Annex 7 – Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) Project

Integrated Marine Biogeochemistry and Ecosystem Research

IMBER Annual Report to SCOR June 2007

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Major Activities and Achievements:

Working groups
Five working groups or task teams have been formed and are active in the development and implementation of IMBER.

1. End-to-End food web Task Team
The End-to-End Food Web Task Team, a joint activity with GLOBEC, is co-chaired by Coleen Moloney (South Africa) and Mike St John (Germany). The group has submitted a review paper to *Trends in Ecology & Evolution* focused on the concept for end-to-end food web research. The Task Team is also preparing a longer paper for publication. A workshop to focusing on end-to-end food webs is planned as part of the IMBER IMBIZO[10] to be held in late 2008.

2. IMBER/SOLAS Carbon Working Group
IMBER and SOLAS have established a joint carbon implementation group. The group is co-chaired by Truls Johannessen (Norway) and Arne Koertzinger (Germany), and works closely with the International Ocean Carbon Coordination Panel (IOCCP). Three sub-groups have been formed to move forward the implementation of carbon research in the two projects. A Joint SOLAS/IMBER Carbon Research implementation plan has been published electronically (February 2006) (http://www.imber.info/products/Carbon Plan final.pdf) and will be published in hard copy in 2007.

Sub-Group 1 Surface ocean CO_2 fluxes (Chair: Nicolas Metzl, France)
This group is focused on synthesis, instrumentation and technology development, observations from Volunteer Observing Ships and mixed-layer sampling strategy. The first major activity of this group was to organize (with IOCCP) an Ocean Surface pCO_2 Variability and Vulnerabilities Workshop (UNESCO, Paris, 11-14 April 2007). The Co-chairs of the organizing committee are Nicolas Metzl and Bronte Tillbrook (http://www.ioc.unesco.org/ioccp/pCO2_2007.html). A special issue of *Deep-Sea Research II* is currently being prepared to disseminate information from this workshop.

[10] *Imbizo* is the Zulu word for a gathering of leaders where an important issue is resolved.

Sub-Group 2 Interior ocean carbon storage (Chair: Nicolas Gruber, Switzerland)
This group covers inventory and observations, natural variability, transformation, designing a strategy for leverage for the ARGO program, and interaction with modelling. They have developed the initiative "Friends of Oxygen on ARGO" (FOA) and prepared a white paper that recommends the incorporation of oxygen sensors to Argo floats, which has been presented to the ARGO SSC. This group is also planning a series of basin synthesis activities. The first synthesis will be for the North Atlantic Ocean and will be conducted in collaboration with CARBOOCEAN.

Sub-Group 3 Carbon cycle climate sensitivities and feedbacks (Chair: Kitack Lee, Korea)
This group focuses on the response of ecosystems and biogeochemical cycles to natural and anthropogenic changes, feedbacks to the Earth System, and future perspective (prediction). The group is starting to move forward with a co-ordinating activity for ocean acidification research.

3. Continental Margins Task Team

LOICZ and IMBER have formed a joint IMBER/LOICZ Continental Margins Task Team. The task team consists of 10 members and is co-chaired by Jack Middelburg (The Netherlands) and Nancy Rabalais (USA). The group is organizing a Continental Margins Open Science that will be held at the East China Normal University in Shanghaï on 17-21 September 2007 (https://www.confmanager.com/main.cfm?cid=792). The aims of the Conference are to estimate the relative importance of the changing forcing factors (global, local, and human) and to determine how much changes in shelf ecosystems can be attributed to each forcing factor. Based on the outcome of this conference, the task team will write a Science Plan and Implementation Strategy for continental margins research in the two projects. There is significant interest in the conference, with more than 150 registrations and 100 papers submitted so far.

4. Capacity Building Task Team

The Capacity Building Task Team (chaired by Wajih Naqvi. India) developed a capacity-building strategy and implementation plan for IMBER to guide capacity building activities (http://www.imber.info/products/Capacity_Building_final.pdf). One objective of the strategy is to enhance research capabilities in developing countries, especially those geographically close to interesting biogeochemical/ecosystem provinces. Another objective is to enhance research capabilities globally in those IMBER activities that have few practitioners, but are crucial for optimal implementation of the *IMBER Science Plan and Implementation Strategy*.

