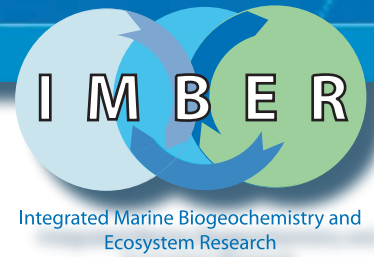


# IMBER *Update*



Issue No. 5 - December 2006

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## *Editorial*

## SIBER Workshop, 3-6 October 2006, Goa, India

*By Raleigh R. Hood and S. Wajih A. Naqvi*

The Indian Ocean (IO) remains one of the least studied and most poorly understood ocean basins. The atmospheric circulation in the region has many unique characteristics which stem in large part from the presence of the Asian land mass, and this forcing gives rise to a wide variety of physical, biogeochemical and ecological responses that are not observed in other ocean basins. The monsoonal forcing results in highly seasonal surface oceanic circulations throughout the northern IO, especially in the Arabian Sea (AS). The IO also has a unique equatorial circulation and thermal structure opposite to those found in the Atlantic and Pacific oceans, and as a result there is no strong equatorial upwelling signal or biological response in the east. Moreover, the IO experiences anomalous climatic events and perturbations such as the Madden-Julian Oscillation, Wyrski jets, and the Indian-Ocean Dipole Zonal Mode. All of these unique forcings have ecological and biogeochemical consequences, however, most of these consequences are not fully understood and many have not yet been characterized. One other unique aspect of the oceanography of the IO is that it contains one of the most intense oxygen minimum zones (OMZs) in the world oceans, but unlike the Atlantic and Pacific oceans, the IO OMZ is located in the north rather than occurring along the eastern boundary. This, again, is due to the unusual geographical setting, climate and circulation of the IO because of which the most intense upwelling anomalously occurs in the northwestern sector (off Oman and Somalia). The resultant higher subsurface respiration rates combine with limited oxygen supply (caused by the lack of local sources of deep waters) to produce near-total oxygen depletion within a 1 km-thick layer in the AS. This, in turn, leads to reducing conditions and several polyvalent elements are biologically transformed into their lower oxidation states. The most important among them is nitrogen, the easily bioavailable "fixed" forms of which (mostly nitrate) are converted to the inert gaseous forms (molecular nitrogen ( $N_2$ ) and nitrous oxide ( $N_2O$ )) by denitrifying bacteria. This makes the AS one of the most important sites of water column denitrification and an important source region of atmospheric  $N_2O$ .

IMBER is an international project of IGBP and SCOR

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International Council for Science  
Scientific Committee on Oceanic Research

In an effort to define the existing gaps in our knowledge, the SIBER (Sustained Indian Ocean Biogeochemical and Ecological Research) workshop was convened in Goa, India, October 3-6, 2006. The event, hosted by India's National Institute of Oceanography (NIO), included 4 days of presentations, posters and working group discussions with participation by more than 200 scientists from all over the world. The overarching goals of the workshop were: to review the state of our knowledge of the biogeochemical and ecological dynamics of the Indian Ocean; define the major scientific questions that need to be addressed; and formulate a plan for future inter-

national research in the IO. The other important motivation for the SIBER workshop has been the planned implementation of a mooring array in the IO as part of the CLIVAR/GOOS observing system. This basin-wide array is designed to study climate variability and oceanic response, and it will complement existing arrays in the Atlantic and Pacific oceans. This deployment provides a unique opportunity for leveraging long-term meteorological and physical measurements and mooring support cruises for making complementary ecological and biogeochemical measurements.

The presentations and working groups identified numerous gaps in our knowledge and defined

sozooplankton grazing in limiting phytoplankton production during the Southwest Monsoon (SWM) in the AS, that still remain to be tested. This is in contrast to the information from recent field and modeling studies, which suggests that low iron levels in surface waters may limit phytoplankton production during the late SWM in the western AS. Indeed, questions about the role of iron limitation extend over the entire basin; that is, it is probably reasonable to assume that the IO sector of the Southern Ocean is also iron limited, but there is very little information on Fe concentrations and/or Fe limitation further north.

Another interesting observation that is yet to be satisfactorily explained is that while the minimum oxygen concentration in the Bay of Bengal (BoB) is lower by no more than 2  $\mu\text{M}$  than that in the Arabian Sea, the BoB remains precariously poised at the denitrification threshold. What is the relative role of biological oxygen demand versus circulation in maintaining such subtle differences in the oxygen field but large differences in biogeochemical cycling and fluxes in the two basins? Another OMZ-related issue concerns the relative importance of denitrification and the anaerobic ammonium oxidation (anammox) in the production of  $\text{N}_2$ . Recent results of  $\text{N}_2/\text{Ar}$  measurements show a large excess of  $\text{N}_2$  over the amounts expected from the computed 'nitrate deficits'. To what extent this mismatch arises from anammox, degradation of non-Redfieldian organic matter, or other factors is yet to be fully resolved. Also unknown are the contributions of aerobic and anaerobic respirations within continental margin sediments, which according to some preliminary data, might be substantially different from other oceanic margins (e.g., low sulphate reduction rates). There is very little infor-



Over 200 scientists from all over the world attended the SIBER meeting in Goa.

several major scientific questions. For example, there is still a pressing need for carrying out first-order basin-wide descriptive science; that is, we need to better characterize and understand the many unique aspects of the IO circulation and the ecological and biogeochemical responses associated with the monsoon forcing and other phenomena like the Indian Ocean Dipole, the Madden-Julian Oscillation, Wyrтки jets, etc. There are major questions and hypotheses that emerged from previous studies (especially from the Joint Global Ocean Flux Study), such as the potential role of me-

national research in the IO. The seven workshop themes were: 1) atmosphere-ocean interactions, 2) nutrient cycling and limitation, 3) biological production and remineralization, 4) pelagic carbon cycling and air-sea exchange, 5) anthropogenic impacts, 6) benthic biogeochemistry and ecology and 7) future plans and technologies. The working groups, which were organized around these themes, were charged with summarizing the information that was presented, identifying scientific questions and making recommendations for future research.

mation available on benthic biogeochemical and ecological processes in the northeastern Indian Ocean (BoB and Andaman Sea) where there are broad shelves with high rates of organic matter loading from riverine sources. It must also be pointed out that the bulk (~60%) of the total global oceanic area of the continental margins exposed to natural oxygen deficiency ( $< 0.5 \text{ mL.L}^{-1}$ ) is found in the Indian Ocean, which in conjunction with the high population density and rapid economic growth in the surrounding countries, makes the coastal environments particularly vulnerable to anthropogenic perturbations. Finally, we still have an extremely poor characterization of rates of open ocean nitrogen fixation. There is tantalizing evidence from satellites, supported by the geochemical signatures (nitrogen isotopes and gas ratios), which suggests that  $\text{N}_2$ -fixation rates may be very high in the AS, the BoB and the southern IO, but the limited field measurements have shown much lower  $\text{N}_2$ -fixation than suggested by the isotopic data. Thus, while it is generally agreed that the IO plays an important role in global nitrogen cycle, including modulation of the oceanic nitrogen inventory on the geological time scale, we still do not have enough information to adequately quantify the fluxes involved.

