

3.0 LARGE-SCALE OCEAN RESEARCH PROJECTS

- 3.1 Global Ocean Ecosystems Dynamics Project, **p. 3-1** *Burkill, Barange*
- 3.2 Global Ecology and Oceanography of Harmful Algal Blooms Program, **p. 3-39**
Hong, Urban
- 3.3 Integrated Marine Biogeochemistry and Ecosystem Research, **p. 3-45** *Sundby, Maddison*
- 3.4 GEOTRACES, **p. 3-65** *Sundby, Jeandel*
- 3.5 Surface Ocean - Lower Atmosphere Study, **p. 3-91** *Hong, Breviere*

3.1 Scientific Steering Committee on Global Ocean Ecosystem Dynamics (GLOBEC) (Joint with IGBP and IOC)

Terms of Reference:

- To oversee the implementation of the Global Ocean Ecosystem Dynamics project in accordance with the published Science and Implementation Plans;
- To develop a programme of Integration and Synthesis for GLOBEC for presentation to the sponsors and the larger scientific community;
- To recommend to the sponsoring organizations the necessary actions to be taken in accordance with the GLOBEC Science and Implementation Plans and to co-ordinate and manage the resulting activities;
- To collaborate, as appropriate, with other related global change projects and programs and planning activities, such as IMBER, LOICZ, WCRP, the IOC program on Ocean Science in relation to living resources (OSLR), and the Global Ocean Observing System;
- To establish appropriate data management policies to ensure sharing and preservation of the GLOBEC data set taking into account the related policies of the sponsors; and
- To report regularly to SCOR, IGBP and IOC and to other bodies such as WCRP, ICES and PICES, on the state of planning and accomplishments of GLOBEC.

Chair:

Ian Perry
Pacific Biological Station
Department of Fisheries and Oceans
Nanaimo, B.C. V9T 6N7
CANADA

Tel: +1-604-756-7137
Fax: +1-604-756-7053
e-mail: perryi@pac.dfo-mpo.gc.ca

Members:

Jurgen Alheit	GERMANY	Astrid Jarre	DENMARK
Kevern Cochran	ITALY	Salvador Lluch-Cota	MEXICO
Brad de Young	CANADA	Olivier Maury	FRANCE
Ruben Escribano	CHILE	Jeffrey Runge	USA
Roger Harris	UK	Yasunori Sakurai	JAPAN
Eileen Hofmann	USA	Svein Sundby	NORWAY
James Hurrell	USA	Francisco Werner	USA

Executive Officer: Manuel Barange

Executive Committee Reporter: Peter Burkill

GLOBEC: Global Ocean Ecosystem Dynamics

Report of the SCOR/IOC/IGBP GLOBEC International Project for 2009/ 2010
to the SCOR General Meeting. Toulouse, France, 13-16 September 2010

Manuel Barange, Director of Science
Plymouth Marine Laboratory, UK, m.barange@pml.ac.uk

The GLOBEC International Programme completed its activities in January 2010 after ten years of sustained and coordinated research. Some national programmes are still completing their research agendas, while some national/regional activities will continue under the umbrella of the IGBP-SCOR IMBER programme, www.imber.net, in particular the ESSAS, CLIOTOP and SPACC regional programmes of GLOBEC. The GLOBEC International Project Office, which supported the programme, closed in March 2010.

1. RECENT PROGRESS: Symposia and Workshops – 2009/10

1.1. GLOBEC-sponsored international symposia

GLOBEC 3rd Open Science Meeting. Victoria, British Columbia, Canada, 22-26 June 2009. The 3rd OSM was entitled “Marine ecosystems: from function to prediction” to focus the meeting towards the overall objective of GLOBEC of “providing a new mechanistic understanding of the functioning of the marine ecosystem, in order to develop predictive capabilities and propose a framework for the management of marine ecosystems in the era of global change”. The GLOBEC OSM was planned to culminate the integration and synthesis activities of the international GLOBEC programme by providing a new mechanistic understanding of the functioning of the marine ecosystem, in order to develop predictive capabilities and propose a framework for the management of marine ecosystems in the era of global change. The first two days of the conference were devoted to ten specific workshops followed by three days of plenary sessions. The OSM was attended by over 300 delegates from 34 countries. Thanks to the contribution of the sponsors (such as SCOR), the organisation was able to invite and offer financial support to 20 scientists from many countries including Peru, India, Lebanon and Namibia. The proceedings of the conference are just about to go to press in a special issue of *Progress in Oceanography* edited by Manuel Barange (UK), Ian Perry (Canada), Eileen Hofmann (USA), Coleen Moloney (South Africa), Yasunori Sakurai (Japan) and Geir Ottersen (Norway). The Proceedings complement the GLOBEC synthesis book (“Marine ecosystems and global change”, Ed. By Barange et al., Oxford University Press, 2010).

1.2 GLOBEC workshops, regional and national symposia

The following is a collection of GLOBEC-sponsored workshops and national/regional meetings hosted during the reporting period:

- ***GLOBEC France symposium. Paris, France, 12-13 January 2009.*** This symposium was the culmination of the GLOBEC France programme and attracted nearly 70 participants. The symposium was convened by Cédric Bacher (IFREMER), François Carlotti (CNRS), Gabriel Gorsky (CNRS), Pierre Petitgas (IFREMER) and E. Theobald (Université Paris 6). 35 oral presentations and 12 poster presentations were presented during 4 sessions: 1) Biological processes: the individual level in food webs, 2) Influence of climate on marine populations, 3) Physics-biology interactions at different scales, and 4) Operation of food webs of the primary production fishery resources. There was also a discussion on how French GLOBEC research could be continued under IMBER.
- ***Monitoring climate change impacts: establishing a Southern Ocean Sentinel program. Hobart, Tasmania, Australia, 20-24 April 2009.*** This workshop considered how to measure, assess and provide early-warning detection of climate change impacts on the Southern Ocean and how these could be used to signal future impacts on marine and other ecosystems elsewhere in the world. The Sentinel programme is developing as part of ICED which is involved in the development of the Sentinel science plan, public outreach documents and a forthcoming special issue publication of the workshop.
<http://www.aad.gov.au/default.asp?casid=35088>
- ***New frontiers in Southern Ocean biogeochemistry and ecosystem research workshop. Princeton University, USA, 8-11 June 2009.*** This workshop was co-sponsored by GLOBEC Regional Programme ICED. The overall objective of this scoping workshop was to facilitate interaction between the physical, biogeochemical, and ecosystem research communities to develop research strategies to resolve current limitations, gaps and discrepancies in our understanding and prediction of the Southern Ocean ecosystems, biogeochemical cycles and carbon uptake. <http://www.whoi.edu/sbl/liteSite.do?litesiteid=32992>
- ***GLOBEC-ESSAS Annual Science Meeting. Seattle, Washington, USA, 18-19 June 2009.*** A series of ESSAS workshops were conducted at the Annual Science Meeting, including sessions on “Gadoid-crustacean interactions” and “Advection and its effects in sub-Arctic ecosystems”. A day was devoted to presentations from the ESSAS working groups on “Regional climate prediction” and “Bio-physical coupling” and the “Modeling Ecosystem Response” working group convened a workshop to examine different approaches to the development of fully integrated end-to-end ecosystem models.
http://web.pml.ac.uk/globec/calendar/meetings/ESSAS_ASM_2009.pdf
- ***CLIOTOP WG3 (Trophic pathways in the open ocean ecosystems) workshop. Sète, France, 6-10 July 2009.*** This five-day workshop in Sète conducted analysis of stomach content data of a common subset of predators (especially tunas) from the Indian, Atlantic, and Pacific Oceans to examine similarities and differences in their trophic ecology in relation to differences in regional oceanography. The approach revealed a number of important

3-4

differences suggesting that large-scale comparisons would be useful to interpret future responses to ocean warming. The workshop in Sète was designed to investigate how to incorporate food web data (both stomach and stable isotope data) from the three oceans into an interoperable database from which the global inter-oceanic comparative analysis will be based.

- ***CLIOTOP WG2 (Physiology, behaviour and distribution) workshop. Swansea, UK, 28-30 July 2009.***
The primary purpose of this workshop was to identify how to work towards modelling the movement and incidence of space-dependent behaviours of oceanic top predators in order to produce a strategy for studying top predator movement with a truly global perspective.
- ***Summer colloquium. Ecosystems and climate: modelling and analysis of observed variability in marine ecosystems. Boulder, USA, 3-14 August 2009.*** 26 students from 7 countries participated in the colloquium which gave the students experience of state-of-the-art ecosystem modelling approaches in the context of climate models and techniques of testing the models versus observational datasets.
- ***ICES Annual Science conference. Berlin, Germany, 21-25 September 2009.*** The programme for the conference included two GLOBEC theme sessions:
 1. Advances in marine ecosystem research: what we have learned from GLOBEC and what we can carry forward in future climate-related programs
 2. Climate impacts on marine fishes: discovering centennial patterns and disentangling current processes
- ***PICES-ESSAS Workshop at PICES ASC: Marine ecosystem model inter-comparisons, 24-25 October 2009.*** The objective of the Marine Ecosystem Model Inter-comparison Project (MEMIP) is to compare the performance of various lower trophic level marine ecosystem simulation models at predicting the abundance and distribution of zooplankton functional groups. Models with high performance and broad generality will be priority candidates for examining the state of marine ecosystem's response to future global climate change. This workshop was a technical, "hands-on" meeting focusing on parameterizing, executing and calibrating various 1-D versions of biogeochemical lower trophic level (LTL) marine ecosystem models
- ***GLOBEC SSC Meeting. Dartington, UK, 11-13 November 2009.*** The final GLOBEC SSC meeting included reports of existing activities and their plans for the future, a day devoted to the legacy of GLOBEC and a day focussing on the closure of the programme and the GLOBEC IPO.
- ***CLIOTOP into the future: building scenarios for oceanic ecosystems in the XXI century. UNESCO, Paris, France, 8-11 February 2010.*** The CLIOTOP mid-term workshop developed plans for the implementation of the second phase of the programme (2010-2014) which will form an addendum to the CLIOTOP Science Plan.
- ***SPACC II workshop. CIBNOR, La Paz, Mexico, 24-26 February 2010.*** This workshop focused on planning the future direction of the SPACC programme after the closure of GLOBEC, both as part of IMBER and independently through ICES.

- **Workshop to develop a summary for decision makers. Paris, France, 8-10 March 2010.**
The summary for decision makers aimed to extract the key messages from the work of GLOBEC on marine ecosystems and global change, and to identify policy-relevant issues and applications for this information.

More information is available on the GLOBEC website, including minutes of GLOBEC SSC meetings.

2. RECENT DEVELOPMENTS AND PUBLICATIONS

2.1. GLOBEC's major findings

Hofmann et al. 2010 (Chapter 11 of the GLOBEC synthesis book, full reference below) provides a summary of the main lessons learned during GLOBEC. They include:

1. **Understanding scales of processes** – The view of marine ecosystems as operating along a continuum defined by space and time underpinned much of the research that was undertaken during GLOBEC. However, the view of how these space and time scales interact to structure marine ecosystems has been significantly altered during GLOBEC. The early ideas presented a view of continuous interaction in which energy cascaded through the food web from larger to smaller scales. The scales at which organisms associated with different trophic levels accessed other parts of the space-time continuum were limited, as were their feedbacks to other parts of the food web. This view has changed to one in which marine ecosystem variability and population recruitment result from the integration of processes across all scales and includes direct as well as indirect interactions. One of the most important advances has been the integration of humans into these scale-dependent processes. The realization that marine ecosystems exhibit different scales of response to environmental forcing and perturbations highlighted the need for coupled physical-biological models that could explore the range of possible outcomes. Understanding the scales of connectivity of marine populations and how these intersect trophic levels that apparently operate at different scales is now known to be critical in determining marine population variability. The recognition that changes in marine ecosystems can occur over short time scales provided acceptance for the concept of regime shifts during GLOBEC. The view of marine ecosystems has developed from one that was characterized by variability about a constant state to one that considers a relatively rapid transition (regime shift) from one mean state to another mean state.
2. **The importance of alternative views of marine food webs** – Prior to GLOBEC much of the understanding of marine food webs was from studies focused on quantifying primary production and microbial processes in the cycling and export of carbon (e.g. JGOFS). As the need for understanding fish recruitment and marine population variability in a fisheries context developed it became apparent that lack of understanding of the dynamics by which lower and higher trophic levels are connected limited progress in this area. For this reason, GLOBEC undertook targeted studies that focused on key zooplankton species. The contribution made by GLOBEC was to study the key species in

conjunction with studies of their habitat, competitors, and predators, i.e. in an ecosystem context. From these targeted studies emerged a view of the key species in relation to the environment and other components of the food web. A significant advancement from these studies was the recognition of the importance of functional diversity in marine food webs. The view of food webs is now one of a linked system of alternative food webs that change in importance in response to environmental conditions and/or changes in species assemblages and abundance. The changed view of food webs includes the concept of dual pathways, which are composed of slow and fast response paths, which has provided insights into ecosystem resiliency in response to natural and anthropogenic forcings. The importance of top predators, including humans, in controlling marine food web structure and function has been clearly demonstrated in all GLOBEC science programmes.

- 3. A broader concept of marine ecosystems as social-ecological systems** – Social-ecological systems are systems that have marine (including physical-biological sub-systems) and human (including cultural, management, economic, and socio-political sub-systems) components, which are highly inter-connected and interactive. Traditionally, natural physical-biological marine ecosystems have been studied independently from their human components, and by different scientific disciplines with largely different scientific traditions. GLOBEC was one of a new generation of programmes that attempted to collaborate with other disciplines to correctly interpret the causes and deal with the consequences of global changes in marine social-ecological systems. Changes in marine ecosystems can have dramatic impacts on human societies that depend on marine resources and how these societies' responses affect marine ecosystems. Responses of the marine physical-biological and human sub-systems to changes and impacts occur over a range of scales. For example, the physical-biological marine system can adjust migration and distribution patterns (short-scale response) or food web dynamics and structure (longer-scale response). Human systems can adjust through changes in intensification of fishing (short-scale response) or diversification outside of fishing (longer-scale response). At shorter time scales, coping responses by both natural and human sub-systems have common elements, but at longer time scales, many of the adaptive capacities of the human sub-system have no analogs in the natural sub-system. A result of the latter is to create a divergence in the long-term consequences of natural sub-system adaptations to environmental alterations compared with those of the human sub-system. The challenge is to develop governance systems for coupled marine social-ecological systems, which account for these short- and long-term consequences of significant environmental changes.
- 4. Paradigm shifts in the study of marine ecosystems** – The field of interdisciplinary modelling advanced as a result of GLOBEC studies showing that coupled models could be used to integrate physical and biological processes across a range of scales to produce realistic simulations of circulation and ecosystem processes for environments that ranged from polar to tropical and from coastal to open ocean. The merger of observational and modelling systems facilitated development of data-assimilative marine ecosystem models. GLOBEC science programmes explicitly included studies of top predators (fish, seals, seabirds, cetaceans) and upper trophic level dynamics. The organisms associated

with upper trophic levels are typically long lived and are likely to be most impacted by decadal and perhaps longer climate variability. Alterations in upper trophic level dynamics potentially can alter controls on ecosystem processes and result in the emergence of alternative pathways in marine food webs. Thus, understanding the responses of these organisms and including these in coupled models will allow the development of projections of ecosystem responses to climate-scale processes to be developed. GLOBEC science has provided concepts, data, and models that have strengthened ecosystem-based management approaches for marine living resources, thereby providing a direct transfer of basic science results to applications. The ecosystem approach to management, for example, requires the productivity of an individual exploited fish stock to be considered in the context of the productivity of the entire ecosystem. How changes in the ecosystem and repartition of energy between components leads to different exploitation scenarios is an area that has been gained exposure as a result of GLOBEC studies, the consequences of which are still relatively unexplored and unknown.

- 5. Importance of the comparative approach** – Species-level studies were central to addressing the GLOBEC objective of understanding marine ecosystem and population variability. The target species were chosen for their ecological or economic importance in their regional ecosystem. Most of the GLOBEC programmes included focused studies of specific zooplankton species or the early pelagic life stages of fisheries species, the results of which were synthesized through individual-based models. Embedding these ecological models into physical circulation models provided enhanced understanding of the spatial and temporal dynamics of plankton and fish larvae and provided answers to questions of dispersal, retention and connectivity of marine populations in a range of environments. The results from these different ecosystems can serve as proxies for manipulations of the same system, particularly when climatic change and over-fishing provide perturbations at the bottom and top of the food webs. Thus, similar approaches used to study the different target species provide a basis for comparisons of properties of different ecosystems across trophic levels and/or trophic function. Another important aspect of GLOBEC was the comparative approach among similar (and different) marine ecosystems across the globe and the use of standard approaches and methodologies across systems. Through the seven GLOBEC regional programmes, comprehensive data sets were collected and a range of food web models were developed, both within and between these systems, providing a long-term legacy for the programme. The use of coupled physical-biological models as the means for effective integration and synthesis across these programmes is a clear result of GLOBEC. Comparative studies of the responses of human systems to environmental and/or socio-economic forcing to show the important consequences of these for marine food webs are also part of the approach used in GLOBEC. The comparative approach often required the use of new technologies, which have been perfected or newly-developed during GLOBEC, such as continued sampling probes for zooplankton and fish eggs, or genetic techniques to analyse the distribution of congeneric species. Technologies were also refined to address what could not be resolved with traditional methodologies. For example, satellite relay data loggers that measure ocean temperature were deployed on crabeater seals to resolve upper ocean

variability in Antarctic continental shelf waters and multi-frequency acoustics were used to map the 3D distribution of key species. These technologies improved field observations and provided data sets that influenced the development of coupled physical-biological models.

6. Emerging scientific themes

- **Scales and thresholds-** Understanding the scales of processes and interactions in marine ecosystems gained during GLOBEC has provided the basis for new ideas about how the results of change are manifested in these systems. For example, linear changes, such as increasing temperature, can result in nonlinear responses in ecosystems. An important result is the recognition that threshold effects, which arise from system nonlinearities, are likely to have unanticipated outcomes in marine ecosystems. The potential for alternative states needs explicit inclusion in marine ecosystem research programmes and in coupled models.

- **Non-climate drivers of ecosystem change-** The non-climate drivers of change, such as intensive fishing, are now recognized as important factors that result in ecosystem change. Recent research has demonstrated an interaction between fishing and environmental factors that compounds their direct impacts on marine ecosystem structure and functioning. A direct consequence of this is that marine ecosystems under intense exploitation evolve towards stronger bottom-up control, greater sensitivity to climate forcing and less dynamic stability. Humans must now be considered as significant drivers of change as well as being affected by these changes. It is therefore essential that future research programmes embrace the need for multidisciplinary research in their design and implementation, if they are to respond to societal challenges.

- **Advancements in modelling capability-** An emerging area of marine modelling is the development of nested models that allow transfer of information from global- to regional-scale models (down-scaling) and from regional- to global-scale models (up-scaling). Initial implementation of nested ocean circulation models has shown marked improvement in model skill and fidelity. Continued advancements in two-way scaling approaches, especially for regionally based models, are needed to develop projections of oceanic responses to climate change. The issues and stresses facing marine systems require consideration and inclusion of human and social systems in more traditional marine ecosystem models. A potential approach for meeting this challenge is to continue development and expansion of community-based models. The focus of an interdisciplinary research community on a particular model structure has allowed advances to be made more quickly than would happen with resources distributed over several models. A large unknown at present is how to include human effects in these models.

2.2. Publications

The IPO has prepared an archive of material comprising three complete sets of GLOBEC publications as well as bound copies of the minutes from the 14 Scientific Steering Committee meetings. Over the course of the programme GLOBEC has produced 27 GLOBEC Reports, 7 GLOBEC Special Contributions, 31 GLOBEC International Newsletters and 30 special issues of

journals (to date). A complete set of the GLOBEC publications will be archived at the National Marine Biological Library (UK), the Woods Hole Oceanographic Institution (USA) and the Oceanography Library of the University of Cape Town (South Africa), and most of the non-copyrighted material will be available through the www.globec.org website for many years to come.

GLOBEC has produced in excess of 3,500 research papers since its implementation. In 2009 and 2010 the following special issues have been published:

Alheit, J., Drinkwater, K.F. and Perry, R.I. (eds). 2010. Impact of climate variability on marine ecosystems; A comparative approach. *Journal of Marine Systems* 79 (3-4): 227-436

Batchelder, H.P. and N Bond (Eds). 2009. Physical and Biological Patterns, Processes and Variability in the Northeast Pacific. *Deep-Sea Research Part II* 56 (24)

Freon, P. M. Barange and J. Aristegui. (eds). 2009. Eastern boundary upwelling ecosystems: integrative and comparative approaches. *Progress in Oceanography* 83 (1-4)

Kawaguchi, S. and Peterson, W.T. (eds). 2010. Krill Biology and Ecology: Dedicated to Edward Brinton 1924-2010. *Deep Sea Research Volume 57, Issues 7-8, Pages 493-692.*

Perry, I., R.I., P.E. Ommer, P. Cury and K. Cochrane (eds). 2010. Coping with global change in marine social-ecological systems. *Marine Policy* 34: 739-820.

The **Progress in Oceanography special issue on the 3rd GLOBEC OSM** will be published in late 2010/ early 2011.

An **Elsevier Compendium** is currently in press, re-printing 30-35 of the top GLOBEC publications produced during the implementation of the programme. The last chapter of the Compendium includes the **GLOBEC Summary for Decision Makers**, a policy summary currently under completion.

One GLOBEC Report was produced during 2009:

- **Wiebe, P.H., R.P. Harris, M.A. St. John, F.E. Werner, B. deYoung and P. Pepin (eds). 2009.** BASIN: Basin scale analysis, synthesis and integration. Science plan and implementation strategy. GLOBEC Report No. 27

Three books were also published in 2009/10:

- **Barange, M., Field, J.G., Harris, R.H., Hofmann, E.E., Perry, R.I., Werner, C. 2010.** *Marine ecosystems and global change*. Oxford University Press, Oxford, UK.
- **Checkley, D. M., Jr., Alheit, J. A., Oozeki, Y., and Roy, C., eds. 2009.** *Climate Change and Small Pelagic Fish*, Cambridge University Press, Cambridge, UK.
- **Ommer, R., I. Perry, P. Cury, K. Cochrane, eds. 2010.** *World Fisheries: a social-ecological analysis*. Wiley-Blackwells Fisheries and Aquatic Resources Book Series (expected Autumn 2010).

3-10

A number of very significant publications were produced by the network in 2009/2010. A few influential papers are listed here for information:

- **Barange, M. and R.I. Perry** 2009. Physical and ecological impacts of climate change relevant to marine and inland capture fisheries and aquaculture. In K. Cochrane, C. De young, D. Soto and T. Bahri (eds). Climate change implications for fisheries and aquaculture. Overview of current scientific knowledge. *FAO Fisheries and Aquaculture Technical Paper*. No. 530. Rome, FAO. pp. 7-106.
- **Beaugrand, G.** 2009. Decadal changes in climate and ecosystems in the North Atlantic Ocean and adjacent seas. *Deep-Sea Research II* 56(8-10): 656-673.
- **Demarcq, H.** 2009. Trends in primary production, sea surface temperature and wind in upwelling systems (1998–2007). *Progress in Oceanography* 83 (2009) 376–385
- **Drinkwater, K.F., F. Mueter, K. Friedland, M. Taylor, G.L. Hunt, Jr., J.A. Hare and W. Melle.** 2009. Recent climate forcing and physical oceanographic changes in Northern Hemisphere regions: A review and comparison of four marine ecosystems. *Progress in Oceanography* 81(1-4): 10-28.
- **Link, J.S., W.T. Stockhausen, G. Skaret, W. Overholtz, B.A. Megrey, H. Gjøsæter, S. Gaichas, A. Dommasnes, S. Falk-Petersen, F.J. Mueter, K.D. Friedland and J.A. Hare.** 2009. A comparison of biological trends from four marine ecosystems: Synchronies, differences, and commonalities. *Progress in Oceanography* 81(1-4): 29-46.
- **Megrey, B.A., J.A. Hare, W.T. Stockhausen, A. Dommasnes, H. Gjøsæter, W. Overholtz, S. Gaichas, G. Skaret, S. Falk-Petersen, J.S. Link and K.D. Friedland.** 2009. A cross-ecosystem comparison of spatial and temporal patterns of covariation in the recruitment of functionally analogous fish stocks. *Progress in Oceanography* 81(1-4): 63-92.
- **Planque, B., J-M. Fromentin, P.Cury, K.F. Drinkwater, S. Jennings, R. I. Perry, S. Kifani** How does fishing alter marine populations and ecosystems sensitivity to climate? *Journal of Marine Systems* 79: 403-417.
- **Strömberg, K.H.P., T.J. Smyth, J.I. Allen, S. Pitois and T.D. O'Brien.** 2009. Estimation of global zooplankton biomass from satellite ocean colour. *Journal of Marine Systems* 78(1): 18-27.
- **Wang, M., J. E. Overland, N.A. Bond.** 2010. Climate projections for selected large marine ecosystems. *Journal of Marine Systems* 79: 258–266

2.3. Website

The GLOBEC website has also been revamped to facilitate access to documentation and information. Each page has been edited and updated, and links to any activities following on GLOBEC's efforts will be activated. This should ensure that the site remain useful and accessible to the community for many years to come, although updates will not be regular, given the lack of support. A screenshot of the home page is provided below for information.



GLOBEC

Global Ocean Ecosystem Dynamics

[Glossary](#) [Contact](#) [Help](#)

Search GLOBEC

[About GLOBEC](#) [Structure](#) [Products](#) [Data](#) [Links](#) [Calendar](#)

To advance our understanding of the structure and functioning of the global ocean ecosystem

The GLOBEC International Programme completed its activities in January 2010 after ten years of sustained and coordinated research. Some national programmes are still in the process of completing their research agendas, while some national/ regional activities will continue under the umbrella of the IGBP-SCOR IMBER programme, www.imber.net. This website will remain active as a repository of documents and information on GLOBEC international, but will not be regularly updated. The GLOBEC International Project Office, which supported the programme and this website, closed down in March 2010

GLOBEC, a study of Global Ocean Ecosystem Dynamics, was initiated in 1990 by the Scientific Committee on Oceanic Research and the Intergovernmental Oceanographic Commission of UNESCO, and incorporated into the IGBP Core Element structure in 1995. The GLOBEC Science Plan was published in 1997, which set out the GLOBEC goal as:



"To advance our understanding of the structure and functioning of the global ocean ecosystem, its major subsystems, and its response to physical forcing so that a capability can be developed to forecast the responses of the marine ecosystem to global change".

GLOBEC considered "global change" in a broad sense to encompass the gradual processes of climate change as a result of greenhouse warming and their impacts on marine systems, as well as those shorter-term changes resulting from anthropogenic pressures such as population growth in coastal areas, increased pollution, overfishing, changing fishing practices and changing human uses of the seas.

Throughout GLOBEC the programme was managed by a Scientific Steering Committee and GLOBEC research was organised around four foci. The work was initially developed within four Regional Programmes and in 2004 two additional programmes began their research activities. A final regional programme, ICED, grew out of Southern Ocean GLOBEC in the final years of the programme.

Now that the project has ended, many of the continuing activities and outstanding scientific questions are being taken forward by IMBER. This website forms part of the legacy of GLOBEC with records of meetings, newsletters, reports and other useful information we hope that it will continue to be used for many years to come.



Co-sponsored by:






© 2010 GLOBEC International.

[Home](#) | [Site Map](#) | [Contact Us](#) | [Help](#)

 Internet | Protec

Key Events

1st GLOBEC Open Science Meeting

Date: 17 Mar 1998

GLOBEC 2nd Open Science Meeting

Date: 14 Oct 2002

Dynamics of Eastern Boundary Upwelling Ecosystems

Date: 01 Jun 2008

Coping with global change in marine social-ecological systems

Date: 07 Jul 2008

3rd GLOBEC Open Science Meeting

Date: 21 Jun 2009

Most Popular Downloads

Newsletter article Essas Hakodate Meeting 2007

Added: 23 Mar 2010

Hits: 20

Report of the ESSAS SSC 2007

Added: 23 Mar 2010

Hits: 17

GLOBEC Report No.25

Added: 22 Feb 2010

Hits: 17

Newsletter 08(1)

Added: 05 Jan 2010

Hits: 17

Newsletter article ESSAS SSC 2006

Added: 23 Mar 2010

Hits: 16

All the non-copyrighted documentation will be available through this website.

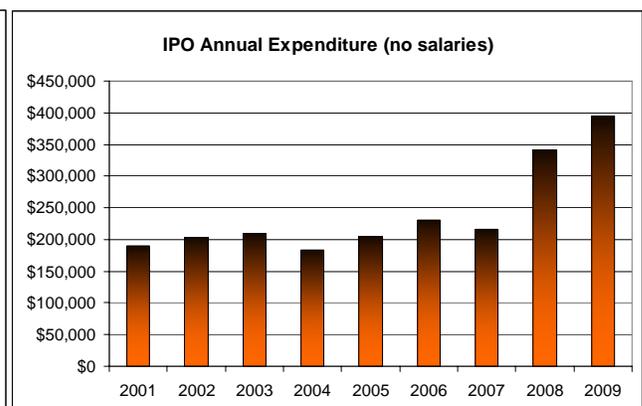
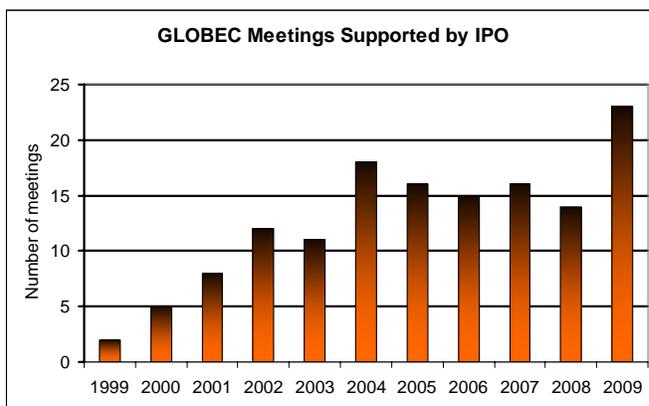
2.4. Awards



Dr. Manuel Barange, Director of Science at the Plymouth Marine Laboratory, and until recently Director of the GLOBEC IPO, was honoured in June 2010 by the Intergovernmental Oceanographic Commission of UNESCO with the Roger Revelle Medal for his “outstanding contributions to ocean sciences”. The Roger Revelle medal, carrying the name of the first president of SCOR, was a direct recognition of GLOBEC’s achievements.

3. FINAL STEPS

The GLOBEC IPO closed its doors in March 2010. As part of the closure a full document of activities sponsored by the IPO was compiled, including the outputs of each and every meeting, and is attached as an appendix to this report. This “activities report” is completed with a “financial report” that summarises how GLOBEC funds were used.



A summary of the activities of the GLOBEC IPO is provided in the two graphs above, organising and supporting approximately 10-20 meetings a year, at a cost of approximately US\$200-350k a year (salaries of IPO staff excluded).

Although the GLOBEC IPO has now closed down there are a number of activities that are still pending:

- the GLOBEC special issue on the 3rd GLOBEC OSM in Progress in Oceanography (expected late 2010)
- the Elsevier Compendium with the top GLOBEC publications (expected autumn 2010).
- the GLOBEC Summary for Decision Makers, appearing both as part of the Elsevier Compendium as well as a stand-alone brochure.

The author of this report would like to express his thanks to the Scientific Committee on Oceanic Research (SCOR, and in particular its Executive Director, Dr Ed Urban jr., for their intellectual, financial and managerial support to GLOBEC international. Without the commitment of the sponsors, and the leadership of SCOR, GLOBEC would not have been able to reach its achievements.

Finally, I'd like to thank the chairs of GLOBEC: **Drs Brian Rothschild, Roger Harris, Cisco Werner** and **Ian Perry**, for their steering of and commitment to the programme, as well as the staff that coordinated the programme from the PML headquarters: **Ms Dawn Ashby** – Deputy Director and Data manager [now PML Communications Officer], **Mrs Lotty Dunbar** – Office Manager [moved on], **Ms Milly Hatton-Brown** – Project Officer [now part time plankton analyst, SAHFOS], **Ms Jessica Heard** – Project Officer [now MEECE Project manager and KE Officer, PML], as well as staff that took administration responsibilities for parts of the project in satellite offices: **Dr Margaret Mary McBride** (M³) – GLOBEC-ESSAS Project Office, Institute of Marine Research, Bergen, Norway, **Dr Keith Brander**, GLOBEC-CCC Coordinator, DTI-AQUA, Copenhagen, Denmark, **Ms Julie Morgan**, GLOBEC-SO Project Officer, Old Dominion University, Norfolk, USA, **Dr Rachel Cavanagh**, ICED Project Officer, BAS, Cambridge, UK.

Appendix - GLOBEC Activities Report 1999-2010

The GLOBEC International Project Office organized and/or provided financial support to the following set of activities over the period 1999-2010. This list links the activities and their outputs, and will be linked to the financial report of the GLOBEC IPO which is available from the GLOBEC IPO.

2009/2010		
Governance		
Meeting	Output	Description
14th GLOBEC SSC Meeting Dartington, UK 11-13 November 2009	Minutes of the 14th GLOBEC SSC Meeting Dartington Hall, UK	The final SSC Meeting was convened to discuss the legacy of the programme, the final newsletter, and the continuation of specific Regional Programmes.
GLOBEC Executive Victoria, Canada 22-26 June 2009	Article in GLOBEC Newsletter 15.2 Special Issue – Progress in Oceanography	The GLOBEC OSM was planned to culminate the integration and synthesis activities of the international GLOBEC programme by providing a new mechanistic understanding of the functioning of the marine ecosystem, in order to develop predictive capabilities and propose a framework for the management of marine ecosystems in the era of global change.

Regional Programmes		
Meeting	Outputs	Description
CLIOTOP Mid-Term Workshop Paris, France 9-11 February 2010	Article in GLOBEC Newsletter 16.1	The goal of the workshop was to review the functioning and the achievements of the Programme during its first 5-year phase (2004-2009) as a GLOBEC regional programme and to define the implementation strategy for its second phase (2010-2014) under the IMBER Programme.
CLIOTOP WG2 Workshop Swansea, UK 28-30 July 2009	Article in GLOBEC Newsletter 15.2	The primary purpose of the workshop is to identify how we might best proceed in order to be able to model the movement and incidence of space-dependent behaviours of oceanic top predators. The aspiration is to produce a strategy for studying top predator movement with a truly global perspective.
CLIOTOP WG3 Workshop Sete, France 6-10 July 2009		The workshop was designed to investigate how to incorporate food web data (both stomach and stable isotope data) from the three oceans into an interoperable database from which the global inter-oceanic comparative analysis will be based.
ESSAS SSC Seattle, USA 17 and 20 June 2009	Report of the ESSAS SSC Meeting 2009	The ESSAS SSC met annually to discuss progress of the working groups and to plan future activities. The annual meeting included three workshops and working group sessions: Gadoid-crustacean interactions in Sub-Arctic Seas; Advection and Its Effects in Sub-Arctic Ecosystems; Comparisons of Approaches to End-to-End Modeling of Marine Ecosystems
ESSAS WG 2 Seattle, USA	Report of the ESSAS SSC	Bio-Physical Coupling: Hotspots and Thresholds

18-19 June 2009	Meeting 2009	
ESSAS WG 3 Seattle, USA 17-20 June 2009	Report of the ESSAS SSC Meeting 2009	Modelling Ecosystem Response
ESSAS WG 4 Seattle, USA 1 June 2009	Report of the ESSAS SSC Meeting 2009	Climate Effects at Upper Trophic Levels
ESSAS WG 3 Seattle, USA 4-10 May 2009	Report of the ESSAS SSC Meeting 2009	Modelling Ecosystem Response
ICED SSC Oslo, Norway 1 June 2010		
ICED OCB Scoping Workshop Princeton, New Jersey, 8-11 June 2009	Draft report of the OCB Scoping workshop	The overall objective of this Scoping Workshop was to facilitate interaction between the physical, biogeochemical, and ecosystem research communities to develop research strategies to resolve current limitations, gaps and discrepancies in our understanding and prediction of the Southern Ocean ecosystems, biogeochemical cycles and carbon uptake.
ICED Southern Ocean Sentinel Workshop Hobart, Australia. 20-24 April 2009	Report of the First Workshop of the Southern Ocean Sentinel Programme	This international workshop was convened to consider how to measure, assess and provide early-warning detection of climate change impacts on the Southern Ocean and how these could be used to signal future impacts on marine and other ecosystems elsewhere in the world.
ICES CCC WG Final synthesis meeting Copenhagen, Denmark 14-17 November 2009		
ICES CCC Workshop at GLOBEC OSM Victoria, Canada 22-26 June 2009	Article in GLOBEC Newsletter 15.2 Special Issue – Progress in Oceanography	
SPACC II Workshop La Paz, Mexico 24-26 February 2010	Article in GLOBEC Newsletter 16.1	The aim of this meeting was to explore ways of continuing the SPACC programme under IMBER with young scientists at the helm.

