a nucleus for further developments of cost-effective and compact field-going diode laser based instruments dedicated to detecting selected trace gases at ambient concentration levels.



New cavity ringdown spectroscopy setup for trace gas sensor development. The novel Aculight Argos 2400 SF cw-OPO infrared laser light source (bluish illuminated devices) offers a wide tunability (λ = 1.38 – 1.60 µm & 3.2 – 4.6 µm), a narrow spectral bandwidth ($\Delta\nu$ < 60 kHz @ Δt = 500 µs), and high output power (P = 1.8 W @ λ = 3.3 µm).

Publications

M. Becker, A. Körtzinger, N. Andersen, B. Fiedler, P. Fietzek, T. Steinhoff, G. Friedrichs; Using Cavity Ringdown Spectroscopy for Continuous Monitoring of $\delta^{13}C(CO_2)$ and fCO_2 in the Surface Ocean; Limnol. Oceanogr.: Methods 10 (2012) 752.

D.L. Arévalo-Martinez, M. Beyer, M. Krumbholz, I. Piller, A. Kock, T. Steinhoff, A. Körtzinger, H. W. Bange; A new method for continuous measurements of oceanic and atmospheric N_2O, CO and CO_2: Performance of off-axis integrated cavity output spectroscopy (OA-ICOS) coupled to non-dispersive infrared detection (NDIR), Ocean Science Discussions 10 (2013) 1281.

I. Galli, S. Bartalini, S. Borri, P. Cancio, D. Mazzotti, P. De Natale, and G. Giusfredi; Molecular Gas Sensing Below Parts Per Trillion: Radiocarbon-Dioxide Optical Detection; Phys. Rev. Lett. 107 (2011) 270802.

Project team: G. Friedrichs (PI) with H. Bange , A. Körtzinger, D. Wallace and D. L. Arévalo-Martinez, M. Becker, I. Piller, I. Sadiek


Antarctic Intermediate

GENDER

Gender equality is more than a goal in itself. It is a precondition for meeting the challenge of reducing poverty, promoting sustainable development and building good governance.

Kofi Annan

Still a Lack of Women in Leadership Positions: Efforts to Bridge the Gender Gap in Kiel

It is widely acknowledged that the equal representation of women and men in leading positions in the German academic system has not yet been reached. The data provided by the Federal Office of Statistics reveal that in 2011 around 80 percent of all German professors were men. Although the proportion of women has more than doubled during the last ten years there is still a significant gender gap, especially in the so-called STEM fields (science, technology, engineering and mathematics). For example, the proportion of female professors in mathematics and natural sciences amounts to no more than 14 percent.

At Kiel University an overall share of only 16 percent women in the group of full and junior professors in 2013 illustrates that improvement is still necessary. "We have a balanced gender representation at the student and doctoral level but we lack women continuing their academic career in postdoctoral positions and beyond", says Dr. Iris Werner, the university's equal opportunities commissioner. During the past several years, a variety of measures have been taken to bridge the gender gap in positions after PhD, in Kiel. Examples are:

- via:mento: the mentoring programme for female postdoctoral researchers continuing their academic career (see next page).
- annual university-wide as well as faculty-specific (Faculty of Mathematics and Natural Sciences) competition for complementary funding of initial research projects for early female postdoctoral researchers
- special travel money for scientific conferences
- new appointment procedures for professorships including rules to assure the equal treatment of female and male applicants
- participation in the Federal Programmes for Female Professors I+II

The German Research Foundation's Research – Oriented Standards on Gender Equality

After the DFG had committed to research-oriented standards on gender equality in 2008, an expert group was installed to support and advise universities in their efforts to implement the standards. Universities were asked to hand in reports stating their plans of action to increase gender equality and the progress they made in implementing them.

The final reports were assessed in spring 2013 and universities were ranked into four groups according to their success. Together with 26 other universities, Kiel University was ranked in the second best group.

Gender Equality and the Excellence Initiative

The Excellence Initiative stands for excellent research. This includes the attempt to bring more highly profiled female researchers into responsible positions. In the research project "Women in cutting edge research: An investigation into implementing gender equality in the German Excellence Initiative" Prof. Dr. Anita Engels and her team from Hamburg University conclude that the Excellence Initiative has led to a higher perception of existing gender inequalities in the German research landscape.

In the second funding period, more measures for a better inclusion of female scientists in high profile research are being promoted. Progress has for example been made regarding the percentage of female principal investigators in research clusters and graduate schools funded by the Excellence Initiative. It almost doubled from 11 up to 21 percent between the first and the second application phase.

In Future Ocean two of the 25 principal investigators are women. Four out of twelve junior principal investigators hired as junior research group leaders in Phase I are female.

The measures taken show success and were positively acknowledged by the German Research Foundation (DFG). Improvement was also attested in the latest issue of the nationwide university ranking by gender aspects published by the Center of Excellence Women and Science (CEWS) in spring 2013. Kiel University advanced into a good mid-range category and progress was pointed out regarding the proportion of women successfully finishing their habilitation for example.

The Cluster of Excellence "The Future Ocean" made a commitment to strengthen its efforts towards gender equality during the second funding phase, too. A coordinator for gender measures in Kiel Marine Sciences was recruited. The 50 percent position is equally funded by the Cluster and the Collaborative Research Center 754. The main project currently being executed is the mentoring programme via:mento_ocean (see next page). Further initiatives are planned, for example gender awareness trainings for male and female postdoctoral researchers as well as start-up grants for female W1-professors involved in the Cluster.

Ruth Kamm, coordinator of the mentoring programmes via:mento and via:mento_ocean and coordinator for gender measures in the Cluster

via:mento_ocean: Focus on Scientific Careers of Women

How can female scientists who have successfully finished their PhD be encouraged to stay in academia and continue their scientific career? How can those who have started ambitious new postdoctoral projects be promoted and supported on their way to leading positions in science? All-embracing answers to these questions can hardly be found. But mentoring programmes are one well-proven measure to speed up the career development of female scientists in non-permanent research positions.

With via:mento, Kiel University has started the first university wide interdisciplinary mentoring programme for female postdoctoral researchers aiming for a professorship or a permanent senior research scientist position in 2010. The programme is based at the equal opportunities office of the university. "We see a high interest of female postdoctoral researchers in using the opportunities the mentoring programme offers to give their individual career development a stronger focus" says Dr. Iris Werner, the university's equal opportunities commissioner. "This holds also true for women in marine sciences", she adds.

Together with the Collaborative Research Center 754 "Climate-Biogeochemistry Interactions in the Tropical Ocean" the Cluster of Excellence "The Future Ocean" therefore decided to finance the development and realisation of a new branch of via:mento that focuses on female postdoctoral researchers in Kiel Marine Sciences. In July 2013 via:mento_ocean started with a first group of 10 mentees – women from different areas of marine sciences in Kiel based both at Kiel University and GEOMAR. Dr. Gesche Braker, coordinator of the Integrated Marine Postdoc Network IMAP, points out: "That more than 40 percent of our female IMAP members have applied for via:mento shows how attractive a mentoring programme in marine sciences is. We are very pleased to see that so many women acknowledge and use this unique opportunity to strategically approach their future career in academia."

The mentees working in fields like biology or geosciences are free to choose a female or male mentor who is working as a professor or in a permanent senior scientist position at any university or non-university research institute in Germany or Europe. The one-to-one mentoring approach is complemented by trainings focusing on soft skills such as leadership and job application in academia. A first workshop will concentrate on individual career planning strategies. In order to reach even more women the workshops are open to all interested female postdoctoral researchers from IMAP and the SFB754. Together with informal networking they give the mentees the opportunity for exchange with like-minded women and to broaden their professional networks in Kiel Marine Sciences and beyond.

Ruth Kamm, coordinator of the mentoring programmes via:mento and via:mento_ocean and coordinator for gender measures in the Cluster

Women in Earth Science – Yiming Wang Joined the ESWN European Board

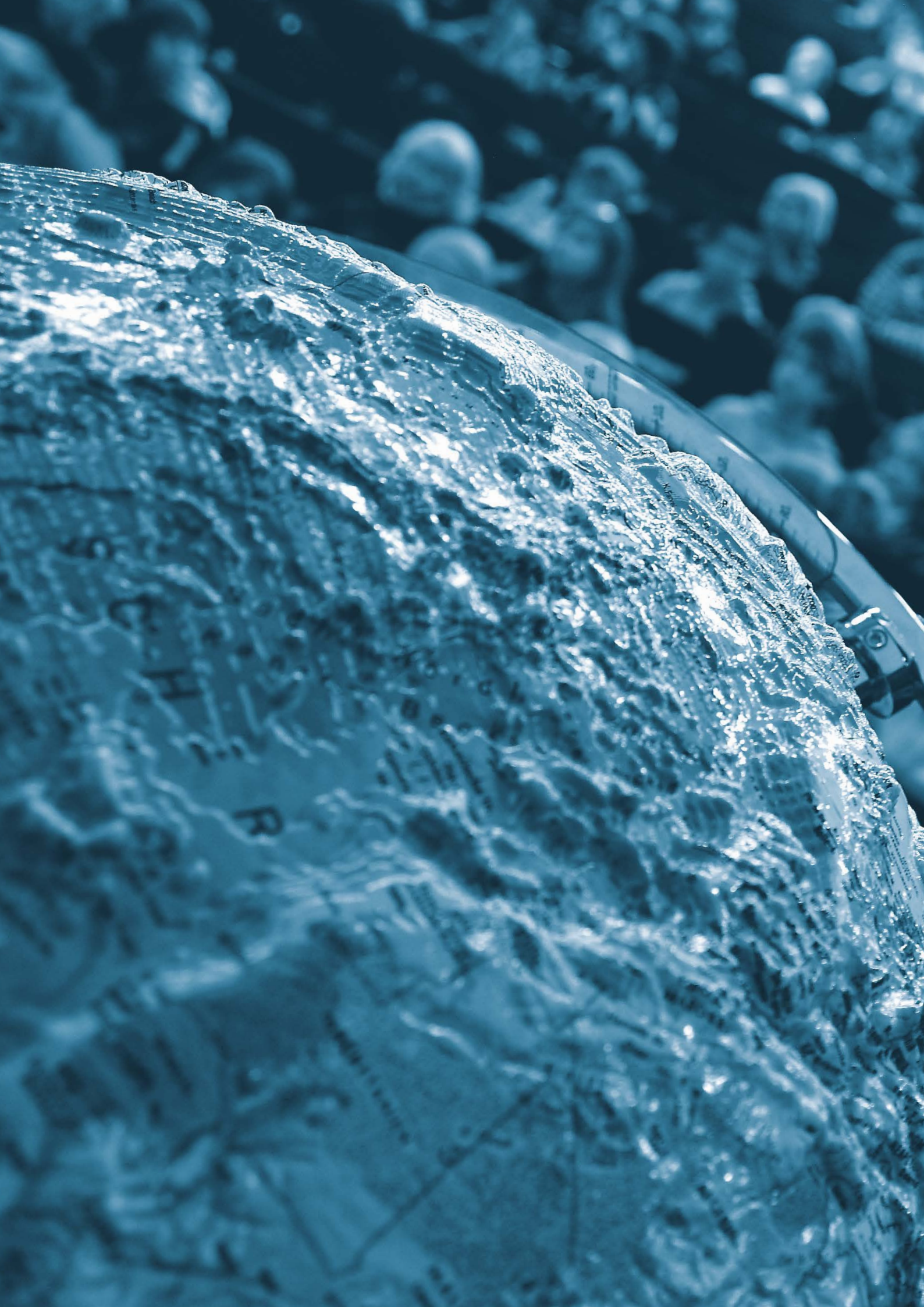
In June 2012 I participated in the Professional Development Workshop "Skills for Networking and Communication" offered by the Earth Science Women's Network (ESWN) in Madison, Wisconsin. This 2.5 day workshop has changed my perspectives about networking and communication in three fundamental ways. As many women scientists, I used to keep my goals private – now, I realize that identifying and communicating short- and long-term professional goals to mentors and peers is absolutely essential for others to help us more efficiently.

I also learned to identify and categorize mentors and peers by their strengths. Understanding the role that each individual plays, I can now build a balanced professional support system with each relationship providing a unique value, which prevents me from over-using a single person and straining relationships or feeling isolated.

Beside the practical skills, I recognized that I am empowered to not only benefit from, but also to give back to our community. This in fact lessens the sense of burden on the task of networking and also has given me much more confidence to ask for help and guidelines from others.

Yiming Wang, Institute for Geosciences, Kiel University

Since personal success is often built upon on the productive support from many others, I realize that we have to work together to build a women's community to promote career development, provide informal mentoring and support, and facilitate professional collaborations. Recently I joined the ESWN European Board, so I can work with others to bring this community awareness and mentality to many more women scientists.



EDUCATION & CAREERS

Education is what remains after one has forgotten what one has learned in school.

Albert Einstein

IMAP NETWORK

Continuously Growing – The Integrated Marine Postdoc Network (IMAP)

With the successful start of the second phase of the Cluster, the postdoc network continued with its new name Integrated Marine Postdoc Network (IMAP). The work of the two co-speakers was supported by hiring a coordinator, strengthening and structuring the work by a full time position. The network has been growing continuously to over 60 heads till now; all members are scientists working on temporary contracts in Kiel Marine Sciences and have associate member status in the Cluster. Postdocs are essential assets to the German academic system but being involved with a multitude of tasks they often feel like its workhorses. Their experience ranges from early postdocs to scientists working on temporary contracts for over 10 years or more. Postdocs, particularly those scientists at a more experienced level, 'are becoming increasingly important for continuity in both research and education particularly under the ongoing reduction of the permanent academic staff at German research institutions' says Prof. Birgit Schneider. Birgit Schneider, co-speaker of the IMAP advisory panel, knows the situation well enough as she just got tenured to a full professorship at Kiel University in 2012. Positions for early postdocs are available on the job market but the respective contracts are limited from a few months to two years. Moreover, since the reduction of permanent positions in the former Mittelbau, no employment models exist for experienced, older scientists apart from the classical track to a professorship position, resulting in insecurity in terms of career perspectives and the personal situation for those concerned. Here, the Cluster offered unique employment opportunities with contracts lasting for three and five years for early and more experienced scientists, respectively, which is a 'fantastic opportunity to build your own profile' confirms Barbara Neumann, geographer and IMAP co-speaker, who 'will use the five year-contract to develop a new research field and to adopt new methods for which one needs continuity'. This describes the path IMAPs in their majority wish to follow: Building their distinctive research profile in a supportive environment that offers more permanency and more secure employment models. IMAPs in their majority actually seek a position where they can do excellent research without necessarily aiming at a professorship position, as discussions at the postdoc retreat in Samain in June 2013 revealed. The IMAP network 'gives them a voice' underlines Birgit Schneider 'which is particularly important regarding the charge of responsibility in precarious working conditions'. Schneider highly recommends joining IMAP to the postdocs in her group because she recognizes the enormous benefits of the structural support this group gathers from the network and its coordination, but she also values the support on an individual basis. 'Each postdoc has very specific needs depending on his/her individual situation and career plans. IMAP helps to figure out these needs and how to accomplish a custom-tailored support strategy'. Indeed, networking, career development support, coaching and mentoring (for female scientists) are on the agenda. Apart from providing measures in human resources development, the second major field in IMAP is the development of management strategies towards more secure career paths for experienced scientists at the postdoctoral level, an initiative that is supported by the presidium of Kiel University. However, the intention is not to find solutions that fit to Kiel University only but to interconnect with similar structures at other institutions and to arrive at a nationwide solution which will then improve the situation of individuals but also affect the German academic system as a whole.