5. Data Management Task Team

The IMBER Data Management Committee (DMC) was formed in September 2006 and is chaired by Raymond Pollard (NOC, UK). The SSC also appointed the IMBER Deputy Executive Officer, Dr. Sophie Beauvais, as the IMBER Data Liaison Officer, to support the DMC and data management activities for IMBER. The Chair and DLO met with representatives from the British Oceanographic Data Centre (BODC) to discuss possibilities for the development of a realistic strategy for IMBER data management. The Chair and DLO also participated in the SCOR Marine Projects Coordination meeting held in London (December 2006) to discuss data management issues faced by all marine projects. The Data Management Committee met in Victoria, Canada in June and has developed an innovative strategy for data management within IMBER.

Human Dimension

IMBER is exploring a collaborative approach with other IGBP core projects to bring together natural and social science communities to develop the issues and questions for Theme 4 in the IMBER SP/IS. Julie Hall met with the Chair of IHDP (Oran Young), who encouraged IMBER to build on the activities of GLOBEC and LOICZ, rather than start a new activity. There is a session at the Continental Margins OCS on human interactions with continental margin systems, and IMBER will be involved in a GLOBEC Focus 4 (Human Impacts) Workshop in July 2008.

Regional Projects

Integrating Climate and Ecosystems Dynamics (ICED)
ICED is a new international multidisciplinary initiative launched in response to the increasing need to develop integrated circumpolar analyses of Southern Ocean climate and ecosystem dynamics. ICED has been developed in conjunction with GLOBEC and EUR-OCEANS. ICED held its first scientific session during the second SCAR Open Science Conference (OSC) in July 2006 in Hobart, Australia. The theme of the OSC was "Antarctica in the Earth System", making this an ideal setting for the first ICED scientific session. Stimulating discussion sessions developed new ideas and potential multidisciplinary collaborations were discussed. ICED submitted a proposal to the International Polar Year (ICED-IPY) committee, which was endorsed and will link and coordinate 10 closely related projects within a consortium entitled "Ecosystems and Biogeochemistry of the Southern Ocean." The ICED team recently completed a Science Plan and Implementation Strategy, which will be reviewed jointly by IMBER and GLOBEC. Information about ICED can be found on their new website: http://www.antarctica.ac.uk/Resources/BSD/ICED/.

Sustained Indian Ocean Biogeochemical and Ecological Research (SIBER) Conference
October 3-6, 2006, Goa (India).
This event, hosted by India's National Institute of Oceanography (NIO), included 4 days of presentations, posters and working group discussions, with participation of more than 200 scientists from all over the world. The participants attended working group discussions organized around seven different themes. The presentations and working groups identified numerous gaps in our knowledge and defined several major scientific questions, including the need for carrying out basin-wide research on the potential role of mesozooplankton grazing in limiting phytoplankton production during the Southwest Monsoon, and relative importance of denitrification and the anaerobic ammonium oxidation (anammox) in the production of N_2. The SIBER workshop provided crucial information that will allow the development of a summary of the state of understanding the Indian Ocean and the definition of the major research questions that need to be addressed. The major outcomes of the workshop include a special journal issue and the development of a science plan to guide future research in the Indian Ocean basin and providing the basis for a major regional research program of IMBER. A workshop to develop a Science Plan for SIBER is being organised in late November in Goa, India.

Endorsed Projects

The marine carbon cycle from North to South along the Galathea route
Leading applicant: Katherine Richardson (funding: August 2006-April 2007)
In August 2006, a Danish research vessel embarked on a global 9-month research cruise: The Galathea Expedition. The cruise track can be seen at http://www.galathea3.dk. The largest project on the expedition, "The marine carbon cycle from North to South along the Galathea route", is a multidisciplinary effort focusing on obtaining a better understanding of the carbon cycle in the upper ocean and in the lower atmospheric boundary layer, and the role of the ocean in climate change. This IMBER-endorsed project is compiling a global dataset describing the upper ocean processes controlling ocean-atmosphere carbon exchange, which will increase our understanding of how physical, chemical and biological processes in the sea influence the carbon dioxide (CO_2) content of the atmosphere.