Other Activities		
Meeting	Output	Description
GLOBEC 3OSM Victoria, Canada	Article in GLOBEC	The GLOBEC OSM was planned to culminate the integration and synthesis activities of the international

3-16

22-26 June 2009	Newsletter 15.2 Special Issue – Progress in Oceanography	GLOBEC programme by providing a new mechanistic understanding of the functioning of the marine ecosystem, in order to develop predictive capabilities and propose a framework for the management of marine ecosystems in the era of global change.
Summary for Decision Makers Workshop Paris, France 8-10 March 2010	GLOBEC Compendium (Elsevier) S4D Brochure (Autumn 2010)	To prepare a Summary for Decision-makers from the work of GLOBEC. This involves identifying central messages from GLOBEC that can inform and support marine management and governance decisions.
4th GLOBEC/IMBER China-Japan-Korea Symposium Jeju, Korea 18-20 May 2010	Report of the 4th GLOBEC/IMBER China-Japan-Korea Symposium	The aim of this symposium was to share scientific findings between the three countries and to look ahead for future directions. The current status and future direction of IMBER-like research in the Northwestern Pacific ecosystems was discussed.
Marine Plankton Phenology - Writing Workshop Woods Hole, USA 1 November 2009	Journal of Plankton Research (in review process)	The main purpose of this meeting was to prepare a paper on marine plankton phenology and life history.
Socio-Economic Dynamics and Ecosystems, Governance Implications Halifax, Canada 28 September – 1 October 2009	Special Issue – Progress in Oceanography Miller <i>et al.</i> In press	The aim of the meeting was to draft a document for the GLOBEC OSM conference proceedings on the implications of climate-related variability in the marine environment for effective governance of human exploitation of fishery resources.
NCAR-GLOBEC Summer Colloquium: Ecosystems and Climate: Modelling and Analysis of Observed Variability in Marine Ecosystems Boulder, USA 3-14 August 2009	Article in GLOBEC Newsletter 16.1	This colloquium provided graduate students with a comprehensive introduction to issues surrounding the development of observational datasets and state-of-the-art marine ecosystem modeling approaches in the context of climate models.

2008		
Governance		
Meeting	Output	Description
13th GLOBEC SSC Meeting and IGBP Congress Cape Town, South Africa 4-9 May 2008	Minutes of the 13th GLOBEC SSC Meeting, Cape Town, South Africa	The GLOBEC SSC met annually throughout the programme to review progress and to plan upcoming activities. The following themes were discussed at the IGBP Congress: End-to-end food webs in marine ecosystems, biogeochemistry and food web interactions along continental margins: Forcings and feedbacks of the carbon cycle in land-atmosphere-ocean systems, social-ecological systems analysis in a changing earth system and climate influences and biological controls in high-latitude marine ecosystems.
GLOBEC Executive and Book Editors Meeting	Book: Marine Ecosystems and	This Executive members and book editors met to make final decisions regarding the structure and content of the

Halifax, Canada 18-20 September 2008	Global Change. 2010 Eds: M. Barange, J.G. Field, R.P. Harris, E. Hoffmann, R. I. Perry and F. Werner.	GLOBEC synthesis book.
GLOBEC-IMBER Transition Task Team Meeting Reading, UK 29 July - 2 August 2008	TTT Meeting Report Article in GLOBEC Newsletter 15.1	The GLOBEC - IMBER Transition Task Team (TTT) was set up to recommend to SCOR and IGBP how the second phase of the IMBER (Integrated Marine Biogeochemistry and Ecosystem Research) programme should proceed, in order to accommodate new developments in marine ecosystem research that need addressing after the completion of the GLOBEC research programme at the end of 2009.

Regional Programmes		
Meeting	Outputs	Description
CLIOTOP SC Meeting Plymouth, UK 26-29 June 2008	Minutes of the 3rd CLIOTOP SC Meeting 2008	The CLIOTOP Scientific Steering Committee met annually to discuss progress of the working groups and to plan future activities.
ESSAS Workshops and SSC Meeting Halifax, Canada 15-19 September 2008	Report of the ESSAS SSC Meeting 2008	The ESSAS Scientific Steering Committee met annually to discuss progress of the working groups and to plan future activities. The workshops included a follow-up 1 day session on predicting future climates in the ESSAS regions, a 1-day workshop devoted to presentations and discussions from the 2008 Science Meeting in Hakodate, a half-day session on advective processes and a 1-day workshop on assessing the best approaches to using models for comparing the ESSAS regions and their responses to climate change.
ICED Modelling Workshop Norfolk, USA 16-18 April 2008	Report of the ICED Modelling Workshop 2008 Article in IMBER Newsletter - July 2008	The main goal of the workshop was to characterise food webs across species, trophic levels and geographical areas, towards developing end-to-end food web models.
GLOBEC PICES CCCC Session at PICES XVII Annual Meeting Dalian, China 23 October - 2 November 2008	PICES XVII Annual Report	The GLOBEC-PICES CCCC sessions at PICES XVII were: Towards ecosystem based management: recent developments and successes in multi-species modelling; Fisheries interactions and local ecology; and Operational forecasts of oceans and ecosystems.

3-18

Focus Working Groups		
<p>GLOBEC F4WG Symposium: Coping With Global Change In Marine Social-Ecological Systems Rome, Italy 8-11 July 2008</p>	<p>Article in GLOBEC Newsletter 14.2 Special Issue: Marine Policy Volume 34, Issue 3, Pages 353-738. 2010</p> <p>Book: World Fisheries: A Social- Ecological Analysis. 2011. Eds: R. Ommer, I.R. Perry, P. Cury, and K. Cochrane.</p>	<p>The central goals of this symposium were to share experiences across disciplines and to identify key next steps and common elements and approaches that promote resilience of marine social-ecological systems in the face of global changes.</p>

Other Activities		
Meeting	Output	Description
BENEFIT Synthesis	Benefit Synthesis Report	BENEFIT, one of the most successful capacity building efforts of GLOBEC, was completed in December 2007. A special GLOBEC Report with scientific highlights, history of the project and appraisal of its achievements by its advisory panel, was published in 2008.
IMBER/IMBIZO Miami, USA 9-13 November 2008		Participants reviewed current knowledge and identified key questions for future research on end-to-end marine food webs, and the biogeochemistry, ecosystems and their interactions in both the mesopelagic and bathypelagic ocean.
32nd Annual Larval Fish Conference Kiel, Germany 4-7 August 2008	32nd Annual Larval Fish Conference Report	The conference was convened to provide a platform for the presentation and discussion of recent research on a wide range of topics related to early life stages of fish and cephalopods.
Dynamics of Eastern Boundary Upwelling Ecosystems: Integrative and Comparative Approaches Las Palmas, Spain 2-6 June 2008	Special Issue: Progress in Oceanography 84, 3-4. 2010 Article in GLOBEC Newsletter 14.2	The symposium considered the dynamics; structure and functioning of the four major eastern boundary upwelling ecosystems linked to the Benguela, California, Canary (African Canary and Iberian Peninsula) and Humboldt Current systems.
GLOBEC/CLIVAR/IMBER Workshop Brest, France 21-24 April 2008		This exploratory training workshop intended to increase the interactions between physical climate science and marine biogeochemistry and ecosystems communities with focus on impacts of climate variability on the marine environment.

2007		
Governance		
Meeting	Output	Description
12th GLOBEC SSC Meeting Hiroshima, Japan 24-26 May 2007	Minutes of the 12th GLOBEC SSC Meeting, Hiroshima, Japan	The GLOBEC SSC met annually throughout the programme to review progress and to plan future activities
GLOBEC Executive Brest, France 8-9 October 2007		The GLOBEC Executive Committee met annually throughout the programme to discuss any issues arising since the SSC and to allocate funding.

Regional Programmes		
Meeting	Output	Description
CLIOTOP OSM La Paz, Mexico 3-7 December 2007	Article in GLOBEC Newsletter 14.1 Special Issue: Progress in Oceanography in Press (2010)	The first CLIOTOP symposium focused on implementing the synthesis objectives of CLIOTOP following three years of intensive workshops.
CLIOTOP WG1 and WG4: Early Life History and Modelling Yokohama, Japan 14-17 May 2007	Presentations for the CLIOTOP Symposium	Workshops gathered field scientists, experimentalists and modellers to put together joint research proposals linking models, observations and experimentations. Workshops were also used to plan and prepare presentations for the forthcoming CLIOTOP Symposium.
CLIOTOP SC May Yokohama, Japan 10-12 May 2007	Minutes of the CLIOTOP SSC Meeting, La Paz, Mexico	The CLIOTOP Scientific Steering Committee met annually to discuss progress of the working groups and to plan future activities.
CLIOTOP Workshop on Designing an Ocean Mid-Trophic Automatic Acoustic Sampler (MAAS) Sète, France 15-19 January 2007	Report of the CLIOTOP MAAS workshop	The goal of the meeting was to set up a project to develop a novel tool for large-scale monitoring of mid-trophic level prey organisms, their horizontal and vertical size-resolved distribution and abundance in the pelagic environment.
ESSAS ASM & SSC and Workshop Hakodate, Japan 8-9 June 2007	Report of the ESSAS SSC Meeting	The ESSAS Scientific Steering Committee meet annually to discuss progress of the working groups and to plan future activities. The first workshop focused on what will happen to the amount, timing and fate of primary production as the temporal and spatial scale of ice cover, as well as its thickness, decreases in response to warming. The second workshop was intended to develop realistic scenarios of the effects of global warming on the climate of sub-arctic seas.

3-20

<p>GLOBEC PICES CCCC Session at PICES XVI Annual Meeting Victoria, Canada 26 October - 4 November 2007</p>	<p>Report of the PICES XVI Annual Meeting</p>	<p>The meeting included the following GLOBEC/PICES CCCC sessions: Towards ecosystem-based management: recent developments and successes in multi-species modelling; Fisheries interactions and local ecology; Operational forecasts of oceans and ecosystems. In addition a pre-symposium workshop on "Climate scenarios for ecosystem modelling was held.</p>
--	---	--

Other Activities		
Meeting	Output	Description
<p>GLOBEC Synthesis Book Meeting Dartington, UK 2-4 July 2007</p>	<p>Book: Marine Ecosystems and Global Change. 2010 Eds: M. Barange, J.G. Field, R.P. Harris, E. Hoffmann, R. I. Perry and F. Werner.</p>	<p>This meeting brought together the lead authors and editors of the final GLOBEC synthesis volume.</p>
<p>Workshop on the Integration of Environmental Information into Fisheries Management Strategies and Advice (WKEFA) Copenhagen, Denmark 18-22 June 2007</p>	<p>Report of the WKEFA Workshop</p>	<p>The workshop was convened to a) estimate the consequences of environmental variability (including "regime shifts") for the biological reference points and other measures which are currently used to guide fisheries management; b) carry out analyses and formulate short-, medium- and long-term integrated advice for the selected cases; c) bearing in mind possible fisheries and ecosystems objectives, identify, develop and evaluate procedures for improving fisheries management strategies and advice by including environmental information and d) identify future directions and needs, including operability, to bring forward the process of incorporating ecosystem advice in the ICES area.</p>
<p>4th International Zooplankton Production Symposium Hiroshima, Japan 28 May - 1 June 2007</p>	<p>Report on the 4th International Zooplankton Symposium Article in GLOBEC Newsletter 13.2</p>	<p>The 4th IZPS followed on from the very successful 3rd IZPS held in Gijon, Spain, May 2003, also co-sponsored by ICES and PICES.</p>
<p>International workshop on Parameterisation of trophic interactions in ecosystem modelling Cádiz, Spain 20-23 March 2007</p>	<p>Special Issue Progress in Oceanography Volume 84, Issues 1-2, Pages 1-138. 2010</p>	<p>This symposium aimed to identify weaknesses in our approaches to parameterization of modelling tools, gaps in understanding and aid in the development of best practices for their future development and application.</p>

2006		
GLOBEC Core Activities		
Meeting	Output	Description
11th GLOBEC SSC Meeting Honolulu, USA 23-25 April 2006	Minutes of the 11th GLOBEC SSC Meeting, Hawaii, Honolulu	The GLOBEC SSC met annually throughout the programme to review progress and to plan future activities.
GLOBEC Executive Plymouth, UK 26-28 September 2006		The GLOBEC Executive Committee met annually throughout the programme to discuss any issues arising since the SSC and to allocate funding.

Regional Programmes		
Meeting	Output	Description
The Role of Squid in Pelagic Marine Ecosystems. A Joint Workshop Sponsored by GLOBEC-CLIOTOP WG3 and The Pelagic Fisheries Research Program (PFRP) Honolulu, USA 14-17 November 2006	GLOBEC Report Number 24	The purpose of this workshop was to consider the role of squid in the pelagic ecosystems, to consider the impacts of climate change on squid and to consider the recent range expansions of <i>Dosidicus gigas</i> in the Pacific Ocean.
CLIOTOP SSC Meeting Hawaii, USA 27 February - 1 March 2006	Minutes of the CLIOTOP SSC Meeting 2006 Article in GLOBEC Newsletter 12.1	The CLIOTOP Scientific Steering Committee met annually to discuss progress of the working groups and to plan future activities.
ESSAS ASM & SSC and Workshop Hakodate, Japan 8-9 June 2007	Report of the ESSAS SSC Meeting	The ESSAS Scientific Steering Committee met annually to discuss progress of the working groups and to plan future activities. The first workshop focused on what will happen to the amount, timing and fate of primary production as the temporal and spatial scale of ice cover, as well as its thickness, decreases in response to warming. The second workshop was intended to develop realistic scenarios of the effects of global warming on the climate of sub-arctic seas.
GLOBEC PICES CCCC Session at PICES XV Annual Meeting Yokohama, Japan 13-22 October 2006	Report of the PICES XV Annual Meeting	This meeting included the following GLOBEC/PICES CCCC sessions: Modelling and historical data analysis of pelagic fish, with special focus on sardine and anchovy; Key recruitment processes and life history strategies: bridging the temporal and spatial gap between models and data; Synchronous and asynchronous responses of North Pacific boundary current systems to climate variability. In addition a pre-meeting CCCC workshop was held on "Climate forcing and marine ecosystems".
SPACC Synthesis Book - Lead Authors Meeting Roscoff, France	Book: Climate Change and the Economics of	This workshop was intended to bring together the lead authors of the SPACC synthesis book and the SPACC Executive Committee members, to plan the final stages of

2-6 October 2006	World Fisheries Eds: R. Hannesson, M. Barange and S.F. Herrick Jr.	the publication. At this meeting the authors circulated their draft chapters, so that areas of overlap, knowledge gaps and style differences could be resolved.
------------------	--	---

Focus Working Groups		
Meeting	Output	Description
4th Meeting GLOBEC F1WG Berlin, Germany 4-8 September 2006	Special Issue: Journal of Marine Systems Volume 79, Issues 3-4, Pages 227-436 (2010) Minutes of the 4th F1WG Meeting Article in GLOBEC Newsletter 12.2	The objective of the workshop was to enhance understanding of the responses of marine ecosystems to environmental change and to improve knowledge of the impacts of climate variability on marine ecosystems.
GLOBEC F2WG/F3WG Workshop: Mathematical Modelling of Zooplankton Dynamics Marseille, France 2-5 May 2006	Article in GLOBEC Newsletter 12.2	This workshop was a joint activity between F2WG (Process Studies) and F3WG (Predictive and Modelling Capabilities). The thematic target of the workshop was "Key issues in the parameterization of zooplankton models"

Other Activities		
Meeting	Output	Description
The Humboldt Current System: Climate, Ocean Dynamics, Ecosystem Processes, and Fisheries Lima, Peru 27 November - 1 December 2006	Special Issue Progress in Oceanography 79, (2-4), P95-412. 2008	This multi-sponsored symposium had the following main topics: Intra-annual to inter-annual, multi-decadal to centennial-scale variability in the Humboldt Current System; Climate and ocean dynamics, and biogeochemical cycles; Lagrangian processes, plankton dynamics and larval survival of fish resources; From phytoplankton to apex predators and fishers, and back; Adaptive strategies of fish and other key species in a highly variable ecosystem; Adaptive management.
GLOBEC/EUR-OCEANS Summer School. Towards Ecosystem Oceanography: Identification and Modelling of Controls in Marine Ecosystems Dragerup Field station, Denmark 18-28 June 2006	Article in GLOBEC Newsletter 12.2	The aim of the summer school was to develop students' understanding of species interactions and their link with climate and other environmental factors.
PICES/GLOBEC	Special Issue. Progress in	The primary scientific objective of this symposium was to present a synthesis of the effects of seasonal to multi-

Symposium on 'Climate variability and ecosystem impacts on the North Pacific: a basin-scale Synthesis' Honolulu, USA 19-21 April 2006	Oceanography 77(2-3): 83-268. 2008	decadal variability on the structure and function of the North Pacific that goes beyond the analysis and understanding developed from studies of a single trophic level, process or region-a True Synthesis.
SCOR WG125 on Global Comparisons of Zooplankton Time Series Honolulu, USA 1 April 2006		

2005		
Governance		
Meeting	Output	Description
10th GLOBEC SSC Meeting Rome, Italy 1-3 June 2005	Minutes of the 10th GLOBEC SSC Meeting	The GLOBEC SSC met annually throughout the programme to review progress and to plan future activities.
GLOBEC Executive Brest France 25-27 October 2005		The GLOBEC Executive Committee met annually throughout the programme to discuss any issues arising since the SSC and to allocate funding.

Regional Programmes		
Meeting	Output	Description
CLIOTOP WG4 La Jolla, USA 8-10 November 2005	Report of the Second Meeting of CLIOTOP Working Group 4 (Synthesis and Modeling)	The working group met to review progress and to make suitable adjustments to the work plan.
CLIOTOP WG1 Malaga, Spain 10-14 October 2005	CLIOTOP Working Group 1 Early Life History Workshop Report	The two main questions addressed at this meeting were: 'What environmental characteristics define the timing and intensity of reproduction and spawning areas?', and 'What environmental and biological characteristics or mechanisms most influence larval survival?'
ESSAS Symposium on "Effects of Climate Variability on Sub-Arctic Marine Ecosystems" Victoria, Canada 16-20 May 2005	Special Issue – Deep Sea Research II 54, (23-26) P 453-2970 2007. Article in GLOBEC Newsletter 11.2 Symposium report	This successful symposium was organised to integrate GLOBEC's research in Sub-Arctic regions, and to launch the new GLOBEC regional programme ESSAS (Ecosystem Studies of Sub-Arctic Seas).
ICED Science Planning	Article in	This meeting was held to plan the ICED regional

3-24

Workshop Cambridge, UK 24–26 May 2005	GLOBEC Newsletter 12.1 ICED Science Plan and Implementation Strategy	programme. The outcomes of this meeting formed the basis of the ICED Science Plan.
ICES/GLOBEC CCC Workshop on Impact of Zooplankton on Cod Abundance and Production Copenhagen, Denmark 7-9 June 2005	Report of the WKIZC 2005	The aim of this meeting was to review and synthesize the knowledge of cod-zooplankton interactions in the North Atlantic.
GLOBEC PICES CCCC Session at PICES XIV meeting Vladivostok, Russia 30 September - 8 October 2005	PICES XIV annual report	The GLOBEC-PICES CCCC sessions at PICES XIV were: The comparative response of differing life history strategists to climate shifts; Modelling climate and fishing impacts on fish recruitment; Modelling and iron biogeochemistry: How far apart are we?; and Filling the gaps in the PICES North Pacific Ecosystem Status Report.
GLOBEC/SPACC Workshop on "Image Analysis To Count and Identify Zooplankton" San Sebastian, Spain 1-3 November 2005	Article in GLOBEC Newsletter 12.1	This workshop was held to evaluate new systems and provide feedback for the manufacturers.

Focus Working Groups		
Meeting	Output	Description
4th Meeting GLOBEC F2WG Dartington, UK 16-20 October 2005	Report of the GLOBEC F2WG Meeting 2005 Article in GLOBEC Newsletter 12.1	WG members contributed a wide range of expertise on geographical regions and ecosystem types as well as providing relevant specialist knowledge of calanoid copepods, euphausiids, gelatinous zooplankton and microzooplankton.
4th Meeting GLOBEC F3WG Aberdeen, UK 25-27 September 2005	Article in GLOBEC Newsletter 12.1	The meeting was an opportunity to review progress on different projects and to plan for the coming years.
3rd Meeting GLOBEC F4WG Sidney, Canada 31 August - 1 September 2005	Article in GLOBEC Newsletter 12.1	The objectives of this workshop were to develop an "appraisal" paper on inter-dependent changes in marine ecosystems and fishing-dependent human communities, and to develop plans for a major symposium on coupled marine ecosystem-human community interactions in the face of global changes.

Other Activities		
Meeting	Output	Description
SCOR Working Group 125 on Global Comparisons of Zooplankton Time Series Maryland, USA 7-10 November 2005		
GLOBEC/IOC Study Group on Regime Shifts Brest, France 28-29 October 2005	Article - Trends in Ecology & Evolution Volume 23, Issue 7, Pages 402-409 2008,	This study group met twice to compile a review paper for a major journal (Nature/Science) that would exemplify the process of identifying, detecting and preventing regime shifts, and applying the knowledge to management and governance of marine resources.
CLIVAR Atlantic Implementation Panel Venice, Italy 20-21 October 2005	Report of the CLIVAR Atlantic Implementation Panel 2005	The panel met to assess progress and problems in the continued implementation of CLIVAR research in the Atlantic sector.
GLOBEC/IOC Study Group on Regime Shifts Rome, Italy 4-5 June 2005	Article - Trends in Ecology & Evolution Volume 23, Issue 7, Pages 402-409 2008,	This study group met twice to compile a review paper for a major journal (Nature/Science) that would exemplify the process of identifying, detecting and preventing regime shifts, and applying the knowledge to management and governance of marine resources.

2004		
Governance		
Meeting	Output	Description
9th GLOBEC SSC Meeting Swakopmund, Namibia 16-19 April 2004	Minutes of the 9th GLOBEC SSC Meeting Article in GLOBEC Newsletter 10.2	The GLOBEC SSC met annually throughout the programme to review progress and to plan future activities
GLOBEC Executive Plymouth, UK 18-20 September 2004		The GLOBEC Executive Committee met annually throughout the programme to discuss any issues arising since the SSC and to allocate funding.

Regional Programmes		
Meeting	Output	Description
CLIOTOP WG2 Meeting Honolulu, USA 2 December 2004	Report of the CLIOTOP WG 2 2004 Article in GLOBEC	CLIOTOP working groups 2, 3 and 5 met in parallel to define their work plan, time line and milestones; to identify people and running projects to follow the proposed activities; to identify future projects; and to define synthesis plans.

3-26

	Newsletter 11.1	
CLIOTOP WG5 Meeting Honolulu, USA 1-3 December 2004	Report of the Meeting 1 of CLIOTOP WG 5 2004 Article in GLOBEC Newsletter 11.1	CLIOTOP working groups 2, 3 and 5 met in parallel to define their work plan, time line and milestones; to identify people and running projects to follow the proposed activities; to identify future projects; and to define synthesis plans.
CLIOTOP WG3 Meeting La Paz, Mexico 31 May - 1 June 2004	Report of the CLIOTOP WG 3 Meeting 2004 Article in GLOBEC Newsletter 11.1	CLIOTOP working groups 2, 3 and 5 met in parallel to define their work plan, time line and milestones; to identify people and running projects to follow the proposed activities; to identify future projects; and to define synthesis plans.
ESSAS Drafting Meeting Friday Harbour, USA 7-9 July 2004		
ICES-GLOBEC Symposium on 'The Influence of Climate Change on North Atlantic Fish Stocks' Bergen, Norway 11-14 May 2004	Special Issue: ICES Journal of Marine Science 62: 7. 2005. Article GLOBEC Newsletter 10.2	This Symposium examined various aspects of the effects of climate change on North Atlantic fish stocks including: fish growth, maturity, recruitment and mortality, the role of zooplankton in climate-fish relations and modelling future climate scenarios in the face of climatic uncertainty.
ICES/GLOBEC CCC Working Group Meeting Bergen, Norway 9-10 May 2004	Report of the ICES/GLOBEC Working Group on Cod and Climate Change (WGCCC)	The working group met to review and evaluate progress on synthesis activities and the outcomes of recent workshops. The group also planned and prepared for future workshops.
GLOBEC PICES CCCC synthesis sessions at PICES XIII Honolulu, USA 15-24 October 2004	PICES XIII Annual report	The GLOBEC-PICES CCCC sessions for PICES XIII: a) The impacts of large-scale climate change on North Pacific ecosystems, b) Modelling approaches that integrate multiple spatial scales and trophic levels between shelf and open oceans, c) The seasonal cycle of plankton production in continental shelf waters around the Pacific Rim” and d) Linking open ocean and costal ecosystems.
SPACC Workshop On the Economics of Small Pelagics and Climate Change Portsmouth, UK 13-15 September 2004	Book: Climate Change and the Economics of World Fisheries Eds: R. Hannesson, M. Barange and S.F. Herrick Jr.	Small pelagic fish species (anchovy, sardine, herring, capelin, etc.) fluctuate significantly on short and long time scales. The focus of the workshop was on the economic implications of these fluctuations.

SPACC Executive Concepción, Chile 17-18 January 2004	Article in GLOBEC Newsletter 10.1	The meeting offered the opportunity to review past activities of the program and to plan for future activities.
SPACC Meeting: Spawning Habitat Quality and Dynamics and the Daily Egg Production Method Concepción, Chile 14-16 January 2004	GLOBEC Report Number 22	The aim of this meeting was to characterize and compare the spawning habitats of small pelagic fish from a variety of systems.
SPACC Workshop: Characterizing and Comparing the Spawning Habitats of Small Pelagic Fish Concepción, Chile 12-13 January 2004	GLOBEC Report Number 21 Article in GLOBEC Newsletter 10.1	The objectives of the workshop were to characterize in terms of environmental parameters the spawning habitats of small pelagic fish (principally anchovy and sardine) from a variety of ecosystems using standardized analysis methods.

Focus Working Groups		
Meeting	Output	Description
3rd Meeting GLOBEC F1WG Honolulu, USA 22-26 October 2004	Report of the 3rd GLOBEC F1WG Meeting 2004 Article in GLOBEC Newsletter 11.1	The aims of this meeting were to identify alternative conceptual frameworks and ideas that might better support fruitful interdisciplinary collaborations and to consider potential applications of the comparative method as a means for effective multilateral research on climate/ ecosystems/ fisheries issues in the Pacific basin.
3rd Meeting GLOBEC F2WG Rhode Island USA 18-20 July 2004	Report of the 3rd GLOBEC F2WG Meeting 2004 Article in GLOBEC Newsletter 10.2	The aim of this meeting was to review and compare process studies within the regional and national GLOBEC and GLOBEC-like programs, and to identify gaps between what has been achieved and goals laid out in the GLOBEC International Implementation Plan.
3rd Meeting GLOBEC F3WG Bergen, Norway 9-10 May 2004	Report of the 3rd Meeting of the GLOBEC Focus 3 Working Group 2004 Article in GLOBEC Newsletter 11.1	The group reviewed the progress of the F3WG and the results of the Basin Scale Modelling Team and their Science paper. The group discussed the practical implementation of the rhomboid and developed possible example systems to study.

Other Activities		
Meeting	Output	Description
2 nd GLOBEC China-Japan-Korea Symposium Hangzhou, China 27-29 November 2004	Special Issue Journal of Marine Systems 67, Issues 3-4, Pages 203-322, 2007	The National GLOBEC Committees of China, Japan and Korea decided to hold a series of joint symposiums to forge co-operation and collaboration among scientists from the three countries. The central theme of this symposium was the relationship between environmental variation and ecosystem responses in the Northwest Pacific region.
OFCCP Workshop on the Application of Stable Isotopes in Pelagic Ecosystems La Paz, Mexico 31 May - 1 June 2004	Report of CLIOTOP WG3 Workshop 2004 Article in GLOBEC Newsletter 11.1	The meeting was designed to review some of the current stable isotope studies in pelagic ecosystems, to present and compare current methods of SIA and to exchange ideas on the interpretation of stable isotope data.
IOC-SCOR Symposium (co-sponsored by GLOBEC) on 'Quantitative Ecosystem Indicators for Fisheries Management' Paris, France 31 March - 3 April 2004	ICES Journal of Marine Science 62(3):307-310, 2005	The symposium was centred on using ecosystem indicators for fisheries management, and as such reflects the growing understanding that exploited fish populations must be considered as integral components of ecosystem function, rather than units that operate independently of their environment.

2003		
Governance		
Meeting	Output	Description
8th GLOBEC SSC Meeting Banff, Canada 18, 19 and 24 June 2003	Minutes of the 8th GLOBEC SSC Meeting	The GLOBEC SSC met annually throughout the programme to review progress and to plan future activities

Regional Programmes		
Meeting	Output	Description
ESSAS 2nd Planning Meeting Seattle, USA 31 October - 1 November 2003	GLOBEC Report Number 19	This meeting was held to draft the ESSAS Science plan.
ESSAS 1st Planning Meeting Bergen, Norway 26-28 May 2003	GLOBEC Report Number 19	This meeting was held to plan the activities and the overall strategy for the ESSAS programme.
SPACC Workshop on Long-term Dynamics of Small Pelagic Fish and Zooplankton in Japanese waters	Article in GLOBEC Newsletter 10.1	The objectives were to present and analyse all relevant long-term data sets on the Kuroshio system and waters surrounding Japan and to compare them with similar data from the Humboldt and Benguela Currents and NE Europe.

Tokyo, Japan 9-11 December 2003		
------------------------------------	--	--

Focus Working Groups		
Meeting	Output	Description
GLOBEC F2WG Meeting Gijon, Spain 18 May 2003	Minutes of the F2WG meeting, 2003	The F2WG met to review the national programs and continue planning the F2WG meeting for 2004.
GLOBEC F3WG Representation at OCEANS WG Harlow, UK 30 May - 2 June 2003	Challenges of Modelling Ocean Basin Ecosystems	
GLOBEC F4WG Meeting Banff, Canada 25-26 June 2003	Article in GLOBEC Newsletter 11.1	The meeting addressed 2 major questions: 'How do marine ecosystem changes affect coastal communities?', and 'What are the reciprocal effects of human responses on marine ecosystems?'
GLOBEC F4WG Representation at GECAFS Miami, USA 2-3 December 2003	Web meeting summary	To determine the scientific nature and geographic scope of a possible collaborative research project and begin planning leadership roles and responsibilities.
GLOBEC F4WG Representation at IHDP Open Meeting of the Human Dimensions of Global Environmental Change Research Community Montreal, Canada 16-18 October 2003	Web meeting summary	The meeting examined the following themes: Transitions and change; Governance, markets and ethics; and Poverty and security.
GLOBEC F4WG Representation at PICES XII Seoul, Korea 10-18 October 2003	Annual Report 2003 PICES 12th Annual Meeting, October 9-18, 2003, Seoul, Republic of Korea	The PICES Annual meeting is an opportunity to recognize achievements in the previous year and to plan forthcoming activities.

Other Activities		
Meeting	Output	Description
GLOBEC-PICES-ICES International Zooplankton Production Symposium Gijón, Spain 20-23 May 2003	Special Issue ICES Journal of Marine Science 61, Number 4, 2004	The main goal of this symposium was to define the current 'state of the art' of zooplankton ecology, with a focus on the effect of climate variability and global climate change on zooplankton.

3-30

2002		
Governance		
Meeting	Output	Description
7th GLOBEC SSC Meeting Qingdao, China 19-20 October 2002	Minutes of the 7th GLOBEC SSC Meeting	The GLOBEC SSC met annually throughout the programme to review progress and to plan future activities.
GLOBEC Executive Plymouth, UK 10-11 May 2002		The GLOBEC Executive Committee met annually throughout the programme to discuss any issues arising since the SSC and to allocate funding.

Regional Programmes		
Meeting	Output	Description
IOC/SPACC Workshop On The Use of Environmental Indices in The Management of Pelagic Fish Paris, France 9-11 November 2002	GLOBEC Special Contribution Number 6	Discussions were centred around three subgroups: Review of case studies where Environmental Indices are used in management Procedures; Framework to establish linkages between environmental forcing and pelagic fish responses; and Requirements to incorporate Environmental Indices in pelagic stock assessment.
SPACC Executive Plymouth, UK 10-11 May 2002	Article in GLOBEC Newsletter 8.2	The meeting offered the opportunity to review past activities of the programme and to plan for 2002-2005.

Focus Working Groups		
Meeting	Output	Description
2nd Meeting GLOBEC F1WG Qingdao, China 13-14 October 2002	Report of the 2nd GLOBEC F1WG Meeting 2002 Article in GLOBEC Newsletter 7.2	The meeting identified core cross-cutting scientific issues among GLOBEC, PAGES and CLIVAR.
2nd Meeting GLOBEC F2WG Qingdao, China 13-14 October 2002	Report of the 2nd GLOBEC F2WG Meeting 2002 Article in GLOBEC Newsletter 7.2	The meeting aimed to define and inter-compare standard approaches and methodologies, define specific tasks to address in the study of the variability of biological rates in relation to physical conditions, and to identify gaps between achievements and the goals laid out in the Implementation Plan.
2nd Meeting GLOBEC F3WG Qingdao, China 13-14 October 2002	Report of the 2nd GLOBEC F3WG Meeting 2002 Article in GLOBEC Newsletter 7.2	The meeting focused on the discussion of the development of basin-scale ecosystem models and biological models for the study of individuals, populations and ecosystems.

1st Meeting GLOBEC F4WG Qingdao, China 15-18 October 2002	Report of the 1st GLOBEC F4WG Meeting 2002 Article in GLOBEC Newsletter 7.2	The aims of the meeting were to define the key questions regarding marine ecosystem changes and human society interactions, and to develop proposals to address issues of marine ecosystem changes and human society interactions.
GLOBEC F4WG Planning Victoria, Canada 3-5 April 2002		

Other Activities		
Meeting	Output	Description
GLOBEC 2OSM Qingdao, China 15-18 October 2002	Special Issue: Fisheries Oceanography 12(4/5) 2003	The second Open Science Meeting served to present results of a midterm evolution in our understanding of local and regional studies of marine ecosystems.

2001		
Governance		
Meeting	Output	Description
6th GLOBEC SSC Meeting Lima, Peru 23-26 May 2001	Minutes of the 6th GLOBEC SSC Meeting Article in GLOBEC Newsletter 7.2	The GLOBEC SSC met annually throughout the programme to review progress and to plan future activities.

