

Annex 9

IMBER: Integrated Marine Biogeochemistry and Ecosystem Research

Report 2003/2004

Submitted by Julie Hall, IMBER Chair
On behalf of the IMBER Scientific Steering Committee

Contents

Development of the IMBER Science Plan and Implementation Strategy
Formation of SSC
SSC Meeting
International Project Office
Links with Other Projects
Development of IMBER Research
Funding

Development of the IMBER Science Plan and Implementation Strategy (SP/IS)

Since the OCEANS Open Science Conference in Paris, the IMBER Transition Team has produced a draft Science Plan and Implementation Strategy (SP/IS) for the IMBER project. On completion of the first draft of the IMBER SP/IS, comment from the scientific community was invited, with a copy of the IMBER SP/IS posted on the Web on 31 October 2003.

An editorial meeting was held in November 2003 (at Johns Hopkins University, Baltimore, USA) at which the comments on the draft received from the scientific community were discussed and used to revise the draft SP/IS. The resulting completed version of the IMBER SP/IS (Appendix 1) was submitted to IGBP and SCOR on 15 January 2004, for review and approval. Following a joint review of the SP/IS by IGBP and SCOR by a panel of 9 scientists from various disciplines, a summary review was provided by IGBP and SCOR to give guidance for revision of the draft SP/IS. The draft SP/IS was approved by IGBP in principle, subject to revision, at the March IGBP SC meeting, and by SCOR by email.

Formation of SSC

An International IMBER Scientific Steering Committee (SSC) was formed in April/May 2004. The members of the SSC include

Julie Hall	New Zealand	<i>Chair</i>
Dennis Hansell	USA	<i>Vice-Chair</i>
Patrick Monfray	France	<i>Vice-Chair</i>
Ann Bucklin	USA	
Jay Cullen	Canada	
Wilco Hazeleger	The Netherlands	
David Hutchins	USA	
Arne Körtzinger	Germany	
Carina Lange	Chile	

Jack Middelburg	The Netherlands
Coleen Moloney	South Africa
S. Wajih A. Naqvi	India
Raymond Pollard	UK
Hiroaki Saito	Japan
Carol Turley	UK
Jing Zhang	China-Beijing

SSC Meeting

The first IMBER SSC meeting will be held in August 2004 (Plymouth Marine Laboratory, UK). The main aims of the meeting are to:

- Review and revise the IMBER SP/IS
- Identify key national and regional IMBER Programmes and linkages with other research programmes
- Develop a plan for implementing IMBER

International Project Office

Since November 2002, a Research Officer has been employed part time in the Interim International Project Office (IPO) for IMBER based at the National Institute of Water and Atmospheric Research Ltd (NIWA), Hamilton, New Zealand with funding from IGBP, SCOR and NIWA. In August 2004, the Interim IPO (employing one person part-time), moved to the Plymouth Marine Laboratory (PML) in the United Kingdom, funded by PML. There are ongoing discussions with Plymouth Marine Laboratory, the First Institute of Oceanography in Qingdao, China, and in France (CNRS and IRD) about funding for the IMBER International Project Office.

Links with Other Projects

SOLAS—To ensure a close and effective collaboration between the two projects in the area of ocean carbon cycle research, IMBER and SOLAS have agreed to develop a joint implementation plan for carbon research. Development of this document is underway, with a meeting planned for September 2004.

Other Projects—Ongoing discussions to develop collaborative relationships are being undertaken with the GLOBEC, LOICZ, GEOTRACES, DIVERSITAS and PAGES projects.

Development of IMBER Research

Several research initiatives that will contribute to IMBER are already underway or are in the planning phase. These include EUR-OCEANS and ICCED.

EUR-OCEANS—The European Network of Excellence (NoE) EUR-OCEANS project aims to achieve lasting integration of European research organisations on global change and pelagic marine ecosystems, and to develop models for assessing and forecasting the impacts of climate and anthropogenic forcing on food-web dynamics (structure, functioning, diversity and stability) of pelagic ecosystems in the open ocean. The NoE will favour the progressive integration of research programmes and facilities of major research institutes all over Europe (69 member organisations from 25 nations). The long-term goal of the

NoE is to create a multi-site Institute for European Research on Ocean Ecosystems under Anthropogenic and Natural Forcings. The international context is provided by GLOBEC and IMBER.