Key Processes and Sustainable Mechanisms of Ecosystem Food Production in the Coastal Ocean of China
Leading applicant: Prof. Qisheng Tang, (funding: 2006-2010)
Following the kick-off meeting at Qingdao on January 24-26, 2006, the new national "973" project "Key Processes and Sustainable Mechanisms of Ecosystem Food Production in the Coastal Ocean of China" (2006-2010) started the implementation phase. In the first half of 2006, a series of meetings were organized in Qingdao and Hangzhou, during which the design for the cruises, field observation in the areas of marine culture, and international cooperation have been discussed and planned. The research cruises will focus on ecosystem function and diversity in the Yellow Sea, including the spring bloom and food-web dynamics. In the East China Sea research will focus on the biogeochemical cycles and its impact on the ecosystem, including the processes that drive shelf-break material

exchanges and hypoxia off the Yangtze River Estuary, taking into account the impact on the food web from end to end.

Integration Analysis of North Adriatic Marine Ecosystem (ECOMADR)
Leading applicant: Cosimo Solidoro (funding: 2006-2007, 20 months)
This project aims to identify key components of the trophic web of marine ecosystem in the northern Adriatic Sea, and to provide a first assessment of energy fluxes among such compartments. The dynamics of the lower levels of the food web (including microbial activity) have been extensively studied, so particular attention is devoted to explore the ecological role of small pelagic fishes (anchovies and sardines) and mussels, with analysis which include the determination of the daily food ratio in different seasons of the year and the development of bioenergetics models. However the research also includes a biogeochemical characterization of water column and upper sediment, the identification of abundance and composition of plankton communities, the determination of primary production, respiration, bacterial activity, and the analysis of space and time variability of major water quality parameters.

Biogeochemistry and Optics South Pacific Experiment (BIOSOPE)
Leading applicant: Hervé Claustre (funding: 2002-2006)
In 2006, the BIOSOPE group was involved in the analysis and quantification of the numerous hydrological, biological, biogeochemical and bio-optical data that were collected in the southeast Pacific Ocean in late 2004. At the scale of the 8000 km transect, from the Marquesas Islands to the upwelling conditions prevailing along the Chilean coast, a large gradient of hydrodynamic and associated trophic conditions was sampled. Along this gradient, a comprehensive understanding is now emerging about the particle and dissolved stock distributions, the structure of the planktonic ecosystem, its interaction with the cycle of elements (C, N, P, Si) and finally for the optical status of the waters. In particular, the extreme oligotrophic character of the South Pacific gyre waters, in the vicinity of Easter Island, is confirmed and described in great detail. Preliminary results have been presented in various meetings (ASLO, June 2005, Santiago de Compostela; AGU-ASLO-TOS, February 2006, Hawaii; Ocean Optics XVIII, October 2006, Montreal). Submissions to a BIOSOPE special issue in the journal *Biogeosciences* started in early January and papers are also appearing in other journals. The database will be publicly accessible by September 2007. (Contact claustre@obs-vlfr.fr) http://www.obs-vlfr.fr/proof/vt/op/ec/biosope/bio.htm

Kerguelen Ocean and Plateau compared Study (KEOPS)
Leading applicant: Stéphane Blain (funding: 2002-2007)
The general objective of KEOPS is to improve our understanding of the response of the Southern Ocean to global climate change. Particularly, KEOPS will study the effects of natural iron fertilisation of the ocean by the Kerguelen plateau on the biological pump of CO_2 and on the cycles of other chemical compounds relevant for climate. Careful examination of the large data set gathered during the natural iron fertilisation experiment (cruise in January-February 2005) has revealed original features. KEOPS results contrast with the observations made in short-term blooms triggered by deliberated iron fertilisation experiments. This is the case for the ecosystem structure, for the magnitude of the carbon export in response to the iron fertilisation, for the DMS production and for the decoupling between the nitrogen and the silicon cycles. Preliminary results have been presented as part of a special session at the Ocean Science meeting (Hawaii Feb 2006) and detailed papers are in the review process for publication as a special issue of *Deep-Sea Research II*. The data set will also fuel different coupled models aiming to describe and to understand the spatial and temporal variability of the natural bloom sustained by natural iron and major nutrient fertilisation. (Contact stephane.blain@univmed.fr). http://www.obs-vlfr.fr/proof/vt/op/ec/keops/keo.html