Regional Programmes		
Meeting	Output	Description
GLOBEC PICES CCCC Session at PICES X Annual Meeting Victoria, Canada 5-13 October 2001	PICES X Annual Report	
SPACC/GLOBEC Workshop on Paleooceanography Munich, Germany 10-13 October 2001	Article in GLOBEC Newsletter 8.1	This workshop was an opportunity for scientists working with sediment cores from the Benguela, California, Humboldt and Peru currents to meet and exchange ideas and results.
SPACC/ENVIFISH/IDYLE Spatial Approaches Of The Dynamics of Coastal Pelagic Resources and their Environment in Upwelling Areas Cape Town, South Africa 6-8 September 2001	GLOBEC Report Number 16 Article in GLOBEC Newsletter 8.1	The meeting was aimed at synthesizing the state of the art concerning recent theoretical achievements, analysis techniques and modelling tools used for the integration of spatial structures in the study of the dynamics of marine populations and their environments.

3-32

SPACC/IOC Workshop on the Use of Environmental Indices in The Management of Pelagic Fish Cape Town, South Africa 3-5 September 2001	GLOBEC Special Contribution Number 5 Article in GLOBEC Newsletter 8.1	In this first meeting the Steering Group drafted a plan of activities for the following 12 months.
SPACC - Causes and Consequences of Climate-Induced Changes in Pelagic Fish Productivity in East Asia Kobe, Japan 25-27 August 2001	GLOBEC Report Number 15 Article in GLOBEC Newsletter 8.1	One of the main purposes of the meeting was to develop a strategic plan for SPACC in East Asia, and to identify ongoing activities and critical gaps in our knowledge.
SPACC - Retrospective data analyses meeting Lima, Peru 29 May- 1 June 2001	Article in GLOBEC Newsletter 7.2	The meeting was held to review progress and accomplishments and to plan future activities.

Focus Working Groups		
Meeting	Output	Description
GLOBEC F1WG Climate Variability Workshop Lima, Peru 27-28 May 2001		
GLOBEC F3WG Meeting Amsterdam, Netherlands 10-14 July 2001	Article in GLOBEC Newsletter 7.2	The meeting was held to review progress and plan future activities.

Other Activities		
Meeting	Output	Description
IRI/GLOBEC Climate-Fisheries Workshop Honolulu, USA 14-17 November 2001	Book: Climate and Fisheries (Open Library) Eds: A. Bakun and K. Broad. 2002 Article in GLOBEC Newsletter 8.1	This meeting was devoted entirely to interdisciplinary and inter-regional "cross-education" and cross-sharing of insights and ideas among scientists with experience ranging over a variety of species and industry types.
Optical Plankton Counter Workshop Tromsø, Norway 17-20 June 2001	GLOBEC Report Number 17 Article in GLOBEC Newsletter 7.2	The aim of the workshop was to demonstrate OPC methods and to unite new users with more experienced users to share their experiences of OPC.

2000		
Governance		
Meeting	Output	Description
5th GLOBEC SSC Meeting Sitges, Spain 15-17 May 2000	Minutes of the 5th GLOBEC SSC Meeting	The GLOBEC SSC met annually throughout the programme to review progress and to plan future activities.
GLOBEC Executive Plymouth, UK 5-6 October		The GLOBEC Executive Committee met annually throughout the programme to discuss any issues arising since the SSC and to allocate funding.

Regional Programmes		
Meeting	Output	Description
GLOBEC PICES CCCC Session at PICES IX Annual Meeting Hakodate, Japan 20-28 October 2000	PICES IX Annual Report	The aim of the workshop was to evaluate our ability to model and observe the climate system and the marine ecosystem in relation to pelagic fisheries and to identify methodological and theoretical gaps in current knowledge. Workshop website

Focus Working Groups		
Meeting	Output	Description
1st Meeting GLOBEC F1WG Sitges, Spain 18-19 May 2000	Report of the 1st GLOBEC F1WG Meeting 2000 Article in GLOBEC Newsletter 6.2	The aim of this meeting was to establish the participants' visions for F1WG and to discuss issues such as data management and collaborations.
1st Meeting GLOBEC F2WG Qingdao, China 10-13 September 2000	Report of the 1st GLOBEC F2WG Meeting 2000 Article in GLOBEC Newsletter 7.1	SCOR Report 2001 contradicts this date and location! The aim of this workshop was to identify key species and define key biological and physical processes and their interactions.
1st Meeting GLOBEC F3WG Chapel Hill, USA 17-20 July 2000	Report of the 1st GLOBEC F3WG Meeting 2000 Article in GLOBEC Newsletter 6.2	A wide range of topics were discussed and a prioritised series of activities was identified for consideration over the next 1-3 years.

Other Activities		
Meeting	Output	Description
Workshop on Interannual Climate Variability and Pelagic Fisheries		The aim of the workshop was to evaluate our ability to model and observe the climate system and the marine ecosystem in relation to pelagic fisheries and to identify methodological and theoretical gaps in current

Nouméa, New Caledonia 6-20 November 2000		knowledge. Workshop website
GLOBEC-PAGES-CLIVAR Meeting Sidney, Canada 25-27 September 2000	Report of the GLOBEC/PAGES/CLIVAR Meeting 2000 Article in GLOBEC Newsletter 7.1	The initial objective of this workshop was to identify the specific information needs of each program (GLOBEC PAGES and CLIVAR) which may have been provided by the other programmes taking part in these discussions.
Workshop on the use of the Continuous Underway Fish Egg Sampler (CUFES) for Mapping Spawning Habitats of Pelagic Fish San Sebastian, Spain 9-11 February 2000	GLOBEC Report Number 14 Article in GLOBEC Newsletter 6.1	The objective of this workshop was to assess the present status of CUFES in comparative studies of spawning habitats and egg production of small pelagic fishes, and to plan and recommend future actions for both the further development of this novel methodology and to address the issues pertinent to Working Group 8.

2000–2009 GLOBEC Representation at other Meetings		
Meeting	Output	Description
GLOBEC/ ICES/ PICES workshop on changes in distribution and abundance of clupeiform small pelagic fish in relation to climate variability Kiel, Germany 3-7 November 2008	Report on the workshop on changes in distribution and abundance of clupeiform small pelagic fish in relation to climate variability	Changes in distribution and abundance of clupeiform small pelagic fish in relation to climate variability and global change [WKSPCLIM]
GLOBEC QUEST_Fish PI Meeting Plymouth, UK 14-15 October 2008	Minutes of the 3rd GLOBEC Quest Fish Meeting	QUEST_Fish is a programme affiliated to GLOBEC that attempts to use climate change and ecosystem predictions to estimate the potential for fish production in the future, and the socio-economic consequences of these.
ICES-GLOBEC symposium "Linking Herring: linking biology, ecology and status of populations in the context of changing environments" Galway, Ireland 26-29 August 2008	Report: Herring: Linking biology, ecology and population status in the context of changing environments. Article in GLOBEC Newsletter 14.2	This symposium was intended to provide the ultimate link to our understanding of herring populations in the Atlantic and Pacific.
ICES-GLOBEC Workshop on Cod and Future Climate Change Copenhagen, Denmark	Meeting Report	This was the 2008 annual workshop of the Cod and Climate Change programme of ICES and GLOBEC, which will conclude at the end of 2009.

16-17 June 2008		
3 rd GLOBEC China-Japan-Korea Symposium Hakodate, Japan 13-15 December 2007	Article in GLOBEC Newsletter 14.1	The 3 rd regional symposium provided new information and a forum for discussion regarding new research findings of the national GLOBEC programmes in this region.
BENEFIT-BCLME Synthesis Symposium Swakopmund, Namibia 19-21 November 2007	Benefit Synthesis Report	The goal was to present the key outputs of the BCLME and BENEFIT programmes, record this legacy and to consolidate plans for future integrated management, sustainable development and protection of the Benguela Current ecosystem.
GLOBEC Germany Symposium Hamburg, Germany 14-15 November 2007		This symposium concluded the activities of this successful GLOBEC national programme.
CLIOTOP WG5 workshop “The challenge of change: managing for sustainability of oceanic top predator species” Santa Barbara, USA 12-14 April 2007	Article in GLOBEC Newsletter 13.2	The purpose of the workshop was to foster the development of a research community capable of addressing the many sources of change and uncertainty affecting the international management of marine top predator species.
ICES/GLOBEC workshop on long-term variability in SW Europe Lisbon, Portugal 20-24 November 2006	Article in GLOBEC Newsletter 13.1	The scientific objectives were to identify possible links to climate variability and to look for possible telecommunication patterns within European and other marine ecosystems.
Advancements in modelling physical-biological interactions in fish early-life history: recommended practices and future directions Nantes, France 3-5 April 2006	ICES Cooperative Report Manual of recommended practices for modelling physical – biological interactions during fish early life Article in GLOBEC Newsletter 11.2	The aim of this meeting was to evaluate the present state and next steps in the developing field of modelling physical-biological interactions in lake, estuarine, shelf and ocean ecosystems.
Workshop on Indices of meso-scale structures Nantes, France 22-24 February 2006	ICES Report of the workshop on Indices and meso-scale structures Article in GLOBEC Newsletter 11.2	The aim was to review numerical methodologies for the construction of indices of meso-scale structures such as fronts, eddies, transport, upwelling and vertical hydrographic changes.
GLOBEC-SPACC workshop on		The workshop was used to fit the NEMURO-FISH ecosystem model to data from several areas that have

3-36

<p>“Fluctuations of sardines and anchovies and impact on coastal fishing communities” Tokyo, Japan 14-17 November 2005</p>		<p>large populations of anchovy and sardine to ascertain if the replacement between both species could be explained as driven by decadal-scale climate variability.</p>
<p>CLIOTOP WG4 (Synthesis and Modelling) Workshop La Jolla, USA 8-10 November 2005</p>	<p>Report of the CLIOTOP Working Group 4 workshop 2005</p>	<p>The aim of the meeting was to review inter-sessional work conducted by participants and develop research ideas that could support future work and collaboration and to agree on specifications for global datasets.</p>
<p>AMEMR: Advances in Marine Ecosystem Modelling Research Plymouth, UK 27-29 June 2005</p>	<p>Journal of Marine Systems Volume 64, Issues 1-4, Pages 1-246. 2007</p>	<p>This international symposium was convened by the Plymouth Marine Laboratory as a forum for presentation and discussion of all aspects of model-based marine ecosystem research, encompassing numerical, conceptual, mathematical and statistical approaches. AMEMR is supported by GLOBEC.</p>
<p>2nd GLOBEC Japan/Korea/China Symposium Hangzhou, China 27-29 November 2004</p>	<p>Article in GLOBEC Newsletter 11.1</p>	<p>The symposium continued the tradition of these three national GLOBEC programmes to co-ordinate their research and contribute to GLOBEC's overall synthesis. The two areas of focus were ecosystem structure and foodweb trophodynamics, and physical-biological processes and models.</p>
<p>UK GLOBEC Open Science Meeting London, UK 26 February 2004</p>		<p>This effort was the culmination of the main UK GLOBEC field programme, 'Marine Productivity', which is due to complete its work in March 2005. The meeting significantly influenced a re-organisation of future funding for fisheries and ecosystem research.</p>

1993-1999 GLOBEC activities prior to establishment of IPO at PML		
Meeting	Output	Description
<p>GLOBEC Workshop on the Assimilation of Biological Data in Coupled Physical/Ecosystems Models Bologna, Italy 28-30 June 1999</p>	<p>GLOBEC Special Contribution 3</p>	<p>The aims of the workshop were to overview the status and assess the prospects for, and potential impact of, biological data assimilation together with the assimilation of compatible physical and chemical data.</p>
<p>4th GLOBEC SSC Meeting Shonan Village, Japan 7-13 May 1999</p>	<p>Minutes of the 4th GLOBEC SSC Meeting Article in GLOBEC Newsletter 5.2</p>	<p>The GLOBEC SSC met annually throughout the programme to review progress and to plan future activities.</p>
<p>3rd GLOBEC SSC Meeting Paris, France 17-20 March 1998</p>	<p>Minutes of the 3rd GLOBEC SSC Meeting</p>	<p>The GLOBEC SSC met annually throughout the programme to review progress and to plan future activities.</p>

1st GLOBEC OSM Paris, France 17-20 March 1998	Special Issue: Fisheries Oceanography 7 (3-4) P175 - 390. 1998 Article in GLOBEC Newsletter 4.1	A main aim of the OSM was to present a draft implementation plan to the wider international scientific community, and to provide opportunity for feedback and discussion.
Meeting of the Southern Ocean Planning Group San Diego, USA 1-3 August 1997	GLOBEC Report Number 7a Article in GLOBEC Newsletter 3.2	The objective of the meeting was to develop cruise and sampling plans for a Southern Ocean GLOBEC programme and to begin the development of the infrastructure needed to co-ordinate and undertake such a program.
2nd GLOBEC SSC Meeting Plymouth, UK 24-26 June 1997	Minutes of the 2nd GLOBEC SSC Meeting	The GLOBEC SSC met annually throughout the programme to review progress and to plan future activities.
1st GLOBEC SSC Meeting Baltimore, USA 11-13 November 1996	Minutes of the 1st GLOBEC SSC Meeting Article in GLOBEC Newsletter 3.1	The GLOBEC SSC met annually throughout the programme to review progress and to plan future activities.
First SPACC Modelling Workshop Ispra, Italy 14-16 October 1996	GLOBEC Report Numbers 11/12	This meeting was convened to draft ideas for the SPACC implementation plan.
First planning meeting on Small Pelagic Fishes and Climate Change Program La Paz, Mexico 20-24 June 1994	GLOBEC Report Number 8 Article in GLOBEC Newsletter 2.2	The aim of the meeting was to bring together scientists representing various marine ecosystems in order to begin drafting an Implementation plan for SPACC.
Southern Ocean Implementation Plan Bremerhaven, Germany 6-8 June 1994	GLOBEC Report Number 7 Article in GLOBEC Newsletter 2.2	The SO GLOBEC implementation plan was finalised at this meeting.
First meeting of the International GLOBEC Working Group on Numerical Modelling Villefranche-sur-Mer, France 12-14 July 1993	GLOBEC Report Number 6 Article in GLOBEC Newsletter 2.2	The aim of this meeting was to discuss and define the scope of numerical modelling in relation to GLOBEC and to develop a programme of activities for the Working Group.
First meeting of the International GLOBEC Working Group on Development of an International GLOBEC Southern Ocean Program Norfolk, USA 15-17 June 1993	GLOBEC Report Number 5 Article in GLOBEC Newsletter 2.2	The working group met in order to discuss the establishment of the SO GLOBEC Regional Programme. Important features of the Southern Ocean and ideas of which scientific areas to focus on were also discussed.

3-38

First meeting of the ICES/International GLOBEC Working Group on Cod and Climate Change Lowestoft, England 7-11 June 1993	GLOBEC Report Number 4	The working group met to review recent advances of models on climate variability, review planning and progress of cod and climate change research and to consider ways of incorporating numerical population models.
International GLOBEC working group on Sampling and Observation Systems Paris, France 30 March – 2 April 1993	GLOBEC Report 3 Article in GLOBEC Newsletter 2.2	This meeting was convened in order to facilitate the exchange of ideas in the area of sampling technologies and their implementation as part of the GLOBEC Programme.
Population Dynamics and Physical Variability Working Group Meeting Cambridge, UK 1-5 February 1993	Article in GLOBEC Newsletter 2.1	Biological and physical processes in zooplankton dynamics were discussed at this meeting.

3.2 Global Ecology and Oceanography of Harmful Algal Blooms (GEOHAB)

(joint with IOC)

Terms of Reference:

The Scientific Steering Committee of the GEOHAB Programme will

1. Coordinate and manage GEOHAB Core Research Projects (CRPs) in accordance with the GEOHAB Science and Implementation Plans.
2. Identify gaps in knowledge required to execute CRPs, and encourage targeted research activities to fill those gaps.
3. Review progress on CRPs over time and initiate new CRPs in priority research areas.
4. Foster framework activities to facilitate implementation of GEOHAB, including dissemination and information tools.
5. Establish appropriate data management activities to ensure access to, sharing of, and preservation of GEOHAB data, taking into account the data policies of the sponsors.
6. Promote comparative and interdisciplinary research on harmful algal blooms by providing coordination and communication services to national and regional research groups, encouraging explicit affiliation with GEOHAB via the endorsement process.
7. Collaborate, as appropriate, with intergovernmental organizations and their subgroups (e.g., ICES, PICES, FANSA, ANCA, WESTPAC/HAB, HANA, NOWPAP), as well as related research projects (e.g., GLOBEC, LOICZ, IMBER) and observational systems such as the Global Ocean Observing System and its regional alliances.
8. Report regularly to SCOR, the IOC Intergovernmental Panel on Harmful Algal Blooms (IPHAB), and the global HAB research community on the state of planning and accomplishments of GEOHAB, through annual reports and, as appropriate, the GEOHAB Web site, a GEOHAB Newsletter, *Harmful Algal News*, special sessions at scientific meetings, and other venues.
9. Interact with agency sponsors to stimulate the support of GEOHAB implementation through various mechanisms (e.g., direct support of GEOHAB initiatives and integration of the GEOHAB approach in national programs).

Acronyms

ANCA = IOC HAB working group for Central America and Caribbean Sea

FANSA = IOC HAB working group for South America

HANA = IOC HAB working group for North Africa

GLOBEC = Global Ocean Ecosystem Dynamics project

ICES = International Council for the Exploration of the Seas

IMBER = Integrated Marine Biogeochemistry and Ecosystem Research project

IOC = Intergovernmental Oceanographic Commission

LOICZ = Land-Ocean Interactions in the Coastal Zone project

NOWPAP = UNEP Northwest Pacific Action Plan

PICES = North Pacific Marine Sciences Organization

SCOR = Scientific Committee on Oceanic Research

WESTPAC/HAB = IOC SubCommission for the Western Pacific HAB working group

3-40

Chair:

Raphael M. Kudela
Ocean Sciences Department
University of California
Santa Cruz, CA 95064, USA
Tel: +1-(831) 459-3290
Fax: +1-(831) 459-4882
Email: kudela@ucsc.edu

Vice Chair:

Elisa Berdalet
Institut de Ciències del Mar (CMIMA,
CSIC)
Dept. Biologia Marina i Oceanografia
Pg. Marítim, 37-49
08003- Barcelona, Catalunya
SPAIN
Tel: + 34 93 2309595 (office)
+ 34 93 2309500 (CMIMA)
FAX: +34 93 230 9555
E-mail: berdalet@icm.csic.es,
elisa.berdalet@icm.cat

Members:

Icarus Allen	UK	Liam Fernand	UK
Stewart Bernard	SOUTH AFRICA	Songhui Lu	CHINA-Beijing
Paul Bienfang	USA	Gires Usup	MALAYSIA
Michele Burford	AUSTRALIA		

Ex-officio Member: Leonardo Guzman (IOC IPHAB)

IOC Staff: Henrik Enevoldsen

Executive Committee Reporter: Huasheng Hong

Global Ecology and Oceanography of Harmful Algal Blooms (GEOHAB) Program

ACTIVITIES 2009-2010

The past 1.5 years has been very productive for GEOHAB in the area of publications and meetings convened. Three special issues of journals and three GEOHAB reports have been published. The [GEOHAB publication page](#) shows the increase of GEOHAB peer-reviewed publications over the recent past. GEOHAB is up to about 10 reports from the program and is discussing distributing the set of reports on CD.

1. SSC Meeting: Honolulu, Hawaii (USA), June 2010

The GEOHAB SSC met in Honolulu, Hawaii, on 26-28 June 2010 and discussed all aspects of GEOHAB work. The meeting discussions included the following topics:

- Review of all the status of all GEOHAB Core Research Projects
- Recap of the outcomes from the Open Science Meeting (OSM) on HABs in Benthic Systems
- Update on the progress of the Modeling Workshop special issue and report, and follow-on activities
- Discussions of plans for GEOHAB completion at the end of 2013
- Update on the joint activity with IOCCG planned for August 2010
- Interactions with GOOS and the Intergovernmental Panel on Harmful Algal Blooms
- Updates on regional, national, and GEOHAB-endorsed projects
- GEOHAB Web site and publications, including other sites such as Wikipedia
- Representation at meetings
- SSC rotations
-

A summary of the meeting will be available on the GEOHAB Web site (<http://www.geohab.info>).

2. Implementation of Core Research Projects

The GEOHAB *Implementation Plan*¹, published in November 2003, specified the formation of Core Research Projects (CRPs) related to four ecosystem types—upwelling systems, fjords and coastal embayments, eutrophic systems, and stratified systems. Since then, initiation and implementation of these CRPs has been the primary GEOHAB objective through OSMs and other activities. All four of the CRP research plans have now been completed.

A. Core Research Project: HABs in Upwelling Systems

This sub-group is chaired by Grant Pitcher (South Africa). The group published a series of

¹ GEOHAB. 2003. *Global Ecology and Oceanography of Harmful Algal Blooms, Implementation Plan*. P. Gentien, G. Pitcher, A. Cembella and P. Glibert (eds.), SCOR and IOC, Baltimore and Paris, 36 pp.

synthesis papers in the journal *Progress in Oceanography* this year (2010). Current discussion involves whether to dissolve the CRP SSC and reconvene a new group of members to target some specific research goals in relation to HABs in upwelling systems.

B. Core Research Project: HABs in Fjords and Coastal Embayments

This sub-group is co-chaired by Allan Cembella (Germany) and Suzanne Roy (Canada). Their CRP Report was published in May 2010, and is available on the GEOHAB Web site (see http://www.ioc-unesco.org/hab/index.php?option=com_oe&task=viewDocumentRecord&docID=5520).

C. Core Research Project: HABs and Eutrophication

The sub-group on HABs and Eutrophication is chaired by Patricia Glibert (USA). The research plan for this CRP was published in 2006. The group held a 2nd GEOHAB OSM on HABs and Eutrophication in Beijing, China, overlapping with the 2009 SCOR Executive Committee meeting and immediately after the second meeting of SCOR/LOICZ WG 132 on Land-based Nutrient Pollution and the Relationship to Harmful Algal Blooms in Coastal Marine Systems. A brief overview of the meeting is shown at the GEOHAB Web page. The group is planning to meet in Crete in conjunction with the international HAB meeting in October, and may plan a third OSM in 2013.

D. Core Research Project: HABs and Stratification

The sub-group on HABs and Stratification was chaired by Patrick Gentien (France) until his death in June 2010, at which time Robin Raine (Ireland) took over as chair. The SSC discussed a new composition of the subcommittee for this CRP in order to proceed within the objectives and key questions indicated in the CRP report (completed in October 2008). The initial idea is that the subcommittee will discuss the next steps during the coming 6-12 months by email communication, and propose activities between now and completion of GEOHAB. The group may meet in Barcelona in the coming year.

E. Open Science Meeting on HABs in Benthic Systems (BHABs)

GEOHAB sponsored an OSM on HABs in Benthic Systems in Honolulu, Hawaii in June 2010, with Paul Bienfang as the convener. Benthic HABs, which include algae that contribute to ciguatera, are probably the most widespread of all algae-related poisonings. About 60 people attended. A training workshop on identifying benthic HABs was held following the OSM and about 20 individuals attended. The OSM organizing committee is writing a report with the main contributions and open questions for the coming years in order to initiate and implement the CRP. An outline of the results will be also reported at the November 2010 International HAB meeting in Crete. There will also be a “town hall” style meeting on this CRP in Crete to announce the CRP to the broader HAB research community and entrain new participants in the CRP.

3. GEOHAB Modeling

A special issue of the *Journal of Marine Systems* with contributions from the GEOHAB Modeling Workshop (held in Galway, Ireland on 15-19 June 2009), edited by Dennis McGillicuddy, is in press. Sixteen papers are included in the special issue. In addition, a report will be finished soon, reporting on the discussion sessions at the workshop on key modeling aspects that need to be incorporated for the advances of the GEOHAB CRPs and regional/national projects. Complete information about the contributions of the meeting will continue to be available at www.geohab-models.org. The future modeling activities and subcommittee, within the GEOHAB structure, were also discussed at the SSC meeting. Icarus Allen is the new lead for GEOHAB modeling activities.

4. GEOHAB Asia

The Science Plan for GEOHAB research and cooperation in Asia was published in May (available at the GEOHAB webpage at http://www.ioc-unesco.org/hab/index.php?option=com_oe&task=viewDocumentRecord&docID=5460). The report was developed from meetings in 2007 in Japan and in 2008 in Vietnam. Songhui Lu and Gires Usup are the new members of the SSC involved on the development of the GEOHAB Asia activities. Usup will chair the GEOHAB Asia subcommittee.

5. GEOHAB Sunset

SCOR and IOC agreed to close the GEOHAB program at the end of 2013, ten years from the publication of the GEOHAB Implementation Plan. Discussions were begun on what would be appropriate final products. At this time, ideas include a summary of program accomplishments for a broad audience and/or an update of the HABWATCH book on HAB-observing technologies, as well as other GEOHAB products such as a review of the use of modeling for HABs and continued CRP reports. The timeline and synthesis plan of GLOBEC is being considered as a model. Different audiences for synthesis information from GEOHAB could include the scientific community, policymakers, and the public. Potential products could include a summary for policymakers, a video, and/or a special issue of a journal. There may be a final open science meeting in 2013.

6. 2010 SSC Meeting

The timing and location of the 2011 SSC meeting has not yet been decided, although the meeting may be held in the Southern Hemisphere, in conjunction with another meeting, and/or in a location that will advance the activities of GEOHAB CRPs. The exact location is being determined based on these considerations as well as total meeting costs and availability of SSC members, with a target date between February-June 2011.

7. IOCCG/GEOHAB Working Group

The International Ocean Colour Coordination Group and GEOHAB are co-funding a working group on HABs and Ocean Colour. The group will

- Summarise the relevance of ocean colour-based harmful algal bloom observation systems.

- Summarise the wide variety of harmful algal bloom types with regard to ecosystem function, consistent with GEOHAB Core Research structures.
- Summarise the principal methodological difficulties for ocean colour in coastal and inland waters, with reference to previous IOCCG Working Groups and other ongoing initiatives, e.g. GEO Tasks, CoastColour etc
- Summarise our current understanding of the physics of phytoplankton community composition from a bio-optical and ocean colour perspective.
- Review the relevance of Phytoplankton Functional Type (PFT) approaches (with reference to IOCCG PFT Working Group) for harmful algal bloom observations across a variety of coastal and inland ecosystems.
- Review and summarise current and emerging harmful algal bloom related ocean colour techniques, from reflectance-based community composition algorithms to ecosystem-specific change-detection algorithms i.e. research and operational applications.
- Compare the results of a variety of algorithms on selected bloom case studies, representative of the GEOHAB core research ecosystems with the specific addition of inland waters, and use these studies to provide a clear guide to ocean colour algorithm performance diagnostics, and optimal ocean colour-based approaches for various bloom and ecosystem types.
- Examine the utility of ocean colour observations beyond the event scale: multi-sensor and -temporal analyses of ecological drivers and response for example systems, analysing and demonstrating the value of routine synoptic data and integration with other observations and models.
- Recommendations concerning future studies, measurements, protocols etc to develop, improve and better understand application limitations for harmful algal bloom focused ocean colour algorithms
- Summary, recommendations and future outlook for the development of new ocean colour observation systems, incorporating future sensors/systems.
- Prepare a monograph to be published within the IOCCG or GEOHAB series.
- Prepare a special issue in a peer-reviewed journal incorporating suitable review and case study chapters as papers.

8. Acknowledgements and Obituary

The GEOHAB SSC wants to express its kind remembrance about Patrick Gentien, the first GEOHAB chair and leader of the Stratified Systems CRP, who passed away suddenly in May. Furthermore, the present GEOHAB SSC acknowledges the great job of Robin Raine as chair of GEOHAB (2005-2009) and Ken Furuya (SSC member, 2003-2010), a key contributor to the GEOHAB Asia implementation. The new members of the SSC (Paul Bienfang (USA), Michelle Burford (Australia), Songhui Lu (China-Beijing), Gires Usup (Malaysia)) were welcomed to the SSC at the Hawaii meeting.

3.3 Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) (joint with IGBP)

Terms of Reference:

Agreed by IGBP and SCOR, April 2004

- To develop the IMBER Science Plan and Implementation Strategy, in accordance with guidance from the sponsoring organisations.
- To oversee the development of IMBER in accordance with its Science Plan and Implementation Strategy.
- To collaborate, as appropriate, with related projects of the sponsors IGBP and SCOR, and other related programmes and organisations (e.g., IHDP, DIVERSITAS, IOC and the Global Ocean Observing System (GOOS), etc.)
- To establish appropriate data management policies to ensure access to, sharing of, and preservation of IMBER data, taking into account the policies of the sponsors.
- To report regularly to SCOR and IGBP on the state of planning and the accomplishments of IMBER.

The IMBER SSC, its subsidiary groups and International Project Office shall operate in accordance with the operating procedures for IGBP Projects and the requirements of the other co-sponsors.

Chair:

Eileen Hofmann
Center for Coastal Physical Oceanography
Old Dominion University
4111 Monarch Way
Norfolk, VA 23508
USA
Tel: +1 757-683-5334
Fax: +1 757-683-5550
hofmann@ccpo.odu.edu

Vice-Chairs:

Mike Roman
Horn Point Laboratory
University of Maryland
Center for Environmental
Science
P.O. Box 775
Cambridge, MD 21613, USA
Tel: +1 410 221 8425
Fax: +1 410 221 8490
roman@hpl.umces.edu

Javier Aristegui
Universidad de Las Palmas
de Gran Canaria
Campus Universitario de
Tafira
Las Palmas de Gran Canaria
Islas Canarias 35017 SPAIN
Tel: +34 928 452906
Fax: +34 928 454490
jaristegui@dbio.ulpgc.es

Carol Robinson
Univ. of East Anglia
School of Environmental
Sciences
Norwich NR4 7TJ
UK
Tel: +44 1603 593174
Fax: +44 1603 591327
Carol.Robinson@uea.ac.uk

3-46

Members:

Javier Aristegui	SPAIN	Su Mei Liu	CHINA-Beijing
Alida Bundy	CANADA	Eugene Murphy	UK
Claudio Campagna	ARGENTINA	Hiroshi Ogawa	JAPAN
Kenneth Drinkwater	NORWAY	Katja Philippart	NETHERLANDS
Jean-Pierre Gattuso	FRANCE	Alberto Piola	ARGENTINA
Nicolas Gruber	SWITZERLAND	Carol Robinson	UK
Julie Hall	NEW ZEALAND	Sinjaee Yoo	KOREA

Executive Committee Reporter: Bjørn Sundby

IGBP Liaison: Wendy Broadgate

Executive Officer: Lisa Maddison

Integrated Marine Biogeochemistry and Ecosystem Research

IMBER Annual Report to SCOR June 2010

MAJOR ACTIVITIES AND ACHIEVEMENTS

- Official incorporation of CLIOTOP and ESSAS into IMBER
- Publication of the Way Forward for IMBER in the IMBER and GLOBEC newsletters
- Establishment of China Regional Project Office (RPO)
- Supplement to IMBER Science Plan
- Science Plan and Implementation Strategy for SIBER
- ClimEco₂ Summer School
- Carbon and nutrient fluxes in continental margins: A global synthesis. KK Liu
- Challenger Workshop on developing IMBER research in the UK
- IMBER/SOLAS special session at EGU
- IMBER poster on Ecosystem-climate responses at high latitudes at IPY
- IMBER at OCB Summer Workshop
- IMBER at SEATECH week
- Launch of the new CMTT
- IMBIZO II
- Special Issue: Ecological and Biogeochemical Interactions in the Dark Ocean
- Special Issue: Parameterisation of Trophic Interactions in Ecosystem Modelling

WORKING GROUPS

Currently four working groups or task teams are active in the development and implementation of IMBER science. A fifth working group on Human Dimensions has been identified as a priority for IMBER and is now under development. Details of the activities of the IMBER working groups and task teams follow.

1 SOLAS/IMBER Carbon (SIC!) Working Group

The joint SOLAS/IMBER Carbon Working Group consists of three sub-groups (SG). The sub-group Chairs report to the Scientific Steering Committees (SSC) of IMBER and SOLAS and work closely with the International Ocean Carbon Coordination Project (IOCCP). Details of the activities of SG2 and SG3, which are led by IMBER SSC members, follow. The activities of SG1, which is led by SOLAS, are provided in the SOLAS report.

3-48

The Joint SOLAS/IMBER Carbon Research Implementation Plan is available at:

http://www.imber.info/products/Carbon_Plan_final.pdf.

Sub-group 1 (SG1) Surface Ocean System (Leader: Nicolas Metzler, France)

Please see the SOLAS annual report for details.

Sub-group 2 (SG2) Ocean Interior (Leader: Nicolas Gruber, Switzerland)

This sub-group is focused on approaches for determining long-term changes in the carbon inventory of the ocean and on the sensitivity of ocean carbon storage to climate change.

Consequently, SG2 is interested in using observations to develop an inventory of ocean carbon storage. The Terms of Reference (TOR) for SG2 are being finalized. New SG members with the expertise to advance these TORs will soon be appointed.

SG2 did not meet formally in 2009, but members were involved in two important workshops held during the year. The first was an Ocean Carbon and Biogeochemistry Program (OCB) workshop that was held in Monterey, CA, USA in late April 2009. The workshop was focused on the use of autonomous sensors and platforms to observe ocean ecology and biogeochemistry. Members of the SG2 used the opportunity to promote the use of oxygen sensors on Argo floats in order to study the seasonal to long-term changes in the ocean's oxygen content, which in turn allows for the export production and long-term deoxygenation of the ocean to be determined.

The second workshop, held in Ascona, Switzerland in July 2009, was organised by Niki Gruber, the SG2 Chair. The goal of the meeting was to initiate a global synthesis of ocean interior carbon data to assess the changes in carbon content since the first global ocean CO₂ survey was undertaken in the late 1980s and early 1990s. A secondary objective was to determine how much of this carbon change is due to the uptake of anthropogenic CO₂ from the atmosphere, and how much is driven by the change in the natural carbon inventory. The latter would indicate that the ocean's carbon cycle has already shifted away from that expected for a time-invariant ocean, for example, as anticipated in response to future climate change. A key outcome of this meeting was the development of an ambitious timeline with the goal to complete the global synthesis by 2012.

Members of the SG also contributed in a substantive manner to the OceanObs'09 conference held in Venice in September 2009. They were involved in the writing of several community white papers, were lead authors of a plenary paper outlining the key observational elements required to properly observe and document the expected biogeochemical changes in the ocean, and co-authored several other plenary papers.

Sub-group 3 (SG 3) Ocean Acidification (Leader: Jean-Pierre Gattuso, France)

The SOLAS/IMBER Carbon Research sub-group on Ocean Acidification (SIOA) was formalized in August 2009 with the objectives of: 1) coordinating international research efforts in ocean acidification, and 2) undertaking synthesis activities in ocean acidification at the international level. Information on SG 3 can be found at:

http://www.imber.info/C_WG_SubGroup3.html.

The first meeting of SG3 was held in Paris, France on 1-3 December 2009. Here, SG3 noted that as several synthesis and review activities have already been undertaken or are currently in progress, SIOA efforts should be directed at generating new knowledge. Thus the initial focus should be on activities that will support new research. There are plans to launch an ocean acidification coordination initiative that will cover the following aspects:

- Integration of the ocean acidification observing network with the ocean carbon network.
- Promotion of international experiments.
- Sharing experimental platforms.
- Regular updating of the “[Guide for best practices on ocean acidification research and data reporting](#)”.
- Guiding principles on data sharing.
- Training students and young scientists.
- Intercomparison exercises.
- Promote international exchange of students and Post docs.
- Promote collaboration between the natural and social sciences.

