Universität Hamburg

KlimaCampus

First PhD Student Conference

# Integrated climate and earth system sciences in Northern Germany

October 4 to 6, 2010
University of Hamburg, Germany


Max-Planck-Institut
für Meteorologie

First PhD Student Conference

‘Integrated climate and earth system sciences in Northern Germany’

October 4 to 6, 2010
University of Hamburg, Germany

# Book of Abstracts

Edited by Ina Lorkowski, Lena Niermeyer und Oliver Dilly

## First PhD Student Conference 2010 Organising Team

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## Content

## Welcome

It is our pleasure to welcome all participants at the PhD student conference on “Integrated climate and earth system sciences in Northern Germany”.

We would like to thank the PhD students from Bremen and Kiel for their effort not only in the program committee, but also in all the planning and discussing about the general framework and all specific items that are now present in this event. Furthermore, we would like to thank the local organizing committee for doing all the dirty work from setting up poster walls to preparing conference bags and hiring ships.

Have fun and enjoy the meeting!

Armine Avagyan, Bente Tiedje, and Sebastian Sonntag
(SICSS PhD student representatives)

## Preface

Welcome to the “First PhD student conference” within the framework of the Third North German Cluster Meeting! In line with previous meetings of the three clusters of excellence in northern Germany, this assembly in Hamburg is particularly devoted to contributions from the doctoral students’ work from Bremen (“The Ocean in the Earth System”), Hamburg (“Integrated Climate Analysis and Prediction”) and Kiel (“The Future Ocean”).

Members of the respective Graduate Schools GLOMAR “Global Change in the Marine Realm”, SICSS “School of Integrated Climate System Sciences” and ISOS “Integrated School of Ocean Sciences” called for papers. Doctoral students from the region, especially from related schools such as from the IMPRS-ESM ‘International Max Planck Research School on Earth System Modelling”, POLMAR “Helmholtz Graduate School for Polar and Marine Research”, ESSReS “Helmholtz Research School on Earth System Science” and ESTRADE “Estuary and Wetland Research Graduate School Hamburg” were also invited. We are pleased to present here the abstracts of the student conference, which takes place on October 4 and 5; the program of the cluster meeting on October 6 is also included.

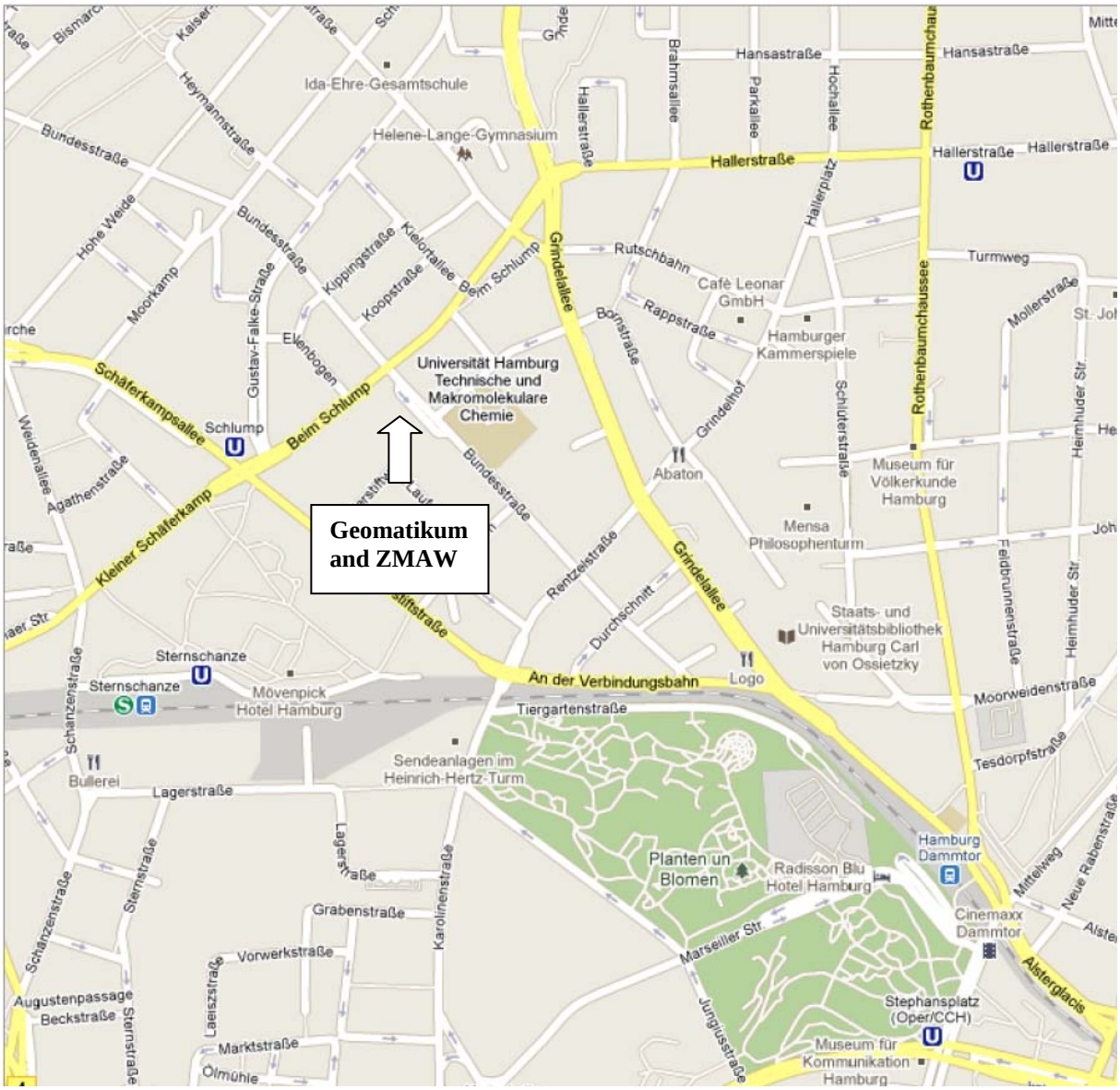
The joint student organizing committee explored the following shared topics:
1. Socio-economic and legal aspects of climate change,
2. Earth system analysis and modeling,
3. Biogeochemical cycling and ecosystems.
Furthermore, the student committee arranged for plenary overview lectures related to key socio-economic aspects, open natural sciences questions and support opportunities for young investigators.

This iniative is pioneering, and the meeting aims at supporting the networking of doctoral students in the field of integrated climate and earth system sciences in Northern Germany, transcending the bounds of individual disciplines and faculties. The assembly has the title ‘Integrated climate and earth system sciences in northern Germany’ and we expect it to advance the knowledge on earth system modeling and environmental biogeochemistry and to contribute to the development of innovative management strategies for sustaining environmental quality and ecosystem health in view of economic and social constraints.

Approximately seventy excellent contributions were submitted along the topics identified, addressing not only natural sciences but also economic and social issues which are crucial research on climate and the earth system.

We gratefully acknowledge the financial supported of the Excellence Initiative of the German Research Foundation and the University of Hamburg, and we wish you a fruitful meeting in our lively city.

Doctoral students, the Coordinators and the Head of SICSS, GLOMAR and ISOS
Hamburg, October 2010

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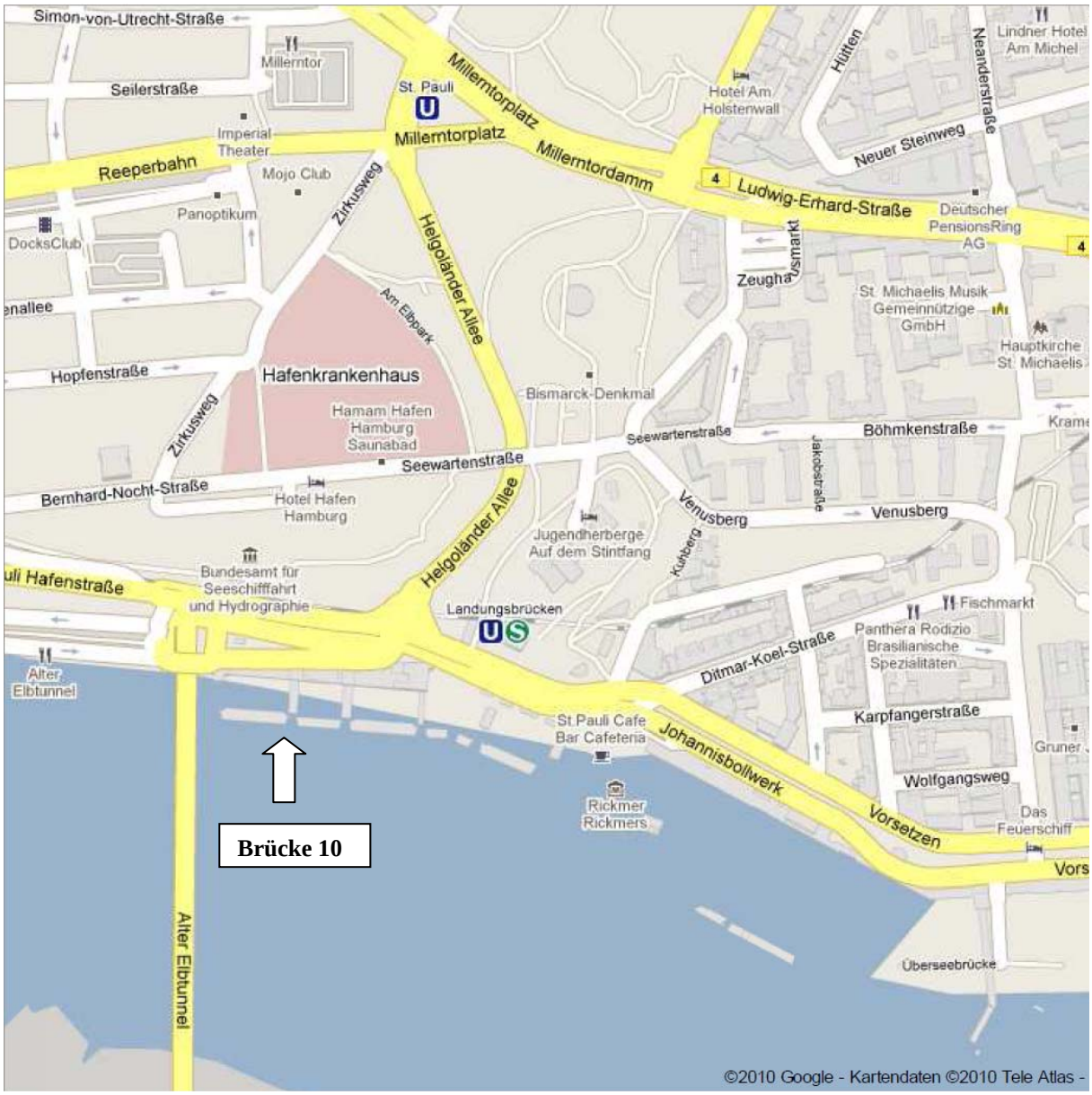
ZMAW, Bundesstr. 53, 20144 Hamburg




Landungsbrücken, Brücke 10, 20359 Hamburg

# Time Table
# and
# Conference Schedule

| Monday 04/10/2010 4:00pm – 10:00pm | |
|---|---|
| 16:00 | **PhD Student Registration and Mounting of Posters** |
| | **Geomatikum – Foyer** |
| 18:30 | **Get-together party** |
| | **Landungsbrücken, Brücke 10 – Boat „Frau Hedi“** |

| Tuesday 05/10/2010 9:00am – 11:00am | |
|---|---|
| 9:00 | **Welcome and introduction of the clusters and graduate schools** |
| | **Geomatikum – Lecture Hall H1** |
| 9:30 | **Keynote lecture "Why Climate Policy is so Difficult – An Economic Perspective" (Prof. Till Requate)** |
| 10:30 | **Coffee and poster session** |
| | **Geomatikum – Foyer** |
| | **Socio-economic and legal aspects of climate change** |
| | Human Dimension of climate variability: Vulnerability and adaptation strategies of small-scale coastal fishers in Bangladesh<br>*M. Mahmudul Islam*, Bremen |
| | Adaptation and adaptation intention to coastal flooding and sea level rise by risk area residents in Northern Europe<br>*Jana Koerth*, Kiel |
| | Spatial terrestrial pasts challenging contemporary coastal zone management - The case of the 'disappearing' Segara Anakan lagoon on Java, Indonesia<br>*Martin Christian Lukas*, Bremen |
| | Beyond hard protection: An anthropological perspective on emerging flood risk management practices in New Zealand<br>*Friederike Gesing*, Bremen |
| | Adapting to climate change – Lessons from the Peruvian anchovy fishery on how to cope with extreme climatic events and environmental variability<br>*Milena Arias-Schreiber*, Bremen |
| | Robustness and conflict potential of $CO_2$ emission scenarios<br>*Jana Peters*, Hamburg |
| | Power and Responsibility in Environmental Policy Making<br>*Wenke Wegner*, Hamburg |
| | Economic prospects of ocean iron fertilization in an international carbon market<br>*Wilfried Rickels*, Kiel |
| | Ocean Fertilization: The Public International Law Perspective<br>*Kerstin Güssow*, Kiel |
| | Assessing the spatial dynamics of small-scale fisheries of the Baltic Sea using geographic information systems<br>*Eva Papaioannou*, Kiel |

| Tuesday 05/10/2010 11:00am – 12:30pm | | |
|---|---|---|
| | **ZMAW Building – Room 022/023** | **Geomatikum – Lecture Hall H1** |
| 11:00 | **Biogeochemical cycling and ecosystems**<br>Chair: *Donata Banyte*, Kiel | **Earth system modelling and analysis**<br>Chair: *Anna Kloss*, Bremen |
| | The North Sea as a sink and source for atmospheric $CO_2$ – the difference between the Southern and Northern North Sea regimes<br>*Ina Lorkowski*, Hamburg | A multi-proxy End-Member approach for the detection of NW African Late Quaternary climate variations<br>*Janna Just*, Bremen |
| | Effect of seawater acidification on microbial community diversity – lessons from natural CO2 leaks<br>*Judith Neumann*, Bremen | The response of the Brewer-Dobson Circulation to a changing climate<br>*Felix Bunzel*, Hamburg |
| | A baseline for assessing the impact of global environmental change on bacterial communities in the arctic<br>*Christina Bienhold*, Bremen | Decadal Changes of Eddy Energy and Eddy Statistics<br>*Stravroula Biri*, Hamburg |
| | Seasonal and regional variability of phytoplankton blooms in the Scotia Sea – apllying SeaWiFS satellite imagery to the Southwest sector of the Atlantic Ocean<br>*Ines Borrione*, Bremen | Transport and pathways of the subpolar gyre inferred by integral methods<br>*Achim Rößler*, Bremen |
| | Sediments underlying the Peruvian oxygen minimum zone – source or sink for reactive nitrogen species?<br>*Lisa Bohlen*, Kiel | Validating Satellite Derived and Modeled Sea Ice Drift in the Laptev Sea with In-Situ Measurements of Winter 2007/08<br>*Polona Rozman*, Bremen |