Eur-OCEANS is organised around a Joint Programme of Activities (JPA). The JPA comprises

- Integrating activities on networking, data, and model integration;
- Jointly executed research organised around four broad modelling tasks (together with observations and experiments), on pelagic ecosystems end-to-end, biogeochemistry, ecosystem approaches to marine resources and within-system integration); and
- Activities to spread excellence, including training of researchers, and spreading excellence to socio-economic users and to the European public (through the Association of Aquariums for EUR-OCEANS public outreach).

ICCED: Integrated analyses of Circumpolar Climate interactions and Ecosystem Dynamics in the Southern Ocean, A Southern Ocean Initiative for the OCEANS Programme

Ad Hoc Planning Group:

Eileen E. Hofmann and Walker Smith, USA

Eugene Murphy, United Kingdom

Ulrich Bathmann, Germany

Steve Nicol and Deborah Thiele, Australia

Evgeny Pakhomov, Canada

During the past decade multidisciplinary national and international studies of Southern Ocean ecosystems were undertaken to understand the processes controlling marine population variability and biogeochemical cycling. These programmes encompassed the whole ecosystem, including environmental structure, and will provide the basis for synthesis and modelling activities and additional focussed studies in the coming years. An emerging result from these studies is the importance of circumpolar climate variability and connections in the regional dynamics of Southern Ocean ecosystems, which implies that climate must be an integral focus of future research programmes developed for this region. The Integrated analyses of Circumpolar Climate interactions and Ecosystem Dynamics in the Southern Ocean (ICCED) initiative proposes a coordinated circumpolar approach to understanding climate interactions in the Southern Ocean and implications for ecosystems and the impacts on biogeochemical cycles. The initiative will be composed of circumpolar remote instrumentation and monitoring, an internationally coordinated circumpolar field effort and enhancement of World Ocean Circulation Experiment (WOCE) transects for ecosystem studies, and focussed process studies in key regions. The initiative will extend existing circulation and biological models and further develop modelling efforts directed at an integrated circumpolar view of the operation of the whole ecosystem. An important objective will be to develop international expertise and capability through focussed training courses, workshops, and personnel exchanges. The ICCED initiative directly addresses the questions put forward as a science focus for IMBER and is related to programmes with a Southern Ocean focus including Climate Variability (CLIVAR), Committee for Conservation of Antarctic Marine Living Resources (CCAMLR), International Marine Global Change Study (IMAGES), Global Ocean Ecosystems Dynamics (GLOBEC) project, Global Ocean Observing System (GOOS), the Scientific Committee on Antarctic Research (SCAR), and the International Whaling Commission (IWC).

The objectives of the ICCED initiative are to

1. develop a circumpolar, interdisciplinary approach which will provide a framework for understanding climate interactions in the Southern Ocean, and its implications for ecosystem functioning and impacts on biogeochemical cycles;
2. implement circumpolar (remote) instrumentation that will include large-scale surveys and monitoring, internationally coordinated field efforts, enhanced CLIVAR transects, and focused process studies in key regions;
3. extend and further develop existing circulation and biological models and facilitate the development of integrated circumpolar coupled biogeochemistry-ecosystem models;
4. stimulate capacity building through focused training courses, workshops, and personal exchange; and
5. collaborate with international programmes and organizations, such as CLIVAR, IMAGES, GLOBEC, GOOS, CCAMLR, IWC, and SCAR.

The ICCED initiative is an international effort. It builds upon the scientific results and experiences from the Southern Ocean Joint Global Ocean Flux Study (JGOFS) program, the Southern Ocean GLOBEC program, the WOCE and CCAMLR efforts, and earlier programs, such as the Biological Investigations of Marine Antarctic Systems and Stocks (BIOMASS). As a result of these programs, the Southern Ocean science community is well poised to undertake a circumpolar effort. It is anticipated that the ICCED initiative will form a partnership with the Southern Ocean initiative that is developing through the EUR-OCEANS effort.