A SIOA website is to be developed that will link to both the IMBER and SOLAS websites. This will provide information on programs and projects, as well as key reports and publications relating to ocean acidification.

The SIOA has endorsed the [PAGES Workshop on Paleo-ocean Acidification and Carbon Cycle Perturbation Events](#). The workshop aims to improve the network and interaction between researchers studying the chemical, biological and physical consequences of past carbon cycle perturbations and will focus on key questions to improve our knowledge of paleo-ocean acidification and its biogeochemical consequences. It will be held from 26-28 August 2010, at the Wrigley Institute for Environmental Studies (WIES) on Catalina Island, CA, USA.

2 Continental Margins Task Team

The original IMBER/LOICZ Continental Margins Task Team (CMTT) completed its mandate (to organise a Continental Margins Open Science Conference and develop a strategy for the implementation of continental margins research for IMBER and LOICZ) and has been disbanded.

A new CMTT is now being formed to take the implementation plan forward. The CMTT will have co-chairs from IMBER and LOICZ and up to six other members assembled for their experience in the biogeochemistry, ecosystem functioning and human dimensions in continental margins. Kon-Kee (KK) Liu (Taiwan) has been appointed as the IMBER co-chair of the task team, and Helmuth Thomas (Canada) is his LOICZ counterpart.

One of the first tasks of the CMTT will be to complete the draft implementation plan for continental margins research that was initiated by the original CMTT. Sections on programme implementation and the human dimension impacts in continental margins need to be added.

3-50

Perspective or white papers will then be produced to stimulate the first integration and synthesis activities of the CMTT.

Several knowledge gaps were identified by IMBER SSC members (e.g., including carbon and nutrient budgets for shelf seas and the role of the continental margin pump. Discussions with LOICZ added the impacts of global change on resources (living and non-living) within the continental margins, particularly fisheries as well as the coastal Arctic. The terms of reference that will be developed once the CMTT membership has been finalised and will need to take all these suggestions into consideration.

The CMTT is expected to meet before the end of 2010 to develop the plans for the first integration and synthesis activity, possibly a 'Continental Margins IMBIZO' to be held in 2011.

The IMBER regional project office in China (IMBER RPO) will take the lead on all IMBER continental margins activities. The organisation of a dedicated Continental Margins IMBIZO has been suggested.

3 Capacity Building Task Team

The Capacity Building Task Team was established to ensure that capacity building initiatives are included in all IMBER activities. This task team aims to foster research initiatives in developing countries, to facilitate participation by early career and developing country scientists in IMBER activities and training programmes, and to enhance research capabilities for IMBER-related research in regions with a limited number of scientists with interests in IMBER science. The Capacity Building Strategy and Implementation Plan is available at:

http://www.imber.info/products/Capacity_Building_final.pdf.

The Task Team has eight members and is chaired by Jing Zhang (China). Jing Zhang also serves as the ex-officio representative for IMBER on the SCOR Capacity Building Committee (see <http://www.scor-int.org/capacity.htm> for details).

Summer Schools have proved to be a successful capacity building mechanism and IMBER has decided to hold these every second year. The first was held in Ankara, Turkey in 2008 and the next, ClimECO₂ will be held at the Institut Universitaire Européen de la Mer (IUEM) in Brest, France from 23-27 August 2010. The five-day training programme entitled: Oceans, Marine Ecosystems, and Society facing Climate Change - A Multidisciplinary Approach, is being co-organized with IUEM and GIS Européen Mer. Seventy-five participants, representing 26 countries, have been selected to attend. More information on the summer school is at:

http://www.europolemer.eu/en/climeco2_0.php.

4 Data Management Committee

The Data Management Committee (DMC) promotes a cooperative data management approach that includes involving experienced data management specialists from the start of a project, and also training young scientists in good data management procedures. Alberto Piola (Argentina) replaced Raymond Pollard (UK) as Chair of the IMBER DMC at the beginning of 2010. The

DMC has six members and plans to include an additional person from Asia to enhance geographic coverage.

Following on the success of the BEER data management training prior to the first IMBIZO, the DMC is organising a one-day Dry Cruise workshop one day prior to the start of the IMBIZO II. Alberto Piola and Cyndy Chandler (from Woods Hole Oceanographic Institution) will lead the workshop, but other members of the DMC will also attend. Training will be based on the data management procedures outlined in the extremely successful '*IMBER Data Management Cookbook*' that was published by the DMC in April 2009. So far, 55 participants have registered, but this number is expected to increase as locals from Crete and other parts of Greece have been invited to attend.

The current DMC plans to hold its first meeting in Crete on 9 October 2010.

5 Working Group on Human Dimensions

Alida Bundy (Canada) has agreed to chair a new IMBER working group on Human Dimensions. This working group is a response to the recommendation of the Transition Task Team that human effects on marine systems are a crucial perspective that needs to be incorporated into IMBER science. An IMBER Human Dimensions working group will build on the work of the GLOBEC Focus 4 Group, and also work done by the PICES - FUTURE Working Group, CLIOTOP WG5 and LOICZ.

Currently, Alida Bundy is working with the IPO to identify potential candidates for the working group. Once appointed, the group will meet in late 2010 and will be asked to organise a Scoping Workshop to determine the role and/or approaches of human dimension research in IMBER science.

REGIONAL PROGRAMMES

IMBER currently has four regional programmes. The Integrating Climate and Ecosystem Dynamics (ICED) Programme was jointly initiated under GLOBEC and IMBER and moved fully into IMBER at the close of GLOBEC in early 2010. Two ongoing programmes, Climate Impact on Oceanic Top Predators (CLIOTOP) and Ecological Studies of Sub-Arctic Seas (ESSAS), that began under GLOBEC were officially incorporated into IMBER when GLOBEC ended on 31 March 2010. The Sustained Indian Ocean Biogeochemistry and Ecosystem Research (SIBER) Programme was initiated under IMBER. Updates on the activities of these regional programmes are given as follows.

Climate Impact on Top Oceanic Predators (CLIOTOP)

CLIOTOP was started under GLOBEC in 2005 and the Science Plan and Implementation Strategy (SPIS) for this programme was published in the same year. CLIOTOP is a 10-year programme which aims to provide a global comparison of the impact of climate variability (at various scales) and fishing on the structure and function of open ocean pelagic ecosystems and

their top predator species, and from this to develop a reliable predictive capacity of top predator populations and oceanic ecosystems.

The merger of CLIOTOP with IMBER required an update to its SPIS. Changes in CLIOTOP science were discussed at the CLIOTOP mid-term workshop, 'CLIOTOP into the future - Building Scenarios for Oceanic Ecosystems in the XXI Century', that was held in Paris, France in February 2010. Eugene Murphy and Alida Bundy, members of the IMBER SSC, attended this workshop and provided input to discussions about modifications to the CLIOTOP SPIS. It is anticipated that the revised SPIS will be available by the end of 2010.

CLIOTOP is structured around five working groups that focus on key processes and scales.

WG 1: Early life history aims to determine the environmental characteristics that influence the timing and intensity of reproduction and larval survival.

WG 2: Physiology, behaviour and distribution investigates the factors affecting spatial dynamics and population structure, as well as reproductive and feeding-related behaviour.

WG 3 Trophic pathways in the open ocean ecosystems compares trophic pathways among and within oceans and investigates whether seasonal and spatial variability could be used to explore the impacts of climate variability. It also considers the importance of mesopelagic versus epipelagic prey resources for oceanic top predators and if this is affected by climate change.

WG 4 Synthesis and modelling explores the importance of fisheries exploitation and the dynamic environment in structuring pelagic ecosystems and seeks the most appropriate mechanism(s) to provide the greatest predictive power.

WG 5 Socio-economic aspects and management strategies considers the socio-economic pressures on tuna fisheries and whether fisheries organisations addressed the impacts of climate variability and climate change. It also examines the usefulness of fisheries management decision support tools and how the flows in capital and knowledge among the world's large fisheries respond to variability.

A highlight for the CLIOTOP programme is publication of a special issue of *Progress in Oceanography* (28 papers) that include papers from the first CLIOTOP symposium held in La Paz, Mexico from 3-7 December 2007.

Ecosystem Studies of Sub-Arctic Seas (ESSAS)

ESSAS was developed in conjunction with GLOBEC and EUR-OCEANS in 2005 and focuses on comparative studies of the impacts of climate variability on the productivity and sustainability of Sub-Arctic marine ecosystems. The ESSAS Programme includes four working groups and several national and multi-national projects. The Science Plan and *Background to the Climatology, Physical Oceanography and Ecosystems of the Sub-arctic Seas* document were produced in 2005.

Two achievements for ESSAS are the recent redesign of the ESSAS website (see: <http://www.imr.no/essas>) and the development of a special NORway-CANada Comparison of Marine Ecosystems (NORCAN) volume for *Progress in Oceanography*. Several papers,

comparing various aspects of Sub-Arctic ecosystems including climate, physical oceanography, phytoplankton production, zooplankton and fish, are currently under review.

The ESSAS 2010 Annual Science Meeting will be convened at the Marine Research Institute in Reykjavik, Iceland from 30 August - 1 September 2010. This meeting includes plenary presentations, as well as comparative workshops of different sub-Arctic seas.

The second ESSAS OSM will be held in Seattle, WA USA from 22-26 May 2011. Planning for this meeting is underway and the conveners are Olafur Astthorsson (Iceland), George Hunt (USA), and Michio Kishi (Japan). The meeting will showcase the progress made by the ESSAS working groups, and the national and multi-national programs affiliated with ESSAS. This OSM will also provide a venue for identifying gaps in knowledge of Sub-Arctic ecosystems and for designing future directions for ESSAS science, especially in regard to interfacing with IMBER science objectives.

Integrating Climate and Ecosystems Dynamics (ICED)

The ICED programme was developed jointly by IMBER and GLOBEC, in partnership with EUR-OCEANS, to determine the main control of Southern Ocean ecosystem dynamics and potential for feedbacks as part of the Earth system. The ICED Science Plan was published jointly by IMBER and GLOBEC in 2008. It is implemented through three major areas of activity (data synthesis, fieldwork coordination and modelling) and involves close collaboration and multidisciplinary integration of knowledge from several groups operating throughout the Southern Ocean. During the past year, ICED programme scientists have produced project-related publications, provided visibility for ICED research at international meetings, and developed proposals and outreach activities. Details are given below.

The proceedings, outcomes and a strategic plan developed by the Southern Ocean Sentinel Workshop (held 20-24 April 2009, in Hobart, Australia) have been published and are available at:

Constable, A.J., Doust, S. (2009) Southern Ocean Sentinel – an international program to assess climate change impacts on marine ecosystems: report of an international Workshop, Hobart, April 2009. ACE CRC, Commonwealth of Australia, and WWF-Australia.

This publication provides recommendations on how to measure, assess and provide early warning of climate change impacts on the Southern Ocean and how these could be used to signal future impacts on marine and other ecosystems elsewhere in the world.

The report of the *Southern Ocean Food Web Modelling Workshop*, which was held in April 2008 at Old Dominion University, Norfolk, VA, was published electronically on the ICED website (see: <http://www.iced.ac.uk/documents/FoodwebsModellingReport-final.pdf>) in January 2010.

3-54

This report provides recommendations for directions in ecosystem modelling for the Southern Ocean. The reference for this publication is:

Murphy E.J., Cavanagh R.D., Johnston N.M. and Hofmann E.E. (Eds). 2010. Integrating Climate and Ecosystem Dynamics (ICED): Report of the Southern Ocean Food Web Modelling Workshop, 16-18 April 2008, Virginia, USA.

The report from the Southern Ocean Scoping Workshop, held at Princeton University, New Jersey, USA in June 2009, was also published on the OCB website in June 2010. This report provides recommendations for Southern Ocean research that will merge biogeochemical and food web studies. The report highlights areas for future research that will allow addressing questions of potential effects of climate change on Southern Ocean biogeochemical cycling, food webs, and carbon budget.

The International Polar Year (IPY) Science Conference was held from 8-12 June 2010 in Oslo, Norway. ICED scientists convened a two-day oral and poster session on “Ecosystems of the Southern Ocean”. The ICED SSC met in conjunction with the IPY Conference.

ICED has identified the coordination of Southern Ocean fieldwork as a major priority and is developing a system for collating information on relevant field activities via a web-based form. Information is fed to a live virtual globe layer (GoogleEarth). The map layer is linked to a database to ensure integration with other relevant IPY ocean projects. A new webpage has been developed on the ICED website (<http://www.iced.ac.uk/science/fieldworkmap.htm>) to accommodate this. This initiative will provide a central focus for fieldwork planning and coordination activities in the Southern Ocean, across all disciplines, for at least the next decade.

As the result of a project funded under the EUR-OCEANS programme, and involving ICED scientists, a data portal has been developed that will allow to dissemination of historical biological data sets acquired from earlier cruises to the Southern Ocean. The data sets include those from the Discovery Investigations (1925-51) and the Biological Investigations of Marine Antarctic Systems and Stocks (BIOMASS) programme (1981-1985). The website will be updated as further data are available

http://www.antarctica.ac.uk/bas_research/data/access/esodap/index.php

ICED scientists have recently been awarded funds from the EUR-OCEANS Consortium to run a Foresight Workshop under the topic ‘*Global Change in Polar Systems*’. The workshop will provide an opportunity to apply the knowledge and experience gained through EUR-OCEANS and ICED and through the Arctic sub-network to explore the impacts of global change in polar marine systems. The outcomes will benefit the international science community and will build the foundations for: (1) planning and coordinating future fieldwork activities to detect natural and anthropogenic change in polar ecosystems, (2) creating a EUR-OCEANS Flagship in Polar Science, and (3) shaping future EUR-OCEANS calls in this research area under the European Framework Programme.

Sustained Indian Ocean Biogeochemical and Ecological Research (SIBER)

SIBER is a developing regional program of IMBER that aims to understand climate change and anthropogenic forcing on biogeochemical cycles and ecosystems in the Indian Ocean.

The draft SIBER Science Plan and Implementation Strategy has recently been reviewed and the IMBER SSC agreed to accept it once the review comments have been incorporated. The SIBER SSC members have also been approved and will be appointed shortly. The first SIBER SSC meeting will take place from 12-16 July 2010 in Hobart, Tasmania.

Endorsed Projects

IMBER currently has 21 endorsed projects from 13 different countries. The following projects have been endorsed by IMBER since the last report to SCOR:

- ***LUCIFER (Lunar Cycles and Iron Fertilization)***
Leading Applicant: Santiago Hernández-León, Spain

Project to examine the biogeochemical consequences of (1) the vertical mixing and the consequent planktonic bloom in the oceanic subtropical waters around the Canary Islands, (2) the influence of the lunar cycle observed in zooplankton in the transport of organic carbon towards the mesopelagic zone, and (3) the process of natural fertilization with iron promoted by the deposition of Saharan dust. This is of relevance due to the aim to carry out massive fertilization with iron to slow global warming.

- **BIOACID: Biological Impacts of Ocean ACIDification**
Leading Applicant: Ulf Riebesell, Germany

Surprisingly little is known about the possible impacts of ocean acidification. BIOACID will facilitate the interaction between BIOACID scientists across disciplines, research themes and projects will include joint experiments, collaborative use of equipment and measurement capacity, exchange of samples and expertise, and the analysis and synthesis of comprehensive data sets towards an ecosystem model of ocean acidification. These activities will be complemented by training workshop offered by BIOACID experts to all members of the consortium. Following this approach, the overarching questions of BIOACID are: What are the effects of ocean acidification on marine organisms and their habitat, what are the underlying mechanisms of responses and possible adaptations on the level of populations and communities, how are they modulated by other environmental stressors, and what are the consequences for marine ecosystems, ocean biogeochemical cycles, and possible feedbacks to the climate system?

- ***MALASPINA Circumnavigation Expedition Malaspina 2010: Global Change and Biodiversity Exploration of the Global Ocean***
Leading Applicant: Carlos M. Duarte, Quesada, Spain

3-56

MALASPINA 2010 aims to provide a coherent, high-resolution inventory of the impact of global change on the ocean ecosystem and an exploration of deep-sea microbial biodiversity and to build cooperative networks within the scientific community, thereby abating the current fragmentation and loss of relevance.

OUTREACH ACTIVITIES

IMBER website

The IMBER website (<http://www.imber.info/>) is the main communication tool for the dissemination of science results and other information relating to IMBER programmes and activities.

The IPO has developed and maintains several other websites for IMBER activities and events, such as for IMBIZO II (<http://www.imber.info/IMBIZO.html>) and the ClimECO₂ Summer School (http://www.europolemer.eu/en/climeco2_0.php). The Ocean Acidification website for the SOLAS/IMBER SG3 (SIOA) is currently under construction. This will be mirrored on the SOLAS website.

IMBER Update

The electronic newsletter "*IMBER Update*" is published three times each year. The most recent edition was published in February 2010 and included a report by Eileen Hofmann (current SSC Chair) and Julie Hall (Past Chair) on the way forward for IMBER over the next 2-4 years as the regional programmes from GLOBEC are incorporated, new programs are developed, and new areas of research emerge.

The newsletter also provides highlights of recent IMBER science, reports of the activities of the IMBER working groups and regional programmes as well as upcoming IMBER-related conferences and workshops. IMBER Update can be downloaded at <http://www.imber.info/newsletters.html>. The newsletter is emailed to about 1200 people who are involved with IMBER in some way or have requested it.

eNews

The electronic eNews bulletin is published monthly to provide information about IMBER activities and current events within the IMBER scientific network. It includes calls for funding, job opportunities, conferences and workshops.

Promotional Material

The IPO produces promotional material for use at meetings or conferences, and for those wanting to know more about IMBER. These products are currently being revised to update the information and to develop a more uniform format. A new brochure, aimed at policy-makers, funding agency representatives and others who wish to know about IMBER, is currently being developed. A new IMBER poster template has recently been produced which can be adapted

depending on the meeting topic or audience. The brochure and posters can be downloaded from the IMBER website (<http://www.imber.info/useful-downloads.html>) and are available on request from the IPO.

Training

ClimECO₂

IMBER is co-organising an interdisciplinary summer school, ClimECO₂ in Brest, France from 23-27 August 2010. This international summer school aims to provide participants with an overview of methods, models and approaches for analyzing the impact of climate change on marine ecosystems and the consequences for society. Themes to be covered are:

- Climate, ocean circulation, biogeochemistry and marine ecosystems.
- Climate driven changes in marine biodiversity and the interactions among species.
- Impact of global change on marine resources and uses.
- Vulnerability and adaptation to climate change in the coastal zone.
- Communicating climate change: from information to action.

Participants include both natural and social scientists working in the realm of ‘oceans and climate change’.

Dry Cruise workshop

The DMC will organise a Dry Cruise workshop aimed (though not exclusively) at early career scientists and students on 10 October 2010 in Crete, Greece. The IMBER Data Management Cookbook, which summarizes best practices for data acquisition, quality control and preservation, will be the focus of this interactive one-day training activity. The aim is to increase awareness of the need to establish data management procedures, highlight the benefits of following such procedures, and to provide hands-on training on data management and data preservation. The data managers of IMBER endorsed projects have also been invited to attend.

INTERNATIONAL PROJECT OFFICE (IPO)

The IMBER International Project Office (IPO) coordinates the scientific and administrative aspects of IMBER to ensure that the decisions of the SSC are executed and that IMBER science moves forward. It is based at the Institut Universitaire Européen de la Mer (IUEM) in Brest, France. Lisa Maddison is Executive Officer, Sophie Beauvais, the Deputy Executive Officer and Virginie Le Saout is the Administrative Assistant.

The IPO is primarily responsible for implementing decisions from the IMBER SSC, obtaining funding to support IMBER activities, providing support for the IMBER working groups and task teams, providing administrative support for the program’s activities, maintaining communication links both within and outside the program, and maintaining a data and information archive.

The IPO is funded by a French consortium that includes the University of Brest, IUEM, the Region of Brittany, Ifremer, the Conseil Général de Bretagne (Department authorities) and the

3-58

City of Brest, Centre National de la Recherche Scientifique (CNRS), Institut de Recherche pour le Développement (IRD), and Université de Bretagne Occidentale (UBO).

In 2009-2010, support for activities of the IPO and IMBER was provided by:

- **IGBP**: support for the SSC meeting (\$31.5K). This included the usual annual sponsorship (\$19K) + transitional funds (\$11.5K) to support the incorporation of the new regional programmes;
- **SCOR**: support from NSF (\$50K annually, grant until 2011);
- **French Consortium**: support for IPO salaries and running expenses (\$254K)

The contract with the French consortium for IPO support terminates in August 2011. A report on IMBER activities and achievements since the start of the present funding cycle was sent to Patrick Monfray (CNRS) who is leading the process to have the contract renewed. A meeting will be organised with all the French consortium partners in fall 2010 to negotiate possible extension of the current contract.

REGIONAL PROJECT OFFICE IN CHINA (CHINA RPO)

In January 2010 a Memorandum of Understanding (MOU) was signed between IMBER and the East China Normal University (ECNU) in Shanghai to open an IMBER regional office in China. The IMBER China Regional Project Office (RPO) will be hosted and financially supported by the ECNU. The RPO will be staffed by a Deputy Executive Officer and an Administrative Assistant, who will report to the IMBER IPO. The RPO will not work independently but will support IMBER activities, focusing mainly on continental margins activities, as well as other IMBER activities in the Asia-Pacific region.

INTERACTIONS WITH OTHER PROJECTS AND PROGRAMMES

SOLAS

Joint SOLAS/IMBER Carbon Research group (SIC!)

The joint **SOLAS/IMBER Carbon Group** (SIC!) was formed in Oct 2005. This group works in close collaboration with IOCCP. There are three sub-groups within the SIC group:

SG1-Surface Ocean Systems Chair: Nicolas Metzl (France)

SG2-Interior Ocean. Chair: Nicolas Gruber (Switzerland)

SG3-Ocean Acidification. Chair: Jean-Pierre Gattuso (France)

LOICZ

Joint IMBER/LOICZ Continental Margins Task Team (CMTT)

A new **IMBER/LOICZ CMTT** is currently being formed and will be jointly funded by IMBER and LOICZ. Kon-Kee (KK) Liu (IMBER) and Helmuth Thomas (LOICZ) have recently been appointed as co-chairs and are in the process of selecting the other team members in collaboration with the chairs of IMBER and LOICZ.

New Continental Margins book published

Carbon and Nutrient Fluxes in Continental Margins: A Global Synthesis, Edited by Kon-Kee Liu, Larry Atkinson, Renato Quiñones and Liana Talaue-McManus has been published by Springer-Verlag in the IGBP Book Series on Global Change. The book provides perspectives on the role of continental margins in the Earth's biogeochemical system as well as highlights of biogeochemical functionality in representative regional settings. More than 150 experts contributed best estimates of carbon and nutrient fluxes in seven types of continental margins.

CARBOOCEAN

An MOU was signed between IMBER and CARBOOCEAN, an integrated project that aims to provide an accurate assessment of marine carbon sources and sinks with special emphasis on the Atlantic and Southern Oceans on a time scales -200 to +200 years.

The core CARBOOCEAN themes contribute to IMBER's goals. For example, basin-wide/regional scale air-sea CO₂ fluxes have been found to be interannually more variable than previously thought, suggesting that the ocean sink is not as reliable and steady, at least at regional levels, as many analysis methods (assuming steady state conditions) expect.

The CARbon dioxide In the North Atlantic (CARINA) project is an activity related to SOLAS-IMBER Carbon Sub-group 2. Its objective is to collect carbon-relevant data sets (many of which had not been available to the public before) and to form a consistent, quality-controlled database for the Atlantic Ocean (including the Southern Ocean and the Arctic). CARBOOCEAN was instrumental in developing the CARINA data set

CLIVAR

Climate Variability and Predictability (CLIVAR), is a core project of the World Climate Research Programme (WCRP). Its focus is the role of the oceans in climate variability and change, particularly on physical climate changes.

At the 2009 CLIVAR Scientific Steering Group (SSG) the need for CLIVAR to develop and strengthen the interactions and activities between CLIVAR's ocean activities and programmes focused on ocean biology, biogeochemistry and ecology was raised. IMBER is represented on all the relevant CLIVAR panels, although there is no direct IMBER representation on the Atlantic or Pacific Panels as yet (links are via the SOLAS/IMBER Carbon group). Ken Drinkwater has been appointed to the CLIVAR SSG, providing a direct link between the IMBER Project and the CLIVAR SSG.

Other areas of recent IMBER/CLIVAR interaction have been through:

- Joint participation with IOCCP and the SOLAS-IMBER Carbon Group in the Global Ocean Ship-based Repeat Hydrographic Investigations Panel (GO_SHIP).
- Substantial contribution to the Community White Papers at OceanObs'09 by the CLIVAR and IMBER communities.

3-60

EUR-OCEANS

IMBER signed an MOU with the EUR-OCEANS Network of Excellence, and continues to retain links with the new EUR-OCEANS Consortium.

The Consortium provided funding for the CLIOTOP mid-term workshop, allocated funding for the IMBER IMBIZO II (Crete, Greece, October 2010), and has endorsed the ClimECO₂ Summer School (Brest, France, August 2010).

PICES

Recent interaction and collaboration between PICES and IMBER includes sponsorship of a joint session at the PICES Annual Meeting. In 2009 the IMBER-sponsored session was entitled “Outlooks and forecasts of marine ecosystems from an earth system science perspective: Challenges and opportunities”. The next PICES annual meeting will occur in October 2010, in Portland, OR, USA. IMBER will co-sponsor a session on “Anthropogenic forcing in North Pacific coastal ecosystems: Understanding changes in ecosystem structure and function” at this meeting.

The workshop themes of IMBIZO II are relevant to FUTURE (PICES’s new science program - Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems). Therefore, PICES is a co-sponsor of the IMBIZO II and is providing travel support for three invited speakers from the North Pacific.

PICES-IMBER cooperation has also been strengthened by the generous contribution of PICES to support nine early career scientists from PICES member countries to attend the IMBER ClimECO₂ summer school. The topics to be covered by ClimECO₂ also fit well with themes of FUTURE.

In the interest of continued collaboration and cooperation, IMBER has agreed co-sponsor the second International PICES, ICES and IOC Symposium on “Effects of Climate Change on the World’s Oceans”, to be held in May 14-18, 2012, in Yeosu (Korea). Support will be provided for an invited speaker to attend a joint IMBER-PICES session.

Similarly, IMBER will sponsor an invited speaker at a joint session at the 2011 PICES Annual Meeting in Russia. The Meeting is entitled: “Mechanisms of ecosystem reorganization in the North Pacific Ocean”.

National activities

IMBER activities are underway in many countries (e.g. Belgium, China, France, Italy, India, Japan, Korea, New Zealand, Norway, Spain, Turkey, UK, and USA). Examples of some of these activities are:

- **Belgium:** there is no specific IMBER initiative in Belgium, but several national programmes contribute to IMBER aims and activities. These include:

PEACE (<http://www.co2.ulg.ac.be/peace/>),
 AMORE (<http://www.ulb.ac.be/assoc/esa/AMORE/amore.htm>)
 BELCANTO-III (<http://www.co2.ulg.ac.be/belcanto/>) and,
 TIMOTHY (http://www.imber.info/EP_CAIBEX.html).

- **China:** a new project, “Key Processes and Mechanisms of Sustainable Food Production in the Coastal Ocean of China” of the IMBER-GLOBEC Marine Dynamics program, has begun and will focus on marine biogeochemical cycles and key processes of end-to-end food web in the China seas. The establishment of the IMBER Regional Project Office in Shanghai is a major achievement.
- **Japan:** IMBER-related scientists in Japan participated in the “Linkages in Biogeochemical Cycles and Ecosystems between Surface Ocean and Lower Atmosphere” data synthesis workshop in December 2009. Also in December 2009, young scientists participated in the ‘IMBER for the creation of new ocean provinces’ workshop in Tokyo. A one-day symposium on ‘Key parameters of biogeochemical cycles in the Pacific Ocean’ symposium was organised by IMBER-Japan and SOLAS-Japan in March 2010 in Tokyo. The POMAL (Population Outbreak in Marine Life), the national project related to IMBER, is ongoing.
- **Korea:** The Korean GLOBEC committee is being transformed into the Korean IMBER committee and will promote IMBER-related activities to the Korean Oceanographic Society to attract more scientists. It will also maintain the supporting program for young scientists. In May 2010, the Korean GLOBEC committee hosted the 4th China-Japan-Korea GLOBEC/IMBER Symposium, where the status and future direction for IMBER-like research in the Northwest Pacific ecosystems were discussed. Jing Zhang, a past member of the IMBER SSC attended this meeting and provided a presentation on IMBER science.
- **France:** Focus 1 of the French program CYBER (“Biogeochemical Cycles, Ecosystems and Resources”), is the French contribution to IMBER. Three projects supported by CYBER are: BOUM (<http://www.obs-vlfr.fr/proof/boum/>), MALINA (<http://www.obs-vlfr.fr/Malina>) and POTES: (<http://www.com.univ-mrs.fr/LMGEM/potes>). The success of the first meeting of the French scientists from the IMBER and SOLAS communities resulted in a recommendation to hold these meetings at two-year intervals. The next meeting will be held in 2011.
- **India:** SIBER recently organised a workshop where a national committee was established which could an IMBER committee.
- **Spain:** There is no formal IMBER program in Spain, however, several projects funded in 2009 are closely related to the IMBER goals. These include:
 - Impacts of global change on Mediterranean marine ecosystems (MEDEICG).
 - Variability of the structure and function of the pelagic trophic webs in productivity areas of the Alboran Sea.
 - Generation of oceanographic scenarios for the 21st century for the Mediterranean Sea and the northeast sector of the Atlantic Ocean.
 - Predicting the metabolic balance of the oceans (PNAS).
- **USA:** Ocean Carbon and Biogeochemistry (OCB) is the US contribution to IMBER.
- **Italy:** a Special Issue of *Ecological Modelling* that resulted from an IMBER–endorsed conference, ‘Challenges for ecological modelling in a changing world: Global Changes,

Sustainability and Ecosystem Based Management' 2007, was published recently (Ecol Mod. 2009, 220 (21): 2825-3110). IMBER has also endorsed the 'Advanced school on complexity, adaptation and emergence in Marine Ecosystems' that will be held in Trieste, Italy at the ICTP Center from 18-27 October 2010. IMBER has also endorsed the now almost completed VECTOR project. A final project report is expected in 2011.

FUTURE ACTIVITIES

- **IMBER at SEATECH Week.** The IMBER IPO presented IMBER at the International Marine Science and Technology week that was held by the Centre of European Excellence for Oceanography and the Marine Environment in Brest, France from 21-26 June 2010. This is an interdisciplinary forum for the marine science and technology sectors. Five days of seminars and workshops are combined with a trade fair, concerned with maritime research and development.
- **IMBER *ClimECO*₂ Summer School** at Institut Universitaire Européen de la Mer, Brest France 23-27 August 2010.
- **IMBER Endorsed Conference:** The 14th Biennial Challenger Conference for Marine Science on "Ocean Challenges in the 21st Century", in Southampton, UK, 6 - 9 September 2010.
- **IMBER DMC Dry Cruise workshop** at the Creteaquarium in Crete, Greece on 10 October 2010.
- **IMBER IMBIZO II**, IMBER's second international science meeting, will take place 11-14 October 2010 at the Hellenic Centre for Marine Research (HCMR) and Creteaquarium in Crete, Greece. The meeting will consist of three interdisciplinary workshops held in parallel, with joint plenary and poster sessions. The workshop themes are:
 1. The effect of varying element ratios on community structure at low trophic levels and food quality at mid and high trophic levels.
 2. Large-scale regional comparisons of marine biogeochemistry and ecosystem processes – research approaches and results.
 3. Sensitivity of marine food webs and biogeochemical cycles to enhanced stratification.

More than 160 applications were received. However, the three workshop have been limited to around 40 participants each in order to ensure good interaction and participation. Workshop outcomes will be published as reports and synthesis papers in special issues of peer-reviewed scientific journals. Six scientists from Brazil, Chile, India (2), Mexico and Turkey will benefit from the SCOR travel funds for developing countries that was awarded to IMBER last year. Additional funding has also been provided by the US National Science Foundation to support the attendance of 5 early career scientists and one workshop convener from the USA.

- **First SIBER SSC Meeting** in Perth, Australia 12-16 July 2010.
- **IMBER Endorsed Workshop** on Paleo-ocean Acidification and Carbon Cycle Perturbation Events, Catalina Island, USA, 26-28 August, 2010

- **Meeting of the SIC! SG2** at the COCOS/RECAPP meeting in Viterbo, Italy from 6-8 October 2010.
- **IMBER joint session** (S12: Anthropogenic forcing in North Pacific coastal ecosystems: Understanding changes in ecosystem structure and function) at the PICES-2010 Annual Meeting from 22-31 October, 2010, in Portland (Oregon, USA).
- Second **IMBER-SOLAS French Meeting** in 2011.
- **IMBER sponsorship** of an IMBER-related session at the ICES PICES IOC 'Effects of Climate Change on World's Oceans' Symposium from 14-18 May 2012, in Yeosu, Korea.
- **Second ESSAS OSM** will be held in Seattle, WA USA from 22-26 May 2011.

SELECTED PUBLICATIONS

Special Issue: Eastern Boundary Upwelling Ecosystems: Integrative and Comparative Approaches, *Progress in Oceanography* Volume 83, Issues, Pages 1-4:1-428 (December 2009)
 Edited by Pierre Fréon, Manuel Barange, Javier Arístegui and A.D. McIntyre.

Supplement to the IMBER Science Plan and Implementation Strategy. The IMBER/GLOBEC Transition Task Team (TTT) was appointed by SCOR and IGBP to recommend how IMBER should accommodate new developments in marine ecosystem research that need addressing post-GLOBEC. The final TTT report was published as a supplement to the IMBER Science Plan early in 2010.

New Continental Margins Book: Liu, K., L. Atkinson, R. Quiñones, and L. Talaue-McManus (Eds.) 2010, Series: Global Change - The IGBP Series 744 p. 278
 ISBN: 978-3-540-92734-1

New SIBER publication: Wiggert, J. D., R. R. Hood, S. W. A. Naqvi, K. H. Brink and S. L. Smith (2009) Indian Ocean Biogeochemical Processes and Ecological Variability. AGU Monograph Series, American Geophysical Union, Washington, D.C.

Special Issue: Parameterisation of Trophic Interactions in Ecosystem Modelling: Edited by Michael A. St.John, Ivo Grigorov, Javier Ruiz and Patrick Monfray. *Progress in Oceanography* Volume 84, Issues 1-2, Pages 1-138 (January-February 2010).

Special issue on China from China-GLOBEC/IMBER "973" project: Deep-Sea Research II China GLOBEC II: Case study of the Yellow Sea and East China Sea Ecosystem dynamics. Qisheng Tang, Julan Su and Jing Zhang (eds.), Volume 57, Issues 11-12, (June 2010)

UPCOMING PUBLICATIONS

SIBER Science Plan and Implementation Strategy (August 2010)

Deep Sea Research II Special Issue: Ecological and Biogeochemical Interactions in the Dark Ocean. Deborah K. Steinberg and Dennis A. Hansell (eds). (July/August/ 2009)

REQUEST FOR FUNDING

IMBER requests SCOR Developing Country Travel Funds to assist scientists from developing countries to attend the following two meetings:

- 1) The Second ESSAS Open Science Meeting that will be held in Seattle WA. USA from 22-26 May 2011,
- 2) The joint SIC SG1 and SG2 Ocean Carbon Synthesis Workshop to be held in Paris, France in summer 2011.

Amount requested: US\$7 500

ACKNOWLEDGEMENTS

IMBER would like to take this opportunity to thank SCOR for its continued support.