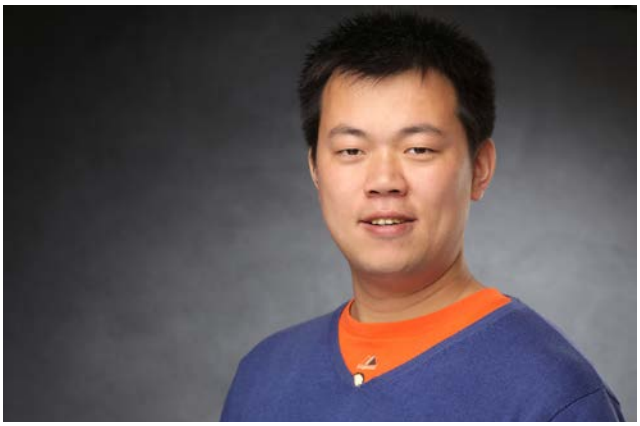
The Integrated Marine Postdoc Network

Dr. Gesche Braker, Postdoc Network Management
Phone +49 431 . 880 6550 | E-mail gbraker@uv.uni-kiel.de

IMAP NETWORK

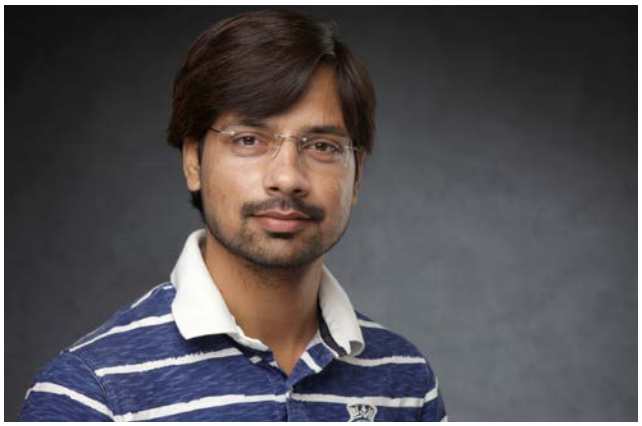
20 New Scientists Join the Future Ocean

„Interdisciplinary research in the Cluster is fantastic. Here, I can continue doing my research in a supportive, inspiring and excellent environment. I feel like being a true researcher on the law of the sea as I can talk to so many marine scientists here."



Dr. Nengye Liu, Research Associate, Walther-Schücking-Institute for International Law, Kiel University

In July 2012 an international call for postdoc projects issued by the Cluster attracted 84 applications. Within the frame of a symposium 20 out of the 36 projects presented were selected for funding, hence newly attracting nine, in their majority international, new early career researchers to join Kiel Marine Sciences. Coming from different disciplines and countries worldwide the diversity they contribute to Kiel Marine Sciences in terms of research and opinions agrees perfectly with the multidisciplinary approach of the Cluster. The incoming postdocs were rapidly integrated into the postdoc network finding a social environment and strengthening the international IMAP community. The new members value the unique structure of the Cluster, the support they were offered and the inspiring environment in Kiel Marine Sciences. Research facilities in general are considered optimal. Sure enough, not all expectations were met and last but not least language barriers make living in Kiel sometimes difficult for foreigners but the overall opinion on having moved to Kiel is very positive.



Arvind Singh, Biological Oceanography, GEOMAR Helmholtz Centre for Ocean Research Kiel

"I like the diversity of research areas represented in IMAP. This offers the potential for interdisciplinary collaborations. I also benefit from working at GEOMAR, because there are not only well-equipped laboratories but there are also very experienced oceanographers whose advice is invaluable to me."

IMAP NETWORK

Art Meets Science – Science Meets Art

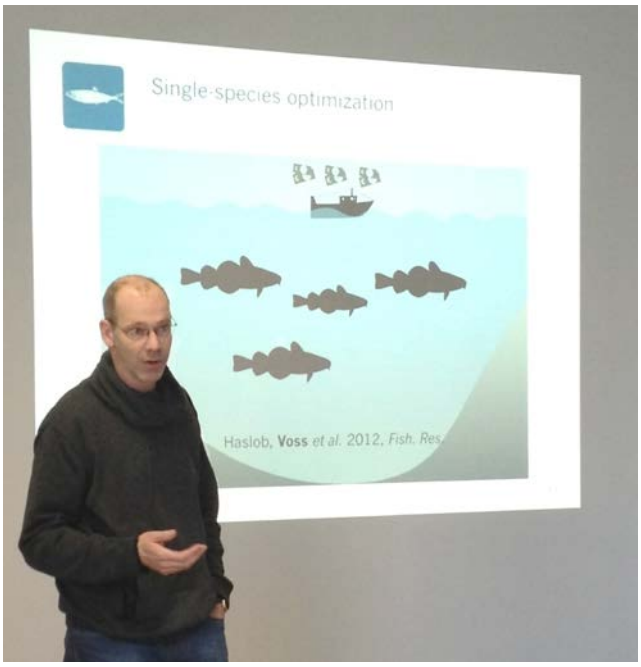
New forms of cooperation and science visualization

Art meets Science – Science meets Art is the motto of a collaboration of IMAP with professors of the Muthesius School of Fine Arts and their students. Usually chances for scientists and artists to interact are rare and challenging as they have entirely different perspectives on science and use different languages. This collaboration has taken up the challenge to communicate marine sciences and to explore marine research in Kiel in the view and with the means of artists. The expectations of the scientists in IMAP on working with artists range from skepticism to 'the belief that joint projects will be able to deliver useful results that can feed into my own research' says Barbara Neumann, a geographer at the CAU. Sven Neulinger, microbiologist at the CAU, is less convinced and describes his expectations as 'being highly interested but unsure about the outcome without any expectations at this stage'. The view of the artists on marine sciences is sometimes like looking at a mystery. This implies that intense work has to be done to arrive at a common understanding of experts in two disciplines so different as science and art. So far, three projects have reached a stage of more concrete planning.

> **"A student from the Muthesius School intends to accompany me on some of the cruises I plan for the next two years and wants to study a so-called 'ocean-addiction' and what drives people to go out and work at sea. Therefore she will study the personal emotions of the researchers and ship crews while working at sea"**

says Tobias Steinhoff, marine biogeochemist at GEOMAR. Neumann described the status as 'mutual exchange on working methods, research questions and aims, as well as on concepts of artistic research. Now the students will develop concrete ideas and (hopefully) one or two master projects'. Asked about the benefit they see for themselves from such collaboration the scientists involved believe that the interpretation of marine science topics by the artists 'will allow them to get a new view on their own research and what is driving them to do it – the ocean itself and how we live with it' agree both Steinhoff and Neumann.

Professor Tom Duscher from the Muthesius Academy of Fine Arts and Design opens the first session of the new collaboration between art students and scientists.



Dr. Rüdiger Voss gives a short overview of his topic on sustainable fisheries.

YOUNG SCIENTISTS CONFERENCE

Young Marine and Climate Researchers Meet at Kiel University to Exchange Ideas

Around 85 Ph.D. students and young researchers from the marine and climate sciences of the universities in Kiel, Bremen and Hamburg gathered together on the 1st and 2nd of October, 2012 in Kiel for the third Young Scientists Conference. Following conferences in Hamburg and Bremen, the event was organized by the Cluster of Excellence "The Future Ocean". Other participants came from the Bremen and Hamburg Clusters of Excellence "MARUM" and "CliSAP".

Which topics are my colleagues in Hamburg, Bremen and Kiel researching? These questions are asked by numerous Ph.D. students and young researchers from the climate and marine sciences. The annual conference of the north German research association from Kiel, Hamburg and Bremen is supporting knowledge exchange on new and interdisciplinary projects, strengthening the network of young researchers, and encouraging interdisciplinary work on scientific topics. "We want a better network for young researchers in the climate and marine sciences. Our conference forms an important basis for future cooperation and career opportunities" says economist Ute Kapaun from the Institute of Economics at Kiel University and one of the main organizers of the Young Scientists Conference. For the first time, new experimental presentation techniques, such as Pecha Kucha and Twin Talks, are being tested at the conference. In Pecha Kucha, a Japanese method, the presenter must explain 20 power point slides with just 20 seconds for each slide. In Twin Talks the researcher finds another person to present the other topic.

The Young Scientists Conference brings together young marine scientists on a PhD student or postdoc level from the marine Clusters of Excellence in Northern Germany from Kiel, Hamburg and Bremen. It is intended to make junior researchers familiar with the topics of the other research locations and allow for networking across the institutions. The conference takes place in alternating turns at the institutions, typically in the first week of October.

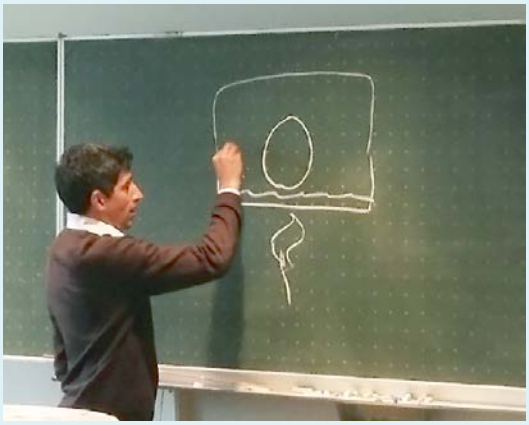
Lively discussions at the Young Scientists Conference in Kiel

"We want the oceanographer to also understand the economist. Therefore the presentations must become more comprehensible overall and we achieve this with new science communication approaches"

says co-organizer Dr. Lavinia Patara, oceanographer at GEOMAR Helmholtz Centre for Ocean Research Kiel. The three north German Clusters of Excellence "The Future Ocean", MARUM and CliSAP focus on marine and climate research. The conference, moreover, strengthens north Germany as a research location.

"The more we know about each other, the more we can also represent German marine and climate research at conferences" the organizers Ute Kapaun and Lavinia Patara assure. The Young Scientists conference is held alternately at the three sites.

Meet the Expert: Ranga Yogeshwar Spends an Hour with Young Scientists



An hour full of challenges, explanations and inspiration: TV science presenter and journalist Ranga Yogeshwar met with young scientists in an open ISOS event. He demonstrated how important it is to understand underlying principles as a prerequisite to the complex issues behind which scientists sometimes hide, using simple yet profound examples from natural sciences. To the young scientists, members of what he called the "in-group" he drew attention to the rest of society, dealing with real-life issues.

Mike Orbach, Professor of Marine Affairs and Policy and Director of the Duke University Coastal Environmental Management Program, North Carolina, USA, is an expert on questions regarding climate change and sea level rise and impacts on policy decisions.

Meet the Prof.: Encounters of a Special Kind

Senior scientists visiting Kiel are often roped into "Meet the Prof." events; unstructured events where they meet personally and informally with young scientists in the absence of the local hierarchy. Whereas each Prof. comes in with a "what-I-always-wanted-to-say-to-young-scientists" thought, the discussion is driven by questions and spontaneous input of the participants.

In the words of one participant: "The Meet the Prof events are informative as well as useful to reduce the reluctanc to pose questions to professors. I think every university should take these events as an example."

Unleash Your Inner Innovator!

Innovation and enterprise are key skills not just for business but equally for a scientific career. Each of us is an innovator, even if we don't acknowledge and recognize our potential.

In a special ISOS event, Dr. Iarla Kilbane-Dawe from London gave hands-on input to tap the full potential for innovation. By working their ideas into projects the participants were exposed to the innovation process; how to collaborate with others, to refine and develop ideas, and how to more effectively communicate their scientific insights.

Perspectives Post PhD: Alumni of the ISOS Programme

Taking part in the PhD programme of the Cluster doesn't end with graduation; we keep in touch with our doctoral candidates as they progress into their careers and lives. Being part of this alumni group keeps them in touch with Kiel Marine Sciences; they receive an annual newsletter and are invited back to speak to the younger generation of their former peer group.

A first "Meet the Alumni" networking event of the Integrated School of Ocean Science (ISOS) brought together active students and alumni from academia and outside. They represented the diversity of professional paths available: post-doctoral research, work in communal climate change management, consultancy and even coordination of a graduate school. The seven alumni reported back on their post-doctoral experiences and decisions; despite following very different paths, they agreed in essence that academic excellence was not the single factor for success. Identifying a positive personal attitude – "joy", "passion", "being true to yourself", but also being aware of one's own competences and flexibility have proven important to them within and outside of academia. The attending PhD students also drew a positive conclusion: "Meeting alumni that know my situation and have been in my shoes, in such an exclusive environment, facilitates networking enormously" responded one PhD student.

Alumni of the PhD Programme

Of the 110 ISOS alumni, 75 went into a first Post-Doc, 19 into positions outside academia, 3 started a new PhD thesis and one is currently unemployed. 47 have stayed for positions in Kiel, 23 moved to different places in Germany, 13 to different countries within Europe and 13 to countries outside of Europe

The PhD Perspective: Our PhD Representatives Speak Out

The cluster has created a new community in marine sciences in Kiel, reflected in the expanding network of young scientists; 150 doctoral students from five faculties take part in the PhD programme of the Integrated School of Ocean Sciences. They are represented in the steering committees of the ISOS and the Cluster by Christina Roth and Erik van Doorn, who bring fresh input into the running of their programme. We asked them to give us their feedback.

"My challenge as a 'PhD 'Rep' is how to motivate my peers to give their opinions on things that are happening. From my own experience, I know that many PhD researchers see their project as an individual challenge, although it might be part of a group effort. This attitude leads to the fact that hurdles and stumbling blocks along the way are seen as rather individual too, and are not easily communicated. That's a pity since these obstacles are more common than one thinks. A strength of our PhD programme is in helping to solve these issues through courses and personal support."

Erik van Doorn, Walther Schücking Institute for International Law, Kiel University

"At some stage of the PhD each of us is forced to think about the next step. One starts to think about the future even while friends and family already concentrate on the question: "What will you do after your PhD?" Should I stay in science? Are there good job opportunities outside of academia? Should I start my own business? There are as many questions as options and some of them are not foreseen, they just happen. So how should one decide what to do? Our journey was shaped by being part of a group with our peers, undergraduate students, postdocs, senior scientists and professors, and by being part of an interdisciplinary PhD community. For many PhD candidates ISOS was very useful on this journey. It helped a lot to create our own profile for our career during and after the PhD phase."

Christina Roth, GEOMAR Helmholtz Centre for Ocean Research Kiel

Avan Antia, Nina Bergmann, Angelika Hoffmann

First Steps to Independent Research: A PhD Miniproposal

Doctoral research often opens up more questions than it answers, inviting young scientists to formulate follow-up projects. At the Integrated School of Ocean Sciences, PhD candidates can experience first-hand what it takes to be an independent researcher by applying for their own funding via a so-called "miniproposal".

A hot topic in climate sciences is how marine organisms will respond to ocean acidification, also labeled "The Other CO_2 Problem". Doctoral candidate Rafael Bermúdez Monsalve researches how shifts in seawater CO_2 levels affect marine phytoplankton by analyzing their fatty acid contents, an indication of their physiological status and their nutritional value for predators. Rafael wondered whether the results of his short-term experiments would be different under long periods of stress, since in the real world phytoplankton experience CO_2 changes that occur slowly and persits over decades. Would changes be transitory (showing physiological adaptation) or permanent (indicating adaptive evolution)?