Outreach activities

IMBER website
The IPO developed a new IMBER website, which was made publicly available in March 2006 (www.imber.info). The website is a major communication tool for IMBER. Between July and December, the website was visited roughly 3600 times with an average of 7 visitors per day and 4 pages per visitors. The most visited pages are Newsletters, Working Groups, and Jobs. Visitors were primarily from USA, UK, Germany, Spain, Japan, Taiwan, Italy, Canada, and India. Two new pages were added recently:

1. The "**Science Highlight**" page is dedicated to IMBER research, ongoing projects, scientific news, etc… (http://www.imber.info/Science_Highlight.html);
2. The "**Young Scientists**" page includes information regarding Early Career Scientist Conferences, Student Courses, Summer Schools and Opportunities for developing country young scientists and students (http://www.imber.info/Education_and_Training.html).

IMBER update
Five issues of the electronic newsletter *"IMBER update"* have been published. The newsletter includes IMBER science highlights, reports from the activities of the IMBER working groups, summaries from IMBER-endorsed and contributing projects, reports from regional and national programmes, and a list of the upcoming IMBER-related conferences and workshops. All issues are downloadable from the IMBER website; http://www.imber.info/newsletters.html.

Brochure and Poster
An IMBER brochure and a poster are now available as a communication tool to promote the IMBER program. They introduce the global scientific context of IMBER and present the four themes of the program with a special focus on the major questions of Theme 2, which is the heart of IMBER. Information regarding how to get involved and how to contact the International Project Office (IPO) are also included. Both the brochure and poster can be downloadedfrom the IMBER website (www.IMBER.info/useful-downloads.html) and available on request at the IPO.

e-News
The IMBER e-news is sent to the IMBER email list monthly. This publication includes a list of upcoming IMBER activities, funding calls, job opportunities, conferences and workshops.

IPO report
In April this year, the IPO initiated an IPO activity report, which is a monthly report sent to SSC members to keep them up to date with IMBER activities.

International Project Office
The IPO is located in Brest at the Institut Universitaire Européen de la Mer. It is funded by Centre National de la Recherche Scientifique (CNRS), Institut de Recherche pour le Développement (IRD), Université de Bretagne Occidentale (UBO) and the Brittany Region. The office is fully staffed. Sylvie Roy was appointed Executive Officer in August 2005, Elena Fily started as administrative assistant in September 2005, Sophie Beauvais was appointed as the deputy executive officer in October 2005.

IPO Funding
IMBER's activities and international office are sponsored by:

- IGBP: support for SSC meeting (20K USD);
- SCOR: support from NSF (50K USD; 2006-2009);
- CNRS: support for activities and travel (32K USD; 2006-2008), for salary (80K USD, 2006-2008);
- IRD: support for salary (52K USD, 2006-2008);
- Region of Brittany: support for salary (33K USD, 2006-2008);
- University of Western Brittany (UBO and IUEM: support for rooms and stationery costs (16K USD, 2006-2008), plus in kind support.

Discussion has started with the current funders of the IPO regarding the renewal of IPO funding in July 2008. A meeting to bring together funders, the IMBER Executive and sponsor representatives is planned in conjunction with the IMBER Executive meeting in early October.

Interactions with other projects and programmes

SOLAS
Joint SOLAS/IMBER Carbon Research group: see earlier description.

LOICZ
Joint IMBER/LOICZ Continental Margins task team: see earlier description.

GLOBEC
Joint IMBER/GLOBEC End- to-end task team: see earlier description.