| Tuesday 05/10/2010 12:30pm – 4:00pm | | |
|---|---|---|
| 12:30 | **Lunch Break** | |
| | **Geomatikum – Foyer** | |
| 14:00 | **Plenary lecture and discussion "Support of Young Investigators – DFG"**<br>**(Dr. Klaus Wehrberger)** | |
| | **Geomatikum – Lecture Hall H1** | |
| 14:45 | **"Young Earth System Scientists (Y.E.S.S.) – formation of a stable communication network"**<br>**(Florian Rauser, Sebastian Sonntag)** | |
| 14:50 | **Get a room!** | |
| | **ZMAW Building – Room 022/023** | **Geomatikum – Lecture Hall H1** |
| 15:00 | **Biogeochemical cycling and ecosystems**<br>Chair: *Ralph Rösner*, Hamburg | **Earth system modelling and analysis**<br>Chair: *Jonathan Durgadoo*, Kiel |
| | Sterile surfaces in bacterial suspension - a key to invasion success<br>*Sven Hammann*, Kiel | Discontinuous Galerkin Method for Computational Flow Modelling<br>*Nicole Beisiegel*, Hamburg |
| | Salt-marsh accretion in the German Wadden Sea<br>*Mark Schuerch*, Kiel | Pushing a 2d adaptive model to the third dimension<br>*Oliver Kunst*, Hamburg |
| | Investigation of soil organic carbon contents along a North-South transect in Northern Yakutia, Russia<br>*Sebastian Zubrzycki*, Hamburg | First steps for a simplified test-framework for cloud parameterization schemes<br>*Vera Schemann*, Hamburg |
| | Spatial variability of soil gas concentrations and methane oxidation in landfill cover soils<br>*Inga Röwer*, Hamburg | Ship emission influence on clouds: A study using MODIS retrieved cloud properties and reanalysis data<br>*Karsten Peters*, Hamburg |

| Tuesday 05/10/2010 4:00pm – 5:30pm | | |
|---|---|---|
| 16:00 | **Coffee and posters** | |
| | **Geomatikum – Foyer** | |
| | **Biogeochemical cycling and ecosystems** | **Earth system modelling and analysis** |
| | Effect of Ocean Acidification on the development of North Sea Cod larvae (Gadus morhua)<br>*Andrea Frommel*, Kiel | On the mechanism of the vegetation collaps in Northern Africa at the end of the African Humid Period<br>*Sebastian Bathiany*, Hamburg |
| | Lost in Migration – Preliminary results of tracking migration routs of European eels (Anguilla anguilla) in the Baltic Sea<br>*Enno Prigge*, Kiel | A multiproxy approach to investigate the contribution of terrestrial organic matter along the Italian shelf<br>*Arne Leider*, Bremen |
| | Retention vs. dispersal: population genetics in Antarctic Notothenioidei<br>*Malte Damerau*, Hamburg | Paleo- and rockmagnetic investigations of Late Pleistocene sediment cores from the North Pacific<br>*Lucia Korff*, Bremen |
| | Modeling the impacts of changing particle aggregation on organic carbon cycling<br>*Laura Bordelon*, Kiel | Holocene cold-water coral development in the Mediterranean Sea<br>*Hiske G. Fink*, Bremen |
| | BIOACID Subproject 5.1: Impact of Alkalinity flux from the Wadden Sea – First approaches of carbonate dissolution on the shelf<br>*Fabian Schwichtenberg*, Hamburg | Modern and Last Glacial Maximum vertical distribution of oxygen isotopes from the benthic foraminifera Oridorsalis umbonatus at the continental slope off Namibia (23°S)<br>*Anna Kloss*, Bremen |
| | Can we predict the response of marine primary production to global warming?<br>*Jan Taucher*, Kiel | An acoustic view of ocean mixing<br>*Tim Fischer*, Kiel |
| | Changes in coccolith weight and morphometry during the Holocene in the Azores region<br>*Christine Bauke*, Kiel | Diapycnal mixing in the tropical ocean's thermocline revealed by a tracer release experiment<br>*Donata Banyte*, Kiel |
| | Impact of large sulfur bacteria on the phosphorus cycle<br>*Sandra Havemeyer*, Bremen | Simulated response to Gulf Stream variability<br>*Ralf Hand*, Kiel |
| | Distribution and speciation of Zinc and Cobalt in the open ocean<br>*Oliver Baars*, Kiel | The Arctic hydrologic cycle and its variability<br>*Laura Niederdrenk*, Hamburg |

| Tuesday 05/10/2010 4:00pm – 5:30pm | | |
|---|---|---|
| | **Geomatikum – Foyer** | |
| | **Biogeochemical cycling and ecosystems** | **Earth system modelling and analysis** |
| | NADPH oxidases in Mytilus edulis and their role in ROS generation and innate immune responses<br>*Julia Saphörster,* Kiel | The 3D geometry of Pine Island Glacier, West Antarctica – a first step towards numerical flow modeling<br>*Nina Wilkens,* Hamburg |
| | Modelling the Life Cycle of Dinoflagellates - The Role of Life Cycle Transitions in Regulating Bloom Dynamics<br>*Alexandra Kroll,* Hamburg | Climate response to major volcanic eruptions in earth system climate models of different complexities<br>*Doreen Metzner,* Kiel |
| | Seasonality of surface and thermocline seawater recorded by Mg/Ca in single specimens of planktonic foraminifera<br>*Tim Haarmann,* Kiel | Rain Intensity Spectra Distribution Over Germany and Western Africa<br>*Mikhail Itkin,* Hamburg |
| | Using tetraether lipid proxies to reconstruct sea surface temperature in the eastern Indian Ocean<br>*Wenwen Chen,* Bremen | Evaluation of an air pressure based proxy for storm activity<br>*Oliver Krüger,* Hamburg |
| | Organic-geochemical proxy parameters of particles during their passage through the water column<br>*Andreas Basse,* Bremen | Climate Variability in China in an Ensemble Simulation for the last 1200 years<br>*Dan Zhang,* Hamburg |
| | Modelling feedback mechanisms between ocean biota and physics<br>*Sebastian Sonntag,* Hamburg | Evaluation of model results for Central and Eastern Siberia<br>*Katharina Klehmet,* Hamburg |
| | | Observation of megacity pollution from space – trends in tropospheric nitrogen dioxide ($NO_2$) in the Mediterranean and Middle East from satellite<br>*Andreas Hilboll,* Bremen |
| | | Calibrating an statistical Model of urban roughnes parametrization based on digital IFSAR height model (DHM)<br>*Thomas Langkamp,* Hamburg |
| | | Classification Scheme of Urban Structures based on climate characteristics designed for land use modeling applications<br>*Christian Daneke,* Hamburg |

| Tuesday 05/10/2010 5:30pm – 9:00pm | |
|---|---|
| 17:30 | **Evening lecture "Open questions related to our human-driven earth system" (Prof. Hartmut Graßl)** |
| | **Geomatikum – Lecture Hall H1** |
| 18:30 | **Joint dinner and Award ceremony** |
| | **ZMAW Building – Foyer** |

| Wednesday 06/10/2010 9:00am – 3:00pm | | |
|---|---|---|
| 9:00 | **Posters and Coffee** | |
| | **Geomatikum – Foyer** | |
| 10:00 | **Welcome Address by CliSAP** | |
| | **I. Earth System Modelling and Observation** | |
| 10:15 | Jin-Song von Storch (CliSAP) | STORM: a consortium effort on high-resolution climate change simulations |
| 10:45 | Thomas Slawig (Future Ocean) | Marine ecosystem models - optimization and validation |
| 11:15 | Stefan Mulitza (MARUM) | Variations in West African precipitation and dust mobilisation: Relation to orbital insolation, ocean circulation and human activity |
| 11:45 | SICSS Students | Wrap up and feedback of the previous PhD student conference day |
| 12:15 | **Lunch and Poster viewing** | |
| | **Geomatikum – Foyer** | |
| | **II. Regions and Processes** | |
| 13:30 | Alexander Löw (CliSAP) | Satellite remote sensing of essential water cycle components |
| 14:00 | Athanasios Vafeidis (Future Ocean) | Impacts of sea-level rise in coastal regions |
| 14:30 | Wolfgang Bach (MARUM) | Geological-biological interactions in the deep sea and their relevance in global biogeochemical cycles |

| Wednesday 06/10/2010 3:00pm – 5:00pm | | |
|---|---|---|
| 15:00 | **Coffee and Posters** | |
| | **Geomatikum – Foyer** | |
| | **III. Economics and Governance** | |
| 15:30 | Jürgen Oßenbrügge (CliSAP) | Urban climate research and governance |
| 16:00 | Daiju Narita (Future Ocean) | Damage costs of climate change through intensification of tropical cyclone activities: An integrated assessment model approach |
| 16:30 | Michael Flitner (MARUM) | Social-ecological research and nodal governance |
| 17:00 | **End of conference** | |

# List of Abstracts

## Why Climate Policy is so Difficult - An Economic Perspective

**Till Requate**

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A major source of the man made climate problem is the abundance of fossil fuel energy, while - contrary to what is often claimed - future shortage of fossil fuel energy is not a problem. In this lecture I discuss policy measures of German and European climate policy, inquiring mainly whether the ambitious goals the EU has set itself can be achieved via the instruments presently employed for the purpose and whether these instruments are efficient and effective at all. I also argue that even if European climate targets are achieved within the European territory, it is likely that these are offset through leakage in other parts of the world, e.g. China. I level criticism at energy policy measures, notably subsidization for renewable energy sources and the overlap with emissions trading. Further I argue that while 20% reduction of CO2 is feasible at a reasonable cost, derived targets such as a share of 20% of renewable energy and 20% efficiency increase are expensive and not necessary. I further argue that, even if more countries cooperate in climate policy, there is also an intertemporal leakage problem. My conclusion is that, instead of subsidizing existing inefficient clean technologies such as photovoltaic and others, resources should better be allocated to research of real new technologies to produce clean energy, but also on carbon capture and storage and other types of geo-engineering.

# Human Dimension of climate variability: Vulnerability and adaptation strategies of small-scale coastal fishers in Bangladesh

**M. Mahmudul Islam**

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Climate variability is assumed to pose significant risks to the livelihoods of coastal fishers. Though Bangladesh is globally cited as one worst affected country to the anticipated impacts of climate variability- still there is a lack of empirical study to link the vulnerability of coastal fishers to climate variability. In this paper we explore the nexus between vulnerability of fisher's livelihoods to climatic variability. For this, data were collected from two coastal fishing communities in Bangladesh using Sustainable Livelihoods Approach. The study assesses household and community vulnerability and their coping strategies with climate variability induced events. The study also argues that for enhancing adaptive capacity of coastal fishers in Bangladesh, it's urgent to create buffer against crises by realizing their capabilities.

# Adaptation and adaptation intention to coastal flooding and sea level rise by risk area residents in Northern Europe

**J. Koerth**[1], A. Vafeidis[1], H. Sterr[1] and A. Daschkeit[2]

1 Institute of Geography, Christian-Albrechts University Kiel, Germany

2 Federal Environmental Agency, Germany

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Climate change and sea-level rise are expected to lead to an increase of extreme flooding events. This increase might be combined with changes in the frequency and intensity of storms, thus leading to more frequent and higher storm surges in the coastal areas of Northern Europe. However the exact changes cannot be predicted. This uncertainty might be reflected in the risk awareness of the public. Experts are arguing for the need of adaptation to climate change at both public and private level. Anticipatory adaptation is cost effective and more efficient than reacting to natural catastrophes. Nevertheless, private anticipatory adaptation of vulnerable parts of the public in Northern Europe seems to be still the exception rather than the rule. This paper addresses the actual adaptation and adaptation intention to the risk of coastal flooding and sea level rise on a private level in two Northern European Countries: Denmark and Germany. A survey using a standardised questionnaire with closed response formats, addressed to risk area residents is conducted, which consists of three parts. The first part intends to quantify the status quo of anticipatory adaptation of risk area residents. Therefore, various options of private anticipatory adaptation are classified. This approach allows a differentiated view of adaptation, which varies in detail; Adaptation options are distinguished according to their costs and efforts in the two categories *soft adaptation* and *hard adaptation*. In the second part, three scenarios are designed in order to explore which adaptation options will be realized according to different possible futures. As a third part, the project intends to develop insights in the intention to adapt in the future and identify the influencing factors. The *Protection motivation theory* (PMT) by Rogers (1983, in Prentice-Dunn and Rogers 1986), which originates from the field of health psychology, is used here to design a questionnaire about such factors. According to PMT, self-protective behavior depends on risk perception or threat appraisal respectively as well as on the appraisal of adaptation or coping appraisal respectively. Demographic data and data, which refer to the housing situation of people, are also collected in order to clarify, which factors explain actual adaptation and adaptation intention in a better way. The theory and methods employed in this project are discussed and the preliminary results of the survey are presented, while a third poll will be carried out in Argentina.

# Spatial terrestrial pasts challenging contemporary coastal zone management - The case of the 'disappearing' Segara Anakan lagoon on Java, Indonesia

**Martin Christian Lukas**

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Social-ecological conditions and processes in coastal areas are often intricately linked to dynamics in their associated river basins. Understanding watershed dynamics and their linkages with coastal areas is therefore a crucial element of efforts towards the sustainable management of marine resources. This requires analysis of intricately linked physical and socio-political processes including their historical evolution. The Segara Anakan lagoon and its watershed on Java, Indonesia is a prime example illustrating how multi-scalar sociopolitical processes and related temporally shifting policy-determining discourses and spatially shifting interventions have produced particular challenges for contemporary environmental management.
With its variety of habitats and its high diversity in living natural resources, this mangrovefringed shallow coastal lagoon is not only ecologically highly valuable, but forms the economic backbone of many people in the adjacent villages. Riverine sediment input has drastically reduced the size of the lagoon, which, together with the overexploitation of marine resources, has forced local residents to shift from fishing to land-based livelihood strategies. While the lagoon has become a hotspot of research over the past decades, the historical dynamics of sedimentation and its drivers, which are situated in the river basin, have mainly been framed by simplistic socio-political narratives rather than comprehensive research, thereby constraining the effectiveness of related management interventions.
This paper explores historical dynamics and drivers of sedimentation, presents first findings of an ongoing analysis of land use changes and links these findings to contemporary management challenges. Results show that lagoon sedimentation, a natural long-term process, begun to accelerate about 150 years ago, reached a maximum during the 1980s and early 1990s and slowed down thereafter, the latter partly due to dredging. Land use change and the present spatial pattern of critical (erosion-prone) land, seen as a major cause for lagoon sedimentation, is partly a result of historically grounded land conflicts. These conflicts go back to the history of colonial forest management, spontaneous and state enforced migration of entire villages in the 1950/1960s in the frame of political instability triggered by the Communist and Islamic movements, repressive modes of state forest management during the New Order regime until 1997, and finally powerful revolutionary counter-movements of peasants, who, partly spearheaded by influential individuals from the forest administration itself, accessed, 'plundered' and started cultivating state forest land after the fall of the military regime. Acknowledgement of these historically grounded spatial patterns of 'critical' land is an important foundation for effective watershed management. However, the effects of upland conservation on lagoon sedimentation are a priori limited since sedimentation rates seem, except by technical means, impossible to be reduced to levels seen prior to agricultural reclamation of the lower river basin, which together with the increased frequency of volcanic eruptions since 1822 and land use dynamics has accelerated sedimentation. Understanding sedimentation as transformation rather than disruption might therefore be the best foundation for lagoon management.