Meeting with his supervisors, he proposed to "establish a network for developing experiments in long-term algal cultures". He knew that establishing such cultures, a long, dedicated and difficult task, was not an immediate option. They were also aware that several such cultures existed at the GEOMAR in Kiel, at the University of California, USA and at the University of Otago, New Zealand. If he could get his hands on these cultures and conduct fatty acid analyses, the problem could be approached more easily.

The common obstacles – money and time – were the next hurdle, since his immediate PhD project did not include this aspect. Rafael turned to his doctoral school, the Integrated School of Ocean Sciences, to see if their miniproposal scheme, which can grant small independent projects to PhDs, could offer a solution. He wrote a proposal that was evaluated and granted. This allowed him to fly in the valuable cultures, conduct the analyses and work up the results. Though the jury is still out while he works on his data, the very process gave him a chance to test his hand at more independent research.

Avan: Rafael, what motivated you to go for the miniproposal scheme?

Rafael: "The possibility to carry on research that I consider an important part of my thesis but was not being covered by my project. I wanted to go the next step, answer the next question."

Avan: What are the most important things you learned?

Rafael: "Proposal design. I had not written a project on my own until I applied for the miniproposal. Also project management, I was not very experienced with such a thing."

Avan: Did doing a miniproposal project make your PhD experience different?

Rafael: "Yes, I took me out of the "PhD bubble" and gave me first-hand experience with the hands-on, real management of research. The miniproposal is a great opportunity for students involved in the ISOS program because it gives a chance to test your own ideas and carry out important additional research."

Academic Achievements and Social Engagement: Christina Roth Awarded the Faculty Prize

PhD candidate Christina Roth was awarded the prize of the Faculty of Mathematics and Natural Sciences in recognition of her scientific achievements and her engagement within her peer group as a student and doctoral researcher. Congratulations!

Christina is a PhD candidate in the research division "Ocean Circulation and Dynamics' at GEOMAR. In addition to her commitment to her research and her continued questioning of its interpretation in a wider scientific context, she has participated consistently in voluntary activities in and outside the university. At the ISOS she has actively contributed to initiating and enhancing dialogue between PhD candidates from different disciplines, and represents her peers in the governing bodies of the Cluster.

For Christina such involvement is intrinsically rewarding: "Why am I doing this? The diverse ISOS community teaches me daily how important a comprehensible transfer of information is, since it consists of natural scientists, lawyers, philosophers and artists. I believe we all learn a lot from this dialogue."

Marvel, Experiment, Try out – Learning is Fun in the new Ocean Lab for Students

In the new Ocean Lab students from grades 3 to 13 can experiment and work on different topics in the marine sciences. The "Future Ocean" facilitates general and specific education and supports teachers' further education and advanced training in the ocean:lab. The ocean:lab is part of the school laboratory "Kieler Forschungswerkstatt" at Kiel University and aims to build a bridge between research, education and outreach.

Already in the first year after its opening the ocean:lab has recorded more than 500 pupils visiting courses and experimenting. Up to now the interest in science education programs remains unbroken. Appropriate to their respective level of school, students get fascinating insights into marine sciences and the working methods of scientists. They can deepen their own understanding and explore areas of interest. The courses and experiments on offer address entire school classes and complement the natural science curricula of the schools. Many teachers feel that the activities are a worthwhile addition to lessons at school and indeed deepen the understanding for certain topics in a way that normal school cannot. The marine science programs in the ocean:lab deal with themes such as the Baltic Sea as a natural habitat, the Ocean as an ecosystem and how it is affected by anthropogenic impacts, e.g. plastic litter or overfishing of the ocean. Furthermore, scientists at the ocean:lab also give teachers new incentives and impulses for their daily teaching. By taking part in these further education courses, teachers can catch up on recent research topics. They gain ideas and tips on how to integrate those research topics into their teaching and into the regular curriculum. Find out more about the ocean:lab and its activities at http://www.forschungs-werkstatt.de / or contact Katrin Knickmeier kknickmeier@uv.uni-kiel.de .

Dr. Katrin Knickmeier explains scientific methods of marine biology to school children and future students.


DEPTHGAUGE
MANIPULATOR

PEOPLE & PARTNERS

If I want to stop a research program I can always do it by getting a few experts to sit in on the subject, because they know right away that it was a fool thing to try in the first place.

Charles F. Kettering

North Atlantic Cooperation Between Halifax and Kiel

Kiel University and Dalhousie University establish a partnership to strengthen international cooperation in the marine sciences

Kiel University and Dalhousie University in Halifax, Canada want to work more closely together in the future. With this benchmark partnership, which is part of Kiel's quality management and internationalization strategy, the two universities are trying out a completely new form of international collaboration.

The two universities are in the process of building a close scientific partnership. In order to get to know one another better and to sound out opportunities for future collaboration, personnel and scientists from Kiel and Halifax met in Kiel in September 2012 for workshops and excursions. The First Secretary for Science and Technology of the Canadian Embassy in Berlin, Dr. Jennifer E. Decker, was a guest of honor at the workshops.

Climate researchers and university representatives from Halifax, Canada visit the GEOMAR Helmholtz Centre for Ocean Reserach Kiel.

In regard to marine science, the workshop aimed at expanding existing contacts between Kiel and Halifax, and establishing new areas of collaboration. The workshop has provided new impulses in the general areas of marine law and economics for the sustainable use of the oceans. It has also proven advantageous on the issue of climate change in the North Atlantic, stressed Ralph Schneider, Vice Spokesperson of the Cluster "Future Ocean" and climate researcher at Kiel University. "These subject areas are already important cornerstones for integrative marine science in the Cluster 'Future Ocean'", said Schneider. "In the future, we want to intensify the research beyond its subject boundaries and with international partners. The workshop with participants from Kiel and Dalhousie University was an important start for this."

Kiel Professors Nele Matz-Lück (International Law of the Sea), Uli Sommer (Marine Biology), Arne Körtzinger (Marine Chemistry) and Martin Quaas (Sustainable Fisheries) contributed further impulses on their research. A return visit to Halifax in September 2013 as well as two joint graduate schools – HOSST on the German side and TOSST on the Canadian – are contributing to the progress of the collaboration.

With this strategic partnership between Kiel and Dalhousie, the administrations of both universities will be incorporated into an international cooperation for the very first time. In the now widely globalized world of science, this new level of collaboration is seeking answers to the challenges of a modern scientific system, in various cultural and legal contexts. Chancellor Frank Eisoldt stressed that this will not only enrich the work of the staff within management and administration, it will also support Kiel University on its way toward true internationalization. "The fact that leading staff members of both administration departments are discussing specific aspects of management has opened up completely new perspectives in our work", said Eisoldt.

> **"It is fascinating to see how scientific institutions that operate successfully in different countries under different conditions are able to learn from each other."**

Dr. Carolyn Watters, Vice President of Dalhousie University, Halifax, Canada

Dräger Foundation EU-US Conference Series "Sustainable Oceans" 2011 - 2013

From 2011 to 2013 the Dräger Foundation sponsored three conferences on "Sustainable Oceans: Reconciling Economic Use and Protection" (2011 Hamburg, 2012 New York, 2013 Lisbon). The Future Ocean Cluster is a co-organizer of the conference series together with the Earth Institute of Columbia University.
In July 2012 the second conference in the series, entitled "Developing a New International Architecture for Maritime Policy", focused on economic gains from shipping against the backdrop of ecological damage from overfishing, noise, pollution and acidification. In June 2013 the third and final conference took place in Lisbon under the title "Good Governance for Sustainable Marine Development". Several Cluster scientists took part as expert panelists and speakers in the conferences.

The conference series has brought together international experts and stakeholders from politics, business, science, NGOs and international maritime organizations to discuss these challenges in a comprehensive way and to identify practical solutions to facilitate future sustainable development. A summary of the outcome on all three conferences is in progress.

More information about the conference series and the summary brochure, when it is available, can be found at the Dräger Foundation website: http://www.draeger-stiftung.de/en/foundation-programs

Leading world experts meet at the Dräger Conference to discuss the challenges to preserving the ocean habitat.

Future Ocean Meets Earth Institute in New York

In order to further the emerging cooperation between the Future Ocean Cluster and the Earth Institute at Columbia University, Cluster researchers met with scientists from the Earth Institute in New York in July 2012 for a joint workshop. The goal was to identify topics and means for cooperation including the topics Paleo-Climate Research, the Economics of Ocean Management, Science Communication/ Games in Research and the compilation of a Future Ocean Atlas.

The meeting identified good possibilities for cooperation especially in the areas of Paleo-Climate (with the Kiel Climate Model) and Science Communication in connection with the Earth Institute climate change project PoLAR (Polar Learning and Responding). Interested parties from both institutions are encouraged to contact the respective organizers Nancy Smith (nsmith@uv.uni-kiel.de) in Kiel or Peter Schlosser (schlosser@ldeo.columbia.edu) in New York to inquire about support for collaborations.

A strong partnership between Kiel University and New York's Columbia University was set up in July 2012.

Web of Knowledge

The UNESCO Chair in Coastal and Marine Sciences goes to Karl Stattegger from Kiel University

For over 15 years Professor Wolf-Christian Dullo held the UNESCO chair for marine geology and coastal management. He is now followed by his college Karl Stattegger, Institute of Geosciences.

"It is a title without financial means", says the marine geologist, yet emphasizes that this chair, distinguished by the UN Organization for Education, Science and Culture, offers unique opportunities. Since the beginning of the UN initiative in 1992, over 600 such chairs have been established globally, ten of them in Germany. This international web of knowledge opens possibilities for science otherwise difficult or impossible to obtain.

Prof. Karl Stattegger (left) on a field trip with young scientists from all over the world explaining measures for coastal protection in Germany.

Stattegger knows what he is talking about. For more than 20 years, the expert in coastal geology has pursued research collaborations with countries and seas south of the equator. Thus UNESCO's approach fits "very well to my research and teaching activities," believes Stattegger, who therefore did not hesitate when asked to succeed Wolf-Christian Dullo.

Stattegger will shape his work through "coordinating, organizing, but also actively collaborating." He has already put words into action when he worked on-site leading a summer school in Mozambique's capital Maputo from the middle of June to the middle of July. He was accompanied by Mozambican PhD candidate Valentina Vassele and French postdoc Camille Traini. The summer school was made possible thanks to a grant from the Cluster of Excellence "The Future Ocean", which offers funding for such activities. From a scientific point of view, Mozambique is "an interesting corner of the world" says Stattegger. Camille Traini agrees: "The country is exciting for us as it is a completely new area with only little existing data."

With the help of these three from Germany and 15 native participants of the summer school at the University of Maputo, this situation has already changed a little. The young researchers were investigating the effects of climate change on the Incomati river delta. The rainy and the dry season are shifting, the rain period is becoming severer and hurricanes from the Indian Ocean carry with them consequences such as floods and soil erosion.

The activities at the Incomati could be only the start. Fitting to UNESCO's goal of supporting North-South-South-Cooperation, Stattegger can imagine continuing the collaboration with the university in Mozambique and maybe adding another partner from Brazil.

An emerging partnership with scientists from the Cape Verdean Islands and a planned research network with Thailand, in which Kiel should support the teaching, are further possible fields of activity.

In general, German marine science enjoys a "good reputation" internationally and thus is welcomed at many institutes, Karl Stattegger knows. Kiel's competence is also sought after at the University in Maputo where a master's course in Coastal and Environmental Geology is being developed and the University is relying on the support of the experienced Germans.

The African side has also profited from the summer school in a practical way. For the duration of the event, Kiel provided numerous measuring instruments which are otherwise not available. In addition PhD student Valentina Vassele is doing her doctorate on the Incomati delta and will work in Kiel until at least March 2015. Further activities in Mozambique are planed and after her doctorate she wants to return to her home country.

All this corresponds to what the UNESCO calls "Capacity Building": the strengthening of local competences in order to develop sustainable research while also profiting from it oneself. "We get a lot back," confirms Professor Stattegger and points out that scientific collaborations trigger impulses on both sides.

By Martin Geist, freelance journalist. The article was first published in the UniZeit, a supplement of the local daily newspaper Kieler Nachrichten.

Alexander von Humboldt Postdoc Fellows in the Future Ocean

Alexander von Humboldt
Stiftung/Foundation

In 2009 a strategic partnership between the Future Ocean and the German Alexander von Humboldt Foundation was established in order to attract high profile international young investigators to Kiel as Future Ocean Humboldt Postdoc Fellows.

In 2012 and 2013 the Future Ocean Cluster is hosting three Alexander von Humboldt Postdoc Fellows. The Cluster-financed fellowships have a tenure of 24 months.

Dr. Isobel Yeo started work on her project in Colin Devey's working group in November 2012. Dr. Yeo earned her PhD at Durham University, UK on the topic of 'Axial Volcanism on the Mid-Atlantic Ridge'. Her Humboldt Fellowship project deals with mapping the ocean floor.

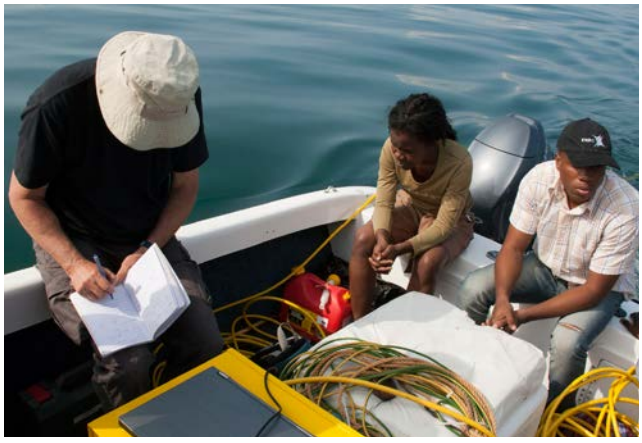
Dr. Mohammad Hiedarzadeh Kolaei started his Alexander von Humboldt Postdoc fellowship project in January 2013. He is working in the group of Sebastian Krastel on "Tsunami hazard assessment for landslide tsunamis". Dr. Heidarzadeh earned his PhD at the Faculty of Civil Engineering, University of Tehran, Iran.

Dr. Zhimian Cao began work on his project in Martin Frank's group in July of 2013. Dr. Cao, from Xiamen University in Fujian, China is working on finding out whether barium isotope rations can be used to trace the biological productivity in the upper water layers of the oceans over millions of years. Dr. Cao knows Kiel well since he already spent one year in Kiel while working on his doctoral thesis in 2010 and 2011.

The Fellows have associated member status in the Cluster and are automatically members of the Integrated Marine Postdoctoral Network (IMAP). They also have access to all of the long term benefits the Humboldt Foundation offers its fellows, such as language courses and continued networking support after their research project has ended.

If you are interested in an Alexander von Humboldt – Future Ocean Fellowship, contact Nancy Smith (nsmith@uv.uni-kiel) for more information or visit http://www.futureocean.org/en/cluster/forschungsstipendien/index.php

Future Ocean Supports Capacity Building Activities in Mozambique



Capacity Building in Mozambique – Prof. Karl Stattegger (left) during practical exercises on a ship

The Future Ocean Cluster is rotating the UNESCO Chair from Christian Dullo, for a period of six to twelve months to Cluster members carrying out projects in Capacity Building. Karl Stattegger took over the Chair in January 2013. He made a preliminary trip in March to Mozambique to sound out possibilities for a north-south-south capacity building partnership with Eduard Mondlane University in Maputo, Mozambique and Universidade Federale do Rio Grande do Norte in Natal, Brazil and organized a Summer School in Maputo June 24 to July 6, 2013 including a one week introductory course in Coastal Hydrodynamics and Sediment Dynamics and a week of ship-based practical exercises with the help of Cluster postdoc Camille Traini.