IMBER/GLOBEC Transition Team
IMBER and GLOBEC have been working together to develop the Terms of Reference and the membership of the Transition Team, which will draft the Addendum to the IMBER Science Plan. These will be presented at the SCOR Executive Committee meeting in Bergen for discussion and approval by SCOR.

CLIVAR
A committee involving CLIVAR, IMBER and GLOBEC has been formed to organize a "hands-on" workshop to be held in April 2008. The objective of this workshop is to bring together young marine scientists working in areas of biogeochemistry and ecosystems research with climate scientists. The goals of the workshop are to exchange information on climate variability impacts and marine impacts between physical climate science and marine biogeochemistry and ecosystems communities.

EurOceans
A Memorandum of Understanding (M.O.U) was signed between IMBER and EUR-OCEANS. IMBER and EUR-OCEANS co-sponsor activities focussed on marine biogeochemical and ecosystem research including:

- End-to-End food webs task team activities;
- Advances in Marine Ecosystem Modelling Research (AMEMR) modelling workshop,
- International Symposium on “Parameterization of trophic Interactions in Ecosystem Modelling” (March 2007);
- ICED;
- A “Floating university” project being developed for early 2008 in collaboration with the BONUS-GOODHOPE project.

CARBOOCEAN
CARBOOCEAN is a European integrated project that aims at an accurate scientific assessment of the marine carbon sources and sinks, with special emphasis on the Atlantic and Southern Oceans on a time scale of -200 to +200 years from now. An M.O.U was signed between IMBER and CARBOOCEAN and discussions are underway to develop joint activities.

GODAE
A joint IMBER/GODAE task team is being formed to review the present biogeochemistry and ecosystem development within GODAE systems and related issues, to identify common interests between IMBER and GODAE, to evaluate real-time datasets and assimilation schemes required for biogeochemistry and ecosystem applications and to provide a report to IMBER and GODAE to recommend further actions. A meeting of this group took place in June 2007.

National activities:
IMBER activities are starting in many countries (e.g., Chile, P.R. China, Finland, France, Germany, India, Italy, Japan, Netherlands, New Zealand, Norway, Spain, Taiwan, Turkey, UK, USA). For example, China has 5-year funding for a IMBER/GLOBEC programme and will be hosting the Second Large Marine Ecosystems Conference. IMBER-JAPAN was established under the Science Council of Japan, chaired by Hiroaki Saito. A northwest Pacific Ocean cruise has been funded for Summer 2008. France just funded for three years the CYBER programme

"CYscles Biogéochimiques, Ecosystèmes et Resources". Spain is developing a co-sponsored proposal with The Netherlands for a “Deep-water Oceanography” project and will be holding a Spanish IMBER symposium in March 2007.

Future Activities

Joint IMBER/LOICZ Continental Margins Open Science Conference: see earlier description

SIBER workshop
A workshop will be held in Goa, India November 27-30th to develop the Science Plan for the IMBER Indian ocean regional programme, based on the 2006 workshop described earlier.

IMBER/CLIVAR/GLOBEC workshop on climate variability: see earlier description.
1st IMBER IMBIZO
This activity is planned for late 2008 and will be a set of three concurrent, co-located workshops:

(a) End-to-end foodwebs
(b) Mesopelagic zone
(c) Bathypelagic zone

These individual workshops will be brought together under the central unifying theme ‘Biogeochemical and ecosystem interactions in a changing ocean’. The IMBIZO will have short daily joint sessions involving participants of the three workshops to stimulate interactions among the workshop participants. The potential to use a Dahlem conference approach to each of the workshops is being investigated.

IMBER supported meetings include:

- CLIOTOP Symposium December 2007, Mexico
- ICED Modeling Workshop early 2008.
- SIC meeting March 2008, USA.
- Climate Change Conference May 2008, Spain.
- Upwelling Conference, June 2008, Spain.
- GLOBEC Focus 4 workshop, July 2008, Italy.
- End-to-End Short Course September 2008, turkey.
- IMBER IMBIZO late 2008.