Climate change and the carbon cycle are also major issues. The IO is warming faster than any other ocean basin and may therefore provide a sentinel for ecological and biogeochemical impacts of global warming in other ocean basins. There is also some evidence which suggests that the monsoon winds may be intensifying due to global warming. This is based on the satellite data which indicate that the upwelling and associated phytoplankton blooms during the SWM may be becoming more intense. Moreover, there are still

large uncertainties related to the role of the IO in the global carbon cycle. There is insufficient data to fully characterize air-sea  $\text{CO}_2$  exchange in the IO basin and there appear to be major discrepancies in some regions of the northern IO basin between the estimated air-sea carbon flux (i.e.,  $\text{CO}_2$  outgassing) versus the apparent net metabolic balance (i.e., net autotrophy).

Finally, the IO (primarily the BoB and the eastern IO rim) is subject to significant riverine injections, with globally significant annual freshwater discharges. The freshwater is accompanied by terrigenous inputs such as dissolved inorganic nutrients, dissolved and particulate organic carbon and other elements. Some of the highest rates of nutrient export inferred from global models are from watersheds in South Asia, a region that accounts for about 1/5 of the global synthetic nitrogen fertilizer utilization, and where the human population is predicted to increase

markedly over the next 50 years. The expected further increases in inputs of N and P to coastal ecosystems and consequent deterioration of coastal water quality will have a large impact on chemical fluxes and ecology of not only the coastal areas but well beyond the continental margins.

The Indian Ocean is, indeed, one of the last great frontiers for ocean biogeochemical and ecological research, and the SIBER workshop has provided crucial information that will allow us to summarize the state of our understanding and define the major questions that need to be addressed. The major planned workshop products will include a special issue and/or a monograph of research and/or overview papers that were presented at the meeting and ultimately a science plan for guiding future research in the IO basin. This plan will be developed with a view toward having SIBER develop as a major regional research program of IMBER.

## Science Highlight

### **The marine carbon cycle from North to South along the Galathea route: an ongoing project investigating the global carbon cycle.**

*By Katherine Richardson, Lone Thybo Mouritsen, Lise Lotte Soerensen*

In August of this year, a Danish research vessel embarked on a global 9-month research cruise: The Galathea Expedition. The cruise track can be seen at [www.galathea3.dk](http://www.galathea3.dk). Onboard are projects investigating a wide variety of topics related to the ocean, ranging in focus from viruses to whales and dealing with physical, chemical and biological processes. The largest project on the expedition, studying "The marine carbon cycle from North to South along the Galathea route", is a multidisciplinary effort focusing on obtaining a better understanding of the carbon cycle in the upper ocean and in the lower atmospheric boundary layer, and the role of the ocean in climate change.



This IMBER-endorsed project is compiling a global dataset describing the upper ocean processes controlling ocean-atmosphere carbon exchange, which will increase our understanding of how physical, chemical and biological processes in the sea influence the carbon dioxide (CO<sub>2</sub>) content of the atmosphere. The oceanic carbon reservoir is about 50 times greater than the amount of carbon stored in the atmosphere as CO<sub>2</sub>. Due to the intense gas exchange through the air-sea interface, oceanic carbon storage will ultimately determine future atmospheric CO<sub>2</sub> concentration. Today, oceanic carbon uptake amounts to about one-fourth of the anthropogenic carbon emissions and, therefore, the ocean helps reduce the rate of atmospheric CO<sub>2</sub> increase. As CO<sub>2</sub> is a strong greenhouse gas, this oceanic carbon uptake counteracts the climatic influence from anthropogenic carbon emissions. Predicting future rates of oceanic CO<sub>2</sub> uptake requires knowledge relating to the magnitude of oceanic carbon uptake today and processes regulating this uptake.

The marine carbon cycle is regulated through interplay among physical, chemical and biological processes. The fate of the biologically fixed carbon depends on the complexity of the food web. Large phytoplankton cells are normally efficiently transferred up a short classical food chain, while small phytoplankton cells, on the other hand, fuel a much more complex microbial food web. The biological pump, where carbon can be transferred from surface to deeper ocean layers, is believed to be most active in regions where large cells dominate. In this project, detailed studies of the structure of the food chain and related processes from the smallest algae to fish are combined with measurements of the CO<sub>2</sub> flux between the atmosphere and the ocean, and

information on the physical and chemical characteristics of the sea. So far, few studies have combined measurements of all three types of processes in order to describe atmosphere-ocean carbon exchange and no such studies have been carried out on a global scale using the same methods. Therefore, this study provides a unique opportunity to compare the roles and contributions of different ocean regions in physical, chemical and biological processes in the global carbon and nutrient cycles.

Over the entire cruise track, continuous measurements of salinity, temperature, chlorophyll *a* are carried out on surface water. In addition, point measurements are made, and samples collected, at different depths down to 4000 m. Parameters studied include salinity, temperature, bulk and size-fractionated chlorophyll *a*, nutrients, primary production, algae physiology (e.g., fast repetition rate fluorescence for determination of photosynthetic capacity of the phytoplankton) and plankton size and species composition, to provide information on the hydrographic

conditions and the biological activity deeper in the water column. Molecular studies and analysis of stable isotopes are used to assess the relative importance of nitrogen fixation compared with upwelled nitrogen in fuelling carbon flow in the pelagic foodweb and eventually carbon sequestration.

Remineralisation experiments are carried out onboard to evaluate the possible effects of changes in temperature and size composition of the particulate organic carbon pool on the export of carbon deeper into the water column. Net and pump collection of zooplankton, as well as trawling for zooplanktivore fish, are also carried out at selected intervals. On some transects, an undulating platform is towed from the ship to collect samples from 0 to 400 m.