Other Capacity Building activities include a project involving the loggerhead sea turtle caretta caretta in Cape Verde. Chris Eizaguirre will lead theoretical and practical training and a workshop for university students in Mindelo, Cape Verde from June 2013 - Jan. 2014.

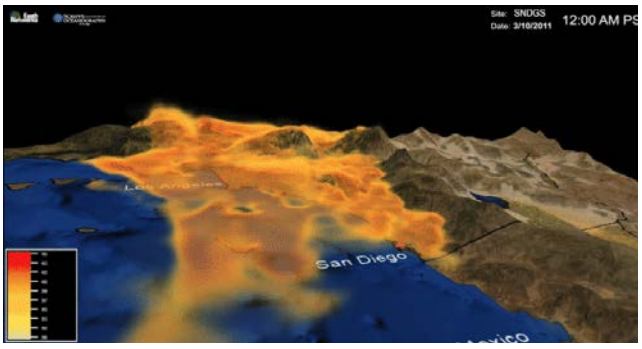
Dr. Tony Haymet, Director & Vice-Chancellor Emeritus at Scripps Institution of Oceanography UCSD visits "The Future Ocean"

Prof. Dr. Tony Haymet

Devastating natural hazards, climate relevant processes or urgently needed resources – the world ocean plays a key role in all these topics. Exploring the oceans is therefore an investment in the future. Due to the vast area that is covered by the oceans, autonomous observing systems and robots are needed to fulfill this task. Dr. Tony Haymet, for many years director of the Scripps Institution of Oceanography in San Diego (California, USA), has long been involved with the development of these systems. In January 2013 he visited the Future Ocean Cluster to educate scientists at the University and GEOMAR on issues of ocean governance and how robots explore the oceans. At GEOMAR Helmholtz Centre for Ocean Research Kiel he was granted the Excellence Award of the Prof. Dr. Werner Petersen Foundation.

Ocean observation systems are especially important in predicting natural climate variations, which can be very destructive. For example the so-called El Niño or El Niño-Southern Oscillation (ENSO) leads to flooding on the west coast of South America and droughts in the Amazonian basin and Australia. Until the middle of the 20th century people were exposed to the impacts of ENSO without any warning. Nowadays such events can be predicted with high precision as much as several months ahead. This requires not only ocean-atmosphere models but in a particular a globally sustained ocean observation system. The ARGO float system comprises more than 3,500 autonomously operating deep-sea drifters, which measure temperature, salinity and other parameters on a regular schedule with real-time transmission of the data. This is one example of how robotic systems and remotely controlled observatories have increased our knowledge and improved predictions about the oceans during the past few decades. As director of Scripps Institution of Oceanography in San Diego, California, Dr. Tony Haymet strongly advocated the further extension of these systems.

While in Kiel Prof. Haymet gave an inspiring public lecture on "The Future of Global Observing Systems and Robotic Exploration and Monitoring of the Oceans". In addition he led a one day seminar on "Global Ocean Initiatives & Governance", focusing on the stumbling blocks to effective global ocean governance. One example he pointed out was the large number of organizations which have a stake in various activities or areas of the ocean; e.g. the Seabed Authority for marine mining activities, the IMO for shipping, and the FAO whose aim is to secure the protein supply from sea fish through sustainable fishing. Together with a group of junior researchers, Dr. Haymet discussed how this and other problems might be addressed by changes to the UN Convention on the Law of the Sea (UNCLOS) or by other means. Dr. Haymet also presented several new initiatives in this area including the Global Ocean Commission, which was announced on 12th February 2013. We look forward to welcoming Tony Haymet again in Kiel in the near future.



Distribution of greenhouse gas along the coast of California. Using automated measuring instruments it is possible to acquire such fundamental data in a coordinated manner. Picture: Scripps Institution of Oceanography.

Kiel Scientists Take "The Earth's Pulse"

Professor Tina Treude processing samples on board the research vessel SONNE

The publisher Wachholtz has now printed a book in which the Collaborative Research Center (SFB) 574 "Volatiles and Fluids in Subduction Zones" presents its research comprehensibly. Exciting reports and awe-inspiring photographs convey the motivation of the scientists from Kiel. Their results change the understanding of our planet.

Getting Closer to the Real Earth

Dr. Marion Jegen gives Honorary Lectures of the Society Exploration Geophysicists

The geophysicist Dr. Marion Jegen from GEOMAR Helmholtz Centre for Ocean Research Kiel belongs to the worldwide recognized experts in her field. Together with her research group, she has developed a method which allows far more realistic geophysical modeling. The Society Exploration Geophysicists (SEG), the worldwide largest society for applied working Geologists and Geophysicists, has invited Dr. Jegen to present her new method in the SEG Honorary Lectures in ten European countries.

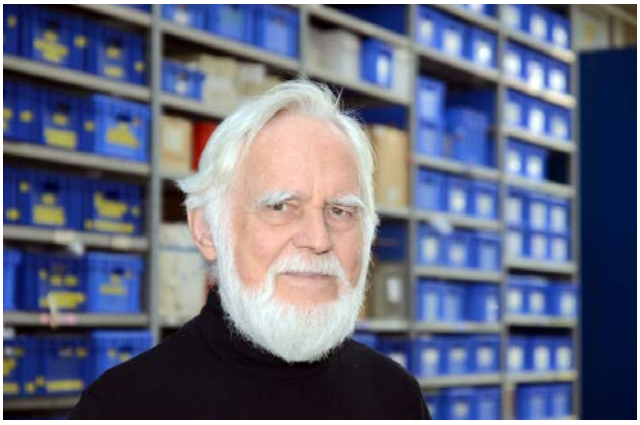
Marine Research is Future Research

The Federal President Gauck visits Kiel's GEOMAR

Future issues of marine research where the focus of the Federal President Joachim Gauck's visit to GEOMAR Helmholtz Centre for Ocean Research Kiel. The visit was part of Gauck's inaugural tour of Schleswig-Holstein.

Gustav-Steinmann-Medal for Hans-Ulrich Schmincke

Kiel volcanologist awarded for his life's work



The Kiel professor and volcanologist Dr. Hans-Ulrich Schmincke was honored by the Geological Association for his work. The 74 year old scientists became known for his fundamental research on the history and activity of the Eifel volcanoes and the Canary Islands. For his scientific achievements he was awarded the Gustav-Steinmann-Medal by the Geological Association "Geologische Vereinigung (GV)"

Albert-Defant-Medal for Lothar Stramma

Kiel Marine Scientist awarded for pioneering research

Weather and climate are significantly affected by our oceans. To recognize his pioneering work on the large scale circulation in the Tropical and South Atlantic and his groundbreaking data analysis of the dynamics and changes of tropical oxygen minimum zones, Dr. Lothar Stramma from GEOMAR Helmholtz Centre for Ocean Research Kiel was awarded the Albert-Defant-Medal 2013 by the German Meteorological Society.

EVENTS

Magnetism, as you recall from physics class, is a powerful force that causes certain items to be attracted to refrigerators.

Dave Barry

A Fascinating Excursion into the World's Oceans: The Exhibition "Exploring the Ocean" on the Day of German Unity in Munich

The Cluster of Excellence "The Future Ocean" and GEOMAR Helmholtz Centre for Ocean Research Kiel invited all visitors of the Day of German Unity in Munich to a fascinating excursion into the world's oceans. On the 2nd and 3rd of October 2012, marine scientists from Kiel presented current marine research topics in the Schleswig-Holstein tent. An unusual view for the marine scientists from Kiel: Instead of the wide horizon which they are accustomed to on board a research vessel, they gaze at the panorama of the Bavarian Alps. In 2012 the Cluster of Excellence "The Future Ocean" is participated in the marine science exhibition on the Day of German Unity for the fifth time. That year it took place in the city of Munich in front of an alpine backdrop. Visitors to the Schleswig-Holstein tent on Ludwigstraße were able to dive into a dark, mysterious deep sea atmosphere. Here, interactive computer simulations, models of highly modern research instruments and three dimensional world maps await the visitor. Which opportunities and risks lie in our world oceans? Who does the sea belong to? How can we explore it? Questions, which partly go beyond the subject boundaries of the natural sciences, were explained to the landlocked visitors. "We are delighted about the great interest of the visitors" says Dr. Gerd Hoffmann-Wieck from GEOMAR. Already within the first hour the presentations were very well received.

> **"Far away from the coasts, the need for information on marine topics is yet a bit higher"**

believes Annika Wallaschek from the Cluster of Excellence "The Future Ocean ". The team from the North left no question unanswered in the deep South. The presentation on the Day of German Unity is supported by the state of Schleswig Holstein and Kiel University.

The Cluster of Excellence exhibits together with the chancellery of Schleswig-Holstein on the Day of German Unity 2012 in sunny Munich

Many Visitors came to the "Ländermeile", the states mile on the Ludwigstraße.

Underwater ambiance: Visitors standing in front of the illuminated world relief map.

Future Ocean Exhibits at the Kiel Week

Once a year Kiel celebrates the Kiel Week and becomes an attractive magnet for guests from near and far

Every summer, the city of Kiel, on Germany's bracing Baltic Sea coast, hosts the world's largest sailing event and one of the largest Volksfests in Germany. More than 3 million visitors pour into town to enjoy various attractions and activities. Along the waterfront, Kiel University showcases it's most important areas of research at the centre of the celebrations. Of course, the Cluster of Excellence "The Future Ocean" is a real crowd-puller during this important event.

On Kiel University's Live Stage, marine scientists explain their research to interested listeners, such as how polar bears are adjusting to their melting habitat. Visitors can learn about the Cluster's research and experience the implications of sustainable fisheries through the ecoOcean computer game. In this novel educational game players become fishermen themselves and learn how much more fish can be caught in the world's oceans without depleting or endangering fish stocks if sustainable management is implemented. Comfortably seated, resting their feet, visitors can watch multimedia displays guiding them along on research vessel expeditions, venturing out in search of new findings in the oceans. The routes of the vessels can be followed on a 3D relief globe. Scientists present and discuss societally relevant topics such as sustainable concepts to protect the oceans, sustainable fisheries, adaptation to climate change and opportunities in marine mining. As every year, Kiel Week is a unique opportunity for the general public and researchers to meet and discuss science.

Future Ocean Exhibits at the Kiel Week – School kids are fascinated by the topography of the seabed.

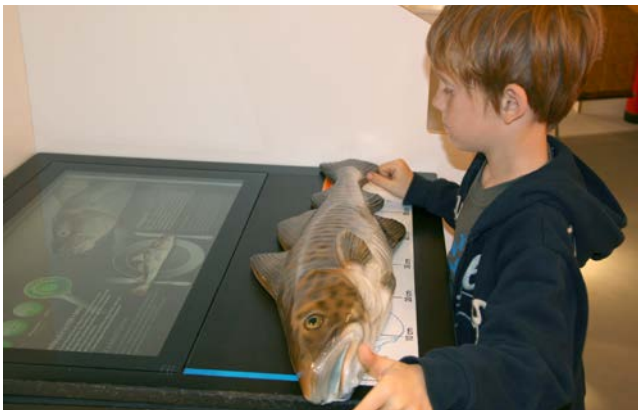
Visitors in the exhibition tent at the Kiel Week, one of the largest Volksfests in Germany, playing the interactive fishing game "eco Ocean" and learning about sustainable fishing.

Kiel Marine Science on the Science Barge MS Wissenschaft

For ten years the organization „Wissenschaft im Dialog" has organized exhibitions on the cargo ship MS Wissenschaft, which has been converted into a floating science center. Exhibitors, together with universities, research institutes and individual scientists, build modules on the big science theme selected for the current year, such as energy or future science.

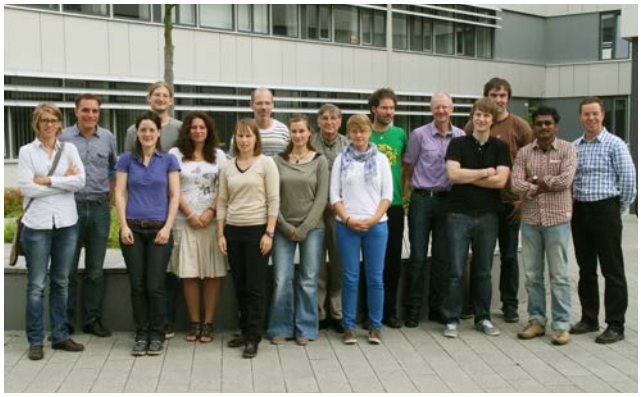
Kiel's marine scientists often board the barge with their topics and exhibits as well, for example in 2012 when the MS Wissenschaft travelled along the German rivers, discussing the topic of sustainability. Over 90 000 visitors were fascinated by the diverse facets of a sustainable economy, sustainable building or sustainable buying. How do we want to live? How should we conduct business? How can we conserve our environment? By trying out and exploring for themselves, the visitors discovered what the CO_2 footprint of different groceries is, how energy can be generated through sewage and why forests are so important for the climate. They also learned about ideas for environmentally conscious laundry washing and sustainable shopping. The Cluster of Excellence "The Future Ocean" was on board with the Fish Length game. Visitors catch model fish of different lengths and then are shown whether the fish is large enough to be eaten or whether it should have remained in the ocean for a few more years.

The Fish Length game on board the science freighter MS Wissenschaft



Is the fish large enough to be eaten? – Future Ocean's exhibition module explains the consequences of catching fish too young in an understandable way.

Kiel Summer School on Sustainable Fisheries



In September 2012 more than twenty young European researchers met to discuss new economic concepts for sustainable fisheries. A new aspect is the special attention given to distributive justice, playing a role, for example, in the exploitation of West African waters by European and Chinese fishing fleets. In addition new paths to fisheries regulation were demonstrated. In New Zeeland, quotas for certain fish species have already been handed over to the fishers as property. Whether such concepts are applicable in the European market and what effect they would have on distributive justice was discussed in lectures, group work and panel discussions. During the summer school lectures were given by renowned fisheries researchers from universities and institutions in Kiel, Lüneburg and Hamburg (all Germany) as well as Namur (Belgium) and Halifax (Canada). The Summer School was organized by the working group on Sustainable Fisheries of the Cluster of Excellence "The Future Ocean".

Symposium Coasts of the Future: How Climate Change and Sea Level Rise are Changing the Coasts

Two-thirds of the world's population live within 50 kilometers of the coast. 75 percent of all megacities with more than 10 million inhabitants lie in coastal zones, mostly in low lying river mouth areas threatened by flooding. These areas also known as deltas and their harbors accommodate industrial centers and are important transportation routes and transshipment points. The offshore shallow marine coastal areas are being increasingly exploited for raw materials and regenerative energies, e.g. wind energy parks. The coasts themselves serve as recreational and tourism areas, harbor ecosystems rich in species and worth protecting and are an important buffer between the land and the sea. The development of these coasts is very dynamic, especially in regard to climate change, sea level rise and human activities. Today many coastal regions are already marked by the effects of climate change, for example by the rise in sea level or the increase in extreme weather events in the form of storm surges or flooding like that caused recently by hurricane Isaac on the American Gulf Coast.