# Beyond hard protection: An anthropological perspective on emerging flood risk management practices in New Zealand

**Friederike Gesing**

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Currently, there are several processes of change that interact and impact upon coastal protection strategies in New Zealand: so-called coastal change (changes in settlement patterns, gentrification, increased development and subdivision of coastal areas), climate change (sea-level rise and increased coastal hazard) as well as changing paradigms in coastal protection practices and policies. Like in some other industrialized countries as well, policy makers and planners in New Zealand increasingly accept the idea that it is technically not feasible to protect the shore through coastal armouring alone in the long run. Hard protection structures cause very high investment and follow up costs and have negative environmental and social impacts. Ongoing erosive processes in front of seawalls induce coastal squeeze and preclude public use of the beach (Jacobson, 2005). The preservation of the natural coastline in the interest of the wider public is now measured against the demand for protective structures by beachfront property owners. This renunciation of so-called hard protection measures will be starting point for a multi-local and multi-method ethnography of emerging coastal flood risk management practices in New Zealand. The anthropological research project concentrates on how coastal protection is negotiated by different actors in the field. The main focus will be on discursive understandings and practices about nature as they are important for understanding different coastal protection strategies and technologies. Three measures will be chosen:

a) hard protection: engineering firm
b) emerging soft/'hybrid' technologies: multifunctional artificial reefs, ASR Ltd., Raglan
c) dune restoration: Dune Restoration Trust New Zealand, Coast Care groups (volunteers)

The study will combine the main body of data gathered from extensive participant observation and semi-structured interviews with additional material like newspaper articles, grey literature/brochures and policy documents, including submissions and protocols from the ongoing review process of the main regulative framework in the area, the New Zealand Coastal Policy Statement (NZCPS).
Main objective is to figure out how coastal protection is negotiated, decided upon and carried out on a concrete, practical level. The focus of this study does not lie on an abstract, institutional level, but on everyday practices, informal processes of communication, networking and decision-making. Why are certain practices successful in claiming to be "state of the art" in coastal protection? What kind of discourses – especially those relying on certain understandings of nature, natural features and the natural character of the coast – back up certain techniques and policies to protect the coast? What role does "nature" as a concept play in defining the need for coastal protection measures in the first place? What role does the idea of managed retreat play as the ultimate opposite of altering the coast for the benefit of human use? How do coastal engineers, dune planting volunteers, scientists and other actors negotiate their perceptions of nature, coast, and protection?

## Adapting to climate change – lessons from the Peruvian anchovy fishery on how to cope with extreme climatic events and environmental variability

**Milena Arias-Schreiber**

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The Peruvian anchovy fishery is the largest worldwide in terms of catches. Starting during the mid 1950s, this fishery has been highly dependent on drastic natural stock fluctuations due to the sensitivity of pelagic fish to ocean-climate variability. Beyond seasonal changes, the fishery bears important yearly variability due to El Niño Southern Oscillation events (ENSO) which affect Peruvian coasts in irregular intervals and magnitude. Since the 1950s, three extreme ENSOs have been recorded in Peru in 1972-73, 1983-84 and 1997-98. This study presents a list of adaptations of the commercial anchovy fishery to the mentioned events in an attempt to improve the resilience of the fishing industry. Some coping strategies were attempted in 1972-73, however an evident reduction of impacts was mainly observed during the 1997-98 ENSO. The strategies included:
(a)instalment at several bays of fish reduction factories and unloading capacities strategically distributed along the Peruvian coast, allowing changes in fishing effort following stock migrations;
(b)opportunistic use of invading fish populations when anchovy is not available; (c)an adaptive management based on flexible formal institutions avoiding those legal instruments that could restrict or delay decision processes; and (d)reduction of market price uncertainty through massive investments of fishing companies in technology for quality improvement of fishmeal, and subsequent decoupling from soybean or other protein-rich substitutes prices. Although our list is not exhaustive, it presents a concrete example on how governments and societies can develop strategies to cope with uncertain change impacting the availability and supply of natural resources.

## Robustness and conflict potential of CO2 emission scenarios

**Jana Peters**

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Future climate change policy has to rely on projections from physical climate models. Those models need as input reliable CO2 emission scenarios, which are usually derived from socio-economic models assuming various evolutions of economic drivers and energy policies. The uncertainty inherent in both socio-economic and climate models has consequences for decision makers. This project investigates non-linear model uncertainty in emission-relevant socio-economic sectors on CO2 emission paths. Model uncertainty is related to the limited knowledge about structures, processes and the interaction of important variables.
Methodologically, robust control techniques will be used, which in contrast to stochastic control, seek to bound the uncertainty rather than express it in the form of a probability distribution. The core idea of robust control theory is to treat the decision maker's model (the baseline model) as an approximation of the true model and to derive a robust policy rule that works well for a set of alternative models. The alternative models are specified in terms of distortions to the shock processes in the baseline model. These distortions can feed back arbitrarily on the history of the states and thereby represent quite generally misspecified dynamics.
A first step in the analysis is an extension of the linear-quadratic model for the study of robust optimal emission paths. Further issues under investigation could be the impact of different emission certificate trade schemes, availability and acceptance of carbon sequestration and storage, individual response to new technologies, individual reduction of energy consumption and future development of nuclear power.
Additionally the implications of CO2 emission reductions on international security will be investigated.

## Power and Responsibility in Environmental Policy Making

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Efforts of creating an international regime which adresses the problem of global climate change have been under way since 1990. Governments had problems finding policies that concur with the request of electoral politics and at the same time satisfy the needs for global responsibility. Responses to the threat of global warming were the United Nations Framework Convention on Climate Change (UNFCCC) and the United Nation Convention to Combat Desertification (UNCCD). This paper will analyze the status of the parties involved in regulating climate conventions and treaties, and design instruments for allocating responsibility to them. In order to point out possibilities of allocating responsibility, the relationship between power and responsibility will be examined. By applying power measures, we estimate the potential impact of the various agents in these contractual or instrumental arrangements with the possibility to take a priori unions into consideration. To explain the relationship between power and responsibility, the set-based concept of freedom of choice will be combined with the agent-based concept of power. The paper will make use of this conceptual framework and discuss responsibility in the collective decision making bodies regulating the climate conventions and treaties refered above. In this study, we will consider the possibility of a priori unions within the sets of decision makers. For the UNFCCC the decision rule is a unanimity one and for the UNCCD there is a two-third majority decision rule. There are equal voting weights. Voting power and responsibility are thus equally distributed amongst the parties of the conventions if we abstract of a priori unions. We define ten a priori unions and apply corresponding a priori power measures. Depending on the decision topics the developing countries hold more voting power and therefore responsibility than the developed countries. Both conventions refer to responsibilities of the parties as common but differentiated responsibilities. There are convincing arguments that the primary responsibilities should fall to the industrial countries which is not reflected in our calculations. It seems that a possible solution for an adequate allocation of responsibility could be a reallocation in power.

# Economic prospects of ocean iron fertilization in an international carbon market

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To stay within the 2°C temperature increase target for climate change calls for ambitious emission reduction targets already for the 2012-2020 compliance period. Cost-efficiency is a crucial criterion for the enforcement of such ambitious targets, requiring analyses of all possible abatement options. Among others, enhancing the oceanic carbon sink by ocean iron fertilization (OIF) could be such an option. In our analysis we consider short-term large-scale OIF modeling experiments for a Post-Kyoto compliance problem to assess the economic prospects of OIF. Our analysis reveals that the critical unit costs per net ton of CO2 sequestered by OIF are in a range of 22 to 28 USD (price level 2000) assuming that the current limitations regarding the use of carbon credits generated in low cost countries and from forestation is completely relaxed. The critical unit costs are defined as those that would make an emitter indifferent between various abatement options. We are also able to show that already seven years of OIF in the area of 30◦ south provide the same amount of credits equivalent to a global forestation project for the duration of 20 years. Over all and from economic perspective, our results indicate that OIF can be considered as an additional abatement option, but, further research, especially on adverse side effects, is needed.

## Ocean Fertilization: The Public International Law Perspective

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As regards the perspective of public international law, the pertinent agreements dealing with the protection of the marine environment indicate that Ocean Fertilization (OF) is to be considered as lawful if and to the extent to which it represents legitimate scientific research. In this respect, the precautionary principle can be used to balance the risks arising out of scientific OF activities for the marine environment with the potential advantages relevant to the objectives of the climate change regime. As scientific OF experiments involve only comparatively small negative impacts within a limited marine area, further scientific research must be permitted to explore the carbon sequestration potential of OF in order to either reject this concept or integrate it into the flexible mechanisms contained in the Kyoto Protocol.

# Assesing the spatial dynamics of small-scale fisheries of the Baltic Sea using geographic information systems

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The safeguarding and sustainability of small-scale fisheries constitute central priorities in the process of ongoing institutional and legislative fisheries' reforms, on both an international and a regional level. In the Baltic Sea, coastal fish communities have long been recognized as important components of the marine ecosystem, while the small-scall fishery that targets the resource is an important income and employment generating sector, particularly for fishery-dependent coastal communities. This study aims to assess how the spatial dynamics of the Baltic small-scale fishing fleet and its economic benefits are affected by ecological and economic factors (such as habitat characteristics and fishing technology), using Geographic Information Systems. Assuming that the small-scale fishing fleet can be defined in terms of gear type, vessel size, and relative distance travelled to fishing grounds, a time-series database of small-scale vessels is created, allocating vessels per country and fishing harbour. Furthermore, logbook data (i.e. quantitative and qualitative data on the landings of the small-scale fishery) are analysed and related with respective fishing areas (ICES rectangles) and fishing harbours where the catches were landed. Then, the data are employed for the analysis of the spatial dynamics of the small-scale fishery. Finally, preliminary results generated within the context of commonly employed climate-change scenarios, enable a first-order assessment of the future distribution of the small-scale fleet and its catches.

# A multi-proxy End-Member approach for the detection of NW African Late Quaternary climate variations

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The continental margin off Gambia (W Africa) is an interesting study area because of its geographical location in between the present Inter-Tropical Convergence Zone (ITCZ) summer and winter position. We study a sediment core off the Gambia River mouth spanning the last 60 kyrs in order to identify different sources and pathways of terrigenous sediment components accumulating at the continental margin. Our aim is the quantification of terrigenous flux rates of fluvial and aeolian load, respectively to improve our understanding of palaeoclimatic conditions and climatic changes in the Sahel and Sahara. It is known that arid conditions prevailed in western Africa during glacials and North Atlantic Heinrich Events. After the Last Glacial Maximum (LGM) global climatic changes also dominated northern Africa (e.g. Heinrich Stadial 1, Bølling-Allerød Interstadial, Younger Dryas, African Humid Period). These climatic changes have already been documented in magnetic, chemical, mineralogical and sedimentological proxies, respectively. However, these investigations were mainly carried out in qualitative approaches and lack an integrated multi-proxy validation. We applied a multi-proxy approach using XRF-element data, environmental magnetic parameters and grain size analyses on 5 cm interval samples of sediment core GeoB13602-1 (13°32.71 N; 17°50.96 W). Separate End-Member (EM) analyses of IRM acquisition curves, elemental ratios and grain size distribution enabled us to unmix the bulk sample into different source components. Interestingly, besides major trends visible in the different EM models, some changes in the composition of these components (EMs) can only be determined by the integration of all models achieved by the different datasets. The grain size EM model reveals three EMs being responsible for the down-core variations, whereby two of them have narrow unimodal (8 and 45 µm, respectively) and one has a broad bimodal (1 and 4 µm) distribution. The IRM dataset can be represented by four EMs, where one is clearly a relict facies, due to the dissolution of iron-oxides while the other three represent primary sediment components. The EM model based on elemental ratios reveals just two distinct EMs.
We conclude that 3 EMs are necessary for describing the signal derived by the multi-proxy analysis. One EM stands for a dust source, which delivers more than 90% of the total sediment input during Heinrich Stadial 1. Its main characteristics are a coarse mode (45 µm), high Si/Al ratio, low Fe/K ratio and a high amount of high-coercive magnetic mineral content (most likely hematite). Two EMs represent fluvial sources (fine grain sizes, low Si/Al, high Fe/K) whereas distinct differences are observable in the magnetic mineral assemblages: During Bølling-Allerød Interstadial higher amounts of high coercive minerals (most likely goethite with respect to hematite) are present in the fluvial load, whereas during the times before the LGM both, magnetite and goethite are common. In contrast, during the African Humid Period magnetite is the prevalent magnetic mineral in the fluvial load. This change in magnetic assemblage gives access to more detailed implications about weathering conditions in the hinterland, since the genesis of iron-oxides in soils is, besides other factors, controlled by the availability of water.

## The response of the Brewer-Dobson Circulation to a changing climate

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The stratospheric part of the residual mean meridional circulation, which is also referred to as the Brewer-Dobson Circulation (BDC), is a main feature of stratosphere dynamics. Air parcels originating from the troposphere enter the stratosphere near the equator via tropical upwelling, and are then transported poleward. Having reached the mid-latitudes they start to sink, so that some of them reenter the troposphere after a relatively short time. Other air parcels, however, proceed traveling to high latitudes, where they eventually sink back into the troposphere. Passive tracers can be used to visualize this transport pattern, and thus provide the opportunity to obtain a measure of the strength of the BDC by calculating the mean age of stratospheric air. The BDC is expected to react to external forcing and, in particular, changes in the tropospheric state. In recent model simulations, increasing greenhouse gas (GHG) emissions were found to be a possible source for an intensification of extra-tropical planetary-wave forcing, leading to an increase in tropical upwelling and thus an acceleration of the BDC, as indicated by stratospheric age of air tracers. However, this result is not supported by measurements of the age of stratospheric air, which do not indicate any systematical change in the strength of the BDC over the past decades. Results obtained from three time-slice simulations performed with ECHAM5 in the T63L47 model resolution will be presented. The three different simulations were run with different sets of boundary conditions with regard to sea surface temperatures (SSTs) and GHG concentrations: preindustrial (1865), present-day (1990) and future (2045, scenario-based) conditions. Climatologies and trends of the tropical upwelling as well as for the age of stratospheric air will be presented.

# Decadal Changes of Eddy Energy and Eddy Statistics

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Altimetry is a mature and well understood technology. With the continuation of the TOPEX/POSEIDON mission through the JASON satellite series, we can now produce a continuous altimetry time series (15+ years) with high resolution measurements of ocean topography with a repeat cycle of 9.9156 days, from which we gain insight into many important aspects of the global and regional ocean circulation. We study the ocean eddy variability, with emphasis on temporal changes of eddy variability, underlying causes and processes. Here the goal is to investigate to which extend the eddy field of the ocean is reacting to changes in the atmospheric forcing, notably interannual to decadal changes of the wind forcing. A main goal is to investigate ocean variability and its interannual to decadal changes and to investigate the dynamical causes for changes in eddy variability. In general terms, ocean variability is dominated by mesoscale fluctuations on 20 to 150 days and 50 to 500 km temporal and spatial scales respectively. The forcings of mesoscale circulation are mainly instabilities from the large-scale circulation and interactions between currents, bathymetry and the direct forcing by the wind. Since eddies transport heat and momentum and interact with the mean flow field, it is important to understand eddy dynamics, their transport properties and their impact on climate.Enhanced SSHA variability can be observed, as seen in the results, in regions that correspond to major ocean currents such as the Gulf Stream current, the Brazil current, the Kuroshio current and the Antarctic Circumpolar current. Areas of enhanced sea surface slope variability are present in the Indian Ocean and along the South Pacific intertropical convergence zone. As seen in the spatial distribution of EKE and EKEsl areas with high eddy kinetic energy appear to coincide with regions of mean frontal structures. The time series of EKE and EKEsl show differences in the occurrence of maximum amplitudes of eddy kinetic energy. The former demonstrates the highest values around 1997 and around 2006, the latter depicts the first maximum a bit later around 2000 and around 2006. This difference can be explained due to the effect of the Tropics which in the first case is intensified. The temporal trend of EKE is intensified at the tropics as well as in regions of mean fronts. Negative temporal trend values are seen in part of the ACC zone in the North Atlantic and in the subtropics in the Pacific. The distribution is consistent with the one for EKEsl apart from the equator which in this case is neglected. The consistency of the spatial distributions of SSH variability, EKE and EKEsl suggests the influence of the wind stress. This effect coincides with the distributions described in Monahan (2006) fig. 2. Kinetic energy of the circulation system is strongly dominated by the geostrophic motions whose spatial structure can be controlled by a number of competing processes including atmospheric forcing, up and down-scale turbulent energy cascades, topographic interactions etc (Ferrari and Wunsch, 2009).