The partial pressure difference between CO<sub>2</sub> in the atmosphere and CO<sub>2</sub> in the seawater is to be measured from Greenland in the north to Antarctica in the south. The measurements around Greenland show under-saturation of CO<sub>2</sub> in the cold Arctic waters, especially

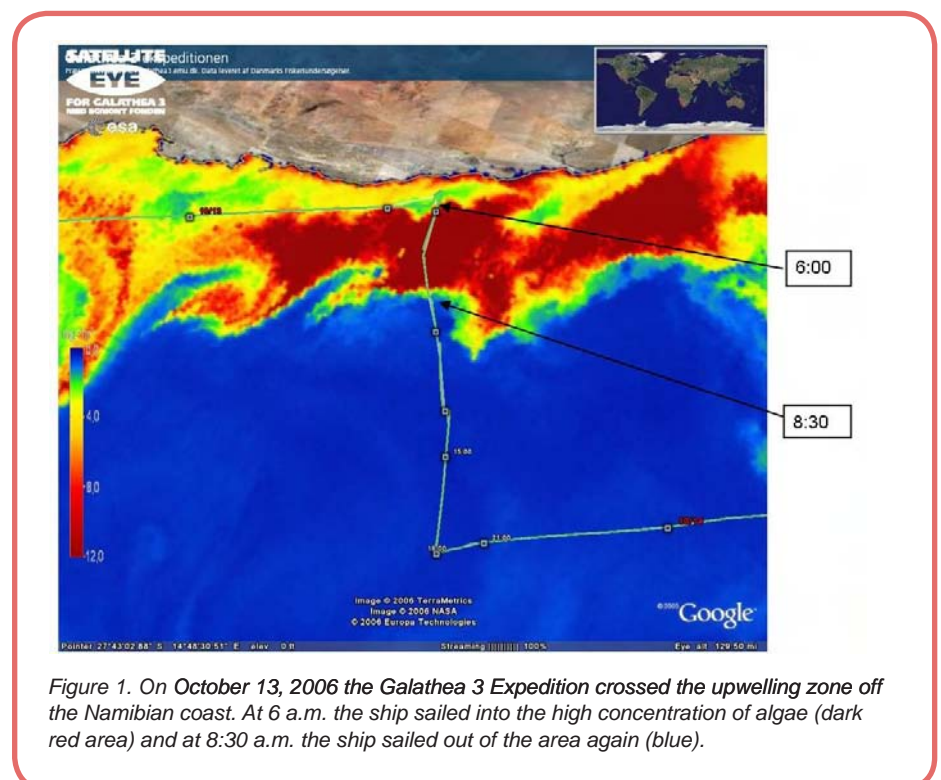


Figure 1. On October 13, 2006 the Galathea 3 Expedition crossed the upwelling zone off the Namibian coast. At 6 a.m. the ship sailed into the high concentration of algae (dark red area) and at 8:30 a.m. the ship sailed out of the area again (blue).

in the fjord systems, which have a high uptake of atmospheric  $\text{CO}_2$  due to under-saturation. The warmer waters around the equator are more or less in equilibrium with the atmosphere but upwelling zones are large emitters of  $\text{CO}_2$ . Following is an example of data obtained in an upwelling zone.

On October 13, 2006 the ship crossed the upwelling area off the coast of Namibia, where cold and nutrient-rich water comes to the surface (Figure 1). The upwelling water also has a high  $\text{CO}_2$  content. When this water reaches the surface, the pressure drops and it is warmed by the atmosphere. Warm water can contain less  $\text{CO}_2$  and, therefore, the emission of  $\text{CO}_2$  is high in this region and some of the highest values ever reported of  $\text{CO}_2$  partial pressure in the ocean ever reported (over 800  $\mu\text{atm}$ ) were measured in this area (Figure 2). In the "high algae concentration area" (the red area on Figure 1) we see that the partial pressure of  $\text{CO}_2$  decreases; however, there is still an out-gassing. The decrease is probably caused by uptake of  $\text{CO}_2$  by the large algae biomass. When the ship leaves the "high concentration algae area" (around 8.30 a.m.) the  $\text{CO}_2$  partial pressure measured in the water decreases to below the partial pressure of the atmospheric  $\text{CO}_2$  indicating that the ocean is taking up  $\text{CO}_2$  (Figure 2).

Each of the activities in the project involve expertise from research teams from various institutions, including Aarhus and Copenhagen Universities, The National Environmental Research Institute of Denmark and Risoe National Laboratory. The results from each of the activities are expected to provide new and important information related to processes influencing the cycling of carbon and the climate on Earth. However, the aim of this project is to combine

and coordinate results from different scientific disciplines to develop a comprehensive understanding of the interaction between the processes involved in the carbon cycle and the spatial variability on a global scale.

For further information contact proj-

ect leader, Katherine Richardson, at [Richardson@biology.au.dk](mailto:Richardson@biology.au.dk).

The project is financially supported by The Danish National Science Research Council, Nordea, The Villum Kann Rasmussen Fund (Denmark) and Knud Højgaard's Fund (Denmark).

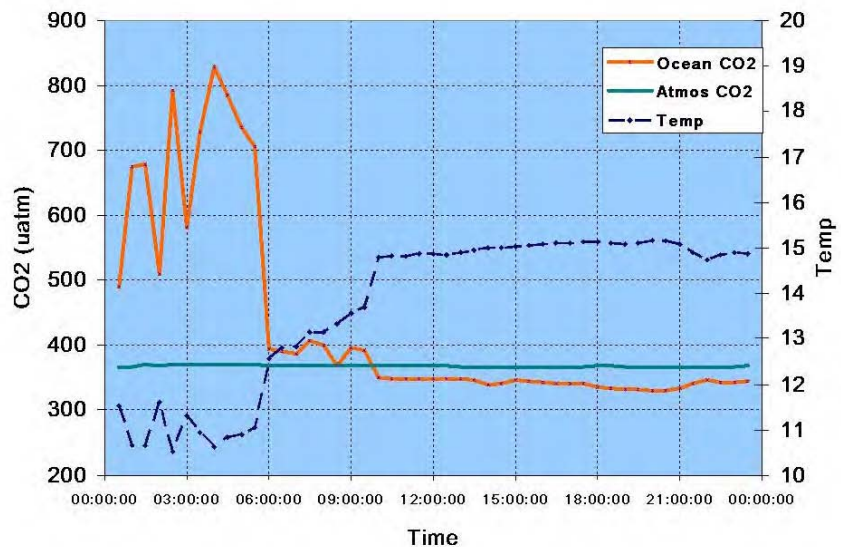


Figure 2.  $\text{CO}_2$  partial pressure from seawater (orange),  $\text{CO}_2$  partial pressure in the atmosphere (green) and temperature in seawater (blue) on October 13, 2006 when passing through the cold and nutrient-rich water of the upwelling area off the Namibian coast and into warmer nutrient-deplete water.



## The "Future Ocean": Cluster of Excellence now established in Kiel

<http://www.uni-kiel.de/future-ocean>

By M. Botros, C. Devey, K. Luchte, M. Lüning, U. Riebesell, R. Schneider, M. Visbeck, D. Wallace

As part of an initiative to promote excellence in research, the German federal and state governments have awarded the network "Future Ocean" in Kiel a grant of 36 million euros over the next five years. The group of more than 100 scientists participating in the proposal were able to succeed in a nationwide competition that involved a highly selective review process. "We are very pleased about the confirmation of the quality of marine science that we cover here in Kiel and look forward to a new and very dynamic development", said Klaus Wallmann, Speaker of the cluster and Professor at IFM-GEOMAR, Leibniz Institute of Marine

Sciences.