But how will the coasts develop further in future? How do they regenerate after impacts from tsunamis or storm surges? Which adaptation strategies are necessary and which make sense to counter the effects of climate change and sea level rise? What role do climate fluctuations play, both natural and anthropomorphic? And what can be gained from comparisons of past warm and cold periods with climate data from the present?

Leading coastal researchers from 24 countries around the globe met in Kiel for an international symposium on coastal change. From 4-10 September 2012 around 70 global leaders in coastal research came to Kiel to attend the third conference of UNESCO's International Geoscience Program IGCP588 Preparing for Coastal Change. The conference is one of the most important international symposia in this field and took place in Kiel for the first time.

The scientific topics of the conference ranged from the analysis of the past 10,000 years, the Holocene, up to current developments and changes of the coastal zones from the tropics to the high latitudes and the resulting adaptation strategies, however, the use of the coasts for renewable energies was also included. Here models predicting coastal change in regard to climate change, human influences and natural threats were discussed.

In addition to the scientific lectures an exchange of ideas among international researchers took place with practical showcases along the Baltic Sea coast, on the Hallig Islands in the North Sea and on the island of Sylt. The Hallig Islands and Sylt are unique in regard to their natural development and human intervention in these natural occurrences. Whereas the building of dykes as a protection measure against flooding on the North Sea coast can be traced back over 500 years, the island of Sylt offers unique insights into the efforts of humans for more than 120 years in trying to halt the erosion of the coasts with the most modern scientific knowledge and methods available at the time.

An exchange of ideas among international researchers took place with practical showcases along the Baltic Sea coast.

The symposium was organized by Prof. Karl Stattegger and Dr. Klaus Schwarzer from the Sedimentology, Coastal and Shelf Geology group of the Institute for Geosciences together with the Geographical Institute (working group Coastal Geography) of Kiel University. Supporters of the conference were UNESCO, the Cluster of Excellence "The Future Ocean" and the International Union for Quaternary Research (INQA).

Link to the website and program of the conference:
www.igcp588.uni-kiel.de
www.coastal-change.org/meetings-2/upcoming-meetings-2/3rd-meeting-germany

ABOUT THE CLUSTER

Information is not knowledge.

Albert Einstein

The Founding Institutions

Christian-Albrechts-Universität zu Kiel

Kiel University is the only full university in the state of Schleswig-Holstein. It is home to more than 22,000 students as well as 2,000 university teachers and researchers. From A for Agricultural Sciences to Z for Zoology, the university currently offers around 80 different subjects of study.

Creating links between the different scientific cultures is the top priority at Kiel University. After all, the reality that is reflected in scientific research is multi-layered and complex and so are the research focuses of the university: marine and geological sciences, life sciences, cultural spaces as well as nanosciences and surfaces. Throughout its nearly 350 year history, the Christian-Albrechts-Universität zu Kiel has been closely linked with the city of Kiel. Together with the university hospital it is now the largest employer in the region.

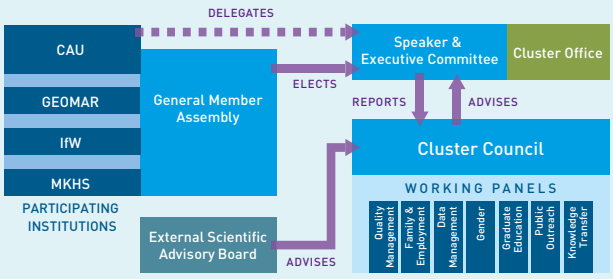
Kiel Institute for the World Economy

The Kiel Institute is one of the major centers for research in global economic affairs, economic policy advice and economic education. The Institute regards research into innovative solutions to urgent problems of the world economy as its main task. On the basis of this research work, it advises decision makers in politics, economics and society, and keeps the interested public informed on important matters of economic policy. As a portal to world economic research, it manages a broad network of national and international experts, whose research work flows directly or indirectly into the Kiel Institute's research and advisory activities.

The Kiel Institute places particular emphasis on economic education and further training and co-operates with the world's largest library in the economic and social sciences.

Organization of The Future Ocean

The Cluster's Executive Committee is responsible for the overall management of the Cluster of Excellence and is accountable to the Cluster Council and the General Assembly. It consists the Speaker, of the Executive Committee, its Vice Speaker, the two speakers of the research platforms and representatives from the research themes. The Council of the Cluster of Excellence gives advice to the Executive Committee on all strategic decisions, such as scientific priorities, yearly budget planning and monitoring criteria. The Council comprises the two leading proponents of each research topic and research platform, the leader of each JRG, the Presidents of Kiel University and Muthesius Academy of Fine Arts and Design, the Directors of GEOMAR Helmholtz Centre for Ocean Research Kiel and the IfW, as well as the Speaker and Vice-Speaker of the Executive Committee. An external Advisory Board acts as an independent quality-control and advising body to evaluate the progress of the project. It consists of ten leading scientists, both national and international, reflecting expertise in all cluster-relevant research fields. Additional members are appointed to evaluate the Cluster's outreach to the general public, stakeholders and industries. The central service office provides necessary support for project management and monitoring activities. It also supports the public outreach and technology transfer activities and the Integrated School of Ocean Sciences (ISOS).



GEOMAR Helmholtz Centre for Ocean Research Kiel

GEOMAR Helmholtz Centre for Ocean Research Kiel is the successor to the Leibniz Institute of Marine Sciences (IFM-GEOMAR) which was founded in January 2004 through the merger of the Institut für Meereskunde (IfM) and the Research Center for Marine Geosciences (GEOMAR). The institute is a member of the Helmholtz Association.

The institutes' mandate is the interdisciplinary investigation of all relevant aspects of modern marine sciences, from sea floor geology to marine meteorology. Research is conducted worldwide in all oceans.

The institute has four major research divisions:

- Ocean Circulation and Climate Dynamics
- Marine Biogeochemistry
- Marine Ecology
- Dynamics of the Ocean Floor

The institute operates four research vessels, state-of-the-art equipment such as the manned submersible JAGO, the deep-sea robots ROV KIEL6000, PHOCA and ABYSS as well as several major laboratories, access to high performance computing facilities and an attractive public aquarium.

GEOMAR is one of three leading institutions in the field of marine sciences in Europe. Together with the National Oceanography Centre in the United Kingdom and Ifremer in France, GEOMAR has formed the "G3 group" of national marine research centres.

Muthesius Academy of Fine Arts and Design

Founded on 1st January 2005, the Muthesius Academy of Fine Arts and Design in Kiel is Germany's northernmost and youngest school of higher education devoted to the systematic study of art and design. Thanks to an innovative course structure, the Academy's concept features a diverse program of curriculum options in the fields of art, spatial strategies and design. The history of the Academy began in 1907 with the founding of separate classes in artistic design at the School of Applied Arts, the Muthesius Academy. It is a story of constant, gradual change in both curriculum and academic structure. The newly founded Academy of Fine Arts and Design will offer approximately 400 places for students.

The Art Academy's size enables it to offer project-oriented and practical instruction in small groups – a tradition harking back to the days of the Muthesius Academy – as well as close contact between instructors and students. Modern media play no less important a role than that of the traditional canons of art and design.

Project Data

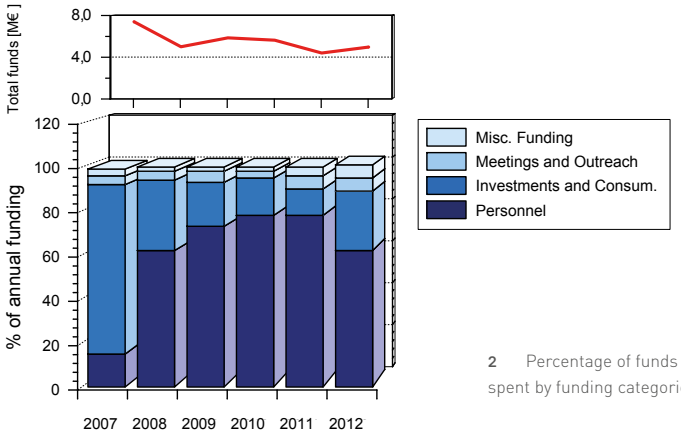
The first funding term of the Future Ocean ended in Fall 2011. An intermediate grant had been awarded by the funding agencies between Fall 2011-2012. Subsequently, with the granting of another five-year term from 2012-2017 the Future Ocean entered its second funding phase in November 2012. As in the previous years, the progress of the project is monitored and key data published on a regular basis. These datasets include financial, personnel, and funding data, as well as information on publications, attendance of meetings and the exchange of scientific personnel. Many changes in budget allocation and spending have been introduced, which are reflected in the recent financial data on the cluster. At the end of the first phase of the cluster in 2012 the fading out of project funding for the installed 10 professorships is clearly visible in the budget spending, while the new strategy to fund project proposals for up to 5 years begins to take over as the main scientific driver of the Future Ocean.

Long term budget planning for 2012-2017

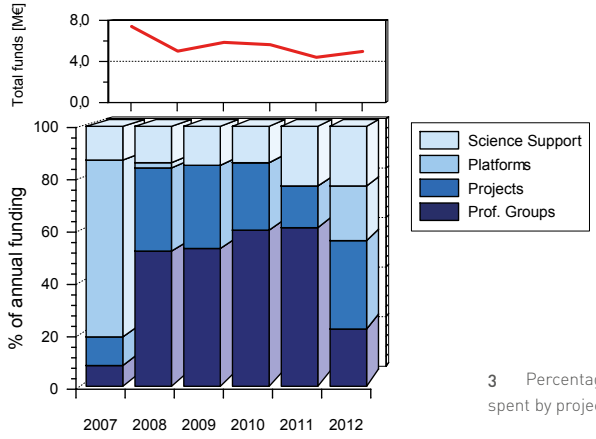
The Cluster of Excellence "The Future Ocean" started the second five year funding term in November 2012. The overall project budget for 2012-2017 amounts to 28.1 million euros. A rough break down into budget categories is summarized in figure 1. About 68 % will be spent for research projects and groups contributing mainly to Future Ocean research topics while about 32 % are allocated to science support in the wider sense, including travel and conferences, but also support for graduate education, the postdoc network, international activities, etc.

k€	2012/2013		2014		2015		2016		2017		Total	
Research	3.45 M€	65 %	4.08 M€	62 %	4.18 M€	69 %	4.01 M€	72 %	3.36 M€	75 %	19.08 M€	68 %
Science Support	1.87 M€	35 %	2.52 M€	38 %	1.92 M€	31 %	1.59 M€	28 %	1.13 M€	25 %	9.03 M€	32 %
Total	5.32 M€		6.60 M€		6.10 M€		5.60 M€		4.49 M€		28.11 M€	

1 Budget 2012-2017



2 Percentage of funds spent by funding categories.



3 Percentage of funds spent by project categories.

Spendings in 2012

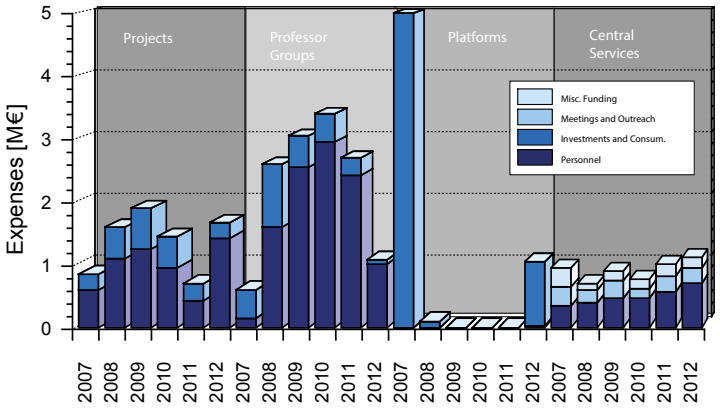
The total budget in 2012 from January to December was about 4.97 M euros. This was more than in 2011, when the total budget was around 4.4 M euros. See figures 2 and 3 for a breakdown of expenses into groups for 2007-2012. Overall the total amount spent for personnel went down from about 3.4 M euros (78 % of total) to 3.1 M euros (62 % of total). This is due to the phasing out of the Junior Research Groups at the end of 2011, while the staffing for the newly granted projects was not yet completed. About 1.35 M euros (27 % of total) were spent on investments and consumables, which was more than double compared to 2011 (0.55 M euros, 12 % of total). About 0.5 M euros (12 %) were spent on other items such as workshops and retreats, meetings and outreach activities, travel grants for outgoing and incoming visitors, equal opportunity, family support and other measures. In 2012 this included some other activities, such as Alexander von Humboldt fellowships and some activities related to internationalization which had been supported by Kiel University and the state of Schleswig Holstein in 2011.

In 2012 the Future Ocean shifted its focus significantly from the establishment of working groups arranged around new professorships to the funding of research projects for postdocs and PhD students. Consequently the funding for professorial groups dropped dramatically from 2011 to 2012 from 2.7 M euros to 1.1 M euros, with only two groups still funded by the cluster in the Law of the Sea and Coastal Research. In contrast the funding for open research projects went up from 0.7 M euros to 1.7 M euros, reflecting the more than 50 projects funded during the course of 2012. This is a straightforward and expected development and will continue during the coming years. For the first time since 2008 some significant investments were made in 2012. About 1.1 M euros were invested in laboratory equipment and seagoing devices in order to prepare the Future Ocean for upcoming research initiatives.

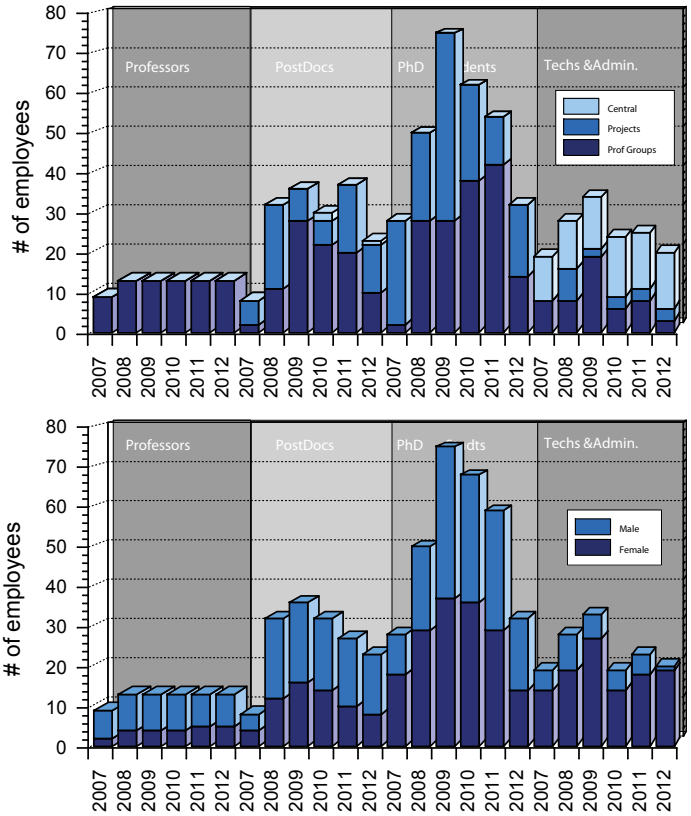
How was the money spent?