Funding

IGBP and SCOR combined funds for Ocean Futures/ Biogeochemistry and Ocean Ecosystems

<u>Income</u>	2003	2004	2005
SCOR - NSF	\$92,114	\$41,667	\$50,000
SCOR Carry-over from Previous Year		\$4,845	\$19,124
IGBP		\$20,000	\$20,000
IGBP (staff support)	\$4,000		
SCOR	\$100		
ICSU	\$50,000		
Registration Fees	\$38,462		
Total Income	\$184,675	\$66,512	\$89,124
Expenses			
Representation at other meetings		\$3,603	
Open Science Conference in Paris	\$138,388		
TT meeting in Paris	\$25,622		
Side Meeting at JGOFS OSM	\$5,458		
Other SCOR Admin	\$2,103	\$351	
IGBP Congress in Banff	\$5,655		
SP/IS Editorial Meeting	\$8,619	\$5,219	
2004 SSC Meeting		\$25,715	
SSC Executive Committee Meeting		\$12,500	
Total Expenses	\$185,844	\$47,388	\$0
Remaining Balance	-\$1,169	\$19,124	\$89,124

Acknowledgements

I would like to thank Ed Urban, Wendy Broadgate and Claire Hamilton for their excellent support during the development of the IMBER *Science Plan and Implementation Strategy*. Special thanks must also go to IGBP, the National Institute of Water and Atmospheric Research (NIWA), SCOR and Plymouth Marine Laboratory for supporting the Interim IMBER International Project Office.

APPENDIX 1: Executive Summary of the IMBER Science Plan and Implementation Strategy Document

The last decade of internationally coordinated marine research has greatly increased our ability to describe and model the ocean's many biological, chemical and physical processes. We have quantified the global fluxes of the major elements, such as carbon, and we continue to identify the organisms and processes central to the functioning of marine ecosystems. A newly emerging challenge, one dictated by society's needs to understand and prepare for the impacts of global change on the Earth System, is to bridge and merge the knowledge bases of the marine biogeochemical and ecosystem disciplines. In response to this need, the Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) project is being formed as an activity jointly sponsored by International Geosphere-Biosphere Programme (IGBP) and the Scientific Committee on Oceanic Research (SCOR). The IMBER project goal is:

To understand how interactions between marine biogeochemical cycles and ecosystems respond to and force global change.

To achieve this goal it will be important to understand the mechanisms by which marine biogeochemical cycles control marine life and, in turn, how marine life controls biogeochemical cycles. In this light, IMBER research aims to identify key feedbacks from marine biogeochemical cycles and ecosystems to other components of the Earth System. IMBER will focus on processes within, and interactions between, the euphotic and mesopelagic layers of the ocean, the continental margins, and high-latitude and polar ocean areas. An interdisciplinary approach to this research, bringing together the biological and biogeochemical communities, as well as utilising long-term sustained observations, will be important. Embedding process studies within long-term observatories and surveys is required for assessing the changing ocean. An even greater challenge will be drawing together the natural and social science communities to study some of the key impacts and feedbacks between the marine and human systems.

The challenge to the scientific community is to understand interrelationships between biogeochemical cycles and food web dynamics, quantify and predict responses of the marine system to natural and anthropogenic perturbations, (e.g., changes in temperature, stratification, pH and nutrient loading), and estimate feedbacks from the ocean to the Earth System. Critical to our progress will be consideration of the marine system as a continuum from the inshore continental margins to the open ocean and of food webs from microorganisms to top predators. This approach will require an effort much larger than any single nation can mobilise to answer the broad interdisciplinary questions, which require multiple investigators from a range of disciplines and intercomparisons of data from a wide range of systems. IMBER will collaborate with and build on other projects that provide the physical, chemical, and biological context that will support the focus of IMBER research.

