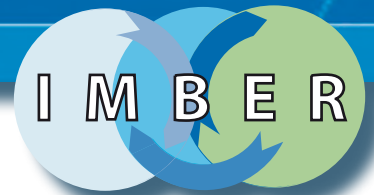


IMBER *Update*



Integrated Marine Biogeochemistry and
Ecosystem Research

Issue No. 4 - September 2006

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Editorial

Integrating Climate and Ecosystem Dynamics - ICED

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Introduction

Integrating Climate and Ecosystem Dynamics (ICED) is a new international initiative aimed at coordinating integrated, multidisciplinary, circumpolar analyses of Southern Ocean ecosystems. The Southern Ocean is a key system in the global ocean with a crucial role in climate, biogeochemical cycles, maintaining food security and biodiversity. In recent years, some of the strongest regional expressions of global climate change have occurred in Antarctica. However, there is little information on the processes generating these changes, and the wider effects on marine ecosystems. Linking analyses of circumpolar climate processes and ecosystem operation is not only essential for improved scientific understanding but is also vital in the development of robust long-term strategies for the sustainable management of exploitation in the region.

ICED will bring together climatologists, oceanographers, biogeochemists, ecologists and fisheries scientists in a single circumpolar research effort, and is being developed in conjunction with the Scientific Committee on Oceanic Research (SCOR) and the International Geosphere-Biosphere Programme (IGBP), through joint support from the Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) and Global Ocean Ecosystem Dynamics (GLOBEC) programmes, and in partnership with the Southern Ocean System of the European Network of Excellence for Ocean Ecosystems Analysis (EUR-OCEANS). This article summarises the latest news from ICED and is aimed at further developing links with the scientific community in order to

IMBER is an international
project of IGBP and SCOR

GLOBAL
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CHANGE

International Council for Science
Scientific Committee on Oceanic Research

maximise the impact of science on the understanding and sustainable management of Southern Ocean ecosystems.

Implementation of ICED

The long-term goal of ICED is to *develop a coordinated circumpolar approach to understand climate interactions in the Southern Ocean, the implications for ecosystem dynamics, the impacts on biogeochemical cycles, and the development of sustainable management procedures.*

Building upon the research and experience of the Southern Ocean Joint Global Ocean Flux Study (SO JGOFS) and Southern Ocean Global Ocean Ecosystems and Dynamics (SO GLOBEC) programme, and linking with many other relevant southern ocean projects, programmes and initiatives, ICED will lead and coordinate international research with EUR-OCEANS and the new International Polar Year (IPY) consortia: ICED-IPY which will lead the Ecosystems and Biogeochemistry of the Southern Ocean component of IPY, and will also link to other IPY clusters and consortia including the CCAMLR 2008 Survey and GEOTRACES.

ICED consists of three major areas of activity:

Data mining and synthesis

Despite extensive Southern Ocean research over almost a century, often only limited parts of more extensive datasets are currently available, and in a variety of formats including original unprocessed hardcopy form. ICED will coordinate circumpolar data mining and synthesis to create unique integrated databases for examining long-term, large-scale

ecosystem functioning, variability and change. These data syntheses will include circumpolar remotely sensed data of sea surface temperature, sea-ice and ocean colour derived chlorophyll a concentration (e.g. Figure 1).

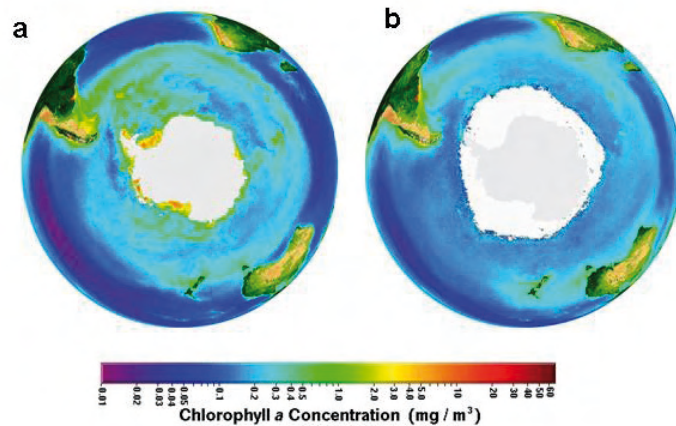


Figure 1

Circumpolar data-series continue to develop and satellite derived series are now being used to examine large scale ecosystem variability. One of the key developing data series for circumpolar analyses is that of ocean colour for the period since 1997. The panels show SeaWiFS derived chlorophyll a concentration climatologies (1997-2005) for a) austral summer and b) austral winter (Winter sea ice covered regions are shown as white). <http://seadas.gsfc.nasa.gov/cgi/climatologies.pl>.

Fieldwork coordination

A major focus of ICED is the integrated planning and development of dedicated field efforts to develop a coordinated circumpolar approach. In addition to potential new field efforts, ICED will facilitate the coordination of existing studies, and develop regional comparisons to maximise the efficiency and scientific value of individual programmes.