Since summer 2011 several calls for project proposals were started from previous funds and are continuing over into the current funding phase. The start, duration and financial commitments of these calls are summarized in Fig 7. Since 2011 ~9.6 M euros have been committed to 68 research projects. These included 21 PhD Projects, 20 postdoctoral projects and ~1 M euros for general small scale projects. About 1 M euros that were allocated in 2011 are still committed to ongoing PhD Projects from the first cluster phase.

With the close of the previous phase in fall 2012 about 1.1 M euros for several significant investments in labs, sampling and sensor equipment were financed with funds from the 2012 budget. Among the instruments acquired, the coastal research group from the university received a Vibrocoring device, a winch, and ocean backscatter sensors. Some laser spectrometry equipment was acquired to upgrade the ocean nanolayer surface chemistry group and significant upgrades to the ICP-MS laboratory at the university and the Gamma-spectrometer lab at the geosciences department were financed. Further 0.3 M euros in investments will be incurred in 2013. Despite additional activities, such as the IMAP network and intensified internationalization efforts, money spent on the Science Support Projects like public outreach, graduate education, the postdoc network, travel grants and meetings remained stable at 1.1 M euros in 2012. Expenses included significant amounts of money spent for science mobility activities such as inviting guests to Kiel for research, but also travel support for researchers to attend conferences, for instance the AGU Fall Meeting 2012 in San Francisco and the EGU General Assembly in Vienna. Both of these conferences were also covered with booths by the Future Ocean, in order to continue our internationalization efforts.



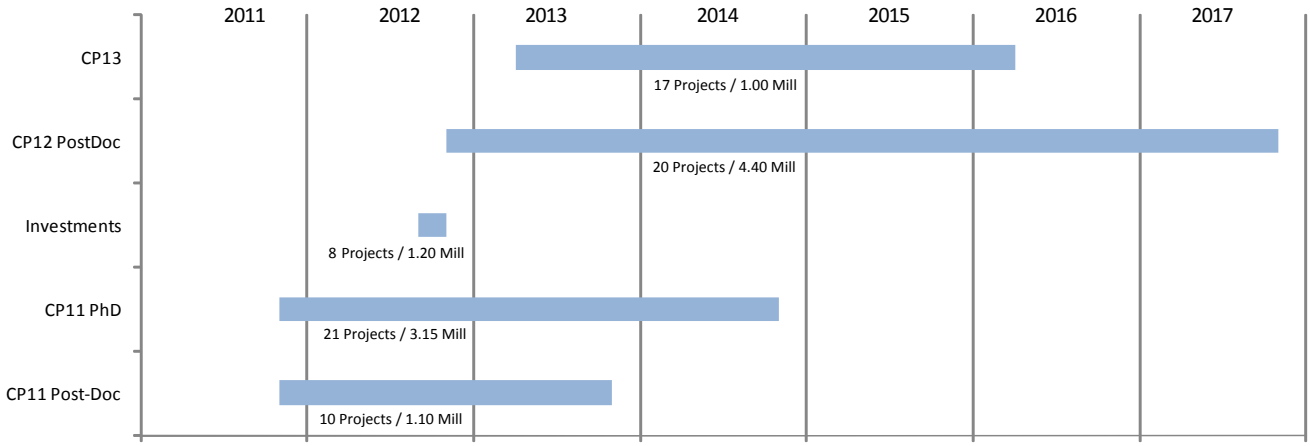
4 Funds spent during the project lifetime by categories.



5/6 Personnel structure during the course of the project.

Personnel

Employees can be grouped into four categories: professors, postdoctoral researchers, PhD students and technical and administrative staff. In 2012 the number of Future Ocean employees decreased significantly from 122 to 88 compared to 2011. There are a number of reasons for this: 1. the transition from funding whole research groups to topic-focused research projects led to a gap, where people left the Future Ocean in 2011 and the positions were not all filled in 2012. 2. Due to investments being made in 2012 there was less money spent for projects and therefore less personnel funding in the system, 3. The group of PhD students lost the most people by far. In the first phase of the Future Ocean most of the PhD project employees, 54 in 2011, received 50 % contracts for their projects, which was standard in most disciplines. Some disciplines, however, like computer science and engineering, issued 75 % or even full positions to be competitive with industry offers. To have equal standards throughout the project the cluster therefore decided to fund all PhD positions with 75 %. This decision, however, has resulted in significantly more expensive PhD student projects, leading to an overall lower number of available positions. In fact most of the PhD projects now are similar in cost to postdoc projects, which is roughly 50-60 % more than before. It can be seen, that the number of PhD students in the Cluster fell from 54 in 2011 to 32 in 2012. 5. In addition a general raise in salaries in 2012-13 added another >5 % salary increase to all contracts. 6. With the shift to project funding, there was less personnel fluctuation in the system, leading to fewer people coming and leaving the Future Ocean and consequently fewer people employed in total. All these factors contributed to a lower total number of people employed by the Cluster. Provided that fewer investments will be made in the future, and the budgets for 2013-16 will be about 20 % higher than in 2012, we expect this number to stabilize at about 100-110 people in the coming years, still fewer than in the recent years of the Cluster.



7 Timing and volume of advertised cluster project rounds.

Project proposal calls

As demonstrated above, the Future Ocean currently dedicates most of its funds to research proposals submitted to the Cluster. Most of the proposals are elicited by calls for proposals issued by the executive board. These calls are usually subject to certain eligibility, funding and evaluation criteria and decided upon according to scientific, strategic and budgetary goals defined in advance of the advertisement of the call. In 2012 two calls for proposals were issued.

The first call was internationally advertized in July 2012 with two major funding lines as a call for three and five year postdoc projects in marine sciences and related disciplines. Line A comprised medium-term postdoc projects with a maximum of three years project duration. Postdocs with a maximum of six years postdoc experience after their dissertation were eligible to propose a project. Line B addressed long-term postdoc projects with a maximum of five years project duration. Postdocs with a minimum of two years postdoc experience were eligible to propose a project. The selection process was carried out during a two day symposium, with the most promising proponents invited to present their projects and discuss their research with Future Ocean PIs. By the deadline 84 proposals had been received, 52 in line A, 32 in line B, 49 coming from outside Germany. 31 of the proposals were submitted by female researchers, 23 proposals (44 %) in Line A, 8 proposals (25 %) in line B.

During an internal selection process, the 35 most promising candidates were picked. These proponents were invited to Kiel to present and discuss their science with Future Ocean researchers during a symposium on October 9-10, 2012. The Future Ocean research topic representatives then decided on certain proposals for funding based on the merit of the proponents and their proposal taking into account comments from all PIs in the Cluster. In the end 20 Proposals were selected for funding and subsequently approved by the executive board. Of these funded proposals, eight (20 %) were submitted by female researchers, five in line A, three in line B. Nine proposals were submitted by foreigners and eleven are being hosted by Kiel University. Most projects started between November and January 2013, with a few starting a little later into Summer 2013. The complete list of all funded projects can be found at the end of this report.

In October 2012 the second open project proposal call was launched. This was an internal call for research projects not exceeding 75.000 Euro each in total. The call targeted interdisciplinary research projects, "risky" projects with good potential to support Future Ocean goals, but less likely to be funded through other third party sources, proposals supporting international institutional partnerships, proposals aiming to improve the Cluster infrastructure, and proposals aiming to support the Cluster's strategic goals. Only Cluster members, PIs and postdocs were eligible to submit project proposals. By the deadline 52 project proposals were received. By early February 2013 these had been externally and internally evaluated. In mid February an internal selection group created a ranking of these proposals as a basis for a funding decision by the executive board. Ultimately 17 projects were funded with a total budget of about 1.0 M euros. A list of all active proposals can be found at the end of this report.

Gender data

Future Ocean has been promoting gender equality since its establishment. We are therefore monitoring the male/female ratio within the project carefully, in order to have records and control on the gender structure of the Future Ocean. During the first phase, the Future Ocean made some progress in hiring female scientists and supporting them in their careers. We were successful in tenuring three female professors and improved in involving female scientists in all our committees. We are, however, still lacking an adequate number of female scientists in leadership positions in Kiel Marine Sciences, and this has not changed yet. There still are significantly more male than female scientists on all decision making panels. We are still spending our precious time convincing our colleagues that the support of parents does not automatically mean the support of women in science– and vice versa.

In order to push for a fair and equal treatment of men and women in marine research the Cluster is committed to supporting DFG gender equality standards promoting a) continuity, b) transparency, c) competitiveness and d) future orientation, as well as e) competency in its gender measures. For this purpose the Future Ocean regularly publishes its personnel structure by male/female ratio as illustrated in figures 1 and 2. Figure 1 shows the personnel structure since 2007 for the four groups: professors, postdocs, PhD students and technical and administrative staff. While the overall number of personnel has decreased significantly from 122 (62 female) in 2011 to 88 (46 female) in 2012, the proportion of male to female workers has remained approximately the same (51% in 2011 vs. 52 % in 2012) during recent years. Consequently the overall picture is about the same as in the years before, with the percentage of male/female employees broken down by groups approximately the same as in the previous two years (Fig. 1). The number of tenure track professors stayed the same, with no change in the staffing of that group. However, the number of women in PhD and postdoc positions has decreased slightly, from 37 % to 35 % on postdoc level, and 49% to 44 % on PhD level. The number on PhD level can be seen as being within the natural variance in staffing.

The decrease on postdoc level, however, was a result of several women, who were offered PhD or Postdoc positions, not assuming their positions. This has mostly been for private reasons, or better job offers from other institutions. We will still continue to keep a close look at hiring and selection practices, to find out if this happened due to a flaw in evaluation or staffing procedures. On the other hand, women are far overrepresented in administrative and technical positions, making up 95 % of Cluster employees in this category.

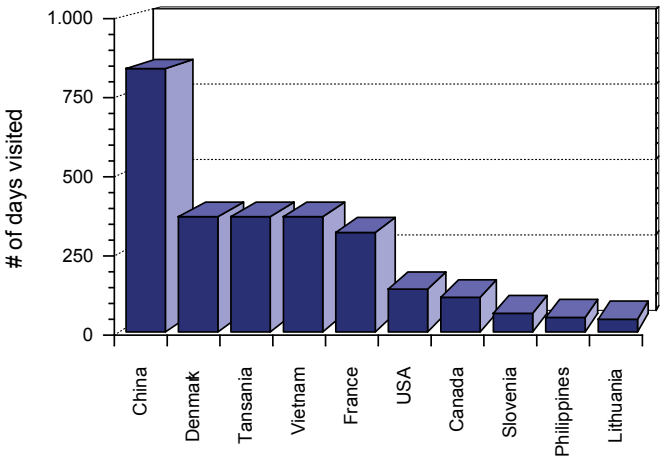
Overall the Cluster's measures on family and employment continue to focus on better publicity of the opportunities offered to employees, as many may not be familiar with what is available in terms of family support. We also expect that the Cluster's increased activities in the field of career advancement on the postdoc level will have an impact on the numbers of woman continuing in research.

International Exchange

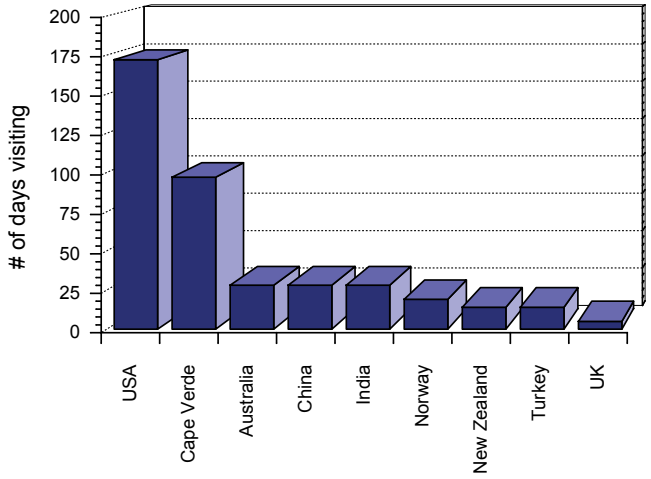
Incoming visitors and visits to foreign institutions by Future Ocean scientists are an important benchmark for international cooperation. In 2012 Future Ocean scientists welcomed 26 registered visitors in total, significantly less than in 2010 (86). These numbers must, however, be evaluated very carefully, as there is no central registration for visitors, nor is there a uniform definition of who counts as a visitor and who doesn't. The numbers therefore are only an indication, which countries we have cooperative projects with. The most important countries in terms of the number of visitors are the USA, Australia, Cape Verde and China. China, Denmark, Tansania and Vietnam are important in terms of countries visited. These numbers illustrate that the Future Ocean and its members are well connected within the international science community. The project cultivates an extensive exchange of research, knowledge, and personnel with foreign colleagues on all levels, actively contributing to the forefront of marine science.

Publications

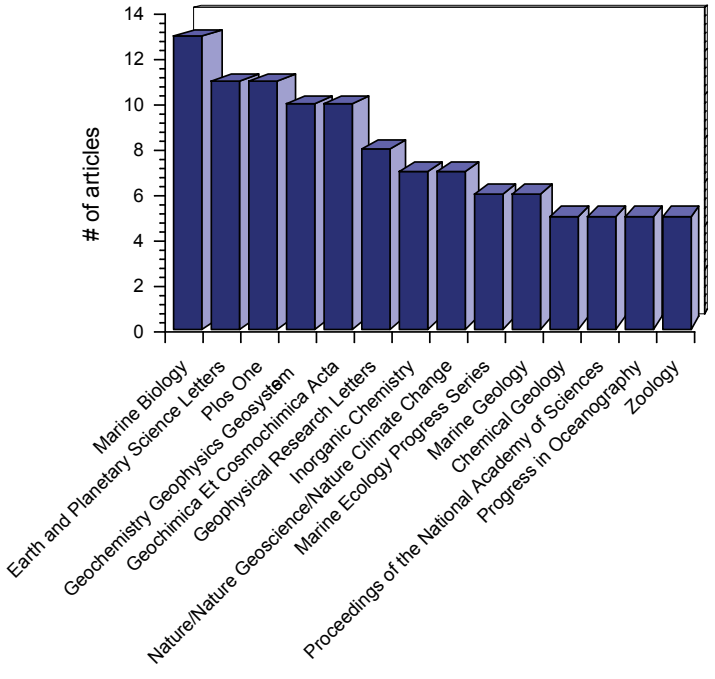
The most important benchmark factor for evaluating people, projects or institutions is related to publication statistics. In 2012 we recorded 496 publications in total, the most important journals being Marine Biology, Earth and Planetary Science Letters, PLoS ONE and Geochemistry, Geophysics, Geosystems, the combined set of Nature Publications (Nature/Nature Geosciences/ Nature Genetics/ Nature Methods) with at least 10 articles in each journal. The fourteen journals in which Cluster members most frequently published are summarized in Figure 9. With Plos One and Marine Biology among the first three most important journals, the representation of life sciences in the project is growing quickly, although the spectrum of journals is still strongly biased by the earth science community. It must be noted that taking the complete publication list into account, it spans the entire spectrum of research conducted in the project, from oceanography to law, from geoscience to economics, from medicine to mathematics, hence these numbers can at best give a vague idea of where the Future Ocean is publishing – in reality the spectrum is as broad as the expertise of its members.