The oceans host our planet's largest ecosystem, help regulate the composition of the atmosphere and global climate, and provide us with essential living and non-living resources. Coastal regions are home to the majority of the world's population and the open seas are important for global trade and security. Today, this vital habitat is at risk, primarily because mankind has been altering the ocean in both direct and indirect ways on a global scale.

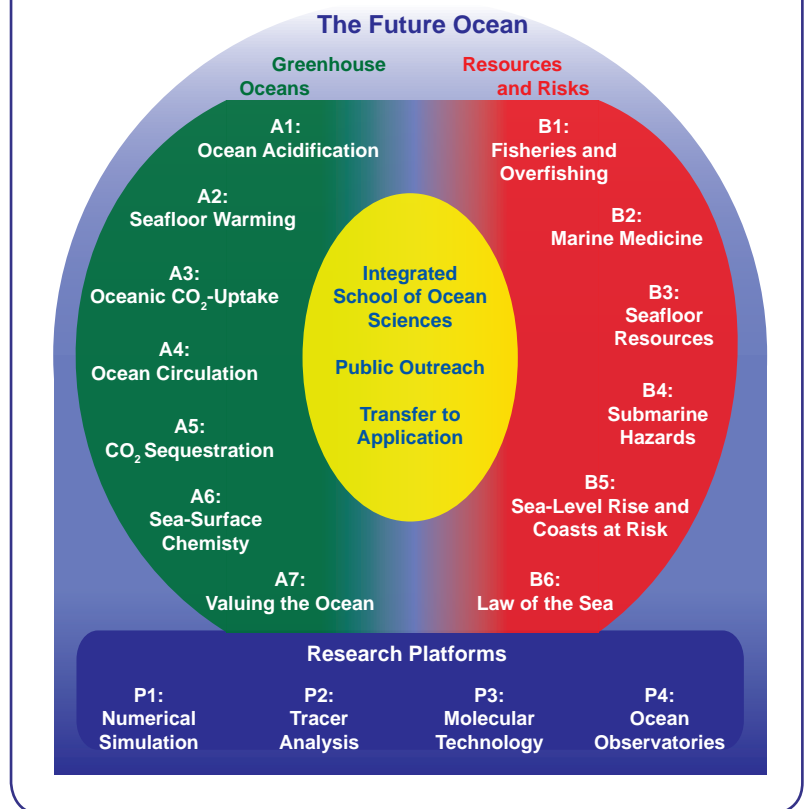
The "Future Ocean" Cluster at the Christian Albrecht University in Kiel (CAU) aims to (1) improve our understanding of ocean changes in response to human activities; (2) provide the scientific basis to develop, implement and assess sound global and regional ocean management options; (3) build our capacity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

The Cluster is fully integrated into the University of Kiel and will function as a virtual institute to strengthen multidisciplinary cooperation among several faculties of the University and the three partner institutes: IFM-GEOMAR, the Kiel Institute for the World Economy, and the Muthesius School of Art. A major impetus to achieve important scientific goals is the establishment of 14 new Junior Research Groups in key interdisciplinary areas (A1 - B6 in Fig. 1). The "Future Ocean" Cluster is currently inviting applications from interested candidates.

The new Junior Research Groups will address Cluster objectives in collaboration with the participating scientists following two main themes:

- **Oceans in the Greenhouse World:** The human-induced rise in atmospheric CO<sub>2</sub> will affect the ocean in two ways: increased surface warming and seawater acidification. These changes may, in turn, trigger major shifts in ocean circulation, ecosystem structure, marine carbon cycling, and exchanges with the atmosphere. These issues, as well as an evaluation of carbon abatement strategies, will be assessed by the Future Ocean Cluster through a highly multidisciplinary approach integrating climate sciences, oceanography, biogeochemistry, marine biology, geosci-

Elements of the "Future Ocean" Cluster consisting of the research topics grouped under Theme A: Greenhouse Oceans (green) and Theme B: Resources and Risks (red). The overarching activities are shown in yellow and the research platforms in blue.



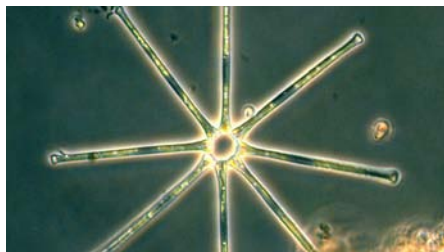
ences and economics.

- **Marine Resources and Risks:** The depletion of resources on land and the changing regulatory and geopolitical environment will lead to increasing pressure to develop marine resources in the future. Concomitantly, ocean change will have immediate implications for the exploitation of marine resources and will increase the likelihood of hazardous and extreme events. This will lead to both new opportunities and new risks for the growing world population. The Future Ocean Cluster will combine natural sciences with medicine, economics, social sciences and law to explore these opportunities and risks in an integrated approach.

Since launching of the "Future Ocean" network in November 2005, participating scientists in Kiel have risen to the challenge of establishing a new level of cross-disciplinary collaboration that addresses the full breadth of research topics related to oceanic processes and their future development. Rarely have experts from such a wide range of disciplines and proven excellence merged to focus on questions of key relevance to society. The scientists in Kiel are hopeful that new avenues of research will emerge from the multidisciplinary cooperation. Based on this



innovative approach, the Future Ocean Cluster will be able to better assess the chances and risks associated with oceanic change and provide sound guidance to both decision makers and the general public.



*The diatom Asterionella bleakley. Photo: A. Stuhr, IFM-GEOMAR.*

Cluster research will be supported by four fundamental research platforms (P1 - P4 in Fig.1). The platforms will offer a wide range of services including numerical expertise, ocean modeling, and super-computer support, isotope and trace element analysis, access to high-throughput molecular analysis facilities, and cutting-edge marine technology to explore and observe the global ocean in space and time from the oceanic crust to the air-sea interface. The Cluster platforms permit the more efficient use of resources and will be further developed and strengthened according to the scientific needs of the Cluster. The multidisciplinary approach of the "Future Ocean" Cluster will be complemented by an integrated educational program in ocean sciences.

The Christian Albrecht University in Kiel and IFM-GEOMAR are proud of having a long tradition of excellence in marine science. The "Future Ocean" Cluster will build on the existing infrastructure by forming a consortium of more than one hundred scientists, including 66 full professors, from six faculties. Together with the partner institutes, this initiative will further broaden and strengthen the CAU's profile as a leading European university in ocean sciences.