Modelling

Improving our ability to understand and predict ecosystem responses to climate change and anthropogenic forcings is a major focus of ICED. In addition to data synthesis, and field efforts, this will be achieved through the development of existing circulation, biogeochemical and biological models to the circumpolar scale, and the development of integrated “end-to-end” circumpolar ecosystem models.

Latest News

ICED Workshop Report and Science Plan

To launch ICED, EUR-OCEANS, the Natural Environment Research Council (NERC), Scientific Committee on Antarctic Research (SCAR), SCOR, IMBER and SO GLOBEC funded the first ICED workshop in May 2005, held at the British Antarctic Survey, involving 34 participants

from 14 countries. The workshop outcomes form the basis for the developing ICED Science and Implementation Plan to be published by IMBER and GLOBEC later this year. A report summarising the workshop will be published electronically in the near future. Further news and updates on ICED will also be posted on the ICED and IMBER websites.

ICED Session at SCAR

ICED recently held its first scientific session during the second SCAR Open Science Conference (OSC) in July 2006 in Hobart. The theme of the OSC was “Antarctica in the Earth System” making this an ideal setting for the first ICED scientific session. The scene was set with an introduction and overview of the ICED programme by Eileen Hofmann. This was followed by Eugene Murphy’s presentation on the spatial and temporal operation of the Scotia Sea, providing a detailed example illustrating how integrated analyses of a regional ecosystem also requires understanding of the circumpolar operation of Southern Ocean ecosystems as a whole.

Following a presentation (HC Shin) on the influences of sea-ice retreat and eddies on differing marine ecological regimes over a meso-scale distance in the southwest Atlantic sector of the Southern Ocean, pointing to the need to further investigate the importance of the different processes, the session moved into sea ice ecosystems (I Melnikov), sea ice gap layers (SF Ackley) and circulation (JM Klinck). These presentations generally illustrated the need to consider physical processes in biological models in order to build up a more accurate picture of the complex interactions influencing ecosystem

structure. Further, the preliminary results presented by Guy Williams from the parallel biological and biogeochemical surveys carried out during the ‘BROKE-West’ cruise in East Antarctica, and the influence of oceanographic structure on the foraging strategies of penguins and seals (S Sokolov) clearly demonstrate the importance of the physical environment to the structure and functioning of the marine ecosystem.

Moving towards more direct consideration of climate change processes, Mike Meredith presented the evidence for rapid climate change in the ocean west of the Antarctic Peninsula, likely influenced by, and contributing to, the observed atmospheric climate change at the Peninsula (Figure 2). This led into Angus Atkinson’s analysis of the potential sensitivity

of Antarctic krill to climate change. The implications drawn from both presentations highlighted the effects of regional warming on key species in the Southern Ocean foodweb through their dependence on the physical environment and the consequential potential impact on ecosystem operation. The final presentation of the ICED session by Valerie Loeb focussed on the importance of ENSO-driven climate variability on the krill-based food web and its implications for krill fishery management.

Stimulating discussion sessions were held after each presentation, and it was clear that new ideas were developed and potential multidisciplinary collaborations envisaged and discussed. The abstracts and presentations from the ICED session at SCAR will be posted on the website, <http://www>.