## Transport and pathways of the subpolar gyre inferred by integral methods

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The Subpolar Gyre of the North Atlantic Ocean is a crucial component for the climate relevant oceanic circulation. Warm and saline water from the subtropics enter the subpolar and polar regions, and subsequently return as the deep and cold limb of the Atlantic Meridional Overturning Circulation (AMOC). Model simulations hint to a relation between deep water formation, the strength of the Subpolar Gyre and the intensity of the AMOC . To measure the variability of the NAC and thus the strength of the Subpolar Gyre, an array of 4 inverted echo sounders with bottom pressure sensors (PIES) was deployed along the Mid Atlantic Ridge between 47° and 53°N in August 2006. The location of the PIES allows the separation of the main NAC pathways through the fracture zones. The data were retrieved by acoustic telemetry in August 2008, November 2009 and August 2010, while the array remained at the seafloor to complete its scheduled 5-year deployment period. The travel time measurements of the PIES are combined with hydrographic data from profiling Argo floats, and ship measurements to calculate time series of hydrographic properties and the transport variability relative to the reference level at 3400dbar. The horizontal bottom pressure differences are used to estimate the fluctuations at the reference level. The full four years of the transport and pathways time series will be presented.

## Validating Satellite Derived and Modeled Sea Ice Drift in the Laptev Sea with In-Situ Measurements of Winter 2007/08

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A correct representation of the ice movement in an Arctic sea ice - ocean coupled model is essentialfor a realistic sea ice and ocean simulation. The aim of this study is to validate the observational and simulated sea ice drift for the Laptev Sea shelf region with in-situ measurements of winter 2007/08. Several satellite remote sensing datasets are first compared to the mooring measurements and afterwards to the sea ice drift simulated by the coupled sea ice-ocean model. The different satellite products have a correlation to the in-situ data ranging from 0.56 to 0.86. The correlations of sea ice direction or individual drift vector components between the in-situ data and the observations are high, about 0.8. Similar correlations are achieved also by the model simulations. The sea ice drift speed of the model and of some satellite products have only moderate correlations of about 0.6 to the in-situ record. The standard errors for the satellite products and model simulations drift components are similar to the errors of the satellite products in the central Arctic and are in the range of 0.03 m/s. The fast ice parameterization implementation in the model was also successfully tested for its influence on the sea ice drift. The model drift simulation have contrary to the satellite products a full temporal and spatial coverage and results are reliable enough to use them as sea ice drift estimates on the Laptev Sea shelf.

# The North Sea as a sink and source for atmospheric $CO_2$ – the differences between the Southern and Northern North Sea regimes

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During the last 40 years, the North Sea was subject to anthropogenic influence due to eutrophication and acidification. Additionally, the North Atlantic Oscillation, with a strongly negative winter anomaly in the year 1996, effected the North Sea ecosystem and the marine carbon cycle.
We conducted a long term simulation of the marine ecosystem from 1970 to 2006 for the North European Continental Shelf. With the model ECOHAM4 we investigated a special aspect of the marine carbon cycle, the carbon shelf pump mechanism: Atmospheric carbon is taken up by marine phytoplankton via photosynthesis or due to physical or chemical mechanisms, vertically exported below the mixed layer and transported into the North Atlantic via lateral advection. This process occurs in the stratified Northern North Sea and thus this area is considered to be a sink for atmospheric $CO_2$, which was confirmed by our simulation. In the non-stratified Southern North Sea the remineralisation of organic matter occurs in the mixed water mass which is in contact with the atmosphere, thus the Southern North Sea is a small source for atmospheric $CO_2$. Our simulation suggests that the Southern North Sea switches between being a source and a sink for atmospheric $CO_2$ on annual basis. The mean uptake of carbon dioxide by the Northern North Sea was about 2.12 mol C $yr^{-1}$ $m^{-2}$, while it was -0.05 mol C $yr^{-1}$ $m^{-2}$ for the Southern North Sea. Since the area of the Northern North Sea is larger, the total North Sea is dominated by the northern part. The mean uptake of the North Sea was 1.31 mol C $yr^{-1}$ $m^{-2}$.
To estimate the effect of physical drivers on the air-sea flux of $CO_2$, we made a second long term simulation without biology. In this simulation the whole North Sea was a source of $CO_2$, mostly due to the input of carbon via the river systems. It became clear, that the air-sea exchange of $CO_2$ is mainly controlled by the sea surface temperature (SST), pH and the net ecosystem production (NEP). The annual NEP is positive in the Southern North Sea, while it is around zero in the Northern North Sea when the complete water column is taken into account. If the water column in the Northern North Sea is separated into the mixed upper 30 m, which is in contact with the atmosphere, and the deeper water, the NEP in the mixed layer is positive as well.
Assuming a superposition of physical and biological effects we subtracted the “physical” air-sea flux of $CO_2$ from the air-sea flux of $CO_2$ of the standard simulation to estimate the effect of biology. For the total North Sea the biology is responsible for the uptake of about 2.32 mol C $yr^{-1}$ $m^{-2}$ while it was 2.81 mol C $yr^{-1}$ $m^{-2}$ for the northern part and 1.48 mol C $yr^{-1}$ $m^{-2}$ for the southern part. This demonstrates the importance of the biological pump as part of the continental shelf pump of the North Sea.

# Effect of seawater acidification on microbial community diversity – lessons from natural CO2 leaks

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CO2 rich hydrothermal vents can be regarded as natural laboratories to investigate risks associated with mitigation strategies to climate change, as in the industrial process of CO2 capturing and storage (CCS) in the ocean. Some leakage sources are vent chimneys others are small cracks in the sedimentary seafloor, or diffusive transport of CO2 through the sediment. The highly concentrated liquid CO2 seeping through the seafloor induces a considerable decrease in pH from a background of pH 7.9 to pH 4 at the vents. Along this pH gradient from low to high CO2 concentrations, changes in macrofauna distribution occur (decreasing richness). Microbial communities on the other hand represent one the key levels for ecosystem functioning, but their short- and long-term structural and functional responses to changes in ocean pH are not well understood. We examined how natural gradients in pH and CO2 flux across the Yonaguni Knoll basin of the Okinawa trough influence benthic bacterial communities. Changes in bacterial community structure were analysed by community fingerprinting using ARISA (Automated Ribosomal Intergenic Spacer Analysis). Our data show a strong shift in benthic community composition along in situ pH gradients mimicking CO2 leakage.

# A baseline for assessing the impact of global environmental change on bacterial communities in the Arctic

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The Arctic Ocean is rapidly changing due to increasing temperatures and the loss of sea ice related to global climate change. These changes will affect physical properties of the Arctic Ocean as well as chemical and biological functions. Little is known about how Arctic communities may react to these environmental changes. Owing to the difficulties in accessing and working in the region, the Arctic Ocean remains largely undersampled, especially in regard to bacterial communities. We had the unique opportunity to establish a baseline study with samples from a sediment core archive from the year 1993 (RV Polarstern ARK IX/4), i.e. from a decade before the dramatic decline in sea ice. We examined changes in bacterial community structure in sediments along three transects on the Laptev Sea continental slope, covering water depths from 37 to 3427 m and encompassing ice-covered and ice-free areas. These data were also correlated with parameters of community function, such as biomass, enzymatic activity, respiration. Our results show that bacterial communities significantly change along the Laptev Sea continental slope. Bacterial alpha- and beta-diversity as well as enzymatic activity were strongly correlated to changes in phytodetritus input. The majority of significant relationships found between relative sequence abundances of individual taxa and phaeopigment concentrations were positive. Nevertheless we also found random and negative relationships of taxa with phytodetritus input, suggesting varying ecological adaptations between bacterial groups. Our results suggest that phytodetritus input is the main driver of bacterial diversity and activity in the oligotrophic Arctic deep sea. No significant correlations with ice cover were detected, confirming earlier hypotheses that algal sea-ice communities provide a significant amount of carbon to the deep sea. Our study provides first insights into the mechanisms that structure bacterial communities along the Arctic continental slope and will serve as a baseline for future studies trying to assess the impact of global environmental change on bacterial biodiversity in the Arctic.

# Seasonal and regional variability of phytoplankton blooms in the Scotia Sea – applying SeaWiFS satellite imagery to the Southwest sector of the Atlantic Ocean

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The islands of the Southern Ocean, the largest of the High Nutrient Low Chlorophyll (HNLC) regions, have an important role in favouring phytoplankton growth and bloom development. Concentrations of iron, which has been demonstrated to be an important limiting micronutrient, play a major role in regulating the intensity and location of these blooms; however, sea-ice melting, ocean circulation patterns and the "island mass effect" may as well help explain such striking events for a HNLC region. This study will focus on the Southwest sector of the Atlantic Ocean, specifically on the Scotia Sea; this region [52°W – 30°W; 48°S – 56°S] is included between the North and South Scotia Ridge, andbetween the Drake Passage and the South Sandwich Islands. The main coastal ecosystems are those of the South Georgia, South Orkney and the South Sandwich islands; also the Antarctic Peninsula is included in the domain. The natural dynamics of phytoplankton blooms in the Scotia Sea have been investigated by analysing SeaWiFS, 9km resolution monthly composites of chlorophyll-a concentrations. The retrieved 12-year satellite time series (1997-2009) shows a clear seasonal trend in chlorophyll concentrations, which start increasing in August. Maximum concentrations (> 3 mg/m^3) are detected between December and January after which bloom regions start shrinking in size, and chlorophyll-a concentrations return to the winter background concentrations. In this presentation we will also show how circulation patterns, bathymetry, continental shelves as well as the Antarctic Circumpolar Fronts are the major factors controlling the extension and location of these highly productive patches. The complexity of interactions between phytoplankton communities and the surrounding environment implies the need for more dedicated surveys and high resolution coupled physicalbiogeochemical models; the latter would provide further information regarding nutrient fluxes and physical processes, especially during the under-sampled winter season, and in the deeper layers not captured by satellite images.

# Sediments underlying the Peruvian oxygen minimum zone – source or sink for reactive nitrogen species?

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Oxygen minimum zones (OMZs) represent key regions for nitrogen (N) turnover in the water column as well as in the sediments. However, the redox dependent source-sink function of sediments for reactive nitrogen ($NO3^-$+ $NO_2^-$+ $NH_4^+$) is not well established. To address this issue, we studied benthic nitrogen cycling under different bottom water oxygen concentrations along a transect traversing the Peruvian OMZ at 11°S. In situ fluxes of nitrogen species across the sediment-water interface were measured using benthic landers and the sediment geochemistry was analyzed in recovered multi-core samples. The fieldwork was conducted through (80 – 400 m water depth) and beyond (700 - 1000 m water depth) the extension of the OMZ. The relative importance of different processes in the benthic nitrogen cycle was investigated using a 1D reaction-transport model tuned to the measured data. The reaction network included the release of ammonium during organic matter mineralization, nitrification and heterotrophic denitrification, as well as anammox. Nitrite was explicitly included in the model as an independent variable. Dissimilatory nitrate reduction to ammonium (DNRA) was also considered where mats of large sulfur bacteria were observed during towed camera deployments (~ 80 - 300 m depth). The model was able to simulate the measured pore water profiles as well as the benthic N fluxes determined from the in situ lander deployments and to decipher the responsible N-turnover processes: (i) at the upper fringe of the OMZ (~ 80 – 250 m), the sediments acted as a source of reactive nitrogen due to enhanced $NH4^+$ release, (ii) at the lower fringe of the OMZ (300 – 400 m), there was a net uptake of reactive nitrogen of up to ~ 1.9 mmol N $m^{-2}$ $d^{-1}$, and (iii) below the OMZ, reactive nitrogen fluxes into the sediments were low (≤ 0.5 mmol N $m^{-2}$ $d^{-1}$). The model further predicted that denitrification was the major control on $N_2$ production along the entire transect whereas anammox played a minor role (< 30 %). At the upper fringe of the OMZ, DNRA was driving ammonium release and determined whether the sediments were a net source or sink for reactive nitrogen species. In contrast, at the lower fringe of the OMZ organic carbon mineralization was the dominant process releasing ammonium. The relative importance of DNRA versus organic carbon mineralization for ammonium release varied systematically between these two end-members along the studied transect.

## Support of Young Investigators – DFG

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The Deutsche Forschungsgemeinschaft (DFG) is the main funding for basic research in Germany.
Promoting young researchers is a key element of our mission. The presentation will describe funding
opportunities for young investigators, with focus on
a) programs supporting early independence and
b) the excellence initiative.
Some personal remarks on stepping stones and stumbling blocks will conclude the presentation.

## Young Earth System Scientists (Y.E.S.S.) – formation of a stable communication network

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We propose to organize young Earth system scientists in an association / network, the Y.E.S.S. Association / Y.E.S.S. e.V.. The purpose of this association is to promote communication and networking across different graduate schools and focuses for now especially on the graduate schools present in the cluster meeting in Hamburg 2010.
We want to perpetuate communication as organized today by the graduate schools in form of a decentralized student-maintained e-mail-list and create a webpage that collects short biographical information of all members.
If successful in recruiting a relevant percentage of young Earth system scientists as organized by graduate schools in Germany we want to include our association into the international Young Earth Scientists (Y.E.S.) Network as the not yet existing German branch of this organization (http://www.networkyes.org/). The YES Network is an international association of early-career geoscientists who are primarily under the age of 35 years and are from universities, geoscience organizations and companies from across the world. The YES Network was formed as a result of the International Year of Planet Earth in 2007.
In our short presentation we will introduce the founding charter of Y.E.S.S. e.V. and discuss further options and details (e.g. yearly meetings, internal and external communication mechanisms, representatives for each school to recruit locally PhD students ...)
If you have comments, ideas or suggestions beforehand, please contact us:
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# Discontinuous Galerkin Method for Computational Flow Modelling

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Mathematical models using advanced numerical techniques are widely used for simulating geophysical phenomena like e.g. wave motion. For the development of hazard warning systems it is essential to eficiently obtain accurate simulations. Therefore much effort is spend on the creation of new models or improvement of existing ones. The overall goal of this study is the development of a new adaptive storm surge model based on the Discontinuous Galerkin (DG) method on triangular meshes. For generating the underlying mesh we use the well-established library amatos (see Behrens et al. 2005).
Space discretization is done with high-order nodal basis functions (polynomials) following an approach that was first introduced by Giraldo et al. in 2002 to receive a desired accuracy. This presentation will highlight some of the advantages that the DG method holds when being applied to hyperbolic problems and will give a brief discussion about an application to the shallow water equations. First results of simulations of propagating waves obtained with the current version of the high-order model will be shown.

Work under supervision of Prof. Dr. Jörn Behrens

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## Pushing a 2d adaptive model to the third dimension

**Oliver Kunst**

Modelling geophysical processes like e.g. the simulation of clouds often involves several scales in space. Clouds have a several kilometers extend, but the cloud boundaries have a very fine structure in centimeter scale. Adaptive grids are used to represent small scales and minimizing computational costs. The software library amatos helps to manage those adaptive meshes[3]. amatos2d uses an effcient meshing paradigm based on space-filling curves speeding up computation[1].
A. Müller from University of Mainz implemented an adaptive 2d simulation of a rising warm air bubble in amatos2d[5]. Now, the challanging task is to bring this model to the third dimension. A former version of amatos3d exists, but misses a lot of features compared to the 2d version, e.g. the space-filling curve approach. Surprisingly, the most convinient way is to add the third dimension to amatos2d.
The presentation gives a short introduction to the model problem and the steps needed to add the third dimension. It focuses on the meshing technique and shows why it could not be canonically applied to the third dimension[2][4].