3.4 GEOTRACES

Terms of Reference:

- Organize national and international planning workshops as well as special sessions at international conferences to obtain community input on the design and implementation of GEOTRACES.
- Establish priorities for research on the sources, sinks, internal cycling, transport, speciation and fate of TEIs, and develop this information into an International Science Plan.
- Promote intercalibration of analytical methods, and the development of standard reference materials.
- Identify new instrumentation and related infrastructure that will help achieve GEOTRACES objectives.
- Define a policy for data management and sample archival.
- Forge scientific linkages with other research programs holding overlapping interests to create synergies where possible and avoid duplication of efforts. To the extent practical, this will involve cross-membership between the GEOTRACES Planning Group and the Planning Groups and Science Steering Committees of other programs.
- Interact with SCOR Working Groups that share common interests including, but not limited to, SCOR/IMAGES WG 123 on Reconstruction of Past Ocean Circulation (PACE) and SCOR/IMAGES WG 124 on Analyzing the Links Between Present Oceanic Processes and Paleo-Records (LINKS).

Co-Chairs:

Robert Anderson
Lamont-Doherty Earth Observatory
P.O. Box 1000
Palisades, NY 10964, USA
Tel: +1-845-365-8508
Fax: +1-845-365-8155
E-mail: boba@ldeo.columbia.edu

Gideon M. Henderson
Department of Earth Sciences
Parks Road
Oxford OX1 3PR UK
Tel: +44 (0)1865 282123
Fax: +44 (0)1865 272072
E-mail: Gideon.Henderson@earth.ox.ac.uk

Other Members

Per Andersson SWEDEN
Andrew Bowie AUSTRALIA
Philip Boyd NEW ZEALAND
Kenneth Bruland USA
Pinghe Cai CHINA-Beijing
Hein de Baar NETHERLANDS
Martin Frank SWITZERLAND
Toshitaka Gamo JAPAN
Catherine Jeandel FRANCE
Bill Jenkins USA
Oliver Marchal USA

Pere Masque SPAIN
Kristin Orians CANADA
Carol Robinson UK
Reiner Schlitzer GERMANY
Igor Semilitov RUSSIA
Sunil Singh INDIA
Angela Wagner BRAZIL
Michiel Rutgers
van der Loeff GERMANY

Alternate: Jing Zhang JAPAN

Executive Committee Reporter: Bjørn Sundby

GEOTRACES SCIENTIFIC STEERING COMMITTEE
ANNUAL REPORT TO SCOR 2009/2010
June 2010

SCOR Scientific Steering Committee for GEOTRACES

Co-Chairs

Robert F. Anderson, USA
Gideon M. Henderson, UK

Catherine Jeandel, France

William Jenkins, USA

Olivier Marchal, USA

Pere Masque, Spain

Kristin Orians, Canada

Carol Robinson, UK

Michiel Rutgers van der Loeff, Germany

Reiner Schlitzer, Germany

Igor Semilitov, Russia

Sunil Kumar Singh, India

Angela Wagner, Brazil

Jing Zhang, Japan (alternate, Japan)

Members

Per Andersson, Sweden

Andrew Bowie, Australia

Philip Boyd, New Zealand

Ken Bruland, USA

Pinghe Cai, China

Hein de Baar, Netherlands

Martin Frank, Germany

Toshitaka Gamo, Japan

The SSC membership (listed above) contains representatives of 15 different countries with diverse expertise including: marine biogeochemistry of carbon and nutrients; trace elements and isotopes as proxies for past climate conditions; land-sea fluxes of trace elements/sediment-water interactions; trace element effects on organisms; hydrothermal fluxes of trace elements; tracers of ocean circulation; tracers of contaminant transport; controls on distribution and speciation of trace elements; and ocean modelling.

SSC meeting

The fourth meeting of the GEOTRACES SSC was held for three days (4-6 November 2009) at the AGU headquarters in Washington D.C., USA. Logistics were organized by Ed Urban from SCOR.

The meeting was attended by 19 member of the 2008/2009 SSC. Other attendees included: Greg Cutter (Chair of the GEOTRACES Intercalibration Subcommittee); Ed Urban (SCOR); Ed Mawji (GEOTRACES Data Assembly Centre); Norio Baba (Japanese Data Management); Don Rice (NSF Chemical Oceanography); Simon Metz (NSF Chemical Oceanography) and, on the afternoon of the first day, a number of representatives from various U.S. funding agencies (details below)

The morning of the first day, following introductions and welcome, was spent in national reports detailing GEOTRACES activities of the last year in 16 countries. These reports outlined an impressive array of active and planned works, with particular highlights being the range of IPY

results now starting to come from previous cruises, and the news that GEOTRACES in India has received funding for the coming 5 years totalling four million US dollars. Plans for other GEOTRACES Sections in the coming year were also discussed by countries including Germany, Holland, Japan, UK, and USA.

The afternoon of the first day was an overview of the programme to agency representatives. For this section the meeting was joined by five additional representatives: Fred Lipschultz (NASA); Candace Major (NSF – Paleoceanography); Hedy Edmonds (NSF – Polar Programmes); Susan Roberts (Ocean Studies Board, National Academy of Sciences); and Eric Itswiere (NSF – Physical Oceanography). David Kadko also joined the meeting to present US plans for Arctic work within the programme. Presentations to introduce agency representatives to GEOTRACES consisted of:

- An overview of the programme (Gideon Henderson)
- Intercalibration (Greg Cutter)
- Data Management (Reiner Schlitzer)
- IPY (Hein de Baar)
- Arctic Workshop (Michiel Rutgers van der Loeff)
- USA Plans (Bob Anderson)
- USA Arctic Plans (Dave Kadko)

This afternoon session appeared well received and generated questions and discussion.

After departure of agency representatives there was brief discussion of plans for capacity building and training.

The second day of the SSC meeting initially focused on three issues that will be reported on elsewhere in this report: data management; planning and funding for the GEOTRACES IPO; and intercalibration. Subsequent discussion addressed cross-national activities and included a report on Arctic Planning Workshop; details of European co-ordination through a COST Action; plans for Mediterranean and Asian workshops; and discussion of links to other international programmes. The day finished by considering applications from four studies to become GEOTRACES process studies: Amandes and Pandora from France; Pine Island from The Netherlands; and PINTS from Australia. All four were considered to meet the published criteria and were accepted as approved process studies.

The third and final day of the SSC meeting started with discussion of BioGEOTRACES and Organic GEOTRACES – two initiative related to GEOTRACES. After some discussion about the practicalities, the SSC approved the plans for BioGEOTRACES – an effort to add a range of biological parameter measurements to GEOTRACES Sections. The SSC also noted with interest the Organic GEOTRACES developments to run a global programme for organic marine chemistry. Subsequent discussion addressed forthcoming workshops and conferences; programme budget, organisation of a formal launch of the field programme at AGU Ocean Sciences; and SSC rotation.

The next SSC meeting is scheduled for 22nd-24th September in Toulouse, France. The gap between SSC meetings is shorter than one year to accommodate the fact that many of those on the SSC will be at sea on GEOTRACES cruises during the later part of 2010.

Measurement Intercalibration during the GEOTRACES programme

There was early recognition during the planning of GEOTRACES that intercalibration of measurements between laboratories would be critical to the success of the program. To that end, intercalibration, along with data management, has been one of the two primary “enabling” activities since the establishment of the GEOTRACES programme and has had a designated sub-committee to oversee its progress (chaired by Greg Cutter).

Following two US-NSF led intercalibration cruises, in 2008 (Atlantic) and early 2009 (Pacific), intercalibration efforts have concentrated on shore-based analysis of recovered samples and collation of results from laboratories worldwide. These results were brought together for public presentation at a special session at the Feb. Ocean Sciences meeting, and then more fully discussed at an international meeting in Norfolk, USA, 8–10 March 2010 hosted by Greg Cutter. This meeting was internationally attended and gave the ocean trace element community an opportunity to fully discuss the successes and difficulties of the intercalibration efforts.

In general, results from the intercalibration were successful, and there was marked improvement between samples from the first cruise and the second cruise. A manual of “Best Practices” documenting lessons learned from the intercalibration and making recommendations to facilitate acquisition of reliable data on future GEOTRACES cruises is very nearly complete. The manual will be completed in summer 2010 and made available via the GEOTRACES Web site.

Further efforts to improve the measurements of some elements and isotopes are required though, and it is generally important for the work of intercalibration to continue within the GEOTRACES programme. The intercalibration subcommittee will continue, and it is anticipated that its next meeting will be held in Europe with funding from the GEOTRACES-related COST Action (<http://costaction.earth.ox.ac.uk/>).

Data Management for GEOTRACES

GEOTRACES has sought to ensure, since the outset of the programme, that data management protocols would be firmly established before the main data collection phase of the programme. To that end a Data Management Committee is the second standing sub-committee of the programme. This committee, co-chaired by Chris Measures and Reiner Schlitzer, met immediately following the SSC meeting on 7 November in Washington D.C.

This meeting reviewed national-level data management, with presentations from Norio Baba (Japan) and Cindy Chandler (USA) accompanied by an over-view of summary information from other nations. It considered requirements for metadata, and for data reporting, and it discussed data mining of pre-GEOTRACES datasets. Other topics considered were the data policy for the programme, and how best to allow data search and retrieval.

Ed Mawji is the GEOTRACES Data Management Officer at the international GEOTRACES Data Assembly Centre (GDAC), hosted at the British Oceanographic Data Centre. He has set up a website which is now welcoming GEOTRACES data, starting with data from the GEOTRACES IPY cruises. This website (see <http://www.bodc.ac.uk/geotraces/>) also provides full details of forthcoming GEOTRACES cruises, and information about all aspects of the data management process and policy for the programme.

The Data Management Committee will next meet immediately before the 2010 SSC meeting to review progress as the main phase of GEOTRACE Section cruises commences.

GEOTRACES International Project Office

A programme IPO has been set up during the past year, hosted in LEGOS, Toulouse, France, under the oversight of Catherine Jeandel. This office is presently staffed by one person: the IPO Executive Officer, Elena Masferrer. Advertisements for this position were placed in early summer 2009 and attracted eight applicants. A selection panel consisting of the two programme chairs (Anderson, Henderson), the local host (Jeandel); and Ed Urban interviewed a short-list of three candidates and Elena emerged as the clear choice for the post. Her appointment has been made for an initial period of 3 years, which is the limit of available funding. This funding is from various sources, with US-NSF contributing the largest share, but other funds coming from CNRS and the local authority in France; from the UAB in Spain, and from German Oceanographic institutes. Seeking additional funding to secure this post (and the Data Management Officer post) beyond their initial periods of employment is a priority for GEOTRACES.

Initial work by the IPO Executive Officer has been to produce a brochure to advertise the programme; helping to organize the GEOTRACES launch (see below) and redesigning the programme Web site. The Executive Officer has recently taken maternity leave from the role, but will return in the autumn at which time the Web site will formally transfer to the new version. Additional tasks at that time will be running of the SSC meeting in Toulouse, and seeking further funding for the management aspects of the programme.

Workshops and events

2nd GEOTRACES Data-Model Synergy Workshop:

Building on the success of the first GEOTRACES data-model synergy workshop in 2007, a second meeting, chaired by Jean-Claude Dutay was held at the École Normale Supérieure in Paris, France from 7 to 10 December 2009. The workshop was funded by US-NSF, SCOR, COST Action ES0801 and INSU France. It had six sessions:

- S1: Observation and modelling of particle concentration
- S2: Observation and Modelling particle reactive tracers – Th and Pa
- S3: Observation and Modelling particle reactive tracers – part 2 Nd isotopes and boundary exchange
- S4: Cycling of micronutrients – The Fe cycle

3-70

S5: Inverse modelling

S6: Stable isotope modelling (N, C, Si, etc)

The workshop was attended by some 50 people representing at least 13 countries. Additional information about this workshop, including a summary of its major discussion points, can be downloaded from <http://www.tiny.cc/ojfgu>.

Launch of GEOTRACES field programme:

A lunchtime event was organized during the Ocean Sciences meeting on 24 February 2010 in Portland, USA. The goal of this event was to inform a wider group of ocean scientists about the goals of the GEOTRACES programme as the major programme of dedicated GEOTRACES Sections commences. Gideon Henderson gave an overview presentation about the programme, which was followed by questions from the audience answered by the two programme chairs. The event was attended by more than 150 people and considered successful in publicising GEOTRACES.

Mediterranean Workshop:

A workshop will be held on 4-6 October in Nice, France, to discuss plans for a GEOTRACES section in the Mediterranean Sea, and to co-ordinate process studies and other relevant trace metal work in that basin. The meeting is organized by a committee representing several Mediterranean countries and chaired by Angelos Hannides from Cyprus. Funding to allow most participants at the meeting to be reimbursed for travel costs are in place from COST, SCOR and US-NSF and it is expected that 50 people representing most Mediterranean countries will attend. Announcements for the meeting are available at <http://www.tiny.cc/ctoyi>.

GEOTRACES Asia Planning Workshop

A workshop will be held on 4-6 October in Taipei to discuss GEOTRACES activities and international co-ordination in east and south Asia. This meeting has been organized by Tung-Yuan Ho who chairs a committee with representatives from across the region. Full details of the workshop are available at <http://proj3.sinica.edu.tw/~geotrace/index.htm>.

GEOTRACES-related sessions at international conferences

GEOTRACES research goals are regularly promoted through special sessions at international conferences. Events during the past year include: two special sessions were convened at the Ocean Sciences meeting (22 - 26 February, 2010; Portland, Oregon) to highlight results pertaining to trace elements and their isotopes:

- CO07: GEOTRACES in the International Polar Year, an
- CO09: Getting the Right Number: Precision and Accuracy in Chemical Oceanography.

Acknowledgements

We offer our special thanks to Ed Urban, who continues to provide tremendous support and valuable advice to the planning of the GEOTRACES programme.

National Reports

Australia

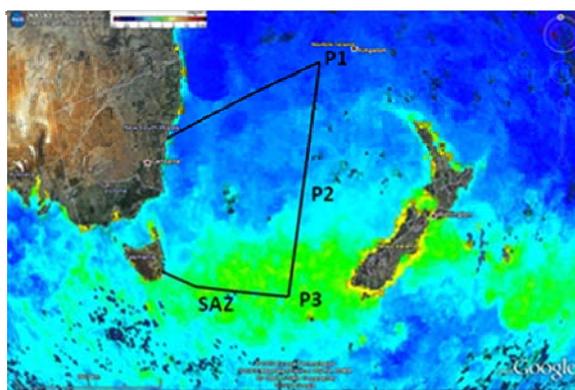
Summary of Australian GEOTRACES activities in the period July 2009-June 2010:

- Data from IPY-GEOTRACES projects *SIPEX*, *SAZ-Sense* and *SR3* submitted to the GEOTRACES Data Assembly Centre at BODC
- Several manuscripts published with results from IPY-GEOTRACES voyages (available on request)
- GEOTRACES process study 'PINTS' (voyage ss2010_v01) in Tasman Sea completed February 2010 (see report below) (PI Hassler)
- Sea ice iron biogeochemistry time-series study undertaken at Casey Station (Antarctica) in November/December 2010 (PI Lannuzel)
- Design specifications for GEOTRACES sampling requirements fed into plans for new Australian oceanographic research vessel
- Preparations for GEOTRACES section along P06 (~30°S) in South Pacific (153°E to 150°W) underway (voyage ss2011_v02), to be undertaken as joint Aus-NZ cruise in May/June 2011 (details presented to Bob Anderson to help planning of US-GEOTRACES Pacific sections) (PI Bowie)
- Participation and sample analyses of GEOTRACES intercalibration exercises for dissolved (Bruland), particulate (Sherrell) and aerosols (Landing) trace elements (Bowie lab)

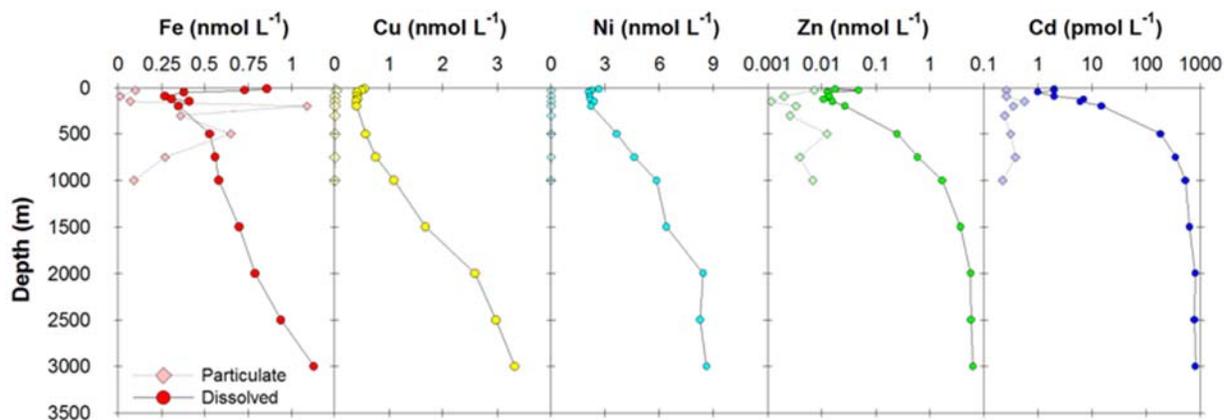
PINTS voyage summary ('Primary productivity Induced by Iron and Nitrogen in the Tasman Sea')

The research voyage studied iron bioavailability, sources and its biogeochemical cycling in the surface waters of the Tasman Sea. For this purpose samples for iron chemical speciation as well as dissolved and particulate concentrations were taken. Other trace metals can act as co-limiting factors on primary productivity. Therefore, samples were taken to analyse several other trace elements that are essential for phytoplankton growth, such as Zn, Cu, Mo and Co. Other parameters that affect biogeochemical processes and the sources at play, such as dissolved Cd and Pb, and Fe and Cu isotopic signatures were also studied. In addition to trace elements, macronutrients and especially nitrogen can limit primary productivity in the Tasman Sea. For this purpose samples were taken to determine the concentration of dissolved and particulate (organic) nitrogen, bacterial nitrogen recycling and the rate at which phytoplankton are able to fix atmospheric nitrogen. All these results on nutrients potentially limiting marine phytoplankton are being compared with phytoplankton biomass, biodiversity, productivity and physiological parameters to gain further insight on their control in the biology of the Tasman Sea. Data were gathered using a mapping approach (CTD, trace-metal-clean rosette and McLane pumps) along a voyage track (see figure below) designed to provide measurements on the effect of variable resources of iron (Australian continental dust, shelf sediments) on iron and nitrogen biogeochemistry. In addition on-deck incubations performed at process stations (P1 to P3) were used to determine how phytoplankton responded to variable perturbations relevant to nutrient limitation and climate change scenarios. The effect of variable source of organic iron and Australian desert dust, variable levels of pCO₂ and increasing temperature were investigated. Preliminary water column data are from P1 are presented in the figure below (Ellwood,

unpublished data). Results from this voyage will improve our understanding of the parameters controlling primary productivity in the Tasman Sea and the biological response to relevant climate change scenarios. A refined understanding of the dynamics of the Tasman Sea is required to improve existing models. Voyage plan and summary can be found online at www.marine.csiro.au/nationalfacility/voyagedocs/index.htm.



Composite chlorophyll a image for January to February 2010 with the voyage track overlaid



Profiles of dissolved and particulate trace metals versus depth for station P1. Note the logarithmic concentration scale for the zinc and cadmium profiles.

Update on outputs from GEOTRACES activities involving Australian researchers (July 2009-June 2010):

Journal articles:

- Bowie A.R., Townsend A.T., Lannuzel D., Remenyi T., van der Merwe P., 2010. Modern sampling and analytical methods for the determination of trace elements in marine particulate material using magnetic sector ICP-MS. *Analytica Chimica Acta*, submitted
- Bowie A.R., Lannuzel D., Remenyi T.A., Wagener T., Lam P., Boyd P.W., Guieu C., Townsend A.T., Trull T.W., 2009. Different processes structure biogeochemical iron budgets in the subantarctic and polar Southern Ocean south of Australia during summer. *Global Biogeochemical Cycles*, 23, GB4034, doi:10.1029/2009GB003500

- Cassar N., DiFiore P., Barnett B.A., Bender M.L., Bowie A.R., Tilbrook B., Petrou K., Westwood K., Wright S., Wagener T., 2010. The influence of light and iron on carbon export production in the subantarctic and polar frontal zones. *Geophysical Research Letters*, submitted
- Cossa D., Butler E., Heimbürger L.-E., Averty B., Bowie A.R., Watson R., Remenyi T., Rintoul S., 2009. Methylmercury formation and organic carbon oxidation in the Southern Ocean. *PNAS*, submitted
- Evans C., Thomson P.G., Davidson A.T., Bowie A.R., van den Enden R., Witte H., Brussaard C.P.D., 2010. Potential implications of climate change-induced shifts in microbial distribution for carbon cycling in the Australian Southern Ocean, Deep-Sea Research II, submitted
- Ibanami E.B., Hunter K.A., Sander S., Boyd P.W., Bowie A.R., 2009. Vertical distributions of iron-(III) complexing ligands in the Southern Ocean, Deep-Sea Research II, in press
- Lannuzel D., Schoemann V., Pasquer B., van der Merwe P., Bowie A.R., 2009. What controls the distribution of dissolved iron in Antarctic sea ice? Spatial, seasonal and inter-annual variability. *Journal of Geophysical Research - Biogeosciences*, doi:10.1029/2009JG001031, in press.

Prepared by: Andrew Bowie (Antarctic Climate & Ecosystems CRC, University of Tasmania, Australia)

Brazil

Brazil has a new member of the GEOTRACES SSC: Dr. Angela Wagner of the Departamento de Química, Pontificia Universidade Católica do Rio de Janeiro. She replaces Dr. Luis Felipe Niencheski of the Fundação Universidade Federal do Rio Grande, a founding member of the SSC.

Guarani Aquifer and coastal zone

The Guaraní Aquifer, located beneath the surface of Argentina, Brazil, Paraguay and Uruguay is one of the world's largest aquifer systems and is an important source of fresh water.

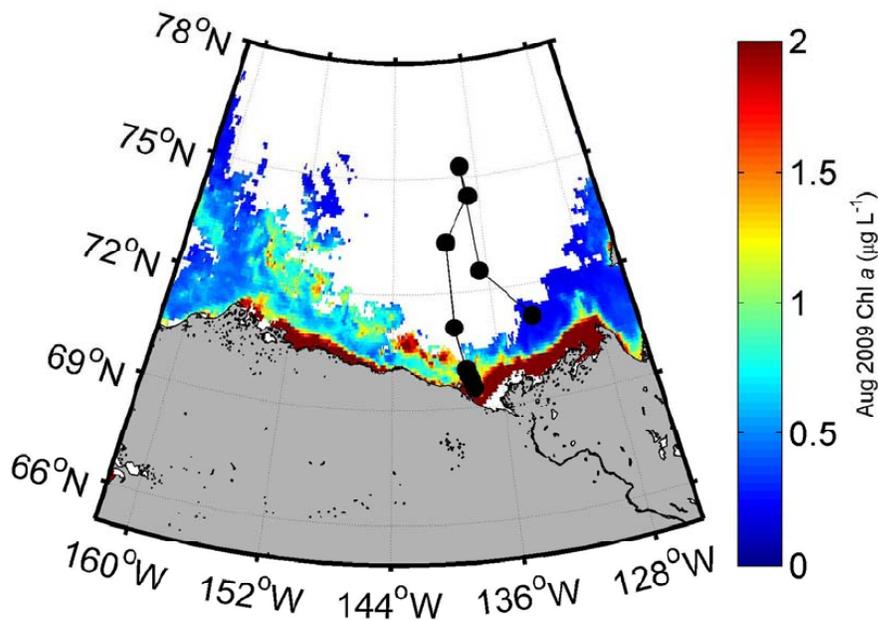
Brazilian scientists are studying the interference of the Guarani Aquifer in the coastal zone through a project entitled “Chemical processes and groundwater discharge associated to coastal continental margins” sponsored by CNPq. We have realized observations of naturally occurring geochemical tracers (^{222}Rn , ^{223}Ra , ^{224}Ra) in the coastal waters as proxies of Submarine Groundwater Discharge. More than 600 km of coast line in Southern Brazil (close to the Uruguayan borders) was investigated. Coastal seawater and shallow beach groundwater (<4m deep) were sampled in 2009.

A cooperative program between Brazil and Argentina is entitled “Connections and interactions between surface water and groundwater in the region of the Middle Paraná River System, Lagoon Patos-Mirim and Costa Patagonia: isotopic evaluation”. Participating scientists include Luis Felipe Hax Niencheski (Brazil) as well as Jose Luis Esteves (Centro Nacional Patagónico) and Pedro Depetris (Universidad Nacional de Cordoba) from Argentina.

3-74

Canada

Canadian scientists successfully completed an IPY-GEOTRACES cruise aboard the *CCGS Amundsen* from 27 August - 12 September 2009 in support of the project entitled “Multi-tracer investigation of the effect of climate change on nutrient and carbon cycles in the Arctic Ocean”. This cruise is the last in a series of IPY-GEOTRACES cruises encompassing both Arctic and Antarctic regions. Samples were collected for all key GEOTRACES parameters, with the exception of aerosols. The cruise track is shown below superimposed on a monthly composite of chlorophyll concentration.



A total of 44 standard rosette casts and 18 casts of a trace metal-clean rosette were completed. In addition, particulate material was collected with in situ pumps during 14 casts. In addition to studies of the biogeochemical cycles of trace elements and their isotopes, experiments were conducted to examine interactions between trace elements (micronutrients) and biota.

Preliminary findings indicate that melting sea ice is a significant source of iron, and that by late summer primary production is limited by nitrate rather than iron. Over the course of a year, iron and nitrate may each serve as limiting factors for phytoplankton growth. In deep waters, large changes in the distribution of dissolved ^{230}Th over the past 15 years record changes in circulation and exchange among the deep basins of the Arctic Ocean.

The Canadian GEOTRACES community is developing plans for a strategic network that would include collaboration with other nations in a larger study of the Arctic Ocean.

China-Beijing

GEOTRACES Activities in China
An annual report for 2009-2010
June 2, 2010
By China-GEOTRACES Working Group

A. Activities:

- 1. Participation in the international GEOTRACES activities- intercomparison (second round):** Th, Ra, Cd, Cu, Al, Pb, Ag (by Xiamen University, East China Normal University and Ocean University of China).
- 2. Invite Prof. Billy Moore from University of South Carolina to train researchers in China to run the Radec system for measurement of radium isotopes.**
- 3. “973” Carbon project—part of China-GEOTRACES has been included in this project and there have been two cruises to Chinese Marginal Seas.**
- 4. Field observations were carried out in the Changjiang drainage basin (main stream and major tributaries) during September-October 2009 to understand the impacts of Three Gorges Dam’s construction on the weathering characteristics of the drainage basin and also the variations of terrestrial flux on the marginal seas of China.**
- 5. Planning of a GEOTRACES process cruise in the Pacific in the spring of 2012.**

B. Products:

1. Preliminary results from GEOTRACES inter-calibration exercise are available. Details not shown.
2. Preliminary results from Ra study indicate that Ra distribution is strongly influenced by submarine groundwater discharge (SGD), coastal upwelling, and river plumes. Based on a mass-balance model, a crude estimate of SGD into the northern South China Sea is about 25% of that of Pearl River.

C. Promotion of GEOTRACES in China:

1. A “clean” system has been tested for underway and stationary trace metal sampling in the “973” cruises to the South China Sea.
2. A new MC-ICP-MS system (Nu) has been set up in Xiamen University and we have used it to measure Pb, Cu, and Fe isotopes in seawater samples.
3. A New ICP-MS system (Agilent 7700) has been set up in Xiamen University. Trace metal samples have been run in this system.

China-Taipei

Scientists in Taiwan have secured funds from the National Science Council and Academia Sinica to host a GEOTRACES-Asia planning workshop, to be held 4-6 October 2010 in Taipei. The objective of the workshop is to coordinate planning of GEOTRACES activities throughout Asia, including research in the Indian Ocean as well as in the western Pacific Ocean.

3-76

Announcements of the workshop have been distributed to GEOTRACES email lists and a Web site has been set up to provide additional information and to accommodate reservations at <http://proj3.sinica.edu.tw/%7Egeotrace/index.htm>.

Motivation for the workshop is summarized as follows (from the Web site):

East and South Asia, the most populous region on Earth, face the Western Pacific Ocean, the Indian Ocean, and their marginal seas. Diverse anthropogenic and natural forcings coexist and interact in the biogeochemical cycling of trace elements and isotopes (TEIs) in these waters. However, their key regulating processes remain largely to be explored. In this workshop, potential key processes that regulate and control the biogeochemical cycles of TEIs, such as their sources, distributions, internal cycling, sinks, and their use as tracers or proxies, will be identified and discussed. These discussions will culminate in the formation of a future action plan in TEIs research in the region. Contributors are invited to present highlights of their relevant research and provide suggestions on future actions and cruise plans. Here, we would like to invite researchers to participate in this workshop.

Contact person for the workshop is Tung-Yuan Ho <tyho@gate.sinica.edu.tw>.

SCOR will provide travel funds for participants from developing nations.

Taiwan has a small community of GEOTRACES scientists but active research on TEIs:

- 4 labs focus on trace metal concentrations in seawater, particles, aerosols, plankton et al. (T.Y. Ho, S.C. Hsu, K.T. Jiann, L.S. Wen), with clean sampling technology & HR-ICPMS
- 3 labs on isotopic composition in seawater, aerosols, corals, marine sediments (D.C. Lee, C.C. Shen, C.F. You) all 3 labs are equipped with both HR-ICPMS & MC-ICPMS
- 7 labs on using radioactive and C/N isotopes to study marine geochemistry and biogeochemistry (C.A. Huh, C.C. Hung, S.J. Kao, K.K. Liu, S.D. Luo, D.D. Sheu, C.L. Wei)
- More than 30 papers focusing on TEIs in the ocean were published during the past 3 years, mainly in the East China Sea and South China Sea.
- Cruise schedules of the 3 RVs are tight. A new 3,000 ton RV will be launched in 2012. Will be used for open ocean research, including GEOTRACES!

Cyprus

Angelos K. Hannides of the University of Cyprus has taken the lead in organizing a GEOTRACES planning workshop on the Mediterranean Sea, to be held 4-6 October 2010 in Villefranche-Sur-Mer, France. Research on the Mediterranean Sea requires special planning due to unique processes (e.g., dust deposition) and its international character. In addition, discussions are underway to jointly organize this workshop with SOLAS, with a view toward

coordinating a GEOTRACES section across the sea with a SOLAS process study. Additional information concerning the workshop can be found at <http://www.cybaes.org/gtmed/>.

Beyond the immediate objective of developing plans for GEOTRACES research in the Mediterranean Sea, it is hoped that the publicity provided by this workshop will contribute toward expanding research on trace elements and their isotopes in Cyprus.

Email contact for Hannides is <hannides@cybaes.org>.

SCOR will provide travel funds for participants from developing nations.

France

Below are the French activities related to GEOTRACES this year:

- AMANDES (process study on the Amazon shelf in 2009): current post-cruise activities (measurements, modelling...). National funds from INSU/CNRS are supporting these lab activities: 14000 euros for 2009 and 2010
- BONUS-GOODHOPE (IPY cruise): current post-cruise activities (measurements, modelling...) national funds from CNRS/INSU supporting this activity: 25000 euros/year from 2008 to 2011
- PANDORA (cruise in the marginal seas of the western tropical Pacific Ocean): Ship time is approved but not scheduled at this date (more information is anticipated on June 28). The science is funded. Two sources of national funds: CNRS/INSU: 220000 euros and ANR: 550000 euros (both covering 2009-2013). CNRS/INSU is also providing material from our national center of material (Brest, C. Marec).
- COMETS (Time series in the Mediterranean Sea, off Nice, at the DYFAMED station...requires the label "process study" for GEOTRACES)

The goal of the 4-year project COMET (CONstructing MEDiterranean Time-series) is to identify the causes and mechanisms responsible for the flux variability at seasonal to inter-annual time scales over the last two decades in the Ligurian Sea (NW Mediterranean Sea). This will be achieved by characterizing the chemical composition of sinking material collected at 200 and 1000m depth every 2 weeks using bulk parameters (POC, PON, POP, $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$), organic biomarkers and some TEIs (^{230}Th , REE, Nd isotopes...). National funds from INSU/CNRS: 10000 euros/year from 2008 to 2011.

- IPO: settled in Toulouse on January 15. Elena Masferrer provided a short report on IPO activities that is incorporated above into this annual report for GEOTRACES. The French yearly contribution to the IPO: 18500 euros
- Organisation of the SCOR and SSC meetings in Toulouse. CNRS contribution: 5000 euros.

Submitted by Catherine Jeandel, 10 June 2010

Germany

The main German GEOTRACES activity of the past year was the preparation and realization of the *RV Meteor* cruise M81/1 (GEOTRACES cruise A11, chief scientist M. Frank, IFM-GEOMAR, Kiel) to the tropical Atlantic Ocean (Las Palmas, Canary Islands - Port of Spain, Trinidad and Tobago, 4 February until 8 March 2010), which was funded by the German Science Foundation. For this cruise, which was exclusively dedicated to GEOTRACES, the trace metal-clean rosette, mobile winch with 8 km Kevlar cable and the clean van of the U.S. GEOTRACES programme had been borrowed. The system was successfully operated over the A-Frame of *RV Meteor* alternating with a normal rosette for less contaminant prone trace metals, as well as in situ pumps for particulate sampling, which were handled in a second clean laboratory container of the University of Bremen. A total of 17 full water depth stations were sampled for all core and ancillary parameters of the GEOTRACES program complemented by continuous surface water sampling with a towed fish (see figure below). In addition to the core parameters, samples were taken for analyses of dissolved transition metals (Ti-Zr-Hf, V-Nb-Ta, Cr-Mo-W), stable Fe-, Cd-, and Si-isotope composition, dissolved Hf isotopes, REEs, ^{234}Th , ^{227}Ac concentration, Ra isotopes, and anthropogenic radionuclides (^{239}Pu , ^{240}Pu , ^{237}Np , and ^{137}Cs). Two crossover stations for the forthcoming U.S. *RV Knorr* (eastern tropical Atlantic; see map) and the Dutch *RV Pelagia* cruises (western tropical Atlantic; see map) were occupied. All samples arrived back in the home laboratories safely and will be measured in the coming 2 years, for which a proposal for funding 4 PhD students will be submitted to the German Science Foundation in summer 2010.

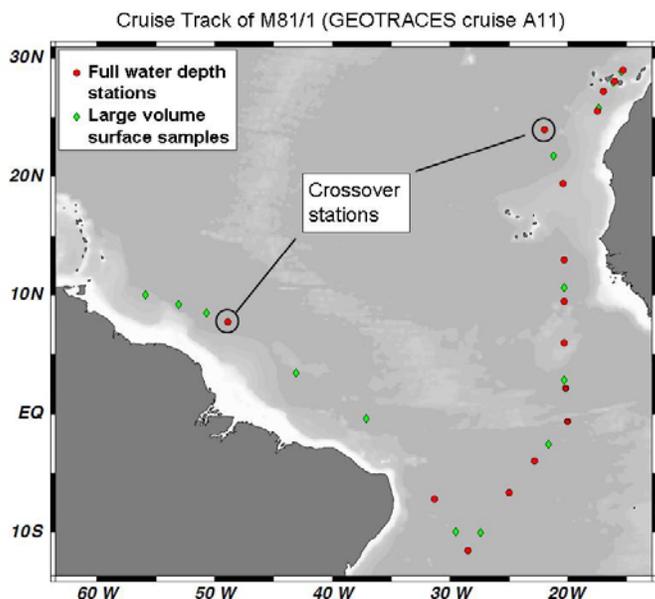


Figure: Track of *RV Meteor* cruise M81/1 (Las Palmas – Port of Spain, Feb.-March 2010).