## Working Groups

### Joint IMBER/LOICZ Continental Margins Open Science Conference

IMBER and LOICZ have created a joint Task Team, which is charged with organizing a Joint IMBER/LOICZ Open Science Conference to be held in Shanghai, September 17-21, 2007. The goal of the conference is to estimate the relative importance of the changing forcings - global, local, and human - and determine how changes in shelf ecosystems can be attributed to the respective forcings. While building on biogeochemical advances from previous research programs, such as JGOFS and LOICZ, this conference aims to take the next steps to:

- link the biogeochemical cycles of the coastal and open oceans,
- link organisms, including higher organisms, to biogeochemical processes, and
- move past the present-day status and incorporate prediction of responses to global and local forcings.

The geographic focus of this conference is the mid- to outer continental shelves, shelf breaks and upper slopes. Furthermore, there exists important forcings across the coastal ocean and oceanic transition, that are global and natural, such as atmospheric and open ocean-shelf exchange. The larger scale forcings are modified by more local and human influences, such as proximity to large river plumes, physiography of the continental shelf, and human activities that modify atmospheric deposition across broad shelf areas. The global, local and human forcings interactively modify ecosystems across the transition.

The conference will be organized around nine themes including (1) ocean-shelf exchanges, (2) continental shelf interactions with coastal systems and the atmosphere, (3) the role of sediments in ecosystem functioning and particle dynamics on the continental shelf, (4) continental shelf ecosystems: commonalities and particularities of high-latitude, temperate and low-latitude systems, (5) eutrophication and oligotrophication in coastal systems, and influences on outer shelf ecosystems, (6) low oxygen on continental shelves, (7) air-sea exchanges and climate-active gases on the continental shelf, (8) sustainable use of continental shelf resources and (9) long time series, remote sensing, observation systems and integrative modeling.

The international organizing committee is co-chaired by Jack Middelburg (IMBER, The Netherlands) and Nancy Rabalais (LOICZ, USA) and composed of 8 additional members: Katja Fennel (Canada), Burke Hales (USA), K. K. Liu (Taiwan), Isabelle Niang Diop (Senegal), Helmuth Thomas (Canada), Paul Wassman (Norway), Kai Wirtz (Germany) and Jing Zhang (P.R. China). A local organizing committee is being formed, chaired by Prof. Dr Lihong Yu, President of East China Normal University (ECNU), and Vice-Chaired by Prof Dr Yunxuan Zhou, deputy director of the State Key Laboratory on Estuarine and Coastal Research (SKLEC/ECNU).

The outcomes of the conference will be an improved understanding of the continental margins, biogeochemical cycles and ecosystems and the development of an implementation for IMBER and LOICZ Continental Margins research.

The Conference poster is downloadable in high or low resolution on both the IMBER and LOICZ websites at <http://www.imber.info/> and <http://www.loicz.org>

For further information regarding this conference, send your enquiries to: [shanghai.osc@univ-brest.fr](mailto:shanghai.osc@univ-brest.fr)

**First Announcement**

Joint IMBER / LOICZ  
**Continental Margins**  
 Open Science Conference

上海 | Shanghai  
 2007年9月 | September 17 - 21<sup>st</sup>  
 17 - 21日 | 2007

Impacts of global, local and human forcings on biogeochemical cycles and ecosystems

Co- conveners :  
 Nancy Rabalais (USA): [nrabalais@lumcon.edu](mailto:nrabalais@lumcon.edu)  
 and Jack Middelburg (Netherlands): [j.middelburg@nioo.knaw.nl](mailto:j.middelburg@nioo.knaw.nl)

International organizing committee :  
 Katja Fennel (Canada), Burke Hales (USA), K.K. Liu (Taiwan),  
 Isabelle Niang Diop (Senegal), Helmuth Thomas (Canada),  
 Paul Wassman (Norway), Kai Wirtz (Germany)  
 and Jing Zhang (P.R. China)

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 International Council for Science  
 Scientific Committee on Oceanic Research

 IMBER  
 Integrated Marine Biogeochemistry and Ecosystem Research

 LOICZ



 SKLEC



## IMBER national activities

### A CHILEAN INTERNATIONAL WORKSHOP ON "OXYGEN MINIMUM SYSTEMS IN THE OCEAN: DISTRIBUTION, DIVERSITY AND DYNAMICS".

By Victor Ariel Gallardo  
 Department of Oceanography and Center COPAS  
 University of Concepcion, Chile  
[vgallar@udec.cl](mailto:vgallar@udec.cl)

On October 24-26, 2006, the international Workshop "Oxygen Minimum Systems in the Ocean: Distribution, Diversity and Dynamics" was held in Concepción, Chile, as part of the celebrations of the 50 years since the inception of marine sciences as an institutional program of the University of Concepción (UdeC). The workshop was jointly organized by the Department of Oceanography and the Center for Oceanographic Research in the Eastern South Pacific (COPAS).

The eastern Pacific Ocean features the largest of all oxygen minimum zone of the present day ocean and study of this, is one of the three major science themes selected in 2001 for the COPAS projects. Most of the ocean's history has been anoxic and there has always been anoxia present in our planet's ocean. While the modern ocean is almost completely oxic, even today there is a significant, highly interconnected, anoxic/hypoxic world ocean sys-

tem allowing for particular biogeochemical processes that impact on climate and, containing especially adapted organisms and communities, some of which have only recently been identified. Emphasizing the vital aspects of oxygen deficient systems (ODS) is a good way to foster interdisciplinary global research effort on ODS. This approach, in the century of biology and genetics, will advance our understanding of the evolutionary legacy held in millions of genomes evolved over billions of years of varying anoxic and oxygen-deficient conditions and promote beneficial use of this knowledge.

The proceedings of the workshop were published in our journal GAYANA (Gallardo 2006), which

scientists, students and collaborators, both local and international, of pioneering interdisciplinary work in the eastern South Pacific region.

The workshop and the publication of its proceedings were possible through the major funding support from a grant in 2000 by Fundacion Andes (Santiago, Chile) to the UdeC and the Woods Hole Oceanographic Institution. We extend heartfelt thanks to Dr. John W. Farrington, former Dean at WHOI, our counterpart in this venture, for his fundamental role. We also extend our appreciation to IMBER, SCOR, and CONICYT (the Chilean Commission for Scientific and Technological Research), for important complementary funding. Finally, we note with

special gratitude that the workshop benefited greatly from the participation and intellectual support of many of the present expert members of the recently created SCOR Working Group 128 on "Natural and Human-Induced Hypoxia and Consequences for Coastal Areas", i.e., Boris Dewitte (France), Werner Ekau (Germany), Pedro Monteiro (South Africa), Wajih Naqvi (India), Temel Oguz (Turkey), Silvio Pantoja (Chile), Nancy Rabalais (USA),

Mary Scranton (USA) and Osvaldo Ulloa (Chile).