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# First steps for a simplified test-framework for cloud parameterization schemes

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Clouds play a major role in weather and climate. Precipitation originates from them, and they strongly alter the planet's albedo depending on their microphysical characteristics. In numerical modeling of weather and climate it is therefore crucial to appropriately represent clouds in the atmospheric system. Different parameterizations of clouds are known to be one of the main reasons for uncertainties in up to date global climate simulations (Randall et al. 2007).The representation of clouds might be improved by a more detailed consideration of subgrid-scale variability. One approach to describe the total water subgrid-scale variability and calculate the cloud cover is the application of a probability density function. The probabilistic scheme (Tompkins 2002) implemented in ECHAM5/6 (Roeckner et al. 2003) uses the beta distribution and defines the function through total water mixing ratio, cloud water mixing ratio and two additional prognostic equations for the second and third order moments.
A first evaluation with satellite measurements showed differences between the observed and the calculated values of the moments of the beta distribution (i.e. skewness and variance, pers. comm. Torsten Weber). Because of these differences it is necessary to do a more precise and detailed evaluation of the scheme. One way to earn a better understanding of the behaviour of the scheme is to develop a framework of simple case studies. To find good testcases it is useful to formalize the expectations for perfect cloud cover schemes. Which behavior is important? How should a cloud process parametrization react to certain processes or evolutions? With these cases and different idealized situations the influence of single parameters and processes can be identified and studied. The currently ongoing work in this project is to develop such test cases and to evaluate and improve the Tompkins Scheme on the basis of the results. In the end, the project aims at the development of an improved statistical cloud scheme based on Tompkins 2002, which better represents cloud-related processes (e.g. radiation and precipitation formation) in global models. With regard to the new global model generation employing local grid refinements, such as the ICON model, beside the improved physics special attention is also given to the potential scale independency of the scheme.

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# Ship emission influence on clouds: A study using MODIS retrieved cloud properties and reanalysis data

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Clouds are of importance in the climate system because of their interaction with the hydrological cycle and the radiant energy flow. Anthropogenic activities come in hand with emissions of aerosols and aerosol precursor gases, making the quantification of their impact on cloud properties, e.g. cloud droplet number concentration, cloud lifetime or even cloud top height, a topic of ongoing research. Aerosol influence on cloud micro- and macrophysical properties are referred to as aerosol indirect effects and are subject to the largest uncertainties of all radiative forcing components of the Earth System when it comes to assessing human induced climate change.
Seagoing ships are the least regulated sources of anthropogenic emissions, burning lowquality residual fuels containing high amounts of sulfur or even heavy metals. Given that conditions for aerosol-cloud-interactions at the top of the marine boundary layer (MBL) are fulfilled, a certain number of emitted particles can serve as cloud condensation nuclei (CCN) , leading to aerosol indirect effects.
In this study, we use statistical analysis to investigate the ship emission influence on clouds by using cloud- and aerosol properties retrieved from measurements of NASA's two MODIS sensors aboard the satellites EOS-Terra and EOS-Aqua. We propose a new method to sample for regions in which ship emission influence on clouds can be observed. By this, pristine and polluted areas having similar meteorological conditions are selected using wind trajectory analysis. We use ERA-Interim reanalysis data to filter the data for large scale meteorological parameters like wind speed, boundary layer height and lower tropospheric stability. Filtering for these parameters is done in a way to control for as many cloud-occurrence determining parameters as possible. Having done so, the effect of ship emissions on clouds is more clearly depictable from satellite data.

## Sterile surfaces in bacterial suspension – a key to invasion success?

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Rather than being clean water, seawater is a dense microbial suspension with >106 prokaryotic and >104 eukaryotic propagules per milliliter. For best performance and development, most of these organisms require a solid/liquid interface. To this end, essentially every submerged surface gets immediately covered by biofilm-forming colonizers upon contact with seawater. Since biofilms may reduce individual fitness through decreasing motility and attractiveness or increasing shearing stress by water currents and infection risk by pathogens, marine organisms evolved to invest energy in reducing the number of surface-colonizers, and/or tolerating settlement and biofilm-formation. In this regard, animal defense mechanisms co-evolved with potentially colonizing microbes. By contrast, neozoa are confronted with novel microbial colonizers upon invading a new habitat, and are expected to be less well protected against surface-colonization.
Here we present results of a thorough screening of the umbrella of the invasive ctenophore *Mnemiopsis leidyi* for epithelial bacteria and archaea. Neither light- and electron-microscopic inspection nor PCR-screening for bacterial and archaeal DNA of 134 adult specimens from different collection sites in the Western Baltic revealed any hint on the presence of prokaryotes on the comb jelly's epithelium. A limited number of bacterial associates was evident from wholebody extracts of both juvenile and adult comb jellies. Their taxonomic diversity, however, was significantly lower in adult than in juvenile specimens, suggesting a maturation of anti-microbial defense upon ontogenetic development. While the mechanisms underlying the effective defense of *Mnemiopsis* against microbial colonization remain unknown, these findings stress the suitability of Ctenophora as a basal model for interactions of metazoans with their epithelial microbiota.
Based on our findings, we propose to make use of invasion events as natural space-for-time experiments on how (sym)biotic interactions change upon environmental change.

## Salt-marsh accretion processes in the German Wadden Sea

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Accretion processes on salt marshes are governed by various biological and physical parameters. Among the physical driving factors the inundation frequency and inundation height are thought to be the most important ones. Predicted SLR and a possible change of storm patterns might therefore impact the ability of salt marshes to survive predicted sea level rise.
Historic accumulation rates on a barrier-connected salt marsh on the island of Sylt were estimated by means of $^{210}Pb$ and $^{137}Cs$ analysis. Additionally, grain size analysis and measurements of organic carbon were conducted.
For the last 75 years accretion rates between 1 and 16mm $year^{-1}$, showing strong variations and extremely high values in the years 1982 and 1992, were measured. Comparison of these sedimentation rates with meteorological data for storm frequencies and storm intensities, indicate that salt marsh growth of mature marshes is strongly dependent on both, storm frequency and storm intensity.
An extensive analysis of tide gauge measurements at 'Hörnum Hafen' was conducted in order to simulate inundation frequencies and heights on the marsh platform for various scenarios of sea level rise and storm patterns. An existing numerical model is being modified and applied to investigate the consequences of these scenarios on the probability of a marsh to survive future sea level rise.

# Investigation of soil organic carbon contents along a North-South transect in Northern Yakutia, Russia

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## 1 INTRODUCTION

Permafrost-affected soils cover nearly one fourth of the terrestrial surface in the northern hemisphere. The estimations of their carbon pool vary from 15 to 30% of the global soil organic carbon. A huge amount of the carbon pool is permanently frozen and excluded from the atmospheric cycles. In the future, permafrost is likely to become a carbon-source, and formation of CO2 and CH4 will probably increase due to the predicted climate change with distinct temperature increase especially in Polar Regions.The knowledge of the soil organic matter pool is still poor for the cold regions of Russia. The estimation of the soil organic carbon pool dimensions in North-East-Siberian permafrost regions is the key issue of this project. During an expedition to Yakutia in 2009, investigations of several soil profiles have been carried out along a north-south temperature gradient to determine the quantity and quality of carbon stored in permafrost-affected soils of different vegetation zones from tundra to northern taiga.

## 2 INVESTIGATION AREA

The study sites were located along a north-south transect (73° - 69° N) on the western side of the Lena River (Fig.1). The climate in the investigation area is arcticsubarctic with continental influence and characterized by low temperatures and low precipitation. The mean annual air temperatures, measured in Tiksi (71°41'N/ 128°42'E) and Dzhardzhan (68°49'N/123°59'E) were -13.6 °C and -19.3 °C; respectively. The mean annual precipitation was 319 mm and 130 mm. The average temperatures of the warmest months August in Tiksi and June in Dzhardzhan were 7.1 °C and 14.9 °C, respectively. Warm summers are of vital importance for development of soils and vegetation.

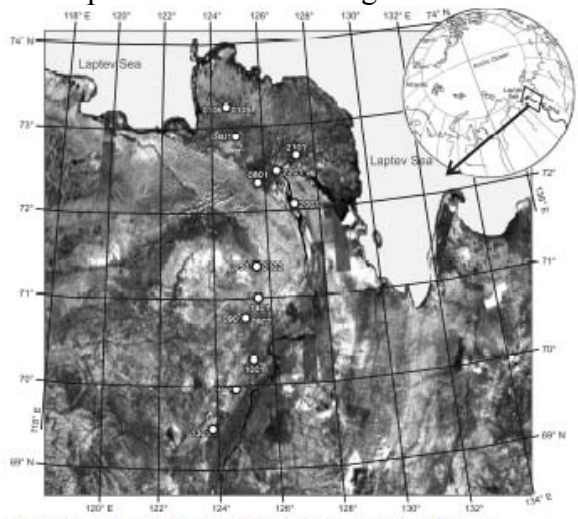


Figure 1. Map of the investigation area with study sites.

Table 1. TOC and pH values and C/N ratios counted per soil profile. Sorted by latitude - southwards. (TOC, N measured by Vario EL III, pH measured by pH-Meter CG820)

| Site ID | Latitude | Ø TOC [%] | Ø C/N | pH |
|---|---|---|---|---|
| 0105 | 73.2° | 4.19 | 16.55 | 4.95 |
| 0401 | 72.8° | 3.52 | 13.67 | 7.25 |
| 2101 | 72.6° | 7.10 | 16.68 | 4.73 |
| 2201 | 72.4° | 4.75 | 22.79 | 6.39 |
| 0801 | 72.3° | 10.96 | 18.28 | 5.21 |
| 2001 | 72.0° | 3.41 | 16.88 | 5.19 |
| 0501 | 71.3° | 41.34 | 21.66 | 4.19 |
| 1401 | 70.9° | 10.89 | 21.37 | 4.48 |
| 0901 | 70.7° | 37.94 | 29.72 | 4.32 |
| 1001 | 70.2° | 29.90 | 23.15 | 4.57 |
| 1201 | 69.9° | 43.43 | 25.63 | 3.68 |
| 1301 | 69.4° | 4.40 | 23.46 | 5.70 |

## 3 RESULTS, DISCUSSION AND CONCLUSIONS

The preliminary results shown below (Tab. 1) give a first impression of the extreme high carbon and low nitrogen contents of the different investigated soils. TOC contents and C/N ratios were higher at the southern than at the northern sample points. The pH values vary from 7.3 to 3.7. The presented data leads to a preliminary conclusion that increasing summer

temperatures have an effect on plants growth and the consequential accumulation of organic matter in soils whose decomposition and mineralization is poor. Further analyses will work out the influences of parent material and the different soil properties on the carbon content.

# Spatial variability of soil gas concentrations and methane oxidation in landfill cover soils

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**Introduction and study aims** Understanding the factors influencing gas migration in landfill cover soils is vital for defining design criteria for covers intended to enhance the microbial oxidation of landfill methane (so- called biocovers). Soil physical properties such as texture and bulk density determine the share of pores available for water retention and gas transport and are thus assumed to strongly impact gas migration. The exposition to methane and oxygen will further influence the oxidation capacity of the cover soil. Therefore, we expected a corresponding variability of the soil properties, of the composition of the soil gas phase, and of the magnitude of methanotrophic activity. The aim of this study was to describe soil gas patterns and to investigate the influence of soil properties and landfill topology on the landfill gas flow patterns, and, subsequently, on the spatial variability of the methane oxidation capacity of a cover soil of an old municipal waste landfill situated in the northwest of Germany.
**Methods** The description of spatially variable flow patterns of landfill gas was approached by mapping the soil gas concentrations using permanently installed soil gas probes. Factors influencing the flow patterns were studied by mapping methane oxidation activity using batch tests and by analysing soil properties retrieved from a soil survey and soil excavations.
**Results** The variability of methane oxidation capacity in the cover soil was high. High capacities concentrated at certain sections of the landfill, mainly the ridge and the steep slopes. So did the soil methane concentrations. High methane oxidation capacities in the topsoil were not necessarily found above high methane concentrations in the subsoil. The $CH_4$ oxidation capacities varied between 0.3 and 19.5 $\mu gCH_4\ gds^{-1}\ h^{-1}$ and, considering the actual gas load of 0.03 $gCH_4\ m^{-2}\ h^{-1}$ calculated according to IPCC tier-2 model (IPCC, 2006), the oxidation capacity for all analyzed samples clearly exceeded the flux to the cover. The topsoil was characterized by low electrical conductivities in soil water, neutral to slightly alkaline pH values, relatively low N and organic C contents. The soil probe survey down to 2 m depth in many cases revealed more than five layers, often with mixed substrates. Cohesive textures were mainly found at the slopes, while on the ridge sandy textures prevailed. Humus was found not only in the topsoil but also in deeper layers. At some positions waste was found only 50 cm below surface, while at other positions the waste body was not reached. We tested the relations between batch test methane oxidation capacities and the corresponding soil gas concentrations ($CO_2$, $CH_4$, $O_2$) at the different depths. Methane oxidation capacity was positively correlated to the methane concentration in 90 cm depth (r=0.42, significant on a 95 % level). Soil properties related to soil gas concentration were bulk density, air capacity and relative ground level. However, no regression model could be derived. Soil properties explaining increasing methane oxidation capacity were decreasing pH towards neutrality and increasing electrical conductivity. Sandy texture, decreasing water holding capacity and decreasing nitrogen contents insignificantly contributed to an increase in $CH_4$ oxidation capacities.
**Conclusions** Landfill gas migration is focused on distinct sections of the landfill. This spatial variability was not explained by the soil properties we analyzed. There was some evidence that bulk density and a mixed effect of cover thickness and texture increase flow resistance, which hinders gas migration. Lack of relations are most probably due to heterogeneity of the waste body as well as of the cover soil substrate, texture, compaction, and subsequent small

scale differences in air capacity and water saturation, which result in formation of fissures, cracks, and preferential gas flow paths, too localized to be detected using the sampling design we used. The spatial distribution of the methane oxidation capacity in the topsoil was partially explained by the presence of methane in 90 cm depth. However, there was no simple relation. The positive effect of decreasing pH on methane oxidation capacity seems to be a complex of methanotroph pH optimum, and of nutrient availability. Oxidation capacities derived from batch tests clearly exceeded the calculated flux. Thus, complete oxidation of the methane generated would be possible provided a uniform distribution of the gas over the entire area. However, emission measurements on the site show that methane is not completely oxidized, supporting that landfill gas migrates within locally confined regions, so called hotspots.

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Buendia, K. Miwa, T. Ngara, & K. Tanabe (eds.). IGES, Japan.

# On the mechanism of the vegetation collaps in Northern Africa at the end of the African Humid Period

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Many paleoclimatic records indicate a collaps of vegetation in the Sahara at the end of the African Humid Period (about 5500 years before present). Modelling studies have shown that this phenomenon may be interpreted as a critical transition that results from a bifurcation in the atmosphere-vegetation system. However, the impact of climate variability must be considered. So far, it has been argued, that large variability will cause intermittency (a flickering between the deterministic stable states), or even obliterate the deterministic equilibria completely, which would lead to only gradual decline in vegetation cover. In order to explain a vegetation collaps despite strong variability, low frequency variations in precipitation have been suggested.
To study the stability properties and the transition from the “green Sahara” to the desert state we coupled the Planet Simulator, an atmosphere model of intermediate complexity, to a simple vegetation model, VECODE, and we explain the results with conceptual models. These results are
1. that the number and nature of stable states depends on the way of coupling. Only if variability is suppressed via asynchronous coupling, multiple steady states emerge.
2. that the synchronous coupling (where variability is large) always leads to conditions similar to the green equilibrium. This is due to the nonlinear relation between vegetation dynamics and precipitation and the multiplicative nature of the noise.
3. that an abrupt decrease in vegetation cover is possible despite a strong and uncorrelated noise.
This results from a feedback between the mean and the variability of annual precipitation. The green state is stabilised via the mechanism indicated in (2.); however, as soon as dry conditions occur, the system cannot escape the desert state anymore because of reduced variability.