In addition, German GEOTRACES scientists (group of M. Rutgers van der Loeff) took part in Leg 1 of Dutch *RV Pelagia* cruise (GEOTRACES) in the western North Atlantic and will receive

samples from Leg 2 of this cruise for measurements of GEOTRACES core parameters ^{231}Pa and ^{230}Th and a number of additional profiles for Nd isotope measurements to complement and extend the section of cruise M81/1.

The main planning activities of the German GEOTRACES community over the past year was the Arctic planning workshop in Delmenhorst (6-8 June 2009) mainly funded by the EU GEOTRACES COST program ES801 (The Ocean Chemistry of Bioactive Trace Elements and Paleoclimate Proxies). The workshop report is available on the GEOTRACES Web site.

India

GEOTRACES (India)
Sunil Kumar Singh
Physical Research Laboratory
Ahmedabad - 380009
India

The Ministry of Earth Sciences (MoES), India accepted the nine proposals submitted under GEOTRACES (India) programme from various laboratories and universities. The ministry has approved a total of Rs. 20 crores (US\$ 4 million) for these projects for a five-year duration. The majority of the funding will be utilised in buying a clean sampling system and establishing a shore-based state-of-the-art laboratory to analyse TEIs in the water and sediment samples. In addition to this budget, the ministry will provide us the ship time required for sampling during this programme. The National Joint Scientific and Technology Advisory Committee (October 28, 2009) has identified the Oceanography Research Vessel *Sagar Kanya* to house the proposed clean sampling system to be procured under GEOTRACES (India) and the first cruise with the clean sampling system for GEOTRACES (India) will be carried out onboard ORV *Sagar Kanya* during January 15 – February 13, 2011 in the Arabian Sea following with a cruise in the Bay of Bengal during March/April 2011. Committee has allotted four cruises during 2010 for coastal research pertaining to GEOTRACES onboard Coastal Research Vessels *Sagar Poorvi* and *Sagar Paschimi*. One of the coastal cruises off the western coast of India in the Arabian Sea is concluded recently (May 3 – May 12, 2010). In addition, two geotracers from India participated in the Japanese cruise *Hakuho-Maru* during November, 2009- January, 2010 in the Indian and Southern Oceans.

As discussed earlier, sampling related to GEOTRACES studies were done in the Arabian Sea, the Bay of Bengal and the Southern Ocean onboard *Sagar Sampada* and *Boris Petrov* during the expedition carried out during November–December 2008 and January-March 2009. The sampling was done on the cruise track finalised in the Indian Basin Planning workshop. Dissolved Nd isotope compositions in the three vertical profiles in the Arabian Sea (Fig. 1) were measured showing significant variation.

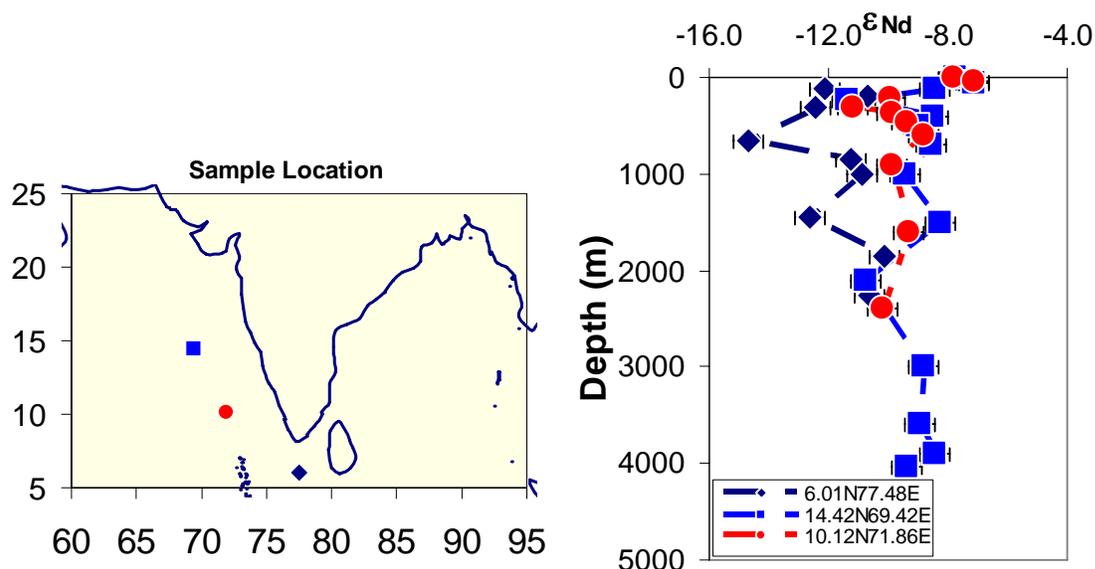


Fig. 1: Sampling location and dissolved Nd isotopic composition ϵ_{Nd} in the Arabian Sea

Dissolved Mo was analyzed in four Indian estuaries i.e. the Narmada, Tapi, Mandovi and the Hooghly, falling into the Arabian Sea and the Bay of Bengal respectively. Among these four estuaries, Mo shows nonconservative mixing in the Hooghly (Fig. 2) and the Mandovi with significant removal in lower salinity ranges (0 to 15‰). Mo seems to be removed due to the local

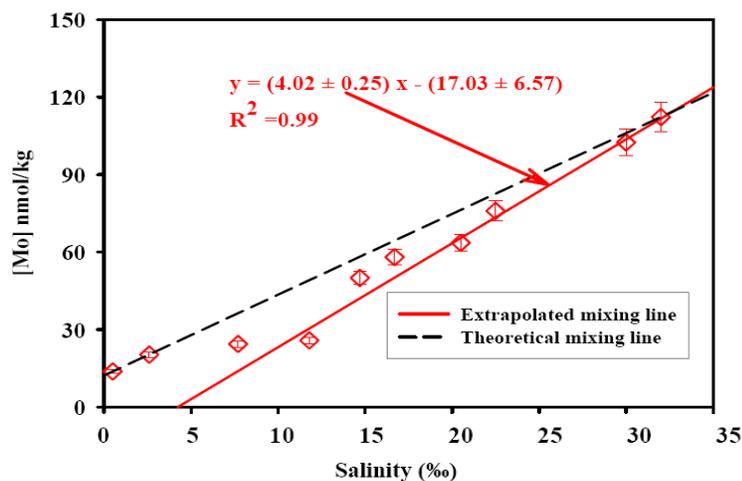


Fig. 2: Mo vs salinity in the Hooghly Estuary

anoxia resulting from the widespread mangrove swamp. Available data on Mo supply ($2.0 - 2.6 \times 10^8$ mol/y) to the ocean and removal ($1.1 - 1.7 \times 10^8$ mol/y) from the ocean indicate a significant missing sink of Mo if it is in steady state with respect to input/output. The current study provides an estimate of an additional Mo sink in the range of 0.4 to 3.1×10^8 mol/y caused by the presence of mangrove swamps in the worldwide oceans.

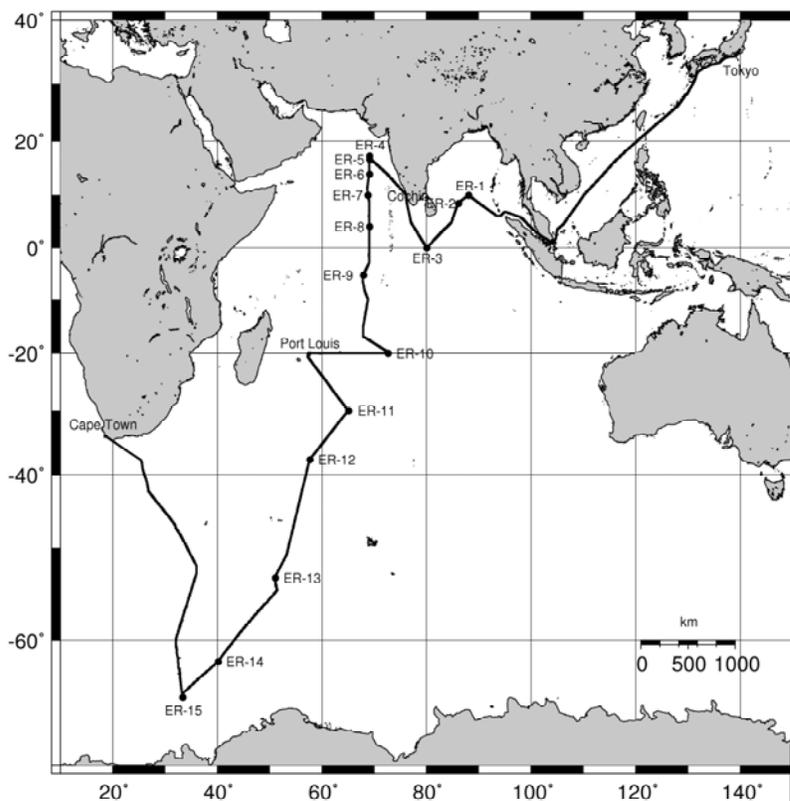
Japan

The first three legs of the *Hakuho Maru* KH-09-5 cruise were successfully conducted as a GEOTRACES cruise, as shown below, from 6 November 2009 to 10 January 2010 (66 days in total) in the north and western Indian Ocean including the Antarctic Sea.

Leg-1: Tokyo, Japan (6 Nov. 2009) to Cochin, India (24 Nov. 2009)

Leg-2: Cochin, India (27 Nov. 2009) to Port Louis, Mauritius (16 Dec. 2009)

Leg-3: Port Louis, Mauritius (16 Dec. 2009) to Cape Town, South Africa (10 Jan. 2010)



KH-09-5 Tokyo-Cape Town

The main study theme of this cruise was marine geochemical observations in the northern (chiefly in the Bengal Bay) and western Indian Ocean from the Arabian Sea to the Antarctic Sea along a meridional line along 65°E. It is a pity that we had to slightly modify the planned course, because of i) the threat of Somalian pirates in the Arabian Sea, ii) an approaching cyclone in the southern equatorial region, and iii) severe weather condition in the Antarctic Sea. The Indian Ocean occupies a vast area of the world ocean, but little is known about the marine biogeochemical cycles on trace elements and isotopes (TEIs). Thus, it is important to understand the role of the Indian Ocean in the global carbon cycle including its temporal variations recorded in marine sediments. We occupied 15 stations to conduct CTD-hydrocast, large volume water sampling, multiple coring, piston coring etc. TEIs measurements were partly done on board the ship and most of them are now ongoing in shore-based laboratories in Japan and other countries.

3-82

We conducted intercalibration studies during the cruise, by comparing the GEOTRACES-recommended Kevlar wire hydrocast with the *R/V Hakuho Maru*'s titanium wire hydrocast. We have also established a GEOTRACES baseline station at (20°S, 72°33'E) in the central Indian Basin, taking seawater samples not only for shipboard scientists but also for other international scientists who will measure in future some of the GEOTRACES key parameters for intercomparisons.

Forty three scientists (including graduate students) from various universities and research institutes in Japan, three technical supporting staff from Marine Work Japan Ltd., one scientist from U.S.A., one scientist from Canada, two scientists from China, and three scientists from India, for a total of 53 scientists who took part in the cruise to pursue international collaborative studies on GEOTRACES. We hope that the data obtained by this cruise will play an important role in the GEOTRACES program as its first accomplishment in the Indian Ocean.

Toshitaka Gamo (Chief Scientist of the Leg-2 and -3)
Hajime Obata (Chief Scientist of the Leg-1)

Korea

Korean scientists G. H. Hong and Y. I. Kim, both of the Korean Ocean Research and Development Institute, plan to attend the GEOTRACES Asia planning workshop in October. In addition, Drs. Hong and Kim have secured seed funding to begin isotope work in support of GEOTRACES.

Netherlands

1) IPY GEOTRACES

Throughout 2009 and 2010 much progress was made in writing, submitting and publishing articles based on the 2007 Arctic and 2008 Antarctic IPY-GEOTRACES cruises aboard *Polarstern*. Rob Middag completed his PhD thesis comprising nine research articles on Al and Mn in the Polar Oceans. One article on Al in the Arctic Ocean is published in *Marine Chemistry* (2009). Similarly several manuscripts/chapters are completed of the theses in progress of Maarten Klunder on Fe in Polar Oceans and Charles-Edouard Thuroczy on Fe Physical-Chemical Speciation in Polar Oceans. Several articles of the Antarctic *Polarstern* expedition ANT XXIV/3 will appear in a special issue of *Deep-Sea Research II*.

2) WEST-ATLANTIC GEOTRACES

PELAGIA 64PE318, 23-27 April 2010, Texel (Netherlands) to Scrabster (Scotland), chief scientist Dr. Loes Gerringa (loes.gerringa@nioz.nl).

In the preceding months *RV PELAGIA* had undergone mid-life refit including a new main engine at Santander (Spain) and returned home at Sunday 18 April 2010. Throughout 19-22 April there

was intensive completion and testing of electronic, hydraulic and mechanical systems of the vessel, and installation of winches and other scientific equipment. Participation of two GEOTRACES guest scientists of China and India for observing our new clean sampling system was cancelled due to general airline flights cancellations (due to volcanic ash plume from Iceland). Similarly, 3 junior scientist observers of Europe could not reach The Netherlands either, yet two others Ana-Maria Blataric (Croatia) and Gregory de Souza (Switzerland) were able to reach Texel and join this brief test and transit cruise. At the Friday 23 April departure news came that the Reykjavik airport was closed and the ship was diverted to Scrabster Harbour (Scotland). Similarly, the 9 scientists scheduled to join in Reykjavik were diverted by train, ferryboat or occasional airline to Scotland, and the itinerary of 5 leaving the ship at Scrabster diverted via Aberdeen to home.

After 2 days transit to deeper waters west of Scotland several tests were done. The 24 novel ultraclean PVDF-plastic butterfly valve samplers of 27L each mounted on the Titanium CTD frame (Fig. 1) functioned perfectly, as did the 24 new Niskin-type samplers of 25L each on a new stainless steel CTD frame. Both sampling systems are deployed alternately, using a new 9800m length, 22mm diameter super-aramide (Kevlar) hydrowire with internal copper conducting cables plus glassfibre communication cable, spooled on the completely overhauled KleyFrance winch.

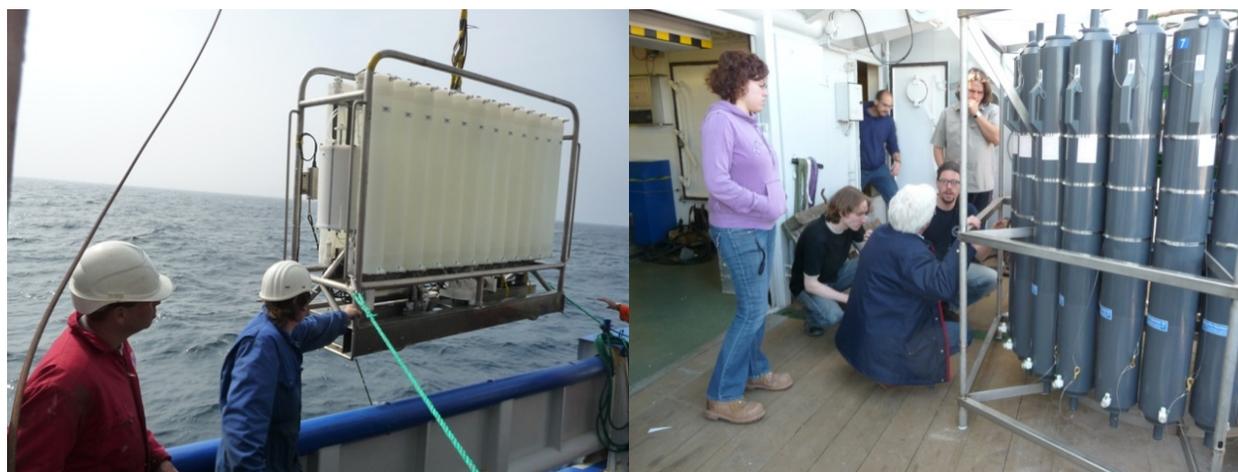


Fig 1. Left is the Titanium frame with new white PVDF 27L butterfly-valve samplers; right is the new set of 25L Niskin-type samplers on new stainless steel CTD frame, Ana-Maria Blataric standing in purple sweater, Gregory de Souza in behind doorway.

The isotope studies of trace metals (Fe, Zn, Cd, Pb) require the larger-volume clean samplers (27L), similarly for the suite of non-contamination-prone isotopes large-volume samples (25L) were chosen. Silicate increases steadily with depth, and comparison of silicate analyses showed that all samplers of the two independent frames close perfectly at intended depth. Moreover, the PVDF samplers were found to be very trace-metal clean at first use, hence superior to the

3-84

internal teflon-sprayed PVC of GO-FLO samplers thus far used. Upon several convincing tests and analyses of Fe, Al and nutrients, the ship returned eastward to arrive at 27 April at Scrabster, Scotland, for exchanging several staff and fuel bunkering and supplies.

PELAGIA 64PE319, 28 April through 25 May 2010, Scrabster (Scotland) to Bermuda, chief scientist Dr. Loes Gerringa (loes.gerringa@nioz.nl).

Overall 18 stations (Fig. 2) were occupied very successfully according to plan along the West Atlantic transect. Due to 2 days time loss as result of diversion to Scrabster (due to volcanic ash causing airline cancellations) and very heavy storms several other stations had to be cancelled. Intense storms were encountered off the south tip of Greenland and off Newfoundland, headwinds also affecting ship velocity down from normal 10 knots to merely 2 knots. Even the intended final Bermuda Atlantic Time Series intercalibration site had to be cancelled due to a nasty small storm exactly there and then.

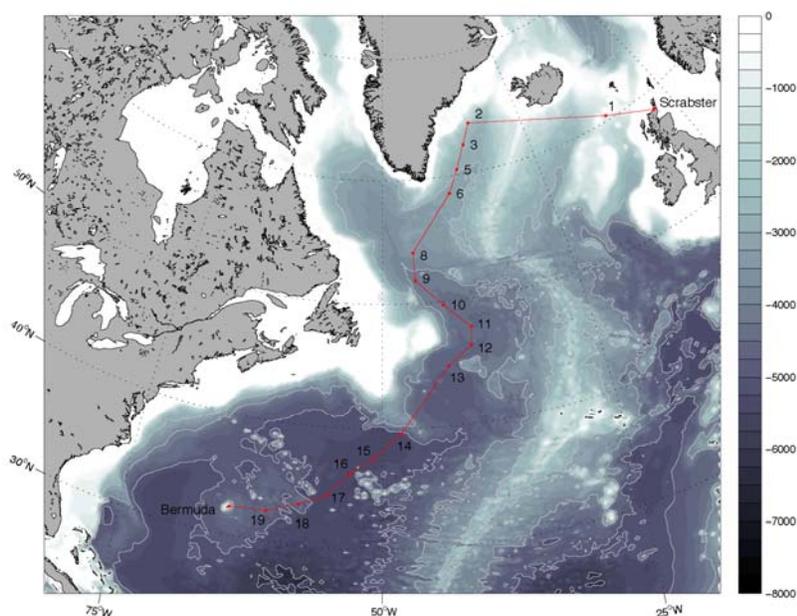


Fig. 2 Cruise track with stations 2-19 at the West Atlantic transect of cruise 64PE319.

Each station comprised 1 ultraclean and 1 regular hydrocast. At selected 6 super- and 3 hyper-stations additional hydrocasts as well as deep pump sampling were undertaken. Upon recovery the ultraclean Titan frame with PVDF samplers was immediately placed inside its clean laboratory container, where sub-sampling of a large variety of filtered or unfiltered seawater was done for (shipboard or afterwards) determinations of concentrations of Fe, Mn, Al, Co, Cu, Ni, Zn, Ag, Cd, Lanthanides, Pt, Pb; physical-chemical speciation of Fe; large volumes for natural isotope systematics of Si, Fe, Zn, Cd, Pb; major nutrients; $^{14}\text{CO}_2$ and $^{13}\text{CO}_2$. Underway clean sampling was done for aerosols with air filter units, and for surface waters for extra samples for Fe speciation and natural Pt, Pb with a torpedo towed alongside the ship from which water is pumped through a tube entering inside one of the shipboard clean laboratory vans.

The regular Niskin-type samplers and the submersible pumps provided the often required large volumes for natural or anthropogenic (radio)-isotopes systematics of ^{15}N , ^{99}Tc , ^{129}I , ^{137}Cs , $^{143}\text{Nd}/^{144}\text{Nd}$, Hf, ^{210}Pb , ^{210}Po , ^{223}Ra , ^{224}Ra , ^{226}Ra , ^{228}Ra , ^{227}Ac , ^{230}Th , ^{234}Th , ^{231}Pa , Np, $^{239,240}\text{Pu}$, ^{238}Pu and supporting parameter Dissolved Organic Matter (DOM). Complementary to GEOTRACES, many samples were collected for a transient tracers program comprising DIC, ALK, O_2 , nutrients, CFC's, SF_6 , $^3\text{H}/^3\text{He}$ and above mentioned $^{14}\text{CO}_2$ and $^{13}\text{CO}_2$, and for a microbial oceanography program comprising DOC, DON, bacterial and viral abundance, bacterial and archaeal and viral production, ^3H -FISH, ^{14}C -FISH and DNA microbial biodiversity and POC, ^{13}C plus ^{15}N by NanoSims, Nitrification, qPCR. We reckon some of these complementary transient tracers and microbial oceanography variables will be useful to support unraveling the processes controlling the GEOTRACES variables, and vice-versa.

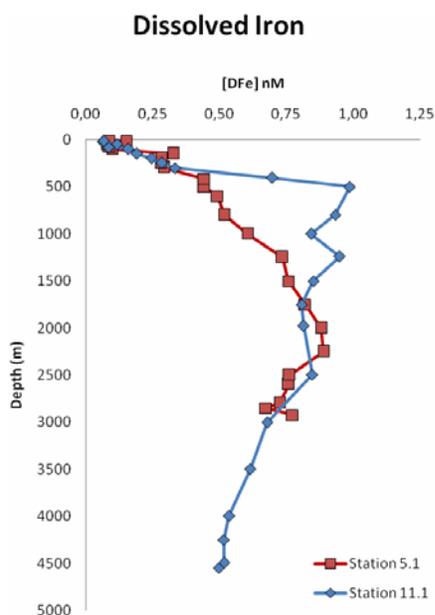


Fig. 3. Dissolved Fe at stations 5 and 11 (see above Fig. 2) of cruise 64PE319.

PELAGIA 64PE321, 11 June through 8 July 2010, Bermuda to Fortaleza (Brazil), chief scientist Dr. Micha Rijkenberg (micha.rijkenberg@nioz.nl). Weather permitting this cruise intends first another effort to occupy the Bermuda Atlantic Time Series intercalibration station. Next a similar program as above 64PE319 is pursued, where it is hoped some 20-25 stations can be done on a transect extending just across the equator. Finally in 2011 the West Atlantic section will be completed in the South Atlantic from about 55°S to the equator aboard *RV COOK* departing 2 March 2011 from Punta Arenas and arriving 7 April 2011 at Las Palmas (Canary Islands).

For general information about Netherlands GEOTRACES contact by email to: Hein.de.Baar@nioz.nl

3-86

New Zealand

In 2009 and 2010 the following GEOTRACES activities have taken place.

i) GEOTRACES-IPY data and metadata

The datasets (trace metal profiles and CTD) have been sent to the GEOTRACES Data Assembly Centre at BODC, UK.

ii) Workshop - GEOTRACES process study

In December 2009 we hosted a 5-day workshop in Wellington to discuss the results from our FeCycle II voyage that took place in September/October 2008. Twenty participants from New Zealand, Australia, USA and Chile presented results and commenced the construction of a coupled Fe and C budget for the upper water column during the development and decline of the spring diatom bloom. Plans to send metadata and data to BODC were finalised on the final day of the workshop.

iii) Planning for a mid-June 2011 P04 zonal section (North Queensland to Tahiti).

We have now confirmed dates for this voyage, and have been liaising with Andrew Bowie and Michael Ellwood in Australia to co-ordinate this joint 2-leg Australia-New Zealand voyage.

iv) Other activities: We have continued ship-of-opportunity dust sampling between Japan and New Zealand, New Zealand and Australia, and Australia and Antarctica in 2009/2010. We recently participated in a Dust-Phytoplankton Workshop In Brisbane which brought together dust scientists, trace metal chemists and ocean scientists.

During the Australian PINTS voyage transect of the Tasman Sea (January 2010), we characterised water column biogeochemistry by measuring a suite of parameters including nanomolar nutrient and trace metals. In addition the impact of dust and variable CO₂ on surface water biology and biogeochemistry was determined by a series of deckboard manipulation experiments.

Submitted by Philip Boyd

Spain

- National committee (under SCOR-Spain)
 - P. Masqué (Barcelona-UAB)
 - A. Tovar-Sanchez (Mallorca-CSIC)
 - A. Cobelo & R. Prego (Vigo-CSIC)
- Universitat Autònoma de Barcelona (UAB) contributing 10 k€/y (2 years) to IPO
- Participation in intercalibration activities (metals and radionuclides)
- Participation in EU-funded COST Action ES0801

- First results of BONUS-GOODHOPE, SPACE and ATOS cruises presented at international conferences (i.e. ASLO-Nice; Goldschmidt-Davos, IPY-Oslo). Several papers published + manuscripts submitted + others in preparation.
- Participation at the Arctic Planning Workshop (Delmenhorst, June 2009)
- Participation in GEOTRACES expeditions in the Atlantic:
 - German *RV Meteor* GEOTRACES M81/1 (PI: M. Frank, 2010)
 - The Netherlands *RV Pelagia* cruises 64PE319 and 64PE321 (PI: H. De Baar, L. Gerringa, M. Rijkenberg, 2010)
- Co-organization of the GEOTRACES - Mediterranean Workshop to be held in Nice in October 2010.

Sweden

Swedish GEOTRACES activities during 2009 include participation in planning activities for a GEOTRACE project in the Arctic and also in COST action ES0801 and the GEOTRACES intercalibration effort.

Planning work related to GEOTRACES

The GEOTRACES Arctic Cruise Planning Meeting on 8-10 June 2009 in Delmenhorst, Germany was attended by four Swedish scientists. Building upon the outcome of the Delmenhorst meeting a proposal has been submitted to the Swedish research council with the aim to use the icebreaker *Oden* as a research vessel for a GEOTRACES cruise in the Arctic Ocean. The proposal includes international collaboration and the time frame for the proposed cruise is within the coming 3-10 year period.

Within the COST action *The ocean chemistry of bioactive trace elements and paleoclimate proxies* (ES0801) students have participated in the following activities:

- The Paris modelling workshop, December 2009
- The test and training cruise organised by Dutch researcher on *R/V Pelagia* from Texel to Iceland (unfortunately the trip was cancelled due to the volcanic ash over European air space)

GEOTRACES intercalibration work

Swedish laboratories participated in the intercalibration effort of Nd isotopes, U-Th isotopes, Si isotopes and some trace elements.

The International Siberian Shelf Study 2008 (ISSS-08)

During 2009 extensive work has been conducted on the samples collected during the ISSS-08. Results have been presented at the Goldschmidt conference in Davos in June 2009 and at the EGU meeting in Vienna (May 2010) with a special session devoted to ISSS-08 results. Publications are prepared and in press.

GEOTRACES promotion activities within Sweden

- An e-mail list is kept and maintained by Per Andersson for distribution of information about the GEOTRACES project among marine scientists in Sweden.
- Presentations of the GEOTRACES project at the Swedish Society for Marine Sciences meeting in November 2009 and at the Swedish SCOR group meeting in March 2010.

Per Andersson

Stockholm 10 June, 2010

UK

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN THE UK

The last twelve months have seen significant funding successes in the UK and we are now preparing for two fully funded full GEOTRACES Sections in the Atlantic.

Further details of UK GEOTRACES activities are now available at a dedicated Web site at <http://www.ukgeotraces.com/>.

GEOTRACES A10: 40°S Zonal Section: Micronutrients and Paleoproxies

Ship time for this cruise had been secured with an earlier NERC Standard Grant to Henderson and Rickaby (Oxford), Mills (Southampton) and Pancost (Bristol). That grant was focused on paleoproxy calibration and did not cover costs for the majority of the GEOTRACES key parameters. In Jan. 2010 we learnt of the success of a larger Consortium Proposal to NERC for 2.5 million pounds. This budget enables the full suite of GEOTRACES key parameters and a range of other measurements to be made, and includes a component of biological research, physical oceanography, and ocean modelling. That proposal involved 10 UK organizations and one from the United States (WHOI), and had support from both South Africa and Uruguay. The funded work focuses on understanding the sources and cycling of micronutrients to the highly productive 40°S region of the Atlantic, and on the importance of deep water micronutrients to the Equatorial Atlantic and Southern Ocean.

The cruise will sail 17 October to 25 November 2010 from Cape Town to Montevideo with 24 scientists on board the *RRS Discovery*. It plans 22 full depth stations with multiple casts at each station, and will also set up an aerosol station on the Falkland Islands and support analysis for a complementary proposal within Uruguay to sample the Plata River at regular intervals.

GEOTRACES A06: Tropics: Micronutrients and nitrogen fixation

Eric Achterberg (Southampton) led a group which also included Maeve Lohan (Plymouth), Alex Baker (UEA) and Ric Williams (Liverpool) in a successful bid to NERC for 900 thousand pounds to run a tropical Atlantic cruise to assess the relationship between micronutrient supply

and ecosystem function, with a particularly focus on nitrogen fixation. The cruise will sample waters influenced by the Sahara dust plume and also contains a transect to the coast to investigate low-oxygen conditions. The cruise will sail on the *RRS Discovery* in Feb. and March 2011. Funding has so far only been secured for a limited number of the GEOTRACES key parameters, but there are plans to identify people to complete the list of parameters, and an expectation that this should be possible with the resources that have recently come to GEOTRACES from NERC.

Other activities

Purchase of clean sampling equipment: Funds have been secured this year for a UK clean winch and cable system. It is likely that this will fund the purchase of a LeBus winch and Nexans conducting cable for full-water column trace metal-clean work. The UK already has two 24 position titanium rosettes which will be deployed from this system. It is unlikely that the winch will be ready for the A10 cruise, which will instead deploy the Ti rosette from a high-breaking strain plastic rope with a depth trigger.

Data Management: BODC in Liverpool continues to host the International GEOTRACES Data Assembly Centre, with Ed Mawji as the dedicated Data Management Officer for GEOTRACES. Initial NERC funding to set up this post is close to its end and, although some additional funds have been secured in recent grants, efforts to provide continued support for this activity are important.

Planning for future activities: UK efforts are presently focused on A10 and A06, but discussions have begun on possible future UK interests. Several UK scientists attended the Arctic Basin Workshop this year and are interested in extending existing UK interest in the Arctic into GEOTRACES subject areas. There is also early discussion about possibly working in the Southern Indian Ocean in future years.

Gideon Henderson June 2010-06-11

USA

U.S. GEOTRACES scientists have been involved in the following activities during the past year.

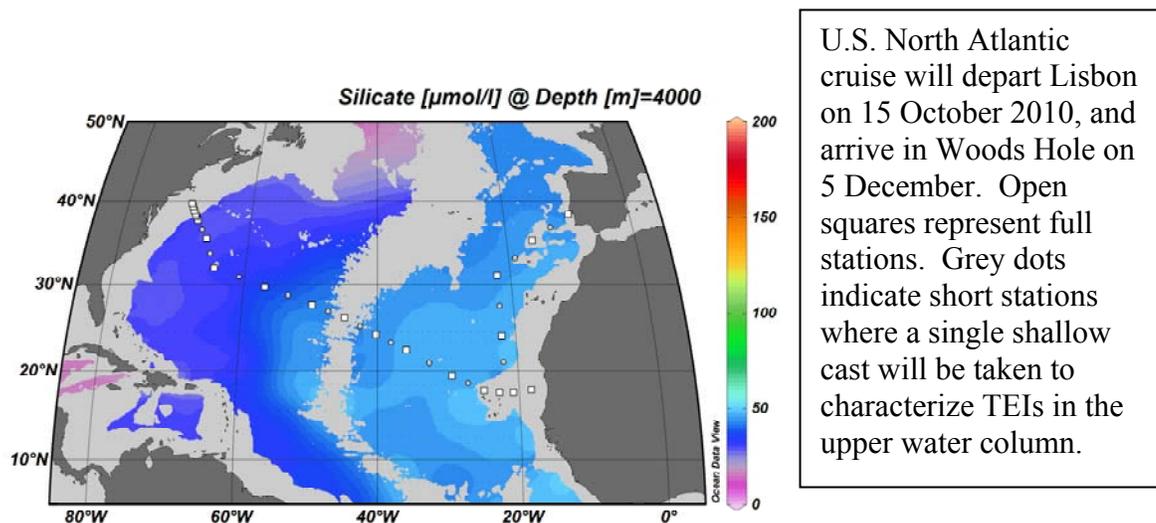
1) Intercalibration: U.S. GEOTRACES, together with Greg Cutter (Chair, GEOTRACES Standards and Intercalibrations Committee), hosted the third and final Intercalibration workshop at Old Dominion University, Norfolk, Virginia (8-10 March 2010). Members of the Standards and Intercalibration standing committee of the international GEOTRACES program participated and reviewed the results of the intercalibration activities. While some further work is required to improve on blanks and on reproducibility for some trace elements and isotopes, it was generally concluded that the international community is ready to proceed with the main phase of the global GEOTRACES field program.

3-90

The workshop also provided an opportunity for scientists to complete the GEOTRACES methods manual. The last section was revised during the first week of June, and Greg Cutter reports that he anticipates final editing and distribution of the document for review in July.

2) Planning Workshops: A planning workshop for the U.S. GEOTRACES North Atlantic Zonal Section was held 11-12 March 2010, at Old Dominion University (hosted by Greg Cutter). Station plans and water budgets were resolved during the workshop. In addition, the cruise was heavily oversubscribed compared to the number of berths available. An important activity of the workshop was to allocate the available berths in a way that enabled all funded projects to carry out their intended sampling. Approximately 24 projects involving approximately 40 principal investigators are funded to participate in, or receive samples from, this cruise. All GEOTRACES key parameters will be covered, as well as a number of additional parameters that will assist in understanding the biogeochemical cycles of trace elements and their isotopes. Additional sampling will be carried out for a number of unfunded studies.

The track for the U.S. North Atlantic cruise has been changed to reduce the number of nations for which permission to work in their EEZ is required. The revised track is shown in the figure below.



3) The U.S. GEOTRACES SSC met 1-2 June 2010 at the Scripps Institution of Oceanography. The U.S. SSC decided to delay the Tahiti-Peru section until early 2013 so that a second planning workshop can be held (tentatively in June 2011). The general plan for this section was established during a planning workshop in October 2008. The primary goal of the workshop in 2011 will be to establish priorities among a large suite of parameters that could be measured along the section, but which are not considered to be key TEIs for the GEOTRACES program.

Submitted by Bob Anderson 10 June 2010

3.5 Surface Ocean–Lower Atmosphere Study (SOLAS) (joint with IGBP, WCRP, and CACGP)

Terms of Reference:

- To develop the Surface Ocean - Lower Atmosphere Study (SOLAS) Science Plan and an Implementation Strategy, in accordance with guidance of the sponsoring organisations.
- To oversee the development of SOLAS in accordance with its Science Plan/Implementation Strategy.
- To collaborate, as appropriate, with other related projects of IGBP, WCRP, SCOR and CACGP and related projects and programmes (e.g., IHDP, DIVERSITAS, IOC and the Global Ocean Observing System (GOOS), etc.)
- To establish appropriate data management policies to ensure access to, sharing of, and preservation of SOLAS data, taking into account policies of the sponsors.
- To report regularly to SCOR, IGBP, WCRP and CACGP on the state of planning and accomplishments of SOLAS.
- The SOLAS SSC, its subsidiary groups and International Project Office shall operate in accordance with the operating procedures for IGBP Projects and as required by other co-sponsors.