8 Number of days visitors stayed with members of the Future Ocean by country.



9 Visitors days by members of the Future Ocean to outside universities and institutions.



10 The most important publication venues in 2012.

Panel Memberships

Executive Committee

Name	Institution*
Behrmann, Jan	GEOMAR
Bleich, Markus	CAU
Bosch, Thomas	CAU
Braack, Malte	CAU
Fouquet, Gerhard	CAU
Friedl, Birgit	CAU
Herzig, Peter	GEOMAR
Latif, Mojib	GEOMAR
Quaas, Martin	CAU
Reusch, Thorsten	GEOMAR
Schmitz-Streit, Ruth	CAU
Schneider, Ralph R.	CAU
Schulz, Rüdiger	CAU
Snower, Dennis J.	IfW
Srivastav, Anand	CAU
Temps, Friedrich	CAU
Visbeck, Martin	GEOMAR
Wallmann, Klaus	GEOMAR
Werner, Iris	CAU

Cluster Council

Name	Institution*
Behrmann, Jan	GEOMAR
Berndt, Christian	GEOMAR
Bleich, Markus	CAU
Böning, Claus	GEOMAR
Bosch, Thomas	CAU
Braack, Malte	CAU
Dullo, Christian	GEOMAR
Duscher, Tom	MKHS
Fouquet, Gerhard	CAU
Frank, Martin	GEOMAR
Friedrichs, Gernot	CAU
Gorb, Stanislav	CAU
Hasselbring, Willi	CAU
Herzig, Peter M.	GEOMAR
Hoernle, Kaj	GEOMAR
Klepper, Gernot	IfW
Körtzinger, Arne	GEOMAR
Krastel, Sebastian	CAU
Latif, Mojib	GEOMAR
Matz-Lück, Nele	CAU
Melzner, Frank	GEOMAR
Odendahl, Kerstin	CAU
Oschlies, Andreas	GEOMAR
Ott, Konrad	CAU
Quaas, Martin	CAU
Rehdanz, Katrin	IFW
Requate, Till	CAU
Reusch, Thorsten	GEOMAR
Riebesell, Ulf	GEOMAR
Rosenstiel, Philip	CAU
Rüpke, Lars	GEOMAR
Schmitz-Streit, Ruth	CAU
Schneider, Birgit	CAU
Schrottke, Kerstin	CAU
Schulz, Manfred	MKHS
Schulz, Rüdiger	CAU
Slawig, Thomas	CAU
Snower, Dennis J.	IfW
Sommer, Ulrich	GEOMAR
Srivastav, Anand	CAU
Stattegger, Karl	CAU
Temps, Friedrich	CAU
Treude, Tina	GEOMAR
Vafeidis, Athanasios	CAU
Visbeck, Martin	GEOMAR
Wallmann, Klaus	GEOMAR

Scientific Advisory Board

Name	Institution
Betz, Gregor	University of Karlsruhe
Brügge, Bernd	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
Bücker, Chistian	RWE Dea AG, GeoSupport Center
Gelpke, Nikolaus	mare dreiviertel verlag
German, Chris	Woods Hole Oceanographic Institution
Gruber, Nicolas	Swiss Federal Institute of Technology Zurich
Harrison, Ed	Pacific Marine Environmental Laboratory
Johannesson, Kerstin	University of Gothenburg
Joye, Samantha Mandy	University of Georgia
Keeling, Ralph	Scripps Institution of Oceanography, UCSD
King, Matthew	European Commission, Directorate General for Maritime Affairs and Fisheries
McKenzie, Judith	Swiss Federal Institute of Technology Zurich
Metaxas, Anna	Dalhousie University
Miller, David	James Cook University
Saito, Yoshiki	Institute of Geology and Geoinformation (IGG), Geological Survey of Japan (GSJ), AIST
Schlosser, Peter	The Earth Institute, Columbia University
Sterner, Thomas	University of Gothenburg
Wu, Lixin	Ocean University of China
Zahn, Rainer	Universitat Autònoma de Barcelona (UAB)

*CAU - Kiel University

*GEOMAR - GEOMAR Helmholtz Centre for Ocean Research Kiel

*IFW - Institute for the World Economy

*MKHS - Muthesius Academy of Fine Arts and Design

Funded Cluster Projects

ID	Author	Title	Start	End
CP0602	Bleich, Markus	CO_2-induced Ocean Acidification: Biological Responses and Adaptions	01.11.06	01.11.08
CP0603	Eisenhauer et al.	Boron Isotopes as a Proxy for pH decresse an pCO_2 increase	01.11.06	01.11.06
CP0605	Froese et al.	Managing Cod and Sprat in the Central Baltic Sea – A bio-economic multi-species approach with Stochastic regeneration functions	01.11.06	01.11.08
CP0608	Luttenberger et al.	dearX – XML Technology for marine Data Exchange, Archiving and Retrieval	01.11.06	01.11.07
CP0609	Macke et al.	The role of light fluctuations on ocean heating and photosynthesis	01.11.06	01.11.08
CP0610	Piepenburg et al.	Synergetic effects of temperature, pH and salinity on the metabolism of benthic organism	01.11.06	01.11.07
CP0611	Schmitz-Streit et al.	Complex Barriers and Microbiota in the Ocean: implications for human barrier disorders	01.11.06	01.11.08
CP0612	Schneider, R. et al.	Radiocarbon dating of fossil biogenic as an indicator of age differences in surface and subsurface water masses in the past ocean	01.11.06	01.11.07
CP0614	Srivastav et al.	Mathematical and Algorithmic in Modelling Marine Biogeochemical Cycles	01.11.06	01.11.08
CP0618	Zimmermann et al.	Beyond Mineral Resources – The International Legal Regime and Regulation of New Uses of the Deep Sea Bed	01.11.06	01.11.08
CP0619	Schneider, R. et al.	Development of a Coupled Climate/Ocean Biogeochemistry Model	01.11.06	01.11.08
CP0663	Körtzinger	Data Mining	01.11.06	01.11.08
CP0702	Bosch et al.	Transgenic Aurelia allow functional analysis of genes involved in control of tissue homeostasis and biological barriers	01.09.07	01.09.09
CP0704	Schulz-Friedrich et al.	Carbon acquisition in coccolithophores: molecular basis and adaptive potential	01.09.07	01.09.08
CP0706	Wahl & Schmitz-Streit	Complex barriers: The biotic control of marine biofilms on algal surfaces	01.09.07	01.09.09
CP0709	Maser et al.	Marine Steroid Pharmaceuticals to Control Human Diseases	01.09.07	01.09.09
CP0710	Eisenhauer et al.	Variations of Trace Element Fluxes induced by Ocean Acidification at Ca^{2+}- Channels/ Ca^{2+}-ATPases	01.09.07	01.09.09
CP0713	Oschlies et al.	A new computational framework to efficiently integrate biogeochemical models from seasonal to multi-millennial time scales	01.09.07	01.09.09
CP0717	Thomsen et al.	Complex barriers and microbiota in the Ocean	01.09.07	01.09.09
CP0718	Klepper et al.	Economic valuation of the oceans role in the carbon cycle and consequences for abatement and mitigation strategies	01.09.07	01.09.09
CP0721	Braack et al.	Parameterization of near surface vertical mixing processes by multiscale methods	01.09.07	01.09.09
CP0722	Sommer et al.	Building up the capacity for δ34S measurements from organic samples by continuous flow isotope mass spectrometry	01.09.07	01.09.09
CP0724	Braack & Schneider	3-D Simulation of Thermohaline Convection in the Oceans Crust with Adaptive Finite Elements	01.09.07	01.09.09
CP0725	Schönfeld et al.	Changing habitats of calcareous plankton in the Greenhouse World	01.09.07	01.09.09
CP0726	Wallace et al.	Improved Methods for Nitrogen Isotope Studies with Specific Application at the Tropical Eastern North Atlantic Time-Series Observatory, Cape Verde	01.09.07	01.09.09
CP0727	Rosenstiel et al.	Deciphering transcriptomal responses to environmental stimuli in simple aquatic model organisms by massive parallel sequencing technology	01.09.07	01.09.09
CP0730	Oschlies et al.	Modelling chemosensor-aided foraging in zooplankton	01.09.07	01.09.09
CP07A32	Koch et al.	3-D Modeling of Seafloor Structures	01.04.08	01.10.10
CP07A34	Oschlies et al.	Carbon and Nitrogen Cycle Dynamics	01.04.08	01.10.09
CP07A37	Luttenberger et al.	An XML-based workbench for marine and biological data (XDataCollection)	01.04.08	01.10.09
CP07A39	Oschlies et al.	Neuronal-network based coupling of benthic and pelagic.	01.04.08	01.04.09
CP07A43	LaRoche et al.	Exploring the genetic resources of deep sea extremophiles: Searching for high performance novel enzymes	01.04.08	01.04.10
CP07A45	Dullo et al.	Biogeochemical Studies on the effects of ocean accidification	01.04.08	01.10.08

ID	Author	Title	Start	End
CP07A46	Weinberger et al.	A transcript profiling tool to investigate synergistic effects of non-biotoc and biotic changes	01.04.08	01.07.09
CP07A47	Karstensen et al.	Glider swarm Project	01.04.08	01.10.09
CP07A51	Requate et al.	Alternative Scenarios for European Fisheries Management	01.04.08	01.04.09
CP07A52	Wahl et al.	The neglected bottleneck: Early life stage ecology in times of global change	01.04.08	01.04.10
CP07A53	Weinrebe	Iceflow activity revealed from submarine morphology-mapping	01.04.08	01.04.09
CP07A54	Piepenburg et al.	Ecophysiological consequences of ocean warming and acidification	01.04.08	01.04.09
CP07A58	Friedrichs et al.	The Potential of Field Measurement of Surface Water pCO_2	01.04.08	01.04.10
CP07A65	Melzner et al.	Gene expression patterns in sea urchin embryos: Establishing a model system for biological and marine medical research in the context of global change	01.04.08	01.04.09
CP0801	Schönfeld & Spindler	Foraminiferal shell loss in the Flensburg Fjord (SW Baltic Sea). Living benthic communities under the risk due to acidification?	01.01.09	01.11.09
CP0802	Zimmer	Bacterial symbionts of an invasive species in a warming sea: Mnemiopsis leidyi	01.01.09	01.01.10
CP0805	Bosch et al.	Developing a novel framework for understanding evolutionary adaption to changing environments: comparative transcriptomics of disparate members of marine Cnidaria	01.01.09	01.07.10
CP0809	Reusch & Waller	Pipefish-parasite interactions under global warming	01.01.09	01.01.10
CP0810	Bialas et al.	OBS-Thermo: co-registration of geophysical data at hydrothermal vents – a first step to a new ocean bottom observatory	01.01.09	01.03.10
CP0811	Meier & Kinkel	Planktonic calcifiers in the Baltic Sea: adaption to carbonate undersaturation in calcifying dinoflagellates?	01.01.09	01.04.10
CP0812	Quaas et al.	Tradable Fishing Grounds	01.01.09	01.09.09
CP0813	Oschlies et al.	Can different feeding strategies help to resolve the paradox of the plankton?	01.01.09	01.07.09
CP0815	Mayerle	The effects of sea-level rise and climate change on long-term morphodynamics in the german wadden sea	01.01.09	01.01.11
CP0816	Melzner & Körtzinger	Seasonal carbonate system variability in Kiel Bay and correlated physiological performance of local blue mussels	01.01.09	01.01.10
CP0818	Weinberger & Treude	Consequences of seafloor warming and salinity decrease for macroalga-microbe interactions	01.01.09	01.01.10
CP0819	Lehmann & Bumke	Detailed assessement of climate variability of the Baltic Sea area for the period 1970-2008	01.01.09	01.01.11
CP0820	Vafeidis et al.	Shipping induced sediment resuspension in the port of Venice: a case study of the effects of forced Shallow water waves	01.01.09	01.01.10
CP0822	Wallmann et al.	Assessing the risk of leakage from submarine CCS	01.01.09	01.04.10
CP0823	Rosenstiel & Schreiber	Establishment of marine invertebrate cell cultures as a tool for immune system and invironmental stress research	01.01.09	01.02.11
CP0824	Wallace et al.	Air-sea flux measurements of trace gases with atmospheric pressure chemical ionization time of flight mass spectometry (APCI-TOF-MS)	01.01.09	01.01.10
CP0901	Wahl, Martin et al.	Missing Baselines and Ecological Noise	01.11.09	01.05.11
CP0906	Bockelmann, Anna et al.	Effects of global change on Labyrinthula-infection in eelgrass Zostera marin	01.11.09	01.05.11
CP0910	Bange, Hermann et al.	A novel system for continuous high-resolution measurements of atmospheric and dissolved N_2O	01.11.09	01.09.11
CP0911	Treude, Tina et al.	The occurrence and relevance of nitrogen fixation in sediments of oxygen minimum zones	01.11.09	01.09.11
CP0912	Krastel, Sebastian et al.	Submarine landslides and associated tsunami risk: Combining observations and an integrated modeling approach	01.11.09	01.09.11
CP0915	Linke, Peter et al.	Novel, non-invasive investigation of seafloor warming on oxygen and heat fluxes from the benthic boundary layer into the water column	01.11.09	01.10.11
CP0918	Temps, Friedrich et al.	Photolysis of Carbonyl Compounds in Seawater: Primary Products, Quantum Yields, and Loss Rates in Natural Sunlight	01.11.09	01.02.11
CP0923	Kiko, Rainer et al.	The role of zooplankton in tropical oxygen minimum layers: physiological adaptation and contribution to fluxes of carbon and oxygen	01.11.09	01.04.10
CP0924	Schäfer, Priska	The bryozoan Flustra foliacaea – impact of ocean acidification on benthic organisms	01.11.09	01.06.11
CP0927	Oschlies, Andreas et al.	Does the rise of slime foster an oceanic jelly carbon pump?	01.11.09	01.08.10
CP0931	Froese, Rainer et al.	Winners and Losers in the Future Ocean	01.11.09	01.11.10