Entrance to the main campus of the University of Concepcion and Campanil, Concepcion, Chile. (Photos: V.A. Gallardo).

was distributed at the start of the workshop. The volume includes both the extended abstracts by the invited speakers (17) and the poster abstracts (56), totaling 73 contributions from scientists representing at least 22 countries and most of the oxygen-deficient systems in the oceans. A major component of the invited talks (6) and several of the contributions to the poster session (18), are a testimony of COPAS's research efforts in the past five years by its own

Gallardo, VA (Ed.) (2006). *Oxygen Minimum Systems in the Ocean: Distribution, Diversity and Dynamics. Proceedings of the Workshop, October 24-26, 2006, Concepcion (Chile).*

Gayana 70: 148 p.

This volume will soon be available in the web under SciELO ([www.scielo.cl/](http://www.scielo.cl/))

## IMBER - Spain

By *Javier Aristegui*

The Spanish IMBER Scientific Committee (SC) was officially constituted in May 2006, with Javier Aristegui (Chair), Antoni Calafat, Josep M. Gasol, Emilio Marañón and Xosé A. Álvarez-Salgado as members. One of the first priorities of the SC was to identify national groups and activities relevant to IMBER, and as a second step to propose common actions at the national level that could be integrated in ongoing IMBER international activities. One of the initial planned activities was the organization, in cooperation with GLOBEC-Spain, of a national symposium, bringing together Spanish scientists working on IMBER and GLOBEC-related activities. The symposium will be held in Valencia (Spain) on 28-31 March 2007. The meeting will include the following sessions and topics – with both oral communications and posters - distributed over three days (more information on the symposium at <http://www.ucv.es/isms07/>):

### Wednesday 28 March

Presentation of the GLOBEC-Spain and IMBER-Spain programmes.

Fidel Echevarría (Chair of GLOBEC-Spain)  
Javier Aristegui (Chair of IMBER-Spain).

**Session 1:** Biodiversity, function and metabolism in the ocean.

Chairs: Josep Gasol, Susana Agustí  
Keynote talk: Carles Pedrós-Alió

**Session 2:** Trophic interactions

Chairs: Enric Saiz, José Luís Acuña  
Keynote talk: Albert Calbet

### Thursday 29 March

GLOBEC Plenary conference  
Manuel Barangé (Director of GLOBEC IPO)

**Session 3:** Retrospective analysis and time-series

Chairs: Antonio Bode, Angel Borja  
Keynote talk: Jurgen Alheit

**Session 4:** Physical-biological interactions in the ocean

Chairs: Celia Marrasé, Pablo Sangrá  
Keynote talk: Miguel Santos

**Session 5:** Impacts of Global Change on species, ecosystems and biogeochemical cycles

Chairs: Xavier Irigoien, Fidel Echevarría

Keynote talk: Angel López Urrutia

Friday 31 March

IMBER Plenary conference

Julie Hall (Chair of IMBER)

**Session 6:** Transfer of energy and materials between marine interfaces

Chairs: Javier Aristegui, Xosé Alvarez Salgado  
Keynote talk: Eric D. Barton

**Session 7:** Role of the ocean and ecosystems in regulating climate

Chairs: Emilio Marañón, Aida Fernández Ríos  
Keynote talk: Isabel Cacho

**Session 8:** Predictive capacity and modelling

Chairs: Antoni Calafat, Francesc Peters  
Keynote talk: Javier Ruiz

## G-IMBER in brief (German IMBER)

Three German consortia each consisting of scientists from several German research institutions are preparing IMBER proposals to be funded by the German ministry for research. The target areas are North Sea, Baltic Sea and the northern Benguela Current off Namibia. The proposals will be submitted in spring 2008.

### Regional programmes



### Interactions between biogeochemical cycles and marine food webs in the North Pacific, session at the PICES XV Annual Meeting

By *Hiroaki Saito*

The PICES BIO-committee and IMBER sponsored topic session “Interactions between biogeochemical cycles and marine food webs in the North Pacific”



during the PICES XV annual meeting in the beautiful port city of Yokohama, Japan. There were sixteen oral and three poster presentations in this session, which was attended by approximately 75 scientists.

The presentations covered four broad topics: (1) on processes associated with nutrient supply, seasonal and recent decadal trends in nutrients, and on micronutrient limitation, (2) lower trophic level characteristics in the PICES region, including both coastal and oceanic waters with results from both field observation and modeling studies being presented, (3) effects of iron limitation in the North Pacific Ocean on marine food webs, (4) vertical exchanges and processes, including new information on settling particles, phytoplankton resting spores, copepod ontogenetic migration and overall processes controlling vertical carbon transport. There were also presentations which addressed nutrient cycling in the context of biological modeling, and presented information on a new free-floating oceanographic instrument for simultaneous tracking of water properties and large particles, including zooplankton. Presentations covered many biological and biogeochemical processes and served as a useful review and synthesis of present knowledge. This session identified the challenges to be faced by the scientific community in linking biogeochemical cycling and marine food webs, especially when considering particular species or groups organisms at higher trophic levels. Linkages between marine ecosystems and biogeochemical cycling were identified and research needs were highlighted.

<http://www.pices.int/>

## 1<sup>st</sup> BASIN Workshop

Hamburg, Germany, 23 – 25 January 2007

### **Resolving the impact of climatic processes on ecosystems of the North Atlantic Basin and shelf seas: Integrating and advancing observation, monitoring, and prediction**

What is BASIN and what are the goals?

BASIN is a funded Specific Support Action (SSA) under the European 6<sup>th</sup> Framework Programme. The scale of influence of global change and the added value of coordinating the scientific activities of the European (EU) and North American countries to assess, predict and mitigate the effects on marine ecosystems of the North Atlantic and their services is the justification for the development of the SSA.

The goals of BASIN are to:

- identify and document the state of the art of climate-related ecosystem research in the North Atlantic basin and associated shelf seas,
- assess the feasibility of developing a joint EU-North American basin-scale research program focusing on the ecosystems of the North Atlantic Ocean, and
- seek to develop an implementation plan whereby joint research initiatives involving the EU and other nations (e.g., USA, Canada, Japan, China) can be developed and funded.

Aim of the workshop

The first BASIN SSA meeting will be held in Hamburg, Germany, from 23 to 25 January 2007. It will bring together researchers and ecosystem managers to consider and plan the next steps in North

Atlantic ocean-basin scale analysis, for the integration, synthesis, and modeling of biological, chemical, and physical oceanographic data sets. The goal is to build upon previous and ongoing research in the North Atlantic Ocean, integrating and synthesizing the results of these programs, thus determining the mechanisms that link zooplankton, fish, and the environment at ocean-basin scales. This first SSA meeting will have a primary focus on European participation, though there will be key invitees from North America. A subsequent meeting will be held in the United States to explore a similar agenda more fully within the North American research community.