# A multiproxy approach to investigate the contribution of terrestrial organic matter along the Italian shelf

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Continental margins play an important role in the accumulation and distribution of autochthonous and allochthonous organic matter (OM). At the Italian shelf the major sources of terrestrial OM are the Po and Apeninne rivers. This is partly transported by the Western Adriatic Coastal Current (WACC) to the south. Additionally, the WACC carries nutrients of the northern river plume to the Gulf of Taranto. We intend to assess if the terrestrial OM can also be transported from the Northern Adriatic Sea into the southern Adriatic Sea & Gulf of Taranto on basis of a latitudinal grid of terrestrial and marine surface sediments, bulk sediment parameters ($\delta^{13}C$ TOC and C/N ratios), terrestrial lipid biomarker proxies (Branched Tetraether Index (BIT-Index), a proxy for fluvial soil input; plant-wax derived *n*-alkanes and their stable isotopic composition). Bulk sediment characteristics and the BIT-Index indicate that there is a restricted transport of terrestrial soil OM to the southern Adriatic Sea and Gulf of Taranto. Signals in plant-wax derived *n*alkanes in marine sediments correspond to terrestrial sediments in southern Italy, which indicates that terrestrial OM dominantly derives from local areas of southern Italy.

## Paleo- and rockmagnetic investigations of Late Pleistocene sediment cores from the North Pacific

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In the framework of the INOPEX (Innovative North Pacific Experiment) project, cruise SO202 to the subpolar North Pacific and the Bering Sea was successfully realized in summer 2009 with a participation of scientists from various countries. Altogether 50 deep-sea sediment cores were taken, delivering more than 830 m of sediment at a total of 45 stations between 38 and 60°N and 149°E to 149°W at a water depth up to 6150 m. The project INOPEX focuses on the application of a number of standard and new methods using a multi-proxy approach to gain a better understanding of the Pleistocene paleoceanographic and paleoclimatic development of this, yet poorly investigated region and its impact on the World ocean. These records will be correlated with climate records obtained from icecores (Greenland, Antarctica), other ocean basins and terrestrial sites (Siberia and Asia) to decipher glacial/interglacial forcing, propagation and amplification mechanisms. Sediment of the North Pacific contain mainly silicious biogenic material and, due to their great depth, often lack carbonate. For this reason magnetostratigraphic methods like Relative Paleointensity (RPI) for the younger and reversal-stratigraphy for the older cores are applied to develop age-models. A combination of rock magnetic methods gives an insight on the magnetic inventory of the terrigenous fraction. This data can support provenance-studies and identify changes in the paleoceanography, in particular the impact of climate change on the environment at regional and basin scales. Measurements of the Magnetic Susceptibility of all cores were already obtained on-board and can be used for core-correlations and preliminary age-estimations. The records show a variability within the cores ranging from very low values close to 0 in biogenic-dominated parts up to high values of more than 2000 [10-6 SI] in parts of the sediment cores which have a higher amount of terrestrial material. Some distinct layers which show higher values can be related to volcanic layers which can also be used to support and refine age models. First results of magnetic measurements are available for the piston core SO202-39-3, which has a length of 20.23 m and was taken at a water depth of 5102 m and the location 38°00.70’N, 164°26.78’E in the NW-Pacific ca. 2000 km E off Japan. The record of the core shows a sedimentation rate of about 2 cm/kyr and indicates that the core extends back to an age of about one million years, nicely illustrating the Bruhnes/Matuyama-Boundary and the Jaramillo-Event. Artificial and natural Remanence magnetisation reveal a distinct cyclicity, with some intercalated sections of very weak magnetization. The darker sediment-color within these horizons nourishes the assumption that they may result from early diagenetic processes leading to a partial dissolution of magnetic minerals. Further studies will address the question, whether these reductive conditions show a signal of a higher biological productivity or rather lower preservation due to a lack of bottomwater ventilation, how this is related to the hydrological, and in a bigger context climatic conditions and how these are connected to glacial-interglacial cycles.

## Holocene cold-water coral development in the Mediterranean Sea

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For a long time, it has been assumed that cold-water corals (CWCs) disappeared from the Mediterranean Sea (MedSea) in the course of the Late Pleistocene (Delibrias and Taviani, 1985). During recent cruises using manned submersibles and remotely operated vehicles (ROV), it could be documented that they currently thrive at various sites in the MedSea (Adriatic Sea, Ionian Sea, Sicily Channel, Gulf of Lions) (e.g. Freiwald et al., 2009). Radiocarbon-dating of CWCs collected in the Ionian Sea (eastern MedSea) even revealed that they were also abundant during the Holocene (Fink et al., in review).
A cluster of small-sized mound-like structures called 'Melilla Mounds' has recently been discovered along the Moroccan margin (Alboran Sea, western MedSea). Around 40 coral fragments, collected during ROV dives along this site and sampled from box and gravity cores, were radiocarbon dated. These dates revealed coral ages comprising the past 14 kyr BP. This finding confirms the data of the Ionian Sea corals and reveals that the Holocene occurrence of CWCs is rather a basin-wide than a local phenomenon in the MedSea. Finally, the coral records from the eastern MedSea revealed a distinct gap between two CWC growth phases spanning from 14-9.5 cal. kyr BP and from 5.9 cal. kyr BP to the present. This gap has been attributed to conditions of reduced oxygen concentrations at the seafloor (Fink et al., in review) related to the sapropel S1 event (9.8 to 5.7 cal. kyr BP) in the deep eastern MedSea (De Lange et al., 2008). A corresponding age gap was identified in the Alboran Sea. However, if those age gaps both root in the same processes still has to be investigated.

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# Modern and Last Glacial Maximum vertical distribution of oxygen isotopes from the benthic foraminifera *Oridorsalis umbonatus* at the continental slope off Namibia (23°S)

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Major reorganisations in the Thermohaline Circulation (THC) occurred in the Atlantic Ocean between the Last Glacial Maximum (LGM, 19-23 ka) and today. Here we present new data to determine the prevailing glacial water masses in the southeast Atlantic, and hence better constrain the glacial Atlantic THC. In order to reconstruct the modern and glacial vertical δ 18O distribution in the southeast Atlantic, we studied a depth transect at 23°S off N amibia, consisting of six gravity cores, seven surface samples and 15 bottom water samples. The samples cover a water depth of 600 m to 2730 m for the sediment samples and from 45 m to 2700 m for the water samples.
The LGM time slice was identified in each sediment core by radiocarbon dating. The oxygen isotopic composition ($\delta^{18}O_{calcite}$) of the epibenthic foraminifera *Oridorsalis umbonatus* (size 350-550 µm) was measured in the LGM time slices and in the surface samples. The $\delta^{18}O_{water}$ composition of the modern bottom water samples was measured and converted into $\delta^{18}O_{calcite}$. The high correlation ($R^2$= 0.83)between $\delta^{18}O_{calcite}$ values of modern foraminifera and of modern water samples indicates that *O.umbonatus* faithfully records the oxygen isotopic composition of sea water.
The modern vertical $\delta^{18}O_{calcite}$ profile indicates the presence of two distinctive water masses at the site: Antarctic Intermediate Water (AAIW) and North Atlantic Deep Water (NADW). During the LGM, deep waters (2000-2700 m) show higher $\delta^{18}O_{calcite}$ values (+0.84 ‰; corrected for ice-volume change) than during modern times. These values can be explained by a colder and more saline glacial deep water mass and suggest a higher influence of Antarctic Bottom Water compared to NADW during the LGM. Besides, shallow waters (700-950 m) show lower $\delta^{18}O_{calcite}$ values (-0.60 ‰) during the LGM than during modern times. This suggests the presence of warmer and less saline glacial intermediate waters, which is consistent with an increased influence of the AAIW in the southeast Atlantic during the LGM. These results add constraints on the distribution of intermediate and deep water masses in the southeast Atlantic during the LGM.

## An acoustic view of ocean mixing

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Knowledge of the parameter K (turbulent diffusivity/"mixing intensity") is a key to understand transport processes of matter and energy in the ocean. Especially the almost vertical component of K across the ocean stratification (diapycnal diffusivity) is vital for research on biogeochemical cycles or greenhouse gas budgets.
Recent boost in precision of water velocity data that can be obtained from vessel-mounted acoustic instruments (vmADCP) allows identifying ocean regions of elevated diapycnal diffusivity during research cruises - in high horizontal resolution and without extra ship time needed.
This contribution relates acoustic data from two cruises in the Tropical North East Atlantic Oxygen Minimum Zone to simultaneous field observations of diapycnal diffusivity: pointwise measurements by a microstructure profiler as well as one integrative value from a large scale Tracer Release Experiment.

## Diapycnal mixing in the tropical ocean's thermocline revealed by a tracer release experiment

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Oxygen supply pathways are investigated in the oxygen minimum zone releasing the tracer/ dye. Precise, time integrated, diapycnal mixing rates are obtained after comparing the tracer spread in water column during the two years.

## Simulated response to Gulf Stream variability

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Recent studies show, that the atmospheric effect of mid-latitude Sea Surface Temperature (SST) fronts connected to Western Boundary Currents like the Gulf Stream extends up to the middle and high troposphere. SST variability has a strong interseasonal to multi-decadal component connected to ocean dynamics in these regions; Thus a better understanding of these still poorly understood interactions might lead to improvements of mid-range climate prediction. In this work 2 experiments with the atmospheric general circulation model ECHAM5 are analyzed with focus on the atmospheric response to the Gulf Stream. The first experiment was a 5 member ensemble run forced with 138 years of monthly varying observed SSTs. Similar to observations it showed a distinct convective signal in the atmosphere over the warm flank of the SST front. Further it indicated that a large part of the atmosphere's interseasonal convective precipitation variability (up to 55% in summer) is connected to the boundary conditions. These findings formed the basis for the second experiment, a sensitivity experiment investigating the effect of a positive SST anomaly added to a climatological SST forcing in the Gulf Stream region.

## The Arctic hydrologic cycle and its variability

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The Arctic plays an important role in the changing global climate system. Due to enhanced moisture transport northward caused by particularly strong warming and increasing freshwater input given by Arctic rivers runoff the freshwater budget of the Arctic Ocean changes rapidly. Additionally, increased melting sea ice and glaciers lead to the following question: Can the Arctic ocean buffer this freshwater accumulation and how does this accumulation influence the decline of the meridional overturning circulation?
Different global general circulation models show remarkable differences in the behaviour of this freshwater accumulation. Either an increasing outflow is simulated or the total freshwater export remains almost constant. A main uncertainty is given by the resolution, e.g. of the Canadian archipelago, of such a global general circulation model.
For this purpose we set up a high resolution primitive equation global general circulation model MPI-OM with rotated poles (which leads to a resolution of about 15km in the region of interest) coupled with the regional atmospheric general circulation model REMO, which contains the full catchment area of the Arctic rivers. To close the hydrologic cycle of the Arctic a discharge model providing lateral terrestrial waterflows is included in REMO. The model is forced with atmospheric data from NCEP reanalysis and has been run from 1958 - 2007. As a first step the relevant processes for the hydrologic cycle of the Arctic are validated with reanalysis and measured data. The results of the hydrological discharge model are analyzed with respect to climatologies and changes within a seasonal cycle. First results of the hydrologic variability are presented.

## The 3D geometry of Pine Island Glacier, West Antarctica – a first step towards numerical flow modeling

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The Antarctic inland ice is flowing through ice streams and glaciers into ice shelves that fringe the Antarctic continent. In contrary to the East Antarctic Ice Sheet, the West Antarctic Ice Sheet rests on a bed that is mostly below sea level and slopes down from the edges towards the interior. This configuration puts it into a potentially unstable position: grounding line retreat may propagate fast inland and water might be able to drain between ice sheet and bedrock, lubricating the ice stream.
Observations have shown that one part of the West Antarctic Ice Sheet, the Amundsen Sea Embayment Area, is undergoing rapid changes. Pine Island Glacier, the worlds longest glacier, with its large drainage area of about 175 00 km2, has experienced acceleration, thinning and a retreat of the grounding line. In the last two years the acceleration is stagnant and questions about the feedback algorithm between its floating extension and the dynamics of the ice stream arise.
Numerical ice flow modeling approaches are needed to improve the understanding of the dynamics of this outlet glacier – ice shelf system. The general aim is to investigate the factors leading to these changes and their possible inter-linkage. This requires a full-Stokes model, as the shallow ice approximation is not valid in the vicinity of the grounding line, and high spatial resolution. As a consequence, the 3D geometry of the ice stream - ice shelf system is of major importance for a realistic flow modeling. Even though the changes in mass balance and surface elevation observed by means of remote sensing have let to increased numbers of field measurements on Pine Island Glacier, the still sparse data needs careful post-processing to assemble a geometry suitable for high resolution modeling in this area.
Here we present a consistent data set of the ice geometry and boundary conditions required for high resolution modeling of Pine Island Glacier. The horizontal margins are derived from TerraSAR-X radar imagery and surface velocities in the tributaries. ICESat surface elevation data and radio echo sounding data are used to generate the vertical geometry. We will compare the newly derived dataset with recently published digital elevation and thickness models.

## Climate response to major volcanic eruptions in earth system climate models of different complexities

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One of the most important natural causes of climate change are major volcanic eruptions as they have a significant impact on the Earth's global climate system, especially on the stratosphere and the troposphere, the atmospheric circulation and chemical composition. The direct injection of gases, aerosols and volcanic ash into the stratosphere has a strong and long lasting radiative influence, which leads to a global cooling of surface temperatures for years, probably decades (or even centuries).
To evaluate the climate response to major volcanic eruptions we use the Earth System Model of Intermediate Complexity (EMIC) CLIMBER by forcing it with a new radiative forcing data set comprising large Plinian eruptions from volcanoes at the Central Volcanic Arc (CAVA) over the last 200 ka. This specifically created radiative forcing data set is based on the “petrological method” and use information about strength and height of the volcanic sulphur injection (Kutterolf et al., 2008a,b).
Our first evaluation involves simulations forced with the assessed radiative forcing of the largest CAVA eruption (~700 Mt SO2) Los Chocoyos (84 ka). By comparing these runs with simulations of the best observed large volcanic eruption, the one of Mt Pinatubo in June 1991 (~17 Mt SO2), we analyze similarities and differences, which may be generated by complex relationships between the radiative forcing and the climate system. The same set of forcing is also used for simulations with the complex Earth System Model (ESM) from the MPI. Similarities and differences between the two different model runs will be used for a better understanding of the complex climate interactions after major volcanic eruptions. We consider global atmospheric effects, as well as changes in the ocean circulation, the carbon cycle and vegetation.

## Rain Intensity Spectra Distribution Over Germany and Western Africa

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Long-term climatological precipitation records derived from spaceborn sensors might contain regional biases due to different temporal satellite sampling around the globe. A large portion of measurements comes from the polar-orbiting satellites that have different revisit time for different latitudes. Thus in some areas less rain events might be captured than in others. Another possible source of errors is low sensitivity of modern spaceborn sensors to light rain events, which may contribute significantly to the total rainfall volume in higher latitudes. To analyze these possible biases it is necessary to know how well can we resolve precipitation diurnal cycle with data from polar-orbiting satellites and what is the fraction of low rain rate events.
In this work we analyze statistics of rain volume and rain occurrence over Germany and Western Africa as a function of the rainfall intensity. We also discuss regional and seasonal variations. Time series contain 15 years long time series with 1 hour temporal resolution over Germany and 3 years long time series over several catchment areas in Western Africa.
Our results show that on the average in Germany light rain events (below 1 mm/h) occur in 78% of the cases and contribute 49% of the total rain volume. Strong and heavy rain events (over 5 mm/h) occur in 1.4% of the cases but contribute 18% of the total rain volume. In Western Africa (Donga river catchment area) rain gauge records show different behavior: light rain events occur in 60% of the cases but contribute 10% of the total rain volume while strong events occur in 15% of the cases and contribute more than 70% of the total rain volume.