ID	Author	Title	Start	End
CP0932	Eisenhauer, Anton et al.	Magnesium Isotope Fractionation in Planktic Foraminifera as a Proxy for Sea Surface pH Variations	01.11.09	01.11.10
CP0933	Requate, Till et al.	Experimenting with marine protected areas in an ecological-economic fishery model	01.11.09	01.04.11
CP0937	Andersen, Nils et al.	Stable isotope fingerprinting of marine organisms	01.11.09	01.11.10
CP0938	Kanzow, Torsten et al.	A glider fleet to observe sub-mesoscale physical-biogeochemical coupling in the tropical ocean	01.11.09	01.08.11
CP0943	Schrottke, Kerstin et al.	Response of tidal basins to sea-level rise and climate change	01.11.09	01.05.11
CP0946	Gutowska, Magdalena et al.	Mechanisms of intracellular $CaCO_3$ crystalization in hemocytes of Mytilus edulis: sensitivity of bivalve calcification to ocean acidification.	01.11.09	01.11.10
CP1101	Dierking, Jan	Local and global patterns in fisheries-induced evolution	01.11.11	01.11.13
CP1103	Gutowska, Magdalena	Evolution of calcification in extant coccolithophores	01.11.11	01.11.13
CP1104	Iyer, Karthik	Quantifying the release of greenhouse gases during sill intrusion in sedimentary basins using numerical flow models	01.11.11	01.11.13
CP1105	Krebs-Kanzow, Uta	Detecting the fingerprint of the Atlantic meridional overturning circulation on decadal to millennial time scales	01.11.11	01.11.13
CP1106	Laß, Kristian	Nonlinear optical probes as tools for characterization of submersed ocean interfaces	01.11.11	01.11.13
CP1107	Phillipp, Eva	The role of metabolic rate depression phases in determining the maximum life span of Arctica islandica – molecular and biogeochemical investigations	01.11.11	01.05.12
CP1108	Rickels, Wilfried	Carbon Sinks – Carbon Leakage	01.11.11	01.11.13
CP1109	Traini, Camille	Deltaic coasts endangered by riverine sediment trapping Example of the Sao-Francisco delta (Brazil)	01.11.11	01.11.13
CP1110	Voss, Rüdiger	Pathways towards ocean sustainability: Management concepts for Baltic fisheries	01.11.11	01.11.13
CP1120	Froese, Rainer	The Future Ocean Atlas	01.11.11	01.07.12
CP1130	Vielstädte, Lisa	Impact of sub-seabed CO_2 storage on marine ecosystems: reactive transport of Cos through surface sediments	01.11.11	01.11.14
CP1131	Andersen, Christine	Controls on hydrothermal vent site locations along Mid Ocean Ridges – potential improvements for Submarine Massive Sulphide exploration strategies	01.11.11	01.11.14
CP1132	Gross, Felix	Seismogenic faults, landslides, and associated tsunamis off Southern Italy contributing to the research topic From ocean hazards to coastal preparedness	01.11.11	01.11.14
CP1133	Schweers, Johanna	Biogeochemical studies on greenhouse gases in organic-rich sediments	01.11.11	01.11.14
CP1134	Dumke, Ines	Investigation of large-scale methane releases induced by increasing temperatures from global warming and break-up magmatism	01.11.11	01.11.14
CP1136	Müller, Irene	Quorum sensing interfering compounds in the host-microbe interactions of Aurelia aurita	01.11.11	01.11.14
CP1137	van Doorn, Rijk	Governing future oceans	01.11.11	01.11.14
CP1138	Mackert, Till	Improved sea-floor representations in ocean models	01.11.11	01.11.14
CP1139	Hoffmann, Julia	The Political Economy of the European Common Fishery Policy	01.11.11	01.11.14
CP1140	Becker, Meike	Field Measurements of Surface Water pCO_2 and $\delta^{13}C(CO_2)$ in the North Atlantic using Cavity Ringdown Spectroscopy and a Voluntary Observing Ship	01.11.11	01.11.14
CP1141	Paul, Allanah J.	New nitrogen production in diazotrophic cyanobacteria and the effect on community carbon sequestration	01.11.11	01.11.14
CP1142	Poggemann, David	Role of intermediate water variability in the Caribbean and Gulf of Mexico in deglacial climate change	01.11.11	01.11.14
CP1143	Pondorfer, Andreas	Valuing marine ecosystem services: A television viewing choice model	01.11.11	01.11.14
CP1145	Vassele, Valentina	Shoreline changes at Macaneta Peninsula, Mozambique and mitigation alternatives	01.11.11	01.11.14
CP1146	Dreshchinskii, Alexander	The sea surface microlayer	01.11.11	01.11.14
CP1148	Reimer, Joscha	Optimal experimental design in marine research	01.11.11	01.11.14
CP1149	Oesterwalbesloh, Jan	Investigation of bacterial and fungal communication and secondary metabolites of micro organisms in the sediment of the greenland sea	01.11.11	01.11.14
CP1150	Miersch, Lothar	Transcriptome comparison of different Emiliania huxleyi morphotypes: identification of calcification related genes and determination if they are under selective pressure in a changing ocean.	01.11.11	01.11.14

ID	Author	Title	Start	End
CP1202	Schmidt, Jörn	From Heiligenhafen to New York and back – Transdiciplinary research for better fisheries governance	01.11.12	01.11.17
CP1203	Kronfeld-Goharani, Ulrike	The sustainability approach on the high seas	01.11.12	01.11.17
CP1204	Liu, Nengye	The European Union and the protection on Marine Biodiversity in the Arctic	01.11.12	01.11.15
CP1205	Takei, Yoshinobu	Tools and steps for the reform of ocean governance: Legal and institutional aspects	01.11.12	01.11.15
CP1206	Voss, Rüdiger	Successful, commonly accepted fisheries management needs economics!	01.11.12	01.11.17
CP1207	Schneider von Deimling, Jens	GQ2	01.11.12	01.11.17
CP1208	Spinner, Marlene	Surface microstructure and physical properties of fish scales as a basis for biomimetics	01.11.12	01.11.15
CP1209	Song, Jie	Conoidean Peptides – Novel ion channel-targeted peptides from the ocean	01.11.12	01.11.15
CP1210	Vandromme, Pieter	Modelling zooplankton and ist impacts of marine ecosystems and particle fluxes in the future ocean	01.11.12	01.11.15
CP1211	Schürch, Mark	Salt marsh development under the influence of decadal and climate variations	01.11.12	01.11.15
CP1212	Laß, Kristian	Advancing non-linear optical probes for ocean interfaces	01.11.12	01.11.17
CP1213	Singh, Arvind	Nitrogen fixation in the ocean: Present and future scenarios	01.11.12	01.11.15
CP1215	Saha, Mahasweta	The drivers og algal invasion success: adaptation and co-evolution of resistance towards foulers?	01.11.12	01.11.15
CP1216	Krebs-Kanzow, Uta	Interactions of the Atlantic Meridional Overturning circulation and the atmospheric hydrological cycle during the Last Glacial Termination	01.11.12	01.11.17
CP1217	Scott, Rebecca	Lagrangian analysis of sea turtle ecology and ocean currents	01.11.12	01.11.15
CP1218	Hoving, Henk-Jan	In situ ocean observations of cape verdean pelagic communities in a changing ocean	01.11.12	01.11.17
CP1219	Patara, Lavinia	Southern ocean CO_2 uptake in high-reolution ocean-biogeochemistry simulations for the 20th and 21st centuries	01.11.12	01.11.15
CP1220	Grundle, Damian	Nitrous oxide production through suboxic interfaces and sea-to-air fluxes at the sea-surface interface	01.11.12	01.11.15
CP1302	Roth & Schulenburg	Emerging marine diesease: why to shift from friendly to nasty	01.04.13	01.11.14
CP1304	Hiebenthal, Claas	Measuring and modeling the effect of calcification on seawater carbonate chemistry in Kiel mussel reefs	01.04.13	01.04.14
CP1317	Duscher & Völker	Next Generation Interactive Scientific Poster	01.04.13	01.04.14
CP1323	Schmitz-Streit & Rosenstiel	Insight to the Evolution of Metaorganisms from an ancient Ocean Invader	01.04.13	01.04.14
CP1324	Treude et al.	The Fate of Microplastics in Benthic Marine Environments	01.04.13	01.04.15
CP1325	Schulz & Oschlies	Modelling microalgae cultures to maximise yield	01.04.13	01.04.14
CP1331	Linke et al.	Quabble	01.04.13	01.04.14
CP1336	Braack & Quaas	Analysis of spatial differentiated shadow prices using the example of the Pacific skipjack tuna	01.04.13	01.06.14
CP1338	Prieß, Slawig & Kriest	Surrogate-based Optimization for Marine Biochemical Models	01.04.13	01.04.14
CP1340	Riebesell & Kiko	Automated high-resoluton imaging system for non-invasive in situ measurements of marine partcles and zooplankton	01.04.13	01.11.13
CP1341	Körtzinger, Hauss & Karstensen	Biogeochemistry and Ecology of Oxygen Depleted Eddies in the Eastern Tropical Atlantic	01.04.13	01.06.15
CP1343	Gutekunst & Schwark	Do cyanobacteria hold an additional CO_2-fixation pathway?	01.04.13	01.08.15
CP1346	Melzner & Thomsen	Invasion of Mediterranean mussels into a warming Baltic Sea: will hybridization with local mussels impact emerging aquaculture enterprises?	01.04.13	01.10.14
CP1347	Sachs & Brandt	At sea	01.04.13	01.04.14
CP1350	Michels & Wirtz	Potential fate of microplastics in the marine water column	01.04.13	01.04.15
CP1351	Schmidt & Pfirman	Marine Spatial Planning Game	01.04.13	01.01.15

Science Support of the Cluster of Excellence The Future Ocean

Speakers of the Cluster of Excellence

Prof. Martin Visbeck
Speaker
Phone +49 431 . 600 4100
E-mail mvisbeck@geomar.de

Prof. Ralph Schneider
Speaker
Phone +49 431 . 880 1457
E-mail schneider@gpi.uni-kiel.de

Project Management

Dr. Emanuel Söding
Cluster Management
Phone +49 431 . 880 1604
E-mail esoeding@uv.uni-kiel.de

Wiebke Martens
Project Assistance
Phone +49 431 . 880 3030
E-mail wmartens@uv.uni-kiel.de

Sabine Hilge
Accounting Specialist
Phone +49 431 . 880 2978
E-mail shilge@uv.uni-kiel.de

International Cooperation

Dr. Nancy Smith
Internationalization Coordinator
Phone +49 431 . 880 4933
E-mail nsmith@uv.uni-kiel.de

Public Outreach

Friederike Balzereit
Public Outreach Management
Phone +49 431 . 880 3032
E-mail fbalzereit@uv.uni-kiel.de

Dr. Katrin Knickmeier
School Programs Coordinator
Phone +49 431 . 880 3031
E-mail kknickmeier@uv.uni-kiel.de

Mette Lüning
Electronic Media Specialist
Phone +49 431 . 880 5476
E-mail mluening@uv.uni-kiel.de

Annika Wallaschek
Exhibitions Coordinator
Phone +49 431 . 880 4726
E-mail awallaschek@uv.uni-kiel.de

Christian Urban
Social Media Manager
Phone +49 431 . 880 3031
E-mail curban@uv.uni-kiel.de

Stakeholder Dialogue

Annette Preikschat
Transfer to Application Coordinator
Phone +49 431 . 880 4308
E-mail apreikschat@uv.uni-kiel.de

Integrated Marine Postdoc Network (IMAP)

PD Dr. Gesche Braker
Postdoc Network Management
Phone +49 431 . 880 6550
E-mail gbraker@uv.uni-kiel.de

Ruth Kamm
Coordinator for gender measures
Phone +49 431 . 880 1833
E-mail rkamm@gb.uni-kiel.de

Integrated School of Ocean Sciences (ISOS)

PD Dr. Avan Antia
ISOS Head
Phone +49 431 . 880 2685
E-mail aantia@uv.uni-kiel.de

Angelika Hoffmann
ISOS Project Assistance
Phone +49 431 . 880 1559
E-mail ahoffmann@uv.uni-kiel.de

Dr. Nina Bergmann
ISOS Project Management
Phone +49 431 . 880 4837
E-mail nbergmann@uv.uni-kiel.de

Daniela Henkel
ISOS, SGMS Managing Director
Phone +49 431 . 880 5917
E-mail dhenkel@uv.uni-kiel.de

Picture Credits

All figures and photographs courtesy of the Cluster of Excellence "The Future Ocean" or its partners Kiel University, GEOMAR Helmholtz Centre for Ocean Research Kiel, Institut of the World Economy (IfW) and the Muthesius Academy of Fine Arts and Design. Special thanks to our partner's photographers: Maike Nikolai, Jan Steffen and Andreas Villwock (GEOMAR Helmholtz Centre for Ocean Research Kiel).

Pictures from external photographers:
ARENA (p. 15): Tom Kwasnitschka; Aquarium (p. 36-37): Madeleine Gulas, Susanne Paasch; WOR Panel Discussion (p. 39): Heike Ollertz; OTIS (p. 40-41): Tim Kalvelage; Portrait (p. 47): Axel Schön; Globe (p 48-49): Uli Kunz; Group Picture/Portraits (p. 50-51): Axel Schön; Group Picture (p. 57): Anna Thielisch; podium participants (p. 61): DB Media Productions LLC/Gabriella Piazza; Tony Hayment (p. 64): Picture Scripps; Lothar Stramma (p. 65): private picture; Gauck/GEOMAR (p. 65): Richard Frommann; Marion Jegen (p. 65): Peter Wolfgram, AWI; Tina Treude (p.65): Bernd Grundmann; Fish length game (p. 65): Ilja C. Hendel; Muthesius Academy (p. 75): Christoph Edelhoff
Many thanks to all of you!

Research for tomorrow

The Cluster of Excellence "The Future Ocean" pursues a research approach that is unique in Germany: marine researchers, geologists and economists join forces with mathematicians, computing, medical, legal, and social scientists and philosophers to investigate ocean and climate change from a multidisciplinary perspective. A total of over 200 scientists from the Christian-Albrechts-University of Kiel (CAU), the GEOMAR Helmholtz Centre for Ocean Research Kiel, the Institute for the World Economy (IfW) and the Muthesius Academy of Fine Arts are using innovative means to share their findings with the international scientific community, stakeholders, decision makers, civil society and the public at large because they believe that by understanding the ocean we can sustain our future.

In order to transfer this interdisciplinary approach to the education of young scientists, the Integrated School of Ocean Sciences (ISOS) was created as a central element within the Cluster. A new focus of the Cluster is the support of young scientists within the network of Integrated Marine Postdocs (IMAP). Further, scientists of the Future Ocean have access to a wide-ranging and excellent research infrastructure. These platforms include tools for ocean observation, numerical simulation, isotope and tracer analysis and molecular biosciences. The Cluster of Excellence "The Future Ocean" is funded by the German Research Foundation (DFG).

Understanding the Ocean – Sustaining Our Future

The Mission of the Future Ocean is to use the results of multidisciplinary scientific research on the past and present ocean to predict the future of the Earth's marine environment. This includes understanding changes to the past, on-going and future ocean as well as the interaction between society and the ocean in regard to marine resources, services and risks. This Mission carries with it an obligation to develop and assess scientifically-based global and regional ocean governance options, taking their legal, economic and ethical aspects into account.

Editing & Production
Emanuel Söding, Friederike Balzereit, Nancy Smith

Layout
Katja Duwe, Muthesius Academy
of Fine Arts and Design

Printing
Universitätsdruckerei
Christian - Albrechts - Universität zu Kiel
Wilhelm - Seelig - Platz 3-5
24118 Kiel

Future Ocean Office
Cluster of Excellence The Future Ocean
Christian - Albrechts - Universität zu Kiel
Christian - Albrechts - Platz 4
24118 Kiel, Germany
Tel. +49 (0) 431 . 880 16 04
Fax. +49 (0) 431 . 880 25 39
info@futureocean.org
www.futureocean.org

Co-Speakers
Prof. Dr. Martin Visbeck
GEOMAR Helmholtz Centre for
Ocean Research Kiel

Prof. Dr. Ralph R. Schneider
Institute of Geosciences,
Christian - Albrechts - Universität zu Kiel

Published January 2014

The Cluster of Excellence "The Future Ocean" is funded within the framework of the Excellence Initiative by the German Research Foundation (DFG) on behalf of the German federal and state governments. Founding institutions of the Cluster of Excellence are the Christian-Albrechts-Universität zu Kiel (CAU), the GEOMAR Helmholtz Center for Ocean Research Kiel, the Institute for the World Economy at the Universität Kiel (IfW) and the Muthesius Academy of Fine Arts and Design.

future ocean
KIEL MARINE SCIENCES

Cluster of Excellence The Future Ocean
Christian - Albrechts - Universität zu Kiel
Christian - Albrechts - Platz 4
24118 Kiel, Germany
info@futureocean.org
www.futureocean.org

CAU Christian-Albrechts-Universität zu Kiel
ifw
muthesius kunsthochschule
GEOMAR