Chair:

Douglas W.R. Wallace
Forschungsbereich Marine Biogeochemie
IFM-GEROMAR
Leibniz-Institut für Meereswissenschaften
an der Universität Kiel

Düsternbrooker Weg 20
24105 Kiel, Germany
Tel. 0431-600-4200
Fax. 0431-600-4202
Email: dwallace@ifm-geomar.de

Members:

Isabel Cacho Lascorz	SPAIN	Yukihiro Nojiri	JAPAN
Minhan Dai	CHINA-Beijing	Patricia Quinn	USA
Veronique Garçon	FRANCE	Eric Saltzman	USA
Cecile Guieu	FRANCE	Guang-Yu Shi	CHINA-Beijing
Sergey Gulev	RUSSIA	Rafel Simo	SPAIN
Christohe Heinze	NORWAY	Jacqueline Stefels	NETHERLANDS
David Kieber	USA	Roland Von Glasow	UK
Cliff Law	NEW ZEALAND		

Executive Committee Reporter: Huasheng Hong

IGBP Liaison: Wendy Broadgate

Executive Officer: Emily Breviere

Annual Report from SOLAS to SCOR.

Reporting period: July 2009- June 2010
Version of 17 June 2010 by Dr Emilie Breviere

SOLAS International Project Office, Kiel and Node Office, Norwich

The SOLAS International Project Office (IPO) was hosted by the University of East Anglia (UEA) in Norwich, UK until March 2010. The IPO was composed of an Executive Officer and a Project Officer (PO). The Executive Officer is Dr. Emilie Brévière since Aug. 2008. From Sept 2008 to Sept 2009, Georgia Bayliss-Brown was PO, and then Dr. Sophie Seeyave took over from Sept. 2009 to April 2010.

In March 2010, the 5-year funding from NERC of the SOLAS IPO in Norwich expired and a new bilateral funding mechanism between UK and Germany started.

As a consequence, in April 2010, the SOLAS International Project Office (IPO) moved to Leibniz-Institut für Meereswissenschaften (IFM-GEOMAR) in Kiel, Germany, where the SOLAS Chair, Doug Wallace is located. The Executive Officer, Dr. Emilie Brévière is now relocated at IFM-GEOMAR. The IPO is supported until January 2013 by the German Ministry of Education and Research (BMBF) and IFM-GEOMAR.

A SOLAS Node office remains at UEA, UK, where the Project Officer, Kath Mortimer, appointed in May 2010, is assisting the IPO. The UK Natural Environment Research Council (NERC) will support this Node Office until October 2011.

And in early fall 2010; a Project Officer position in the IPO, Kiel should be filled. The search is currently underway.

SOLAS Scientific Steering Committee

The SOLAS Scientific Steering Committee (SSC) met in Lueneburg, Germany end of April 2010 for its 10th SSC meeting.

The current membership of the SSC is listed below:

Name	Gender	Country	Expertise	Term	Term ends
Guang-Yu Shi*	M	China	Atmospheric transport / dust	2	2010
Isabel Cacho Lascorz	F	Spain	Paleoceanography	2	2011
Sergey Gulev (WCRP)	M	Russia	Air-sea physical interaction	2	2011
Veronique Garcon	F	France	Ocean Biogeochemical modelling	2	2012
David Kieber	M	USA	Marine Photochemistry	2	2012
Cliff Law	M	New Zealand	Air-sea exchange / nutrients	2	2012
Eric Saltzman**	M	USA	Atmospheric chemistry	1	2010
Jacqueline Stefels**	F	Netherlands	Sulfur cycle / sea ice	1	2010
Roland von Glasow**	M	UK	Atmospheric halogens / modelling	1	2010
Doug Wallace***	M	Germany	Ocean Carbon, air-sea overview. Chair	1	2010
Min-Han Dai	M	China	Coastal Carbon / acidification	1	2011
Cecile Guieu	F	France	Marine ecosystems / nutrients	1	2011
Patricia Quinn	F	USA	Aerosols / atmos chemistry	1	2011
Rafel Simo	M	Spain	Ocean biogeochemistry / trace gases	1	2011
Christoph Heinze	M	Norway	Carbon cycle modeling / paleoceanology	1	2012
Yukihiro Nojiri	M	Japan	Ocean carbon	1	2012

In December 2010:

* Guang-Yu Shi will be rotating off the SSC.

** Three members (Jacqueline Stefels, Eric Saltzman and Roland von Glasow) will have completed their first terms and have been nominated to have their membership renewed for a second term.

*** The SOLAS Scientific Steering Committee Chair, Doug Wallace, will have completed his first term as Chair of the SSC. The SSC members have nominated Doug Wallace to have his chairmanship extended by one year.

In October 2009, the SSC member Nilgun Kubilay (F, Turkey) expressed her wish to rotate off the SSC. Her background was in atmospheric aerosol composition.

SOLAS National Networks

Twenty-six nations are part of the SOLAS network. Each has a representative and/or a coordinator. Find the list below. The country and name underlined are changes which took place during the reporting time.

Australia: Michael Grose

Belgium: Christian Lancelot

Brazil: Amauri Pereira de Oliveira

Canada: Maurice Levasseur

Chile: Giovanni Daneri

China: Minhan Dai

Denmark: Lise Lotte Soerensen

France: Remi Losno

Germany: Hermann Bange and Ulrich Platt

India: Dileep Kumar

Ireland: Brian Ward

Italy: Maurizio Ribera d'Alcala

Finland: Gerrit de Leeuw

Japan: Mitsuo Uematsu

Korea: Kitack Lee

Netherlands: Jacqueline Stefels

New Zealand: Phil Boyd

Norway: Abdirahman Omar

Russia: Sergey Gulev

Spain: Rafel Simo

Southern Africa: Carl Palmer

Sweden: Katarina Abrahamsson

Taiwan: Gwo-Ching Gong

Turkey: Baris Saglihoglu

UK: Phil Williamson

USA: Wade McGillis

Implemented in Jan 2009, the national representatives of the SOLAS nations are asked to report annually about the SOLAS network in their country. To facilitate the reporting activities, a template form is provided. In February 2009, 17 reports were received and posted on the SOLAS website. The information contained in the reports has been/are a great source of information for the IPO to report to sponsors, but also to facilitate the coordination job and to redistribute the results and progress from some nations to the rest of the SOLAS community via the Newsletters and the website. A summary of all the reports received during the reporting period is available in an Addendum to this report.

Development of the SOLAS Mid-term strategy

Starting in May 2008, the SSC identified SOLAS' emerging priorities, arising from the Science Plan and the early years of SOLAS research, and subsequently prepared a set of White Papers (available on the SOLAS website) with a special effort to stimulate activity at an international level. These papers were presented to U.S. program managers from five funding agencies (NOAA, NASA, NSF, DOE and ONR) during the SSC meeting in March 2009. The presentations were very well received. Considerable interest was shown and there was a long, detailed discussion.

In November 2009, these new initiatives (7 topics) formed the basis of the afternoon discussion sessions at the SOLAS Open Science Conference in Barcelona. Short version reports from these discussion sessions are published in the SOLAS News Issue 10, longer versions are available on the SOLAS website at <http://www.solas-int.org/news/conferencemeetings/discsess.html>. The goals and priorities over the next years for SOLAS are to keep developing its mid-term strategy. The seven themes are developing at different speeds and recently one topic was put on hold due to the weak interest expressed by the oceanographic part of the SOLAS community (theme 'Ship Plume'). SOLAS is currently dedicating a large part of its funding towards the development of its mid-term strategy. Please find below update about the current status of each of the theme:

• Sea-ice biogeochemistry and interactions with the atmosphere

It was suggested that the way SOLAS could proceed with this theme is to link with or build on several ongoing studies and initiatives. As part of the International Polar Year legacy, several initiatives were mentioned: Circumpolar Flaw Lead System Study (Arctic, Canada, *CCGS Amundsen* <http://www.ipy-cfl.ca/index.html>), the IPY Science Conference 2010 in Oslo (8-12 June, <http://www.ipy-osc.no/>) and PolarCat (<http://www.polarcat.no/>). Jacqueline Stefels, leader of this initiative, successfully organized an opportunistic 'lunch-meeting' at the IPY conference in Oslo recently. She also recently had her workshop proposal to COST Action 735 accepted. A workshop of about 20 participants should take place in Amsterdam in April 2010.

• Atmospheric control of nutrient cycling and production in the surface ocean

During the OSC09 discussion session it was identified by the participants that a set of ongoing, planned and potential regional studies should be expanded, and systemized under SOLAS. The groups involved with these presently separate efforts were urged to link their proposals and plans

together so that similar experimental and analytical approaches can be applied in different regions, thereby allowing for later comparison between regions. Cecile Guieu, leader of this theme, proposed to hold a workshop in Turkey in December 2010. The COST Action 735 will provide part of the funding.

- **Air-sea gas fluxes at Eastern Boundary upwelling systems**

A first step to achieve the goals of this theme led by Veronique Garcon will be a SOLAS workshop on the 8-10 November 2010 in Lima, Peru at IMARPE with about 40-50 participants (see SOLAS website). Plans are well underway.

- **SOLAS Observatory and MOIN: the Minimalist OceanSITES Interdisciplinary Network**

The progress since OceanObs'09 are under investigation, a summary should be published in summer 2010 in the issue 11 of the SOLAS Newsletter.

- The theme on '**Ocean-derived aerosols: production, evolution and impacts**' led by Dave Kieber has not been as successful as expected at the OSC discussion session. However, efforts are underway to better engage the community.

- The theme on '**SOLAS large-scale field experiments - A compendium of proposals**' was very popular during the OSC discussion session; however, no clear large scale field experiment has been yet identified which could lead to an international funding effort.

In addition, most of the COST Action 735 workshops and the FTI on 'Upper Ocean Nutrient Limitation: processes, patterns and potential for change' are contributing to the development of the SOLAS Mid-term strategy.

SOLAS Open Science Conference 2009

The Open Science Conference (OSC) that took place at the CosmoCaixa science museum in Barcelona from 16 to 19 November 2009 brought together 250 participants from 28 different countries. Plenary talks covered many aspects of SOLAS science, including overviews and updates of the well-established research areas such as air-sea gas exchange, marine aerosols and atmospheric deposition. The programme also featured some new additions to the "traditional" programme. These included the application of new techniques to SOLAS research, such as the deployment of an autonomous network of gliders to map ocean physics and phytoplankton distribution, which can be controlled and monitored via the Internet. Molecular biology featured strongly at this OSC, with a session dedicated to genomic and genetic studies of ocean-atmosphere exchanges, which covered the application of functional genomics to the study of bacterial dimethylsulfoniopropionate (DMSP) cycling, N₂ fixation and nutrient-limited growth. The topical issues of ocean fertilization and geo-engineering were covered by both a plenary talk and a discussion session (see website or SOLAS News Issue 10).

All 65 student posters were entered into this OSC's student poster competition. The posters were judged by a different panel of judges for each of the 3 SOLAS foci. All panels were chaired by Alison Green, the managing director of the journal *Environmental Chemistry*, which was the official sponsor of the poster sessions and competition. The winners received a year's journal subscription, the recently published SOLAS textbook *Surface Ocean-Lower Atmosphere Processes*, and last but not least, an open-mouthed ceramic fish made of deep-sea mud!

SCOR kindly partially sponsored 5 scientists from developing countries to participate in the conference and present a poster. The OSC was a valuable experience for them, as shown by some of their testimonials (NL Issue 10).

Following the OSC, a survey was distributed to the OSC attendees in order to get direct feedbacks. Comments from the community will be taken into account when the next OSC is organized. Plans are underway to hold the next SOLAS Open Science Conference in early 2010 in Latin America or the USA.

International SOLAS Summer School

The 2009 SOLAS Summer School (SSS) was held from 3 to 14 August, once again at the Institut d'Etudes Scientifiques de Cargèse, Corsica. Organised by the SOLAS International Project Office and coordinated by Véronique Garçon, the school welcomed 71 PhD students and early career scientists from 24 countries and a wide range of scientific backgrounds, covering all of the SOLAS foci. The Summer School offered, once again, young researchers the opportunity to expand their knowledge of all aspects of SOLAS science and to create and strengthen future collaborations with SOLAS scientists from around the world.

The lectures covered a range of SOLAS topics, including an introduction to SOLAS (Doug Wallace); the carbon, iron and DMS cycles (Laurent Bopp, Phil Boyd and Peter Liss); greenhouse gases, climate change and variability (Laurent Bopp and Isabelle Ansorge); atmospheric physics, chemistry and dust sources (Uli Platt and Andy Ridgwell); air-water gas exchange (Phil Nightingale); biogeochemical modelling and changes (Corinne Le Quéré and Andy Ridgwell); remote sensing and time-series observations (Mike Behrenfeld, Eric Saltzman and Phil Boyd); marine ecology, aerosols and macronutrients (Osvaldo Ulloa, Eric Saltzman and Phil Boyd); and processes in the coastal zone (Minhan Dai). Special sessions covered topical science issues, such as the IPCC process (Corinne Le Quéré) and key feedbacks in the climate system (Thomas Schneider). Other sessions were aimed at teaching the students about more practical issues such as communicating with the press (Phil Boyd) and ethics in science (Doug Wallace).

As well as attending lectures, the students took part in hands-on practicals where they were introduced to techniques used in atmospheric chemistry, modelling, gas exchange, nutrient measurements and cruise work on the French vessel *Thetys II*. Science communication workshops gave the students guidance and constructive criticism on presenting their research via posters, manuscripts and oral presentations. The students then had the opportunity to present their improved work to the rest of the school.

To run the SOLAS International Summer Schools, we rely on the generous support from various bodies. For example in 2009, the school received support from SCOR, the U.S. National Science Foundation (NSF), International Geosphere-Biosphere Programme (IGBP), Centre National d'Etudes Spatiales (CNES), Centre National de la Recherche Scientifique (CNRS), Deutsche

Forschungsgemeinschaft (DFG), Natural Environment Research Council (NERC) and other national funding agencies, universities, projects (53 sources in total). In particular the first three programmes mentioned above, help to bring most of the developing countries students to the school. SOLAS is extremely grateful for the support from these programs.

As this was the 4th SOLAS Summer School, the organisers have been able to watch the evolution of its past students. Although it is difficult to keep track of all of them, a significant number are continuing to carry out SOLAS science, as shown by their participation at the Open Science Conference 2009 (OSC). The conference in Barcelona included 9 participants from the 2003 summer school, 4 participants from 2005, 14 from 2007 and 10 from 2009. At the OSC, the professional maturity reached by the students from the earlier summer schools was demonstrated by the fact that 3 of the alumni were invited to give plenary presentations (Christa Marandino, Eric Galbraith and Ashwini Kumar) and one was leading a discussion session on ship plumes (Roland von Glasow). Furthermore, 2 alumni won the student poster competition (Wiebke Mohr and Annette Kock), showing the high caliber of the summer school students. The 2007 summer school was particularly well represented at the OSC, and the alumni from this year took the opportunity to get together for dinner on the first night of the conference. Thus, they were able to rekindle friendships and reinforce their links with potential future collaborators.

The SOLAS Summer School is highly successful, as self-evaluations from the students and lecturers have shown, and also from the excellent 'after-SSS' careers of the alumni. The atmosphere is ideal for interaction between students and lecturers, and this capacity building is felt by SOLAS to be of fundamental importance to the long-term legacy of the project. Therefore, plans are well underway for the 5th SSS.

A 1-day meeting took place in February 2010 involving Peter Liss, Veronique Garçon and Emilie Breviere to discuss the format/timeline and funding strategy of the **5th SOLAS Summer School**. The changes decided during this meeting will be implemented for the SSS 2011. The 5th Summer School will take place in Cargèse, Corsica between the 29 August and 10 September 2011.

'Surface Ocean-Lower Atmosphere Processes' textbook

The lectures from the 2007 Summer School were developed into a textbook (Corinne Le Quéré and Eric S. Saltzman, Surface Ocean- Lower Atmosphere Processes, 2009, *Geophysical Monograph Series*, Volume 187, 350 pp., hardbound, ISBN 978-0-87590-477-1, AGU Code GM1874771). The volume is designed to provide graduate students, postdoctoral fellows, and researchers from a wide range of academic backgrounds with a basis for understanding the nature of ocean-atmosphere interactions and the current research issues in this area. The volume has been published by AGU in December 2009. To order a copy visit <http://www.agu.org/pubs/books/>.

Participants in the SSS2009 received a copy of the textbook. The volume will serve as a textbook for future SOLAS Summer Schools.

3-98

Plans are underway to distribute copies of the textbooks to libraries of Institutes from developing countries and also to sponsors acknowledging by this way their continuous support.

COST Action 735

In late 2006, SOLAS was provided networking funds from the European Coordination in the field of Scientific and Technical Research office (COST) for a dedicated 'Action' 735 which seeks to develop global air-sea flux data sets of gases and aerosols. The IPO administers the networking funds. Over the reporting period, the COST Action 735 has held 2 Management Committee meetings, one in Nov. 09 in Barcelona, Spain and another one in May 2010 in Hamburg, Germany.

* Listed below are the workshops that took place over the reporting period, which have facilitated coordinated efforts. Full reports are available to download at <http://www.cost-735.org/meetings/meetings.html>.

- Sub-WG1 'Iron bioavailability in the surface ocean' meeting: 1 -2 February 2010, Kiel, Germany. Leader: Peter Croot
The overall aim of the meeting was to critically examine and discuss the issues associated with iron bioavailability in the surface ocean.
- Sub-WG1,2&3 'Earth Observations for ocean-atmosphere interactions science- towards a collaborative action with ESA' meeting: 30-31 March 2010, Toulouse, France. Leader: Veronique Garçon
The meeting participants identified and described in a 3-page document each scientific topics. More information will be provided in a later section.
- Sub-WG1 'Marine Secondary Organic Aerosols (SOA) Formation' meeting: 26-28 April 2010, Bologna, Italy. Leader: Cristina Facchini
The workshop merged expertise in the field of biogenic SOA formation (terrestrial and marine) and expertise in marine boundary layer atmospheric chemistry (laboratory, field and modelling).
- Sub-WG2 'Particle deposition in the marine environment: how far have we progressed since Slinn & Slinn' meeting, 28-29 April 2010, Sopot, Poland. Leader: Jacek Piskozub and Tom Bell
The aim was to discuss the progress of our understanding of processes controlling dry and wet particle deposition over the ocean within the last 10 years. Focus was on parameterisation of particle deposition velocities used in regional- and global-scale models.
- Sub-WG2 'Evaluation of strategies used to determine physical and chemical sea spray fluxes' meeting, 10-11 May 2010, Galway, Ireland. Leader: Ian Brooks and Colin O'Dowd
The meeting was convened to discuss issues relating to primary marine aerosol fluxes, their measurement, and the extension of source functions determined from in-situ

process-based measurement campaigns and laboratory studies to a global scale via satellite retrievals.

In the COST Action 735 framework, a significant proportion of the funding is to be used to develop young research talent through the “Short Term Scientific Mission” mechanism (STSM). These missions provide resources for young talent to travel to a participating institution for the purpose of research coordination and development. Over the reporting period, four Missions have been accomplished. The list with details and reports is available at <http://www.cost-735.org/science/STSM.html>.

1. *Katja Seitz, from University of Heidelberg, Germany to University of East Anglia, Norwich, UK, 05/10/09 to 24/10/09
Topic: Modelling DOAS measurements of reactive halogen species
2. *Mercedes de la Paz, from CSIC, Spain to Newcastle University, UK, 01/10/09 to 15/12/09
Topic: High precision chromatography analysis of Nitrous Oxide and Methane in seawater
3. *Rachel Beale, from PML, UK to IFM-GEOMAR, Germany, 03/05/10 to 07/05/10
Topic: Knowledge exchange of Oxygenated Volatile Organic Compounds (OVOC) research
4. *Xose Antonio Padin, from IIM, Spain to Galway, Ireland, 01/03/10 to 31/05/10
Topic: Biological effect on air-sea CO₂ fluxes using the eddy covariance method

Planning has been finalized for the year 2010-2011 (4 STSMs and 6 workshops) and the next Management Committee meeting should take place in Dec. 2010 in Istanbul, Turkey.

- Sub-WG3 meeting proposed by Alberto Borges on ‘Experimental, typological and modelling approaches to evaluate at global and regional scales horizontal and vertical fluxes from land to the open ocean through rivers, estuaries and the coastal ocean’. Oct. 2010
- Sub-WG1 meeting proposed by Peter Croot on ‘Trace metal speciation data in COST Actions 735 and 801: Current state of the art and towards the construction of a database’. Aug. 2010
- Sub-WG2&3 meeting proposed by Michael Cunliffe on ‘What is the sea surface microlayer? Towards a unified physical, chemical and biological definition of the air-ocean interface’. Sept. 2010
- Sub-WG2&3 meeting proposed by Cecile Guieu on ‘Atmospheric versus land-based controls of nutrient cycling and production in the surface ocean: from fieldwork to modelling’. Dec. 2010
- Sub-WG1&3 meeting proposed by Mark Moore on ‘Upper ocean nutrient limitation: Processes, patterns and potential for change’. (IGBP/SCOR FTI) 3-5 Nov 2010
- Sub-WG1 meeting proposed by Jacqueline Stefels on ‘Sea-ice biogeochemistry and interactions with the atmosphere’. Apr. 2010

3-100

Fast-Track Initiatives

In May 2009, IGBP launched two fast track initiatives (FTI) proposed by SOLAS and other IGBP core projects. Both FTIs were endorsed by SCOR.

1- SOLAS is coordinator of the IGBP/SCOR Fast-Track Initiative on **Upper Ocean Nutrient Limitation: processes, patterns and potential for change** (2009-2011). The scientific coordinators are Mark Moore (NOCS, UK) and Matt Mills (Stanford Univ., USA). A special session at the AGU/ASLO Ocean Sciences meeting in Oregon (Feb. 2010) provided the opportunity for a small pre-meeting of some of the FTI actors. A workshop will take place in Southampton, UK on 3-5 Nov 2010 to address the FTI specific goals. The COST Action 735 will financially support the attendance of 2-3 participants. More information is available at <http://www.igbp.net/page.php?pid=503>.

2- SOLAS is contributing to the IGBP/SCOR Fast-Track Initiative on **Megacities and the Coastal Zone: air-sea interactions** (2009-2011). This initiative is coordinated by Sarah Doherty from the IGAC IPO, Roland von Glasow (UEA, UK), Tim Jickells (UEA, UK), Tong Zhu (Peking University, China), Ramesh Ramachandran (Institute for Ocean Management, India) and Josef Pacyna (Norwegian Institute for Air Research, Norway). 3 IGBP core projects are contributing to this FTI: LOICZ, IGAC and SOLAS. A workshop took place in Norwich, UK, on 13-15 April 2010 to address the FTI-specific goals. The 15 participants had very lively and productive discussions and agreed on writing a brief overview/review paper for a high-profile journal. This activity is led by Roland von Glasow. An update article will be published in the Issue 11 of the SOLAS News, scheduled for Summer 2010. More information are available at <http://www.igbp.net/page.php?pid=509>.

Task teams:

Task team acknowledged by SOLAS during the reporting period: Asian Dust and Ocean EcoSystem (ADOES)

The proposal 'Long-range transport of Asian dust and its effect on oceanic ecosystem: An introduction to ADOES' was received in April 2008 (Asian Dust and Ocean EcoSystem). The 4th ADOES workshop took place in Oct. 2009 in Jeju, Korea. During the SOLAS OSC 09 in Barcelona, a discussion session led by Mitsuo Uematsu and Huiwang Gao was entitled 'Future for the Asian Dust and Ocean EcoSystem (ADOES) with Asian SOLAS'. From the last 2 ADOES events clear goals emerged (see report at <http://www.solas-int.org/news/conferencemeetings/discsess.html>); over the past 2 years ADOES has matured into a Task Team. SOLAS is encouraging ADOES to take a step forward in coordinating international activities related to Asian dust. SOLAS officially acknowledged ADOES as a SOLAS Task Team in Jan. 2010. The next 5th ADOES workshop will take place in Nagasaki, Japan, in spring 2010.

Update on the SOLAS/IGAC Task Team: Halogens in the Troposphere (HitT)

<http://www.HitT-task.net/>

Even though the "brand" HitT is not as prominent as it could be, there was a lot of HitT-specific activity in 2009. The field is very active as evident in a steady number of papers and 2 current

Special Issues in ACP: RHaMBLe (Brittany and Cape Verde field campaigns) and GSHOX (Summit, Greenland field campaign; first papers to be submitted). Most of the RHaMBLe papers explicitly mention HitT in their acknowledgements.

There were Tropospheric Halogens sessions both at EGU in April 2010 and AGU in December 2009. Planning is underway to hold a session at AGU 2010. Though not specifically labelled as "HitT" sessions these were organised by core HitT people, such as Roland von Glasow.

The German SOLAS project SOPRAN is entered in its second 5-year phase with a strong halogen component. Another major German research cluster, HALOPROC is also getting ready for its extension. HALOPROC's focus is on halogen release from soils and salt lakes and atmospheric cycling involving aerosol particles.

The Cape Verde observatory, with a strong focus on halogens, has become a WMO station which, in addition to more funding by NERC, is helping to establish this as a long-term observatory.

There is a lot of activity in the halogen community dealing with polar regions, several larger projects are finishing with IPY coming to an end (e.g. GSHOX, Summit, Greenland) or are in the proposal stage.

Endorsed projects:

Over the reporting period, SOLAS endorsed 2 new projects:

-BIOACID Project *Endorsed since November 2009*

<http://bioacid.ifm-geomar.de/>

To close the many gaps in our understanding and to allow a systems-based assessment of the risks and uncertainties associated with ocean acidification, BIOACID will take an integrated approach combining the expertise of molecular and cell biologists, biochemists, plant and animal physiologists, marine ecologists, ocean biogeochemists and ecosystem modellers. See article in SOLAS News Issue 10.

-CHOICE-C Project *Endorsed since November 2009*

‘Carbon cycling in China Seas - budget, controls and ocean acidification’ (CHOICE-C) focuses on the carbon budget, controls, ecological responses and future changes in coastal ocean systems. The focal area includes, but is not limited to, the continental shelves of both the South and East China Seas. More information at <http://973oceancarbon.xmu.edu.cn>. See article in the SOLAS News Issue 10

The endorsement submission forms and update of all the SOLAS endorsed projects are available on the SOLAS website. Articles on all the SOLAS endorsed projects are available on the SOLAS News Issue 9 and 10.

SCOR WG 131:

The on-going SCOR WG 131 on ‘The Legacy of in situ Iron Enrichment: Data Compilation and Modeling’ is co-chaired by Philip Boyd (New Zealand) and Dorothee Bakker (UK). This working group is financially sponsored by SCOR and the U.S. National Science Foundation and was approved in August 2007.

The activities of this group are of major importance to the SOLAS community in that they provide a key data resource as well as improved insight into the mechanisms and linkages

3-102

between iron supply and subsequent changes in the upper ocean inventory, and efflux/drawdown, of climate-relevant gases including CO₂, DMS, CH₄ and N₂O.

This WG is planning to have a workshop in early 2011. By hosting the workshop in Kiel, Germany, this WG could benefit from the help of the IPO for the logistical issues but also could benefit from financial support discussions are underway.

SOLAS- IMBER Carbon Group

Much of the science of SOLAS Focus 3 overlaps with IMBER and thus a joint SOLAS/IMBER Carbon Group (SIC) was formed during a meeting held in Colorado in Oct. 2005. This group is working in close collaboration with International Oceanic Carbon Coordination Project (IOCCP). The SIC group is currently subdivided into three working groups:

***WG1-Surface Ocean Systems** Chair: Nicolas Metzl (France)

***WG2-Interior Ocean.** Chair: Nicolas Gruber (Switzerland)

***WG3-Ocean Acidification (since August 2009).** Chair: Jean-Pierre Gattuso (France)

Update on the 3 WGs are reported below:

***WG1-Surface Ocean Systems : the Surface Ocean CO₂ Atlas (SOCAT)**

<http://www.socat.info>

At the Surface Ocean CO₂ Variability and Vulnerability (SOCOVV) meeting in Paris, April 2007, the SOCAT database was identified as a priority for the SIC-WG1 activity. Regional PIs were identified. A series of meetings (7) took place over the last 2 years. Two workshops took place over the reporting period:

06/2010 - SOCAT Southern Ocean and Indian Ocean regional workshop was held in Hobart, Australia

02/2010 - SOCAT Equatorial Pacific, North Pacific, and Indian Ocean regional workshop was held in Tokyo, Japan

The regional group mainly discussed organization for Science and also met with the developers of the Live-Access Server tools to learn how LAS can be used in the QC effort for SOCAT. Full reports are available at <http://www.socat.info>. In February 2010, the SOCAT LAS version 2.3 was launched.

The SOCAT database has been assembled by Are Olsen (BCCR, UNIFOB AS Bergen) and Benjamin Pfeil (Carbocean, Bergen) in close collaboration with Alex Kozyr (CDIAC). The version 1.3 of SOCAT contains data from 2175 voyages, with 7.6 million recalculated fCO₂ values, covering a time frame from 1968 to 2007. The SOCAT is scheduled to be released only by early 2011.

***WG2-Interior Ocean**

Update from Jan. 2010.

Global assessment of ocean interior carbon change planned for the next 2 years. A major focus for the next two years is the completion of a first global assessment of the ocean interior carbon change since the first global CO₂ in the ocean survey was undertaken in the late 1980s and early

1990s. One of the key objectives is to determine - on a global scale - the amount of carbon that the ocean has taken up from the atmosphere since this period. A particularly important question is to assess whether this uptake has already shifted away from that expected for a time-invariant ocean, for example, as anticipated in response to future climate change. Basin-wide workshops are planned for 2010, and a global-scale workshop is currently being planned for the summer of 2011 in Paris, the latter jointly with WG1. The goal is to complete this global synthesis by early 2012, so that this critically important information is available for IPCC AR5. In addition, the WG continues to pursue all means to establish an Oxygen on Argo observing system. It will assist national and international consortia in the planning and coordination of a pilot project, and will work with Argo to ensure that protocols are maintained and data quality procedures designed and implemented. A first synthesis of the already existing oxygen on Argo data is planned for 2010.

***WG3-Ocean Acidification (SIOA)**

In August 2009 the SIC working group 3 on ocean acidification was launched, replacing the working group on sensitivity (future ocean). The members are Jim Barry (USA), Jelle Bijma (Germany), Minhan Dai (China), Dick Feely (USA), Jean-Pierre Gattuso, Chair (France), James Orr (France), Ulf Riebesell (Germany), Lisa Robbins (USA), Carol Turley (UK), Yukihiro Nojiri (Japan). The tasks of this group are to:

- 1- Coordinate international research efforts in ocean acidification
- 2- Undertake synthesis activities in ocean acidification at the international level

The group held its first meeting in Paris, France on 1-3 December 2009. This meeting was mainly sponsored by SOLAS and IMBER. The sub-group identified and prioritised topics for immediate attention, with an indication of proposed deliverables and a plan to achieve them. More information reported in the SOLAS News Issue 10 from Jean-Pierre Gattuso (<http://www.solas-int.org/news/newsletter/newsletter.html>).

SOLAS Project Integration

Since November 2006, Tom Bell has been funded by the UK Natural Environment Research Council (NERC) on a Knowledge Transfer project within UK SOLAS. Tom was tasked with galvanising the relevant parts of the international SOLAS community toward achieving large-scale synthesis of past and existing work.

SOLAS Integration has been very successful, and projects have been developed to assemble surface ocean databases of DMS (DMS-GO), halocarbons (HalOcAt), methane and nitrous oxide (MEMENTO) and atmospheric measurements of aerosol iron over the Atlantic Ocean (IRONMAP). Many of these projects have been discussed in the SOLAS News issue 9 and 10. Some are ongoing, with initial outputs anticipated in approximately a year or so (e.g. HalOcAt and MEMENTO). DMS-GO completed and published the results. Other such as IRONMAP is closer to completion, with the aim to publish the results (and make them fully available to the community) in the very near future. Of course, none of this would be possible without the excellent levels of engagement, interaction and data contribution(s) from the SOLAS community.

Aside from assembling databases, synthesis of intellectual understanding has also been an important component of SOLAS Integration. Facilitated in no small way through COST Action 735, discussion workshops have been held on various SOLAS-relevant topics. In particular, this has brought about a number of outputs that are highly relevant to the air-sea gas/particle interaction community (reported in previous sections). Unfortunately, the SOLAS Project Integration funding has not been renewed by NERC for 2010.

Other SOLAS activities:

*SOLAS partially sponsored 2 speakers to attend the **PICES BIO Workshop ‘Natural supplies of iron to the North Pacific and linkages between iron supply and ecosystem responses’**

The PICES Annual Meeting (“Understanding ecosystem dynamics and pursuing ecosystem approaches to management”) was held on the beautiful island of Jeju, Korea from the 23 October–1 November 2009. More info reported in the SOLAS News Issue 10 from Stephanie Dutkiewicz (<http://www.solas-int.org/news/newsletter/newsletter.html>).

*The **International Conference on Planetary Boundary Layers and Climate Change** was held at the Kirstenbosch Botanical Gardens in Cape Town on 26-28 October 2009. With a view of highlighting the important role of the ocean, the meeting incorporated a plenary **SOLAS session** showcasing southern African SOLAS science. The meeting was attended by a small but eminent audience including specialists in atmospheric dynamic from the Ukraine, Norway, Russia and the USA along with local scientists. See article in the SOLAS News Issue 10.

*A joint IMBER/SOLAS special session has been conducted every year since 2005 at **EGU General Assemblies** in Vienna. This continued effort is well attended every year. In 2010 it was led by Baris Salihoglu and Veronique Garcon.

*In June 2009, the European Space Agency contacted the IPO to explore if the SOLAS project could be a potential candidate to initiate **ESA activities dedicated to SOLAS in 2010**.

In 2008, the European Space Agency launched the Support to Science Element (STSE) as a new tool to support scientific activities. In 2010, ESA decided to develop a thematic call in collaboration with the air-sea interaction community and contacted the SOLAS IPO. The first meeting between ESA representatives Diego Fernandez and Graig Dolon and the SOLAS community and leaders took place during a dedicated discussion session entitled ‘Identifying SOLAS scientific requirements for a new joint ESA-SOLAS activity’ at the SOLAS OSC in Barcelona in Nov. 2009. This first successful meeting allowed identification of 3 or 4 themes that were thought to be key to an ESA/SOLAS collaboration and the SOLAS community interested in the ESA proposition to organised itself in a ‘leading group’ of 5-6 scientists. This group and ESA representatives met in late March 2010. They identified and described in a 3-page document each, the following 4 scientific topics: 1) Sea spray aerosol production, 2) Sources and sinks of climatically-active gases in the Eastern Boundary Upwelling and Oxygen Minimum Zone (OMZ) systems, 3) Air-sea exchange of greenhouse gases using satellite data and 4) sea-ice biogeochemistry and interactions with the atmosphere. This meeting was sponsored by the COST Action 735. More information is available at <http://www.solas-int.org/news/conferencemeetings/discsess.html>. During summer 2010, ESA will decide which of

the 4 topics will form a call (likely 2). The call will be open to both public and private institutions.