The specific objectives of this BASIN SSA workshop are to:

- (1) Assess and report on the status of climate-related ecosystem research in the North Atlantic basin and associated shelf seas (from Georges Bank to the Barents Sea and the North Sea shelf) conducted intensively over the past decade, particularly through national GLOBEC-related programs (US, Canada, UK, Germany), GLOBEC related projects (ICES, Mare Cognitum), and EU projects, particularly ICOS and TASC;
- (2) identify and document gaps in systematic observations and process understanding of atmospheric and oceanic parameters, necessary to improve forecasting of ecosystems in the North Atlantic Ocean and associated shelves;
- (3) identify via the development of a meta-database the potential for consolidation of long-term observations from EU and international databases for the modeling and, in particular, prediction of the dynamics of North Atlantic Ocean and associated shelf ecosystems and their services (biogeochemical and exploited resources);

(4) consider the feasibility of producing a science plan for the future development of a basin-scale research program on:

- a. resolving the natural variability, potential impacts and feedbacks of global change on the structure, function, and dynamics of the ecosystems of the North Atlantic Basin and associated shelf seas;
- b. improving the understanding of marine ecosystem functioning in North Atlantic Basin and associated shelf seas;
- c. developing ecosystem-based management strategies that incorporate the effects of global change and hence contribute to the sustainable use of the marine resources of the North Atlantic Basin and associated shelf seas.

The workshop steering committee consists of Mike St. John (Germany), Roger Harris (UK), Cisco Werner (USA), Peter Wiebe (USA), Brad deYoung (Canada).

The workshop will be a mix of plenary talks by invited speakers, working group sessions, and plenary discussion sessions.

Additional details about travel funds, the structure of the workshop, pre-meeting documents, registration and logistical details will be forthcoming.

Please RSVP your interest in attending this workshop to [michael.st.john@uni-hamburg.de](mailto:michael.st.john@uni-hamburg.de) and [christian.moellmann@uni-hamburg.de](mailto:christian.moellmann@uni-hamburg.de) and register to attend at <http://www.globec.org/structure/imber/euroceans/basin/reg.asp>.

## Announcements

### Ocean Surface pCO<sub>2</sub> and Vulnerabilities Workshop

By Sylvie Roy

The Ocean surface pCO<sub>2</sub> and vulnerabilities workshop co-sponsored by the International Ocean Carbon Coordination Project (IOCCP), the Integrated Marine Biogeochemical and Ecosystems Research project (IMBER), the Surface Ocean-Lower Atmosphere Study (SOLAS) and the Global Carbon Project (GCP) will be held at UNESCO, in Paris, April 11-14, 2007.

The aim of this workshop is to review current knowledge and enhance international cooperation to resolve the magnitude, variability and processes governing ocean sources and sinks of carbon, from observations, process-based models and atmospheric and oceanic inversions. Key questions to be addressed through plenary talks, poster sessions, and working groups include:

- What are the decadal changes in the air-sea CO<sub>2</sub> flux today and how well can we predict their changes in the future?
- Are present oceanic and atmospheric models simulating the observed changes correctly?
- How do changes in ocean physics (temperature, salinity, and circulation) and atmospheric dynamics impact air-sea CO<sub>2</sub> fluxes today, in the near future, and in the far future?
- What is the possible contribution of changes in marine

ecosystems on air-sea CO<sub>2</sub> fluxes?

- How can we use evidence from the present and the past to set bounds on the possible response of the carbon cycle to physical and biological changes in the future?
- Are there instabilities and thresholds in the marine carbon cycle?
- What is the current knowledge of regional and temporal variability in mixed-layer CO<sub>2</sub> and air-sea CO<sub>2</sub> fluxes?
- Can we estimate how CO<sub>2</sub> fluxes have changed in the coastal ocean?
- What is the current knowledge and what are the future approaches to quantify gas transfer rates?
- What processes have controlled the observed CO<sub>2</sub> flux variability?
- What observational strategies, instrumentation and model developments are required to deliver better air-sea CO<sub>2</sub> flux estimates into the future?

The expected outcomes of this workshop are (1) the publication of a volume of meeting proceedings or a special issue of a journal, including articles from key invited talks and posters, and major synthesis articles developed by the working groups; (2) a workshop report outlining needs for research and observation coordination, data exchange and data synthesis activities, and plans for follow-up activities to address the needs highlighted by the workshop.

The International Organizing Committee is composed of Nicolas Metzler (Co-Chair; IPSL, France), Bronte Tilbrook (Co-Chair; CSIRO, Australia), Dorothee Bakker (Univ. East Anglia, UK), Kitack Lee (Pohang Univ., Korea), Scott Doney (WHOI, USA), Dick Feely (NOAA, USA), Jeff Hare (SOLAS IPO, UK), Sylvie Roy (IMBER IPO,



France), Corinne Le Quéré (Univ. East Anglia, UK), Roger Dargaville (IOCCP, UNESCO, France).

For more information regarding this workshop, visit the IOCCP website at [http://www.ioc.unesco.org/ioccp/pCO2\\_2007.html](http://www.ioc.unesco.org/ioccp/pCO2_2007.html).

### Related conferences and workshops

#### IMBER WORKSHOPS and CONFERENCES

AMEMR workshop: Modelling the response of marine ecosystems to increasing levels of CO<sub>2</sub>

February 12-14, 2007, Plymouth, UK

<http://www.amemr.info/default.asp?page=workshop2>

EGU - General Assembly 2007  
IMBER/SOLAS Special Session (OS6)

April 15-20, 2007, Vienna, Austria

[http://www.cosis.net/members/meetings/sessions/information.php?p\\_id=249&s\\_id=4048](http://www.cosis.net/members/meetings/sessions/information.php?p_id=249&s_id=4048)

IMBER SSC meeting

June 12-14, 2007, Victoria, Canada

Joint IMBER / LOICZ Continental Margins Open Science Conference

September 17-21, 2007, Shanghai, China

[www.imber.info](http://www.imber.info)

[www.loicz.org](http://www.loicz.org)

[Shanghai.OSC@univ-brest.fr](mailto:Shanghai.OSC@univ-brest.fr)

Joint IMBER/CLIVAR/GLOBEC/SOLAS Workshop

Climate driving of ecosystem – making the connection”

End 2007, venue to be confirmed

#### IMBER-RELATED CONFERENCES

#### 2007

Austral Summer Institute VII  
January 2-26, Concepción, Chile

Arctic Frontiers - An international conference

January 21-26, Tromsø, Norway

<http://www.arctic-frontiers.com/>

U.S. North American Carbon Program (NACP) Investigators Meeting

January 22-24, Colorado Springs, USA

[http://www.nacarbon.org/2007\\_meetings/index.htm](http://www.nacarbon.org/2007_meetings/index.htm)

Water Rocks!