## Evaluation of an air pressure based proxy for storm activity

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Yearly percentiles of geostrophic wind speeds serve as a widely used proxy for assessing past storm activity. Here, daily geostrophic wind speeds are derived from a triangle of surface air pressure measurements and are used to build yearly frequency distributions. It is commonly believed, however unproven, that the variation of the statistics of strong geostrophic wind speeds describes the variation of statistics of ground level wind speeds. First, this study evaluates and validates this approach by examining the correlation between specific annual (seasonal) percentiles of geostrophic and of area maximum wind speeds to determine whether the two distributions are linearly linked in general. Second, the dependence of the linear link on the size of underlying surface triangles or on surface properties is examined.The strongest linear link has been found for small triangles and for triangles over sea.
Such investigations require long, homogeneous, and physically consistent data. As such dataare barely existent, regional climate model generated wind and surface air pressure fields in a fine spatial and temporal resolution are made use of. The chosen regional climate model is the spectrally nudged and NCEP driven REMO that covers Europe and the North Atlantic. Required distributions are determined from diagnostic 10m and geostrophic wind speed, which is calculated from model air pressure at sea level.

## Climate Variability in China in an Ensemble Simulation for the last 1200 years

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The temperature in China is simulated using the atmosphere-ocean general circulation model ECHAM5/MPI-OM for 800-2005AD subject to anthropogenic and natural forcings. The ensemble simulation which comprises five members is compared with available regional reconstructions. The comparison reveals weak consistency with long term anomaly periods known as the Medieval Warm Period (MWP), the Little Ice Age (LIA) and the Modern Warming (MW). Transient temperature anomalies in the Northeast, Southeast, and West China are detected up to centennial time scales.
The uncertainty of the simulations is assessed by the ensemble spread which varies on long time scales and shows some relation to decadal variability. In the beginnings of the 13th and the 19$^{th}$ centuries, which are characterized by high volcanic activity, the ensemble spreads decrease. The amplitude of the annual cycle since 1800AD is distinctly lower than during the MWP. Temperature variability shows a continuous power-spectrum with weak long term memory including an ENSO (El Nino/Southern Oscillation) signature and deviates from the nonstationary power-spectrum of the reconstructed temperature. The simulation underestimates variability on centennial time scales while the reconstruction of the mean in China underestimates variability on decadal time scales. The model shows enhanced precipitation during the LIA and a distinct decrease during MW. There is no evidence for a relationship between temperature and precipitation anomalies.

## Evaluation of model results for Central and Eastern Siberia

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In order to investigate climate change in Central and Eastern Siberia consistent data over long time spans are necessary. Due to a sparse meteorological station network and large measurement biases e.g. of precipitation observation data is limited in that area. Therefore, regional climate models are a good tool to provide additional information of various climate parameters at high spatial and temporal resolution.
The regional climate model COSMO-CLM is used with a grid mesh resolution of about 50 km for the whole area with focus on Lena-river catchment and Laptev-Sea and about 7 km for subregions (e.g. Lake Baikal). Boundary conditions are taken from NCEP reanalysis. To ensure that the model is able to reproduce climate in that region of the northern high latitudes different configurations will be tested for some periods.
The poster will present an evaluation of spatial and temporal characteristics of simulated temperature and precipitation in comparison to observation data. Since cryosphere plays a crucial role in determining regional climate special attention will be given to the ability of simulating snow and permafrost conditions as well. This knowledge will be used later on to run a climate reconstruction over that domain for the last 60 years.

# Observation of megacity pollution from space – trends in tropospheric nitrogen dioxide (NO2) in the Mediterranean and Middle East from satellite

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At the beginning of the 2010s, more than 50% of the Earth's population lives in cities. This ongoing urbanisation leads to increased growth rates of megacities. Their high traffic, energy use and industrial production make them hot-spot areas in terms of pollution.
To obtain long and consistent time series of atmospheric trace gases with global coverage, satellite instruments provide a useful tool. They prove to be invaluable to study the temporal evolution of atmospheric pollutants, as they allow to apply identical measurement techniques to all investigated regions, yielding comparable results.
In this study, we focus on tropospheric nitrogen dioxide (NO2) as a proxy for pollution over megacities. We provide a first investigation of tropospheric NO2 trends over megacities of the Mediterranean and Middle East regions in the time period from 1996 until 2009, drawing on a combined dataset spanning the GOME and SCIAMACHY instruments. Improved stratospheric correction and air mass factor databases
are employed. We observe very diverse trends over the considered cities, ranging from decreases of up to five percent per year (e.g. some western European cities) to increases of 10% and more per year (e.g. some Arabic and northern African cities), whereas some cities show no significant trend at all.
Notably, our findings show differing trends for summer and winter months. Generally, trends during the winter months tend to be considerably stronger by a factor of up to 3 compared to during the summer months.

# Calibrating an statistical Model of urban roughnes parametrization based on digital IFSAR height model (DHM)

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The very heterogenic surface of the city results in a large roughness that significantly alters the wind field in the city's boundary layer. Thus a highly resolved roughness mapping is needed for sufficient modeling of the urban climate in dimensions of city planing purposes. Today's state of the art roughness parameters are derived from land-use-data, but they do not represent the heterogeneity of urban surfaces at high resolutions. Most of those morphometric methods of urban roughness estimation are based on empirically derived functions of obstacle geometry parameters mostly based on idealized urban 3D models and thus have significant shortcomings. In this study we present the results of the calibration of a new approach based on the topology, statistics and texture of all real roughness elements. This method represents the roughness elements in a more realistic way by a Digital Height Model generated from side-looking Interferometric Synthetic Aperture Radar (IFSAR).
This state of the art remotely sensed high resolution data is available for Western Europe, the US, parts of Asia and the Caribbean.
A set of new angular dependent urban morphology parameters was developed and calibrated for suitability in improved high resolution roughness mapping. The results of the statistical models presented are for the city of Basel and for the city of Hamburg. They turned out to be significantly correlated with roughness measurements of a wind channel model and field measurements, but with different parameter configurations. One also correlates with the updated Davenport roughness classes defined in Wieringa (2001) for different urban building typologies, and with the extended urban typology scheme described in Daneke et al. (2010), based on the thermal climate zones defined in Stewart and Oke (2009).
Further calibration data with idealized regular obstacles and a validation of the models with another independent dataset is still to happen to implement it into a statistical downscaling process at the microscale. Further it is foreseen to integrate the resulting model maps of highly resolved urban roughness classes into dynamical regional climate models (mesoscale) for improved dynamical downscaling.

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## Classification Scheme of Urban Structures based on climate characteristics designed for land use modeling applications

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Urban morphology plays a large role in the alteration of the local climate. Different structures have different impacts on the wind, stored heat, Albedo and others, leading to the creation of an Urban Heat Island. The formation and existence of the Urban Heat Island has been studied for many urban areas and is widely known.
In order to further understand and analyze the creation of an Urban Heat Island and its impacts, different modeling approaches can be applied, for example using numerical mesoscale climate models. Currently numerical mesoscale models lack a sufficient representation of the different types of urban structures and the different impacts. In such models the heterogeneity of urban structures is displayed in a few classes and secondly it is assumed that the urban surface is static.
This talk / poster will present a classification scheme, based on a Thermal Climate Zone scheme designed for North American Cities and translated for a European City (Hamburg). The scope of the talk / poster is to demonstrate the differences between the different types of cities and the need for a European Scheme. Further, its use in urban system models is displayed and the necessity for land use models for numerical mesoscale climate modeling is discussed.

## Effect of Ocean Acidification on the development of North Sea Cod larvae (*Gadus morhua*)

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In a large, land-based mesocosm experiment (March to May 2010) at the marine facilities of the University of Bergen in Espegrend, Norway, the impact of $CO_2$ on the development of North Sea cod (*Gadus morhua*) eggs and larvae was tested. Newly fertilized eggs were reared for two months in twelve 2500L tanks in a flow-through system with natural seawater taken directly form the Bergen Fjord. Natural conditions such as light, temperature and salinity were maintained while the larvae were fed with natural zooplankton filtered from the fjord. Using a pH-controlled computer system, $CO_2$ was bubbled into the tanks at three different treatment levels (860, 1400 and 4000ppm) plus control. Larvae were sampled bi-weekly in the first two weeks and thereafter once a week, photographed for size and frozen for further biochemical analyses. First results from this experiment will be presented.

# Lost in Migration - Preliminary results of tracking migration routs of European eels (*Anguilla anguilla*) in the Baltic Sea

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Scientists are documenting a steep decline in both recruitment and stock size of the European eel (*Anguilla anguilla*) since the 1980s. Today, the stock is considered to be out of safe biological limits and *A. anguilla* has been listed in the red book of endangered species all over Europe. As a result of numerous most likely interacting factors, estimates of actual spawning stock biomass have been reduced to 2 to 12% and the abundance of glass eels to less than 5% of its level prior to the early 1980s.
In 2007 the Council of the European Union adopted a new regulation to establish measures for the recovery of the stock. One of the main targets is to allow 40% of the silver eels to leave continental waters and reproduce. However, up to date information on the success of the spawning migration of silver eels are sparse and numerous questions remain unanswered. We are currently trying to document migration routes of eels in the Baltic Sea by a mark-recapture experiment. Silver eels tagged with data storage tags (DST), recording pressure and temperature, and T-Bar anchor tags are released at the outlet of the Schwentine near Kiel. We are interested in whether or not formally stocked eels are capable of finding their way out of the Baltic Sea to continue their spawning migration towards the North Atlantic. Prior to the release of tagged eels, every individual eel is staged to clarify migratory motivation. In the last 2 years we tagged about 150 eels with T-Bars and 35 with DSTs. Despite the relatively small number of tagged fish we have already recovered 8 T-Bartagged eels and 2 DSTs.
This poster shows the first preliminary results of our tagging-experiment. Future work will focus on correlating migratory tactics with spawner quality to further improve predictions on silver eel escapement and migratory success.

## Retention vs. dispersal: population genetics in Antarctic Notothenioidei

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Since the cooling of the Southern Ocean approximately 25-20 Mio. years ago, the cold adapted notothenioids dominate the ichthyofauna on the Antarctic shelves and nearby islands in terms of numbers and biomass. Today, 121 notothenioid species are known and most are endemic (97%) to Antarctic waters. The majority are demersal as adults and therefore dependent upon the shelves.
Paradoxically, their development usually includes a protracted pelagic larval phase of several months up to more than one year. During this period larvae may be dispersed into the open ocean and away from shelf habitats by means of strong currents (e.g. the Antarctic Circumpolar Current, ACC). On the other hand, they may be retained in lee gyres in the vicinity of their spawning grounds. In this study, we compare seven notothenioid species with differing life-histories (*Chaenocephalus aceratus, Champsocephalus gunnari, Chionodraco rastrospinosus, Gobionotothen gibberifrons, Lepidonotothen squamifrons, Trematomus eulepidotus* and *T. newnesi*), which inhabit the South Shetland and South Orkney islands shelves in the southern Scotia Arc, to examine the role of larvae in population structuring. We use two types of genetic markers, mitochondrial DNA (d-loop, cytochrome b) as well as 6-10 microsatellites, in combination with data from drifting buoys to examine the genetic diversity within each species, genetic differentiation among island groups, and the amount and direction of gene flow between populations. Our results show that high-Antarctic species have a higher genetic diversity than lesser-Antarctic species and that the differentiation among populations from different island groups is low in all species. Drifter data suggests that pelagic larvae may be dispersed from the South Shetland onto the South Orkney sheIf within 45 days. Although 4 of 7 species showed only a reduced gene flow between island groups, a considerable amount of gene flow in the direction of the prevailing current system was apparent in the two species *C. aceratus* and *C. gunnari*. In contrast, the only cryo-pelagic species in this study, *T. newnesi*, shows a substantial amount of gene flow in the opposite direction against the current. We conclude that retention mechanisms must exist for pelagic larvae and that larval dispersal is highly species dependent. Cryo-pelagic species may use the underside of ice that forms in the winter to cross deep basins between shelf habitats.

# Modeling the impacts of changing particle aggregation on organic carbon cycling

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Increasing CO2 in the atmosphere and resulting ocean acidification have become important topics of study in recent years. While both phenomena are becoming increasingly documented, their effects on marine biogeochemical cycles are not well understood. Laboratory and mesocosm experiments have shown an increase in carbon fixation by marine plantkonic organisms (carbon overconsumption). This could be paralleled by a decrease in calcification and may result from ocean acidification. Both changes have the potential to alter the ratio of inorganic to organic carbon (PIC:POC) of natural particle fluxes in the water column. The PIC:POC ratio has been shown to have a major influence on the partitioning of carbon between atmosphere and ocean and it is suggested as one of the decreases of glacial/ interglacial pCO2 variability. Here we use an ocean biogeochemical model (PISCES) to assess the sensitivity of organic matter formation to ocean acidification and the consequences on particle flux and finally air/sea Co2 exchange. Our aim is to introduce a ballasting equation into the model grid so that the net effect of (1) carbon overconsumption (positive feedback) and (2) reduced ballasting (negative feedback) via particle fluxes on atmospheric CO2 can be quantified.

## BIOACID Subproject 5.1: Impact of Alkalinity flux from the Wadden Sea - First approaches of carbonate dissolution on the shelf

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The estimation of alkalinity flux requires reliable calculations of total alkalinity (TA) changes that depend on physical, chemical and biological processes. For budgeting of TA in the North Sea we applied the ecosystem model ECOHAM. We tested the mass conservation of TA in a single water column (1 m² x 40 m) as a 1D-simulation without atmospheric nitrogen fluxes by applying the model for fifteen successive years. The annual cycles of TA (2360-2367 µM), DIC (2110-2210 µM) and pH (7.95-8.12) show variations in a realistic range. This simulation was used as a reference for our sensitivity studies to find out the dominant biological processes concerning TA.
With ECOHAM we are able to investigate spatial-temporal patterns of possible carbonate dissolution above the lysocline on the shelf. In a first approach, we tested different methods such as the *ad-hoc* technique by Heinze et al. (1991) using thermodynamical parameters together with an overall dissolution rate or the algorithm by Jansen & Wolf-Gladrow (2001) who modelled carbonate dissolution in guts of copepods. The latter model dynamically simulates the dissolution by using our own zooplankton-module.
Within the scope of other simulations (including atmospheric nitrogen fluxes and benthic decalcification) near the boundary of the coastal North Sea to the Wadden Sea, data exchange will be carried out with subproject 3.4.1 “Micro-environmentally controlled (de-) calcification mechanisms”.
Therefore, examples of observations from Wadden Sea are presented. Furthermore, we aim for 3Dsimulations with different boundary conditions for the coast to obtain TA budgets

## Can we predict the response of marine primary production to global warming?

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Marine biological processes play an important role in the global carbon cycle through uptake of atmospheric CO2 by phytoplankton and subsequent transport of carbon from the surface to the deep ocean, a mechanism commonly referred to as the 'biological pump1. A number of studies have investigated the biological pump's sensitivity to climate-driven changes in upper-ocean nutrient supply and light availability. Although many biological processes are strongly temperature dependent and recent mesocosm experiments also suggest a strong direct temperature effect on marine ecosystem processes and carbon cycling, such direct temperature effects have not yet received much attention in global model studies. Here we employ a global Earth System model to demonstrate that direct temperature effects can play a dominant role in the response of marine ecosystems to climate change. Although direct temperature effects have little impact on the modelled net carbon export, carbon flow through the model ecosystem reveals strong sensitivities to the description of temperature in the model simulations. Dependent on whether biological processes are assumed temperature sensitive or not, simulated marine net primary production (NPP) decreases or increases under projected business-as-usual emissions over the 21st century. This suggests that changes in the supply of nutrients and light are not the only relevant factors to be considered when modelling the response of marine ecosystems to climate change. Even the direction of change in NPP cannot be predicted reliably without a better understanding of direct temperature effects on marine ecosystems.