SOLAS communication and outreach

- SOLAS website: <http://www.solas-int.org/>
- COST Action 735 website: <http://www.cost-735.org/>
- The SOLASNews newsletter is emailed to ~1700 scientists and airmailed to ~200 scientists mainly from developing countries. The NL is also available from the website.
 - Issue 9 (July 2009), this issue focuses on SOLAS collaborations and overlaps with partner projects, including a section on Palaeo-SOLAS. This issue was for the 1st time printed and airmailed from China.
 - Issue 10 (Jan 2010) This issue mainly featured reports and articles from the Summer School 09 and the Open Science Conference 09.
- Public outreach was an important part of the OSC09 and was organised in collaboration with the CosmoCaixa Science Museum. There were three lectures followed by a question and discussion session, with translators available. The lectures took place on Tuesday 17 November from 17.30 to 21:00 and attracted ~200 participants, both locals and conference attendees. Stimulating talks were given by Rafel Simó (Institut de Ciències del Mar, Barcelona, Spain), Corinne Le Quéré (University of East Anglia, UK) and Jeremy Jackson (Scripps Institution of Oceanography, USA) on the subjects of the marine biosphere, CO₂ in the ocean and ecosystem extinction and evolution.
- A summary for policy makers on ocean fertilisation has been prepared for consideration of scientific advice at the London Convention under the auspices of IOC. The draft version has been reviewed positively and is now being completed (July 2010).

SOLAS Funding

This year 2009 was rather exceptional event-wise for SOLAS, the two major SOLAS events took place the same year, 3 months apart, this has inevitably an important impact on the SOLAS budget and staff time. As a consequence it has impacted commitments towards other activities. However, since January 2010, and for the next 1.5 years SOLAS will be able to contribute financially and help in moving forwards the development of its Mid-term Strategy.

Addendum to the SOLAS Report to SCOR: SOLAS National Networks

Version of 16 June 2010 by Dr Sophie Seeyave

A number of nations have SOLAS research programs or projects in the planning stages, but research is active in many countries. Reports of SOLAS activities for 2009 are available on the SOLAS website (<http://www.solas-int.org/aboutsolas/organisationandstructure/solasnetwork/nationalnetworks.html>). Some highlights are reported below.

Australia:

Southern ocean foraminifera are showing reduced calcification

New Australian research has shown that the shell weights of foraminifera in the modern ocean are significantly lighter (by 30-35%) than those in the sediments laid down throughout the Holocene. This may have implications for marine ecosystems and the drawdown of atmospheric carbon dioxide by the oceans. See Moy, A.D., et al. (2009), *Nat. Geosci.* 2: 276-280.

Renewed focus on aerosol and climate

Australia is adjacent to some major sources and sinks of aerosol, as well as being affected by biomass burning, wind-blown dust, anthropogenic aerosol and vegetation and soil interactions within the continent. A major review of current knowledge and future research priorities has been published recently (Rotstayn, L.D., et al. (2009), *Int. J. Climatol.* 29: 461-479).

New findings in Southern Ocean biogeochemistry

Australia kept a strong focus on the Southern Ocean in 2009. Ongoing programs include ocean-atmosphere carbon fluxes (program led by Bronte Tilbrook), carbon fluxes to the deep ocean (program led by Tom Trull), cycling of micronutrients (led by Ed Butler), ocean acidification, productivity and iron limitation.

Clean air research and monitoring

Volatile organic compounds (VOCs) are now being measured at the Cape Grim Baseline Air Pollution Station. This work has helped to raise the profile of VOCs in the clean marine boundary layer, and highlight the importance of the ocean as the source of a large suite of trace gases.

Equipment and information integration

As part of the new Integrated Marine Observation System (IMOS, <http://imos.org.au/about.html>), the Southern Ocean Time Series set of moored instruments will collect observations of ocean-atmosphere physical, chemical and biological properties in the Sub-Antarctic Zone.

New research vessel

The national science organisation CSIRO has announced \$120m in funding for a new marine research vessel to replace the *Southern Surveyor*.

Belgium:

The coupled river-coastal sea model RIVERSTRAHLER-MIRO-CO₂ (R-MIRO-CO₂) has been successfully applied in the Channel and Southern North Sea to assess the decadal changes of carbon cycling in the Belgian coastal zone over the period from 1951 to 1998 in response to the increase of atmospheric CO₂ and changing nutrient river loads (Gypens et al. 2009). The results highlight that changes in river nutrient delivery loads due to management regulation policies can modify carbon cycling in the coastal zone, and lead transiently to stronger changes in carbonate chemistry than ocean acidification.

B. Delille, J.-L. Tison, and B. Heinesch together with Belgian colleagues, and in collaboration with H. Eicken (University of Alaska Fairbanks) and T. Papakyriakou (University of Manitoba) carried out a 6-month survey (from January to June 2009) of air-sea ice CO₂ fluxes, sea ice physics and biogeochemistry in Barrow, Alaska. First results show in April some effluxes from the ice to the atmosphere despite low temperature at the ice-snow interface (-14°C). This is consistent with the CO₂ oversaturation of sea-ice brines observed at the site. The fluxes are triggered by wind speed over 7 m s⁻¹ suggesting that wind pumping through the snow is one of the main processes controlling the air-ice fluxes at that time.

The last year of the BELSPO BELCANTO-III (<http://www.co2.ulg.ac.be/belcanto/>) and PEACE (<http://www.co2.ulg.ac.be/peace/>) projects was used for the synthesis of data generated by the projects. Main results of these two projects were presented at the SOLAS Open Science Conference 2009.

A.V. Borges co-organized a workshop in January 2009 in Kiel regarding synthesis of CO₂/N₂O/CH₄ data in the coastal ocean (jointly organized as COST Action 735 WG3 and SOCAT activities), with 31 participants from the EU, USA, China, Taiwan, India and Chile.

Canada:**Natural iron supply stimulates dimethylsulfoniopropionate (DMSP) production in the NE Pacific**

Results from an oceanographic cruise conducted in the North East (NE) subarctic Pacific suggest that Fe supplied by mixing, either laterally or vertically, stimulates DMSP production through an increase in the abundance of DMSP-rich phytoplankton species. This stimulation may occur whether Fe is supplied artificially or naturally (see Royer et al., accepted for publication in *Limnol. Oceanogr.*).

Formation, distribution and global mapping of surfactant films on the ocean's surface

A long-term study of the enrichment of surface-active substances (SAS) in the sea-surface microlayer (SML) was conducted from June 2008 to November 2009. The data will be used to interpolate a threshold value for primary production and wind speed as indicators of the presence

3-108

of the SML. Global maps of primary production and wind speed can then be used to estimate the coverage of the ocean with microlayers. Preliminary results show that microlayers persist at wind speeds exceeding 6.6 m s^{-1} .

Arctic-SOLAS synthesis workshop (Quebec City, Oct. 2009)

Tackling themes such as surface ocean–climate interactions as well as atmosphere dynamics and climate feedbacks, workshop participants focused on the integration of two datasets encompassing both oceanographic and atmospheric measurements.

North Pacific fieldwork (June 2009)

Experiments were conducted to determine the impact on the North Pacific ecosystem and on climate of atmospheric dust deposition originating from Asian deserts. Preliminary results from this project were presented at the 2009 SOLAS Open Science Conference in Barcelona.

Canadian Arctic fieldwork (Aug.-Oct. 2009)

Two cruises took place in the Canadian Arctic Archipelago in 2009: ArcticNet-GEOTRACES and the Beaufort Gyre Exploration Project. The main goal of this study was to gain a better understanding of how sea ice influences the movement of CO_2 at the ocean-atmosphere interface in order to better predict how changing sea ice conditions will affect CO_2 distributions globally.

China:

The highly productive western East China Sea acts as a CO_2 source in autumn

Underway $p\text{CO}_2$ surveys showed that the western inner shelf of the highly productive East China Sea served as a moderate or significant sink of atmospheric CO_2 in winter, spring and summer, while it turned to a net source in autumn. This may be caused by low biological productivity in autumn or the collapse of summer stratification and recovery of bottom hypoxia in autumn.

Carbon cycling in China Seas - budget, controls and ocean acidification (CHOICE-C, <http://973oceancarbon.xmu.edu.cn>)

CHOICE-C is a SOLAS-endorsed project funded by the China National Basic Research “973” Program, from 2009 to 2013 (PI Prof. Minhan Dai of Xiamen University). CHOICE-C is an integrated study of carbon cycling, using field observations, remote sensing and numerical modelling, and focuses on the carbon budget, controls, ecological response and future changes in coastal ocean systems. The first cruise took place from July 18 to Sept. 1, 2009, involving 105 participants from 12 Chinese institutions. An international workshop was held on March 6-8 2009 in Xiamen, China.

Yellow Sea Large Marine Ecosystem : Assessing and Monitoring the Impacts of Climate Change on the Yellow Sea’s Ecosystem (2009)

This project was just funded with 97 K USD by UNDP/GEF. Prof. Ruixiang Li from the First Institute of Oceanography (FIO), SOA serves as PI of the project.

4th Joint Workshop on Asian Dust and Ocean Ecosystem (ADOES) with Asian-SOLAS, Jeju Island, Korea, 12-16 October 2009

The objective of this workshop was to improve understanding of the transport processes, especially the changes in physical and chemical properties of Asian dust particles during their transport from source regions to the ocean, and their impact on marine ecosystems.

Future projects:

- Biogeochemical Impacts of Asian Dust on the North Pacific Ecosystem and Climate (2010-2012), funded by the Ministry of Science and Technology; PIs Guipeng Yang from Ocean University of China and Maurice Levasseur from the University of Laval (Canada).
- Response of marine ecological system in the marginal seas and open ocean of the western North Pacific to climate change (2010.03-2013.02), funded by Strategic Japanese-Chinese Cooperative Program on “Climate Change”; PIs Huiwang Gao (Ocean University of China, China) and Uematsu Mitsuo (University of Tokyo, Japan).

Denmark:

Analysis of the data from the Danish Galathea 3 cruise (www.galathea3.dk), which took place from 2006-2007, is coming to an end and several papers are in preparation. The work is focused on sea spray fluxes and air-sea exchange of CO₂ and part of the data analysis is carried out in collaboration between The National Environmental Research Institute, Aarhus University and Uppsala University in a Ph.D. study. Spectral techniques are being used to estimate the air-sea fluxes measured at the cruise in order to validate air-sea flux parameterisations. This work will be further expanded to study air-sea flux in coastal Arctic regions.

A new Nordic project on air-sea CO₂ flux in the coastal area of Greenland has been granted by the Nordic Council of Ministers and the measurements will start spring 2010. Activities on air-sea CO₂ exchange in the coastal area of Greenland are planned for 2010. A measurement station will be established in the Godthaabs Fjord in spring 2010 as a collaboration between the National Environmental Research Institute, Aarhus University (contact person: Lise Lotte Soerensen; email: lils@dmu.dk), the Nature Institute in Greenland (Soeren Ryesgaard), Uppsala University (Anna Rutgersson) and University of Lund (Torben Kristensen). A second measurement station will be established within this project in 2011 at the coastal station Daneborg on the east coast of Greenland.

Germany:

SOPRAN Phase I (2007-2010) has now come to an end and Phase II has been funded for 2010-2013.

Research projects

* TransBrom: With a new transport model and hot-spot measurements in the Western tropical Pacific the WGL project TransBrom investigates the contribution of marine emissions of very short-lived bromine compounds on stratospheric bromine. PI Kirstin Krüger (IFM-GEOMAR, Kiel), <http://www.ifm-geomar.de/index.php?id=5390&L=1>.

* EU project SHIVA (Stratospheric ozone: Halogen Impacts in a Varying Atmosphere): SHIVA aims to reduce uncertainties in present and future stratospheric halogen loading and ozone

3-110

depletion resulting from climate feedbacks between emissions and transport of ozone-depleting substances (ODS). Of particular relevance will be studies of short and very short-lived substances (VSLS) with climate-sensitive natural emissions.

* MEMENTO: The MarinE MethanE and NiTrous Oxide database; A joint SOLAS/COST Action 735 Initiative, Contact: Hermann Bange (IFM-GEOMAR, Kiel), Tom Bell (UEA, Norwich, UK)

* HALOCAT: Halocarbons in the Ocean and Atmosphere database project. It brings together global oceanic and atmospheric data of mainly short-lived brominated and iodinated trace gases, Contact B. Quack (IFM-GEOMAR) and Tom Bell (UEA, Norwich, UK).

Workshop

* COST Action 735 WG3 Technical Workshop on Coastal CO₂, N₂O and CH₄ Data, Kiel, 22/23 January 2009, Co-chairs H. Bange (IFM-GEOMAR, Kiel), A. Borges (Univ. Liege), 30 participants from 13 countries. The workshop report can be downloaded from <http://www.cost-735.org/meetings/minutes/wg3jan09.pdf>.

Cruises

* *R/V Sonne* cruise TransBrom from Tomakomai (Japan) to Townsville (Australia), 9–24 Oct 2009, PI B. Quack (IFM-GEOMAR, Kiel).

* SOPRAN mesocosm CO₂ enrichment experiment in Kiel Bight, Baltic Sea, May-June, 2009. PI Ulf Riebesell (IFM-GEOMAR, Kiel)

India:

Integrated Campaign on Aerosols gases and Radiation Budget (ICARB)

This major campaign (2006-2009) involved 26 laboratories and involved concurrent measurements of optical and physical properties. The study helped in the first-ever precision mapping of aerosol radiative forcing over the Northern Indian Ocean and brought out contrasting radiative characteristics between the air masses over the Bay of Bengal and Arabian Sea. Several publications have resulted from the project^{1,2,3}.

Chemical characteristics of aerosols in MABL of Bay of Bengal

The study conducted by Physical Research Laboratory, Ahmedabad, revealed that anthropogenic SO₄²⁻ is a dominant constituent of aerosols and accounts for about 65 % of the total water-soluble species. Furthermore, large enrichment of heavy metals (Pb, Cd and Cu) in aerosols indicates long-range transport of pollutants. Relatively large chloride deficit in the aerosols is associated with smaller size particles and strongly correlated with SO₄²⁻, suggesting that sea salts are a potential sink for anthropogenic SO₂ over the Bay. These results have important implications for evaluating climate forcing by sulphate aerosols in the MABL.

Influence of extreme climatic events on physical and biogeochemical processes in the coastal Bay of Bengal

Time-series observations conducted by National Institute of Oceanography (2007-2009) revealed the injection of anthropogenic nutrients to the coastal Bay of Bengal as a result of an extreme rainfall event that caused a two-week phytoplankton bloom and a substantial decrease of oxygen

in the subsurface layer. The impact could be seen all along the east coast of India due to the equatorward flow of East India Coastal Currents (EICC) during winter. This study also suggests that, in contrast to the Arabian Sea, seasonal suboxic to hypoxic conditions are not favoured in the Bay of Bengal due to frequent formation of eddies.

¹Moorthy KK et al. (2009). Q. J. R. Meteorolog. Soc., doi:10.1002/qj.525.

²Satheesh SK et al. (2009). J. Geophys. Res. 114, D05204.

³Nair VS et al. (2009). J. Atmos. Sci. 66: 2640-2658.

Ireland:

* Gogasmos Cruise: In collaboration with the LOCEAN laboratory in Paris, the Air-Sea Interaction Profiler (ASIP) was deployed in the Bay of Biscay on the *R/V Antea* over 20 days during May [Brian Ward (NUIG) and Adrian Callaghan (NUIG)].

* Gogasmos workshop: a 1-day workshop was held in Paris to discuss the results from Gogasmos, which will be presented at the AGU Ocean Sciences 2010 [Brian Ward (NUIG) and Adrian Callaghan (NUIG)].

* SOLAS-Ireland 5th annual workshop held at NUIG in December, attended by about 20 Irish researchers as well as 1 UK presentation.

* Eddy covariance flux measurements on the *R/V Celtic Explorer*

* Iodine monitoring at Mace Head: a field campaign on the detection of molecular iodine I₂, and the halogen radicals IO, BrO and OIO was organized for the 3rd and 4th week of August 2009. Two IBBCEA instruments were set up near the shoreline at Mace Head Research Station, Co. Galway, at the location where previous field measurements by other teams were performed over the summer using other techniques [Andy Ruth (UCC), Sophie Dixneuf (UCC), and Dean Venables (UCC)].

* ACCENT Final Event, European Commission, Brussels, Invited presentation on “Aerosol Production from Natural Systems”.

* Mace Head project on new particle formation by iodine oxides and secondary organic aerosol
Mace Head project on primary organic aerosol characterization from various plankton species in controlled bubble-mediated tank experiments.

* Mace Head ICOS campaign on quantification of marine boundary layer structure through remote sensing.

* Using an updated version of the O’Dowd et al. (2008) combined organic-inorganic sea-spray source function, the global budget of primary organic marine aerosol was quantified. The global budget for submicron aerosol was found to be 8.2 Tg yr⁻¹ while the supermicron budget was

found to be 4.5 Tg yr^{-1} . This amounts to approximately 25% of the global anthropogenic budget. Results are from the EU-funded SOLAS-related project MAP (coordinated by Colin O'Dowd).

Japan:

- *Mirai* (MR09-01), South Pacific: Trans-oceanic measurement of aerosols with ATOFMS was performed by ORI-UT.
- *R.V. Tansei Maru* (KT-09-04), Western Pacific: VOC and DMS in air and surface water were continuously measured during the spring bloom season by multiple organizations of W-PASS.
- *R.V. Tansei Maru* (KT-09-20), Western Pacific: N_2 fixation and diazotrophic organisms were measured around Ryukyu Islands by UT.
- *R.V. Hakuho Maru* (KH-09-04), Bering Sea and subarctic Pacific: Dissolved Iron concentration was continuously measured with biological mapping by HU and UT.
- *R.V. Hakuho Maru* (KH-09-06), Indian Ocean: Trace metals and VOC were measured by W-PASS member with GEOTRACES group.
- Time series observations in subarctic and subtropical western North Pacific has started by JAMSTEC with *R.V. Mirai* (PI: T. Saino).
- UT-ORI symposium on “Data synthesis symposium on *Hakuho Maru* cruise KH-08-02”. Tokyo, 12-13 Dec. 2009. The symposium was convened by M. Uematsu, H. Ogawa and A. Tsuda. KH-08-02 cruise was mainly organized by Japanese SOLAS members and progress in analysis and future corroboration was discussed. Over 50 scientists attended the symposium.
- UT-ORI symposium on “Future direction of oceanography in western Pacific”. Tokyo, 19-20 Dec. 2009. The symposium was convened by H. Saito and H. Ogawa. This symposium summarized the accomplishments of Japanese SOLAS and IMBER activities and the future directions. Over 80 scientists attended the symposium.

Korea:

Enhanced DMS production due to grazing activity in a greenhouse world

Results from a mesocosm experiment conducted in Dec. 2008 investigating the effects of high CO_2 and temperature on DMS production were analysed during 2009 and manuscripts are in preparation. During the experimental period, in all treated enclosures (high CO_2 and high CO_2 /high temperature), the population of microzooplankton increased considerably relative to that in controlled enclosures. Grazing activity was also enhanced in the treated enclosures. Consequently, the production of DMS (high pCO_2 and high pCO_2 /high temperature) was substantially higher in the treated enclosures than in the controlled enclosures. The study indicates that grazing-induced DMS production can be enhanced in the future greenhouse world.

Temporal trends in oceanic uptake of anthropogenic CO_2 in the East/Japan Sea

The East/Japan Sea in the western temperate North Pacific is ventilated from the surface to the bottom over decades. This short overturning circulation indicates that the anthropogenic CO_2 content of the East/Japan Sea is intimately tied to changing surface conditions over similarly short periods. As a consequence of the changing nature of the East/Japan Sea, this basin is an

excellent site for investigating temporal trends in oceanic uptake of anthropogenic CO₂ in response to regional or global climatic change. As part of the East Asian Seas Time-series-1 project (funded by the Ministry of Land, Transport and Maritime Affairs of Korea), data were collected on the Russian *R/V Akademik M.A. Lavrentyev* from 9–18 July 2009. A team of 33 scientists from six institutes (POI, SNU, POSTECH, PNU, CNU, KDU) participated in this cruise. At 38 hydrographic stations salinity, temperature, oxygen and nutrient concentrations were measured, and concentrations of total dissolved inorganic carbon and total alkalinity were determined at 27 of these stations. Total inorganic carbon and total alkalinity were measured using coulometric titration and potentiometric acid titration in a VINDTA system.

Netherlands:

Continuous measurements of atmospheric oxygen and carbon dioxide on a North Sea gas platform

A new atmospheric measurement station has been established on the North Sea oil and gas production platform F3, 200 km north off the Dutch coast (54°51'N, 4°44'E). This station is the first fixed sea-based station with on-site continuous O₂ and CO₂ measurements and therefore yields valuable information about the CO₂ uptake in coastal marine regions, specifically the North Sea.

In comparison to land-based stations, the data show low day-to-day variability, as they are practically free of nightly inversions as well as human influences, due to the station's remoteness. Therefore, the data set collected at this measurement station serves directly as background atmospheric data for the coastal northwest European region. The first data show the seasonal cycle as expected during August 2008 through June 2009.

Quantification of the deposition of nitrogen and sulphur compounds to the oceans with the global atmospheric chemistry transport model TM for the years 2000, 2025 and 2050.

The model shows that projected growth in ship emissions until 2050 leads to increased acid deposition to the oceans, in particular near the east coasts of the USA and Asia and the west coast of Europe.

As a side-product of QUANTIFY, a project investigating the climate impact of aviation, shipping and road traffic, KNMI has produced global maps of dry and wet deposition of atmospheric nitrogen and sulphur compounds in 2000, 2025 and 2050. A large contribution to acid deposition to the oceans is due to international ship emissions, and this contribution is projected to continue to grow at a considerable rate.

First method to measure in-vivo DMSP biosynthesis and loss rates using stable-isotope incorporation and proton-transfer-reaction mass spectrometry (PTR-MS)

Understanding and quantifying the physiological regulation of DMSP, precursor of the climate-active gas DMS, is fundamental to accurately model the marine sulfur cycle. There is controversy around the up- and down-regulation of DMSP because current gas chromatographic methods are unable to measure fluxes of DMSP. A simple model was developed that uses data from the incorporation of stable isotopes into DMSP and particulate DMSP concentration measurements to resolve both specific DMSP production and loss rates. Incorporation of deuterium or ¹³C into DMSP can be monitored using a highly sensitive PTR-MS. The change in

3-114

ratio of labeled versus non-labeled DMSP in time is a measure of the *de novo* DMSP production. This Mass Ratio Progress (MRP) method provides us, for the first time, with the opportunity to directly investigate the physiological response of phytoplankton to environmental stress factors, such as salinity changes, grazing, light and nutrient stress.

New Zealand:

Database of open ocean iron fertilisation experiments

A database comprising 11 of the mesoscale open ocean iron fertilisation experiments (including SOLAS experiments such as SAGE and SERIES) has been compiled via the SCOR WG 131. This database was launched at a workshop just prior to the Ocean Science meeting in Portland. This relational database resides at BCO-DMO and will enable inter-comparisons of data between experiments conducted in the HNLC waters of the Southern Ocean, Equatorial and Subarctic Pacific. We hope that this will stimulate exciting and novel opportunities for data synthesis and modeling, from 1-dimensional biological models through to complex 3-dimensional ocean biogeochemical models.

Special Issue of *Deep-Sea Research II*

Eleven papers on the NZ SOLAS SAGE Iron fertilisation experiment will appear in a

Legislation on ocean fertilisation

New Zealand SOLAS scientists have been involved in the development of legislation on Ocean Fertilisation at national and also international level via the IOC/London Convention.

Norway:

A 65-day cruise in the Nordic Seas, May 28 – Jul 17/2009

Three Norwegian institutions in Bergen (Geophysical Institute, Institute of Marine Research, and Bjerknes Centre for Climate Research) joined forces to undertake a 65-day long scientific survey. The main objective was to study climate and environmental changes in ocean circulation, carbon uptake, biology and ocean acidification. In addition “on-deck mesocosm” studies were conducted to study the effect of ocean acidification on bacteria communities.

The following specific goals were achieved:

- Measurements of ocean physics, chemistry and biology (biogeochemistry) in the Nordic Seas, including onboard mesocosm studies.
- Direct measurements of the CO₂ flux were made using the Eddy correlation method in collaboration with Dr. Wade McGillis at Lamont-Doherty Earth Observatory, USA.
- The physical and chemical data obtained is to be used to close the budgets in the region on energy and carbon transports, uptake and air–sea exchange.
- Biology, plankton trawls studying, phytoplankton (algae/chlorophyll) and zooplankton abundance. Additional project work involving trawling for krill and macrozooplankton as well as using a towed underwater vehicle to collect data on acoustics (38, 200 and 333kHz), zooplankton and phytoplankton using a variety of instrumentation.

- Foraminifera was sampled for stable isotope analyses and water samples were collected to measure the $[\text{CO}_3^{2-}]$ concentration in the water column. Onboard mesocosm studies were conducted during Legs 1 and 2 to study bacteria communities response to future ocean acidification.

Training Workshop on The Fundamentals of carbon biogeochemistry, 24th to 26th February 2009

The Bjerknes Centre for Climate Research, University of Bergen, Norway hosted the workshop which was funded by the EU FP7 Integrated Project EPOCA. The workshop was open to students and researchers involved in ocean acidification research. The main focus was on the fundamentals of the marine carbon dioxide system. The participants were introduced to the IOCCP-sponsored “*Guide of Best Practices for Oceanic CO₂ Measurement and Data Reporting*” (2007) and were provided a comprehensive insight into:

- The marine carbon cycle
- pH scales and dissociation constants
- Instrumentation for measurement of the marine CO₂ system
- Ecosystem carbon biogeochemistry
- Education and outreach

A 55-min movie about the CARBOOCEAN project

This documentary video was the result of an initiative taken by the office of the EU project CarboOcean at the University of Bergen, Norway. Through interviews with scientists, including the current SOLAS SSC chair Doug Wallace, the film links climate change and the marine carbon cycle. It also shows the challenges involved in the realization of the type of science described in the SOLAS science plan. The movie can be viewed at:

<http://www.carboocean.org/upload/flowplayer/carboocean/index.html>.

Southern Africa:

International Conference on Planetary Boundary layers host SOLAS Session

The International Conference on Planetary Layers and Climate Change was held at the Kirstenbosch Botanical Gardens in Cape Town from the 26-28 October 2009. The choice of the forum location was motivated by the role of tropical oceans and convection in the climate system, and the prominent demonstration of the climate sensitivity to the ocean heat uptake observed off Cape Town. With a view of highlighting this important role of the ocean, the meeting incorporated a plenary SOLAS session showcasing southern African SOLAS science. The meeting was attended by a small, but eminent, audience including specialists in atmospheric dynamics from the Ukraine, Norway, Russia and the USA along with local scientists. One of the primary aims of the meeting was to advertise the activities of the southern African SOLAS network to the scientists from overseas. The second and potentially more important aim was to inform the South African atmospheric community about the SA-SOLAS initiative; a process that was started at the recent South African symposium on Atmospheric Sciences

3-116

(SASAS), held in Cape Town in September. This is particularly important in Southern Africa, as the SOLAS initiative currently has an ocean science bias. To achieve this, the current activities of the SA-SOLAS and the international project overview were highlighted in a talk given by Carl Palmer. This was followed by highlights of local science, including recent work from Mathieu Rouault (UCT) entitled “Boundary Layer modification across the Agulhas Current” and Brett Kuyper (UCT/South African Weather Services) on “Time series data for bromoform in the Cape Town marine boundary layer”. In the discussions after the session the foundation for a new SA-SOLAS newsletter were drawn up and the names of various atmospheric scientists added to the SA SOLAS distribution list.

Main Cruises

Antarctica	23 Dec. 08 - 3 Mar 09	<i>M/V S.A. Agulhas</i>
Marion	4 Apr. - 20 May	<i>M/V S.A. Agulhas</i>
Gough Island	3 Sept. - 10 Aug.	<i>M/V S.A. Agulhas</i>
Antarctica	9 Dec. 2009 - 10 Mar. 2010	<i>M/V S A Agulhas</i>
St Helena	Monthly	<i>M/V Algoa / M/V Africana</i>

Spain:

- SOLAS Open Science Conference, Barcelona, 16-19 November 2009
- Isabel Cacho (UBarcelona) and Rafel Simó (CSIC) acted as local organisers. Over 250 scientists from 6 continents attended the conference. A public lecture event was organised in collaboration with CosmoCaixa.
- The ATOS Project (part of IPY-Spain activities) team finished its activities in February 2009 with the second ATOS cruise to Antarctic waters (the first took them to the Arctic in 2007). Senior researchers involved were C.M. Duarte (project leader), J. Dachs (cruise chief scientist), M. Alcaraz, D. Planas, S. Agustí, A. Tovar, D. Vaqué, D. Gomis, M. Sala, E. Saiz, A. Calbet, J.M. Arrieta, S. Lacorte, R. Tauler, and R. Simó. The team successfully completed their objectives of sampling seawater, krill, iceberg ice, glacier ice, and aerosols. Currently, ongoing analyses and data processing should provide insight on the role of ice melting in seawater biology and biogeochemistry, and the impacts of deposited atmospheric nutrients, metals and organic pollutants on the planktonic food web.
- P. Serret (U Vigo) participated in the research cruise ICON of the SOLAS-UK (15 April - 27 May 2009) with funding from the Spanish Ministry of Science and Innovation. The objective of this participation was the measurement of bacterial and plankton community respiration, and net community production.
- Extensive field studies aimed at assessing ocean carbon fluxes (SOLAS Focus 3) are being conducted by ICMAN-CSIC (Cadiz) in the South-western Iberian Peninsula, including the Gulf of Cadiz, Strait of Gibraltar and Alboran Sea areas. Research has been funded by the EU through the Integrated Projects CARBOOCEAN (FP6-511176GOCE) and SESAME (GOCE2006-036949) (6th FP) and by the Spanish MICINN grants CTM2008-05680-C02/MAR and CTM2009-05835-E/MAR.

- The IIM-CSIC group (Vigo) has measured air-sea CO₂ fluxes during the CAIBEX project led by Eric Desmond Barton (IIM-CSIC) and also within the FAMOSO project led by Mikel Latasa (IEO Gijón). The main objectives of these projects are the study of shelf-ocean exchanges in the Canarias – Iberian Large Marine Ecosystem and the fate of the northwestern Mediterranean open sea spring bloom, respectively. Both projects have been funded from the Spanish Ministry of Science and Innovation.
- The ICMAN-CSIC (Cadiz) and IIM-CSIC (Vigo) groups have contributed to provide CO₂ data to CDIAC for time-series and moorings and SOCAT databases.
- The ICMAN-CSIC group (Cadiz) has generated a data set representing the most complete oceanographic information available for the whole south Atlantic Iberian coast and one of the largest in the temperate Atlantic in terms of both spatial coverage and sampling frequency. The oceanographic and meteorological data can be checked in Prieto et al. (2009).

Taiwan:

Long-term Observation and Research of the East China Sea (LORECS)

The LORECS project, initiated in 2000, aims at understanding biogeochemical cycles in the East China Sea with a special focus on the dust-induced phytoplankton blooms in spring. LORECS has begun to study the effect of Asian Dust Storm (ADS) on upper ocean biogeochemistry in the nutrient-limited northwest Pacific Ocean between 2005 and 2008. A station (123.15 °E, 25.10 °N water depth=1690m) approximately 160 km northeast of Taiwan was taken as the study site. Intensive field observations were conducted during the prevailing ADS period (from late winter to early spring). Phytoplankton chlorophyll, primary production and export flux of particulate organic carbon were found about two to three times higher than the values in non-ADS period. The predominant group of picophytoplankton was changed from *Prochlorococcus* to *Synechococcus* during an ADS event. Vigorous growth of *Synechococcus* from 1.4×10^4 to 1.0×10^5 cells ml⁻¹ was also observed. Most of these newly appeared *Synechococcus* belonged to clade II based on the phylogenetic analysis of 16S rRNA. In addition, mRNA levels of iron, nitrogen and phosphorus deficiency indicator levels decreased from prominent values to non-detectable levels.

South-East Asia Time-series Study (SEATS)

The SEATS project was initiated in 1998 with a global perspective of documenting the crucial marine biogeochemical processes that may occur in intra-annual to decadal time-scale as through direct observations.

Atmospheric Forcing on Ocean Biogeochemistry (AFOBi)

The new initiative, AFOBi, is focused on how the exchanges of momentum, energy and matter across the air-sea interface may affect the biogeochemistry of the oceans.

Turkey:

Although the Turkish SOLAS network is very recent, the Institute of Marine Sciences (IMS) of Middle East Technical University (METU) and the Euroasia Institute of Earth Sciences of

3-118

Istanbul Technical University (ITU) have already initiated many SOLAS-related EU and national projects.

Aerosol samples were collected in 2009 in the Mediterranean, Aegean Sea, Sea of Marmara and Black Sea, as part of FP6 SESAME (Southern European Seas: Assessing and Modelling Ecosystem change) project. IMS-METU also has an atmospheric sample collection tower situated off the Turkish Mediterranean coast. Aerosol and rain samples have been collected on the tower in order to perform nutrient (nitrate, ammonium, phosphate, silicate) analyses since 1999. Within the scope of the FP7 CityZen project, current air pollution distribution in and around certain megacities/hot spot regions are quantified and the future impact from emission changes will be estimated. IMS-METU carries out observational studies on the chemical and optical aerosol characteristics of the boundary layer. Modelling studies carried out by IMS-METU focus on the effect of atmospheric CO₂ on O₂ sensitive cycles of P and N in ocean basins of decreased O₂. Additionally, aerosol dust transport models are used to investigate the influence of atmospheric nutrient inputs on marine nutrient cycles and production in the Mediterranean and Black Sea basins.

The climatic effects of urbanization in Istanbul have been investigated using statistical and numerical modeling tools. Both methods indicated significant warming in the atmosphere over the city. The model results have exhibited a significant expansion of the urban heat island in Istanbul from 1951 to 2004, fairly consistent with the expansion of the city in this period.

United Kingdom:

ICON: The impact of coastal upwelling on the air-sea exchange of climatically important gases

The *RRS Discovery* hosted an impressive international and interdisciplinary team of scientists during the final cruise of the UK SOLAS programme off north-west Africa in April-May 2009. The ICON cruise, led by Carol Robinson (UEA), investigated the influence of coastal/shelf regions on the air-sea exchange of climatically important biogenic gases (CH₄, N₂O, CO₂, DMS/DMSP). Along the Mauritanian shelf, upwelling can result in high concentrations of these gases – with their air-sea fluxes strongly influenced by spatial and temporal variability in plankton community structure and productivity (stimulated by the high nutrient content of the upwelled water) and light-driven breakdown of both upwelled and recently produced dissolved organic matter. All these processes were studied on *Discovery 338*. Successful tracking of upwelled filaments as they moved offshore (real time SF₆ tracer tracking and surface drifters) allowed large-scale lagrangian studies to be performed, whilst also monitoring filament evolution (nutrients and physical ocean properties). Interestingly, peak chlorophyll concentrations were found not in filament centres but at their edges, where they met older waters containing lower nutrient levels.

HiWASE (High Wind Air-Sea Exchanges study, on *MS Polarfront*)

This 3-year time series of the turbulent air-sea fluxes of sensible and latent heat, momentum and CO₂ ended in Dec. 2009. The value of this work will be increased as further NERC funding has

been awarded for follow-on deployment of the instruments on *RRS James Clark Ross*, although no longer part of the UK SOLAS programme.

Ironmap

A climatology for the Atlantic Ocean developed for the Ironmap project (wet and dry deposition of soluble and total Fe) was successfully applied to nitrogen data collected over the last decade to create a nitrogen climatology (*under revision to Global Biogeochemical Cycles*). Ironmap also facilitated collaboration and knowledge exchange with the UK Met Office providing access to an aerosol database built up over ~10 years