ASLO 2007 Aquatic Sciences Meeting

Ocean Carbon and Biogeochemistry (OCB): A New Multi-disciplinary Oceanographic Program

February 4-9, Santa Fe, USA

<http://ocb.whoi.edu>

<http://aslo.org/santafe2007/>

SOLAS Open Science Conference

March 6-9, Xiamen, China

<http://www.solas2007.confmanager.com/main.cfm?cid=457>

EUR-OCEANS Symposium on Parameterisation of Trophic Interactions in Ecosystem Modelling

March 20-23, Cadiz, Spain

<http://www.eur-oceans.org/index2.php>

Gordon Research Conference on Polar Marine Science

An Interdisciplinary Look at Processes Over Multiple Scales of Variability

March 25-30, Ventura, USA (CA)

<http://www.grc.org/programs.aspx?year=2007&program=polar>

Surface pCO<sub>2</sub> and Ocean Vulnerabilities workshop

April 11-14, Paris, France

[http://www.ioc.unesco.org/ioccp/pco2\\_2007.htm](http://www.ioc.unesco.org/ioccp/pco2_2007.htm)

EGU General Assembly

April 15-20, Vienna, Austria

Sensitivity of marine ecosystems and biogeochemical cycles to climate change (OS13)

[http://www.cosis.net/members/meetings/programme/view.php?p\\_id=249](http://www.cosis.net/members/meetings/programme/view.php?p_id=249)

Climate variability and the carbon cycle (past, present and future): The EuroCLIMATE Programme on multi-proxy reconstructions and coupled climate models at European and regional scales (BG5.09/CL49)

[http://www.cosis.net/members/meetings/programme/view.php?p\\_id=236](http://www.cosis.net/members/meetings/programme/view.php?p_id=236)

Ocean Controls in Abrupt Climate Changes / ESF Research Conference

May 19-24, Obergurgel, Austria

<http://www.esf.org/conferences>

The 2007 AGU Joint Assembly

May 22-25, Acapulco, Mexico

<http://www.agu.org/meetings/ja07/>

4th International Zooplankton Production Symposium

Human and climate forcing on zooplankton production  
Session on zooplankton biogeochemical cycling

May 28-June 1, Hiroshima, Japan

[http://www.pices.int/meetings/international\\_symposia/2007\\_symposia/4th\\_Zooplankton/4th\\_Zoopl.aspx](http://www.pices.int/meetings/international_symposia/2007_symposia/4th_Zooplankton/4th_Zoopl.aspx)

5th Study Conference on BALTEX

June 4-8, Kuressaare, Saaremaa, Estonia

Christian MÖLLMANN ([christian.moellmann@uni-hamburg.de](mailto:christian.moellmann@uni-hamburg.de))

Early Career Scientist  
Conference- New Frontiers in  
Marine Science  
June 26 -29, Baltimore, Maryland,  
USA  
[http://www.pices.int/meetings/  
international\\_symposia/2007\\_  
symposia/Young\\_scientists/  
newfrontiers.aspx](http://www.pices.int/meetings/international_symposia/2007_symposia/Young_scientists/newfrontiers.aspx)

International Sea-Ice Summer  
School  
July 2 – 13, Svalbard, Norway  
<http://www.seaice.info>

Ocean Carbon and  
Biogeochemistry (OCB) Summer  
2007 Science Workshop  
July 23-26, Woods Hole, MA,  
USA  
Mary Zawoysky ([mzawoysky@whoi.  
edu](mailto:mzawoysky@whoi.edu))  
<http://ocb.whoi.edu>

Chemical Oceanography GRC  
Conference  
August 5 -10, New Hampshire,  
USA  
[http://www.grc.org/programs.aspx?ye  
ar=2007&program=chemocn](http://www.grc.org/programs.aspx?year=2007&program=chemocn)

Effects of Climate Change on  
Marine Ecosystems - Inter-  
Research Symposium # 2

Convened in conjunction with the  
42nd European Marine Biology  
Symposium  
August 27-31, Kiel, Germany  
[http://www.ir-symposia.com/Conf\\_  
home.asp?ConferenceCode=EMBS  
%202007](http://www.ir-symposia.com/Conf_home.asp?ConferenceCode=EMBS%202007)

2nd Global Conference on Large  
Marine Ecosystems  
September 11-13, Qingdao, China  
[http://www.imber.info/jobs-  
announcements/LMEs\\_first\\_  
announcement.pdf](http://www.imber.info/jobs-announcements/LMEs_first_announcement.pdf)

Dissertations Initiative for  
the Advancement of Climate  
Change Research Symposium  
Interdisciplinary Opportunity for  
Recent PhD Graduates:  
September 10 -17, Kilauea,  
Hawaii  
<http://discrcs.org>

Long Time-Series Observations  
in Coastal Ecosystems AGU  
Chapman Conference  
Comparative Analyses of  
Phytoplankton Dynamics on  
Regional to Global Scales  
October 8-12, Rovinj, Croatia  
[http://www.agu.org/meetings/  
chapman.html](http://www.agu.org/meetings/chapman.html)

1st CLIOTOP Symposium:  
Climate impacts on oceanic top  
predators  
December 3-7, La Paz, Mexico  
[http://web.pml.ac.uk/globec/structure/  
regional/cliotop/symposium.htm](http://web.pml.ac.uk/globec/structure/regional/cliotop/symposium.htm)

## 2008

The 14th Ocean Sciences  
Meeting  
(Joint with ASLO, ERF, TOS and  
AGU)  
March 2 -7, Orlando, FL, USA  
<http://www.aslo.org/meetings.html>

40<sup>th</sup> International Liège  
Colloquium on Ocean Dynamics  
and Advanced Research  
Workshop  
Oceanography of the rapidly  
changing Arctic and Sub-arctic  
May 5-9, Liège, Belgium  
[http://modb.oce.ulg.ac.be/  
colloquium/2007.html](http://modb.oce.ulg.ac.be/colloquium/2007.html)

ICES/PICES/IOC Symposium  
Effects of climate change on the  
world's oceans  
May 19 - 23, Gijón, Spain  
[http://www.pices.int/meetings/All\\_  
events\\_default.aspx#Int\\_Symp](http://www.pices.int/meetings/All_events_default.aspx#Int_Symp)



## INSTRUCTIONS TO CONTRIBUTORS

The *IMBER Update* is published quarterly and is released in on-line version ([www.imber.info/newsletters.html](http://www.imber.info/newsletters.html)).

### ARTICLES

We invite you to submit your contribution to the *IMBER Update* using the following guidelines:

Articles can be up to 1000 words with accompanying figures and/or pictures. When sending illustrations for the *IMBER Update* please include them in as high resolution as possible, minimum requirement is 300 dpi as tiff or eps. Text should be in .doc or .txt.

Contributions should be sent to [elena.fily@univ-brest.fr](mailto:elena.fily@univ-brest.fr)

The Science Plan and Implementation Strategy is available on request at [imber@univ-brest.fr](mailto:imber@univ-brest.fr) and is downloadable from the website, [http://www.imber.info/products/IMBER\\_SPIS\\_Final.pdf](http://www.imber.info/products/IMBER_SPIS_Final.pdf)

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