To address the IMBER goal, four scientific themes, each including several issues, have been identified for the IMBER project. The themes of IMBER are broad; however, their context is narrowed by the issues and priority questions identified. The eventual content of IMBER will be focused further as detailed implementation plans are developed for each theme and individual nations fund specific research. Theme 1. Key Processes: What are the key marine biogeochemical cycles, ecosystem processes, and their interactions, that will be impacted by global change?

Issues

- Sources and sinks in marine biogeochemical cycles and how these impact macro- and micronutrient stoichiometry;

- Relationships between biodiversity, structure, function, and stability of marine food webs; and
- Interactions between biogeochemical cycles and the structure, function and dynamics of marine food webs.

Theme 2. Sensitivity to Global Change: How will key marine biogeochemical cycles, ecosystems and their interactions, respond to global change?

Issues

- Impact of climate-induced changes in circulation, ventilation and stratification on marine biogeochemical cycles and ecosystems;
- Response of marine biogeochemical cycles, ecosystems and their interactions, to increasing anthropogenic CO₂ and changing pH; and
- Response of marine biogeochemical cycles, ecosystems, and their interactions, to changes in inputs of macro- and micronutrients.

Theme 3. Interactions with the Earth System: What is the role of the ocean biogeochemistry and ecosystems in regulating climate?

Issues

- Oceanic storage of anthropogenic CO₂;
- The role of hypoxia/anoxia in the oceanic nitrogen cycle; and
- Direct ecosystem feedbacks on ocean physics and climate.

Theme 4. Responses of Society: What are the relationships between marine biogeochemical cycles, ecosystems, and the human system?

Issues

- Human lifestyle effects on the state of the ocean; and
- Mitigative and adaptive policies that could reduce the impact of global change on society.

IMBER will encourage investigations in four key domains of the ocean: the euphotic zone, the mesopelagic layer, the continental margins and high-latitude and polar ocean areas.

IMBER will take advantage of new and innovative approaches to conducting marine research, ranging from new molecular techniques to sustained in situ and remotely sensed observations. The development of sustained observation sites will be an important part of the implementation strategy for IMBER, which will be complemented by targeted field-based process studies, in situ mesocosm studies, and both field and laboratory experiments. A suite of hierarchical models will be developed to investigate hypotheses, analyse and extrapolate data in space and time, and identify crucial gaps to be filled by new observations to reduce uncertainties in our knowledge. Extrapolation to the global scale will require integration of data from basin-wide global surveys. To support the modelling and synthesis efforts, interconnected databases of biological, geochemical and physical variables will be constructed, extended and updated in near real time.

The following outcomes are anticipated over the ten-year life of this project.

- An understanding of key marine biogeochemical and ecosystem processes and their sensitivity to global change;
- An increased understanding of the role of biodiversity and food web structure on the cycling and storage of carbon in the ocean;
- Establishment of new high-technology systems for sustained measurements;
- A hierarchy of integrated models that link the mechanisms of biogeochemical cycles with ecosystem processes and provide predictions of the impacts of global change on the ocean system;
- Internationally shared, publicly available data sets and assimilated data products of ocean biogeochemical and ecosystem state variables;
- Identification of potential adaptive and mitigative policies to address the impacts of global change on the ocean system;
- A new generation of marine scientists from developed and developing countries trained in interdisciplinary research and using a systems approach; and
- Sound scientific knowledge to assist policy makers in making informed decisions.

IMBER will encourage the development of collaborative activities that will draw on the expertise of other projects and programmes to avoid unnecessary duplication and ensure that IMBER takes an interdisciplinary scientific approach. These collaborative associations will involve other IGBP/SCOR marine projects and IGBP integrative projects and programmes such as the World Climate Research Programme (WCRP), the International Human Dimensions Programme (IHDP), global observing programmes such as the Global Ocean Observing System (GOOS). A close collaborative relationship with GLOBEC (Global Ocean Ecosystem Dynamics) will be particularly important to ensure that fully integrated biogeochemistry and ecosystems research is undertaken across the entire food web. After 2009 the IGBP II structure will contain a single marine project.