# Changes in coccolith weight and morphometry during the Holocene in the Azores region

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Coccolithophores are one of the most productive calcifying organisms, playing a major role in the marine ecosystem as primary producers and in the global carbon cycle (Rost & Riebesell, 2004). Coccolithophores live in the surface layer of the ocean and their biogeography and abundance is controlled by parameters such as temperature, nutrient levels, thermocline depth and water transparency (Baumann et al., 2005).
In recent years, there has been a rising interest in the possible impact of ocean acidification on coccolithophores. Most of these studies rely on batch cultures and short-term experiments (see e.g. Iglesias-Rodriguez et al., 2008a; Langer et al., 2009; Riebesell et al., 2000). In these experiments, different results for increasing pCO2 were obtained. An increase in malformed coccoliths along with a decrease in calcification in some studies (e.g. Riebesell et al., 2000) is in strong contrast to the observation of no malformation and a rise in calcification of coccoliths in other reports (e.g. Iglesias- Rodriguez et al., 2008a). More recent studies have shown that the response to ocean acidification is strain specific with variable growth and calcification rates as a response to different pCO2 levels (Langer et al., 2009).
This raises the question, how can the natural variability in coccolithophore calcification be disentangled from effects related to ocean acidification? Up to now, however, hardly any studies on natural variability are available.
The history of coccolithophore calcification and its natural variability can be studied by analyzing coccolith size and weight from sediment cores. As part the project BIOACID (Biological Impacts of Ocean Acidification, funded by the German Federal Ministry of Education and Research) we investigated the natural variability of coccolith weight and morphometry during the Holocene as there are only slight changes in the carbonate system during the last 6000 years before the onset of human influence on the carbon cycle.
Here, we present the first investigations on changes in morphometry and weight of *Emiliania huxleyi* in a sediment core from the Azores region. The core GEOFAR KF 16 is located off the Azores (37°99.90'N, 31°12.83'E) in the North Atlantic at a water depth of 3050 m, on the northern rim of the subtropical gyre and therefore is characterized by stable climatic and environmental conditions.
Samples from the mid to late Holocene sequence of the core were analysed with the automatic recognition system SYRACO (Beaufort & Dollfus, 2004). These results will be compared with selected samples from other Holocene sequences within the North Atlantic.

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## Impact of large sulfur bacteria on the phosphorus cycle

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As limiting factors, phosphorus and nitrogen control primary productivity, thus affecting the carbon cycle and thereby indirectly also climate on earth. In contrast to nitrogen, phosphorus limits over geological time scales and therefore can be considered the ultimate limiting nutrient. Globally, the largest phosphorus pools are located in marine sediments that act both as sinks and sources for phosphorus. Phosphate is continuously removed from the pool of biological available phosphorus by phosphogenesis. This reaction results from an oversaturation of phosphate in sediment pore water, which leads to the spontaneous precipitation of phosphorus-rich minerals. Recent studies revealed a microbial impact on phosphorus sequestration, especially by polyphosphate accumulating bacteria in the sediment. Indications for an influence of sulfur bacteria on phosphogenesis were reported by Schulz and Schulz (2005). Furthermore, recent studies on a marine lithotrophic *Beggiatoa* strain revealed that sulfide and anoxia induced polyphosphate decomposition and phosphate release, which may mediate precipitation of phosphorus-rich minerals (Brock and Schulz-Vogt, in press).
In order to find out whether sulfide and anoxia are general inducer for polyphosphate decomposition and phosphate release in sulfur bacteria, we investigated *Beggiatoa alba* strain B15LD. *B. alba* is a close relative to the already studied marine lithotrophic *Beggiato*a spp., but is a heterotroph and inhabits freshwater systems. In the experiments with *B. alba* polyphosphate was not decomposed in response to increasing sulfide concentrations and anoxia. Instead, polyphosphate decomposition was stimulated by alkaline and moderately acidic pH. Hence, the trigger for polyphosphate decomposition and phosphate release differ within the genus *Beggiatoa*. These differences in polyphosphate usage could be either habitat dependent (marine versus freshwater habitats) or metabolism dependent (lithotrophy versus heterotrophy). In order to find a general pattern for polyphosphate usage in sulfur bacteria, other freshwater and marine strains with different metabolisms will be studied.

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## Distribution and speciation of Zinc and Cobalt in the open ocean

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We report the distribution and chemical speciation of the bio-essential trace metals Zinc (Zn) and Cobalt (Co) in open ocean seawater samples. For Zn we present the first time basin wide study in the Atlantic sector of the Southern Ocean (ANT24-3, 02-05/2008). Co is present at very low concentrations in oligotrophic waters and an in-depth speciation analysis of this trace nutrient is shown from the oligotrophic eastern tropical Atlantic (RV Meteor, M80/2, 11-12/2009).
In the case of Zn two north to south transects in the Atlantic sector of the Southern Ocean covered the major frontal systems along the Zero Meridian and across the Drake Passage. We discuss the effect of oceanographic and biological impacts on the distribution of Zn. Zn speciation was assessed using a combination of Anodic Stripping Voltammetry (ASV) titrations and pseudopolarography. Free Zn concentrations in the Southern Ocean were 3 orders of magnitude higher than previously reported values from the Subantarctic Zone and we were able to reveal the presence of ubiquitous inert organic ligands and their possible sources.
For Co speciation a modification of an existing catalytic cathodic stripping voltammetry (CSV) detection was developed. The new method represents an alternative to the conventional catalysis with nitrite opening a way around the large amount of nitrite salts needed (e.g. 0.5 mol/L) thus reducing the risk of metal contamination at increased sensitivity. Based on this method a comprehensive speciation scheme was designed for a process study to assess (1) kinetic, (2) thermodynamic and (3) redox aspects of natural Co compounds - all of which are of direct importance for the ability of primary producers to acquire Co. In near surface waters most Co was present as inert Co(III). A smaller fraction was reactive and likely to be associated with organic Co(II) complexes. In the upper water column Co(III) was reducible with the mild reductant Ascorbic Acid in contrast to deeper samples pointing towards the presence of more residual Co(III) compounds at greater depths.
We present new insights into the distribution and speciation of Zn and Co in the open ocean that improve our understanding of the biogeochemistry and bio-availability of these important micronutrients.

# NADPH oxidases in *Mytilus edulis* and their role in ROS generation and innate immune responses

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Life in diverse environments is coupled to the interaction of individuals and species living within. Especially marine filter feeders, such as the blue mussel *Mytilus edulis*, are constantly in close contact with the surrounding microbiota. To cope with pathogens, invertebrates solely seem to rely on innate immunity and lack an adaptive immune system. Several genes and principles of the innate immune system are highly conserved throughout the animal kingdom. Invertebrates may therefore be regarded as important models to identify and understand evolutionarily conserved mechanisms of immune responses. One important and phylogenetic early immune response is the production of reactive oxygen species to mediate immune responses and kill pathogens, generated by members of the NOX/DUOX NADPH-oxidases family.
To search for NOX/DUOX orthologs in *M. edulis*, transcriptomes of stressed and control *M. edulis* individuals were generated using massively parallel sequencing (454, Roche). Orthologs of NOX (*Myt*NOX1, *Myt*NOX2) and DUOX (*Myt*DUOX1, *Myt*DUOX2) enzymes as well as co-factors (*Myt*DUOXA, *Myt*gp22phox) were identified which show distinct expression patterns in different tissues of *M. edulis*. Functional analysis showed that upon incubation of hemocytes (the bivalves´ immune cells) with zymosan A, *Myt*NOX2 was upregulated within the first 30 min. The high expression of *Myt*NOX2 in hemocytes and an increase in expression after immune stimulation makes this gene a potent candidate to be a major factor of the ROS triggered immune response.
Further functional analysis consisting of Real-Time PCR, *in situ* hybridization and siRNA transfection will give more insights into the function of NOX/DUOX and their role in host-microbe interaction in marine bivalves. Hereby it will contribute to the understanding of the evolution of the innate immune system itself.

## Modelling the Life Cycle of Dinoflagellates - The Role of Life Cycle Transitions in Regulating Bloom Dynamics

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Dinoflagellates are microalgae frequently observed in coastal regions and shelf seas. Despite low growth rates, dinoflagellates can build up high biomass concentrations, which can hardly be explained by current model approaches. The transitions between planktonic growing cells and benthic resting cysts may play an important role in the formation and termination of the blooms. We have developed a numerical model that examines the regulation of dinoflagellate blooms by life cycle events. Our model distinguishes between different life cycle stages, for example, vegetative and resting cells. The transfer between the life cycle stages (en- and excystment) are functions of environmental conditions (e.g. temperature) and internal factors (e.g. maturation time). The model has been calibrated based on data from laboratory and field experiments for the dinoflagellate Biecheleria baltica and coupled to a water column model. We show that the model is able to successfully represent the seasonal cycle of dinoflagellates. This study allows to gain a better understanding for the underlying dynamics of dinoflagellates' bloom formation.

# Seasonality of surface and thermocline seawater recorded by Mg/Ca in single specimens of planktonic foraminifera

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The seasonal migration of large-scale wind patterns leads to strong seasonal differences in upwelling intensity and the structure of the water column in many regions of the oceans. Changes in upwelling can have dramatic impacts for climate (e.g. ENSO) and as such the reconstruction of seasonal variability is a prime objective for Paleoceanography. Planktonic foraminifera calcify over a period of up to one month and therefore the range of Mg/Ca temperatures obtained from single specimens potentially records the seasonality, provided that the selected species exists throughout the year. In order to test this, we analyzed Mg/Ca ratios of single foraminifera (*Globorotalia inflata*, *Globigerinoides ruber* pink and *Globigerinoides ruber* white) from a sediment trap off Cape Blanc (20°45.6'N, 18°41.9'W). We further evaluate various Mg/Ca temperature equations applied to single specimens of the respective species.
Sediment trap CBi-3 was deployed between July 2005 and September 2006 in a water depth of 1277 m. The location is in an area influenced by upwelling and exhibiting seasonal changes in water temperature with changing upwelling intensity. Hence, this trap is ideally suited to investigate if the seasonality of seawater temperature is recorded by single foraminiferal tests. Samples were cleaned using a flow through cleaning device. The main advantage of this method over routinely applied cleaning methods for bulk samples is that no material is lost, and that it therefore allows analysis of single tests.
*G. ruber* pink was collected throughout the year. Mg/Ca single shell ratios show a strong seasonality. We found that the calibration of Regenberg et al. (2009) is best suited in order to track sea surface temperatures (SST), while reconstructed SSTs using other calibrations are either too high (e.g. Anand et al., 2003) or too low (e.g. Elderfield et al., 2000). Using the Regenberg et al. (2009) calibration, highest Mg/Ca temperatures follow SST, while the lowest Mg/Ca temperatures suggest the deepest calcification of *G. ruber* pink at ~50 mbsl. Contrastingly, *G. ruber* white was in highest numbers collected between January 2006 and May 2006. During this time no SST-related-seasonality is apparent in Mg/Ca ratios. *G. inflata* (four chambered, apparently unincrusted) single shell Mg/Ca does not exhibit an apparent seasonality off Cape Blanc. Comparison of *G. inflata* shell Mg/Ca to water temperatures measured by CTD casts and to atlas temperatures reveals a habitat depth ranging between 60 and ~400 mbsl, coinciding with the depth of the seasonal thermocline

# Using tetraether lipid proxies to reconstruct sea surface temperature in the eastern Indian Ocean

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The tropics play a crucial role in modulating regional and global climate owing to their large heat and moisture storage capacity. The tropical Indian Ocean forms the major part of the largest warm pool on Earth, and its interaction with the atmosphere triggers important climate veriations on both regional and global scales. To date, numerous palaeoclimatic studies have focused on the tropical Pacific zonal sea surface temperature (SST) gradient-related shifts in convection, extending an El Niño-Southern Oscillation (ENSO) framework to interpret millennial-scale climate variability.
However, little is known about the past SST changes of the tropical Indian Ocean. We picked up a sediment core (GeoB10053-7) and sediment trap (Jam2) from the Indonesian continental margin off Java. We performed $U^{K}_{37}$ and $TEX_{86}$ (tetraether index of GDGTs with 86 carbon atoms) temperature proxies on a sediment core to reconstruct SST during the past 22,000 years. The average SST using TEX86 was 25.22°C, slightly cooler than SST derived from $U^{K}_{37}$, which is 25.60°C. And Discrepancy between the two SST-reconstrctions exists mainly in the earlier part of the record. Both proxies are generally assumed to represent annual mean SSTs. So far, we assume different seasonality and/or depth habitat of the processor organisms would explain the discrepancy between the records. Resutls from sediment trap show that the alkenones flux was declining from March to May, and rapidly increasing from May to November 2002, similar to the TOC. Trap studies show that most of the flux to the sediments occurs during the SE monsoon, when warm and dry air from Australia induce coastal upwelling in the study area.

# Organic-geochemical proxy parameters of particles during their passage through the water column

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In this study we compare $U^{K'}_{37}$-& $Tex_{86}$-derived SST estimates from samples of surface water particulate matter, sediment traps, in-situ pumps and surface sediment out of the NW-African upwelling system (Cape Blanc).

## Modelling feedback mechanisms between ocean biota and physics

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The marine ecosystem constitutes an important and active component of the global climate system. However, the direct effects of the marine biota on its physical environment have been only crudely parametrized or even neglected in climate models. Within the marine ecosystem in particular positively buoyant cyanobacteria play an important role. They can build up huge surface mats altering the oceanic optical and mechanical properties through changes in absorptivity, surface albedo and viscosity. These changes have a direct impact on the heat and momentum distribution and thereby affect ocean stratification and mixed layer dynamics as well as the general circulation, which all in turn affect marine biology.
In this work we study the effect of a changing phytoplankton community composition to one with higher abundances in surface buoyant cyanobacteria on the physical oceanic properties. Within the framework of the General Ocean Turbulence Model we set up idealized phytoplankton models taking into account the effect of biology on physics through changes in absorptivity and albedo. We perform several numerical experiments in order to quantify the resulting effects on oceanic mixed layer properties.
The simulation results show that an increase of surface buoyant phytoplankton can lead to substantial changes in temperature distribution affecting the dynamics of the mixed layer. Furthermore, first modelling results indicate that the effect due to altered absorptivity is larger than the effect due to changes in the albedo.

## Open questions in the Earth System dominated by us

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*Homo sapiens* is now the dominating species of the Earth system. We are beyond tolerable bounds for at least three issues: biodiversity loss, the globally disturbed nitrogen cycle and the enhanced greenhouse effect. My talk will concentrate on the synergistic consequences of the enhanced greenhouse effect and biodiversity loss as well as the attempts to reduce both these dominant environmental problems via the 1992 conventions of the United Nations and European Union directives, the latter following from these conventions. Then I will present decisions needed for a safe landing, which would result in a new energy system, but also involve changes of our personal life styles. I will finally pose some research questions that need to be answered in order to be able to decide more intelligently.

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