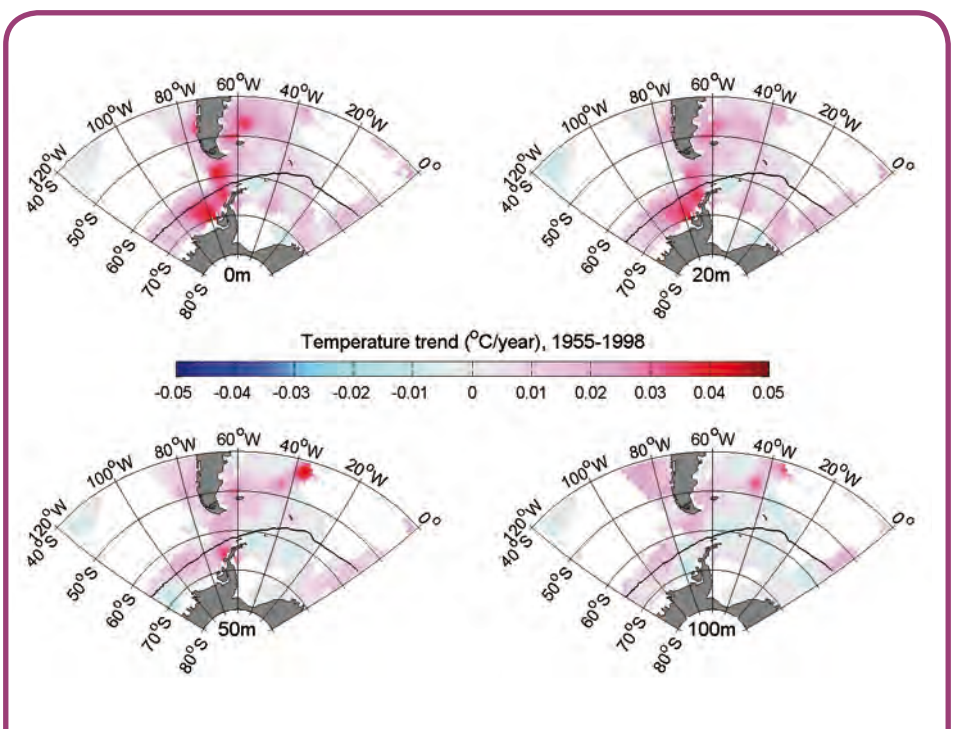


Figure 2

Trends in ocean summer temperature during 1955–1998, for four different depth levels (surface, 20m, 50m and 100m). Gridcells with no data are left white. Note that the significant warming trend observed close to the Antarctic Peninsula is strongly surface-intensified, decaying virtually to zero at 100 m depth. Source: Meredith & King (2005).

antarctica.ac.uk/Resources/BSD/ICED/, which is currently under development and should be available in late Fall 2006.

Future development of ICED

Current planning is focused on development of workshops that will further the goals of the three main areas of activity for the ICED programme. Information on workshops will be forthcoming in the next few months and will be posted on the ICED website. ICED is still in its early development phase and further input from scientists in the relevant fields is most welcome as are suggestions for collaboration and other feedback on the programme.

For further information see:

ICED: <http://www.antarctica.ac.uk/Resources/BSD/ICED/> (currently under development and should be available in late Fall 2006).

ICED-IPY: <http://www.ipy.org> and <http://www.ipy.org/development/eoi/proposal-details.php?id=92>

EUR-OCEANS: <http://www.eur-oceans.org>

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Science highlight

ECOMADR Ecological role of key components in the “end to end” trophic food web of North Adriatic Sea

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²*Università di Trieste*

Nowadays oceanographic community is devoting significant attention to the integration of nutrient cycling and microbial processes to dynamic of higher predators into a common picture of the system. The topic is

key because of the need for a holistic view of marine (eco)systems in which all components and interactions are simultaneously considered. This is critical also for policy makers, who require comprehensive assessment of ecosystem response to changes in environmental forcing and anthropogenic stressors, with particular regard to global changes. Given the demand for predictive capabilities, the development of reliable numerical models of “end to end food web” are particularly sought. The topic is challenging. Many different processes occurring at widely different temporal and spatial scales need to be simultaneously addressed and integrated in a common frame. This calls for a multifaceted approach to research including the use of a hierarchy of models and the identification of the appropriate scales for integration. There also exist parameters and processes that we are not able to measure as precisely and accurately as we would like. Most importantly, there still are many aspects of ecosystem functioning - including kinetics, functional response, causal relationships, key species - which are not fully understood or poorly quantified, and hence are difficult to incorporate into models.

The Northern Adriatic Sea (NAS) is a shallow bay that can show eutrophic and oligotrophic conditions within small temporal and spatial scales. It is enclosed on three sides and opened to the Mediterranean Sea. Several marine institutions are located in the countries surrounding the NAS. This has led to intensive national and international studies in this area. As a consequence, a remarkable amount of data, general knowledge, conceptual and mathematical models is available about both the physical and ecological features of this area. Particularly in the Gulf of Trieste, a long term ecological research lasted for more than 30 years, and important insight on nutrient cycling, microbial dynamic and plankton trophodynamics has been gained (Cossarini and Solidoro, 2006; Fonda Umani and Beran, 2003; Fonda Umani et al. 2004, 2005, 2006; Querin et al., 2006; Solidoro et al. 2006;).

Over the last decade, researches on pelagic environment focussed mainly on defining the biological climatology, to assessing trophic status of the system, and on identifying the main processes leading to gel mass accumulation (mucilage). Beside the year-to-year variability, results revealed the existence of a clear seasonal dynamic, with a late winter diatom bloom followed by autotrophic nanoplankton prevalence and by the dominance of cyanobacteria in late

summer. Concurrently, heterotrophic community evolves from a microzooplankton dominated plankton community to the dominance of larger mesozooplankton in summer. Experimental assessments demonstrated that whereas in the spring all available autotrophic biomass is grazed by zooplankton, in autumn the low primary production still fuels both micro and mesozooplankton food webs but far less efficiently, and in late winter a large fraction of autotrophes is exported to the bottom. The planktonic system is prevalently heterotrophic, i.e. most of the time respiration exceeds primary production. Furthermore the uncoupling between primary production and bacterial carbon demand, which leads to accumulation of dissolved organic carbon (DOC), occurs each year, though it is clearer in the years when mucilages form (fig. 1)

ECOMADR builds on this knowledge, and - while providing continuity to it - broadens the aim of the research by including dynamic and ecological role of small pelagic fishes and of suspended filter feeders. In particular, sardines and anchovies - planktivorous feeders that feed mainly on copepods and represent the target of the most important fishery in the Gulf of Trieste - and mediterranean mussels - which are massively cultured in a large part of the Gulf - are considered. In fact they constitute significant components in the carbon and nutrient cycles in the system. This will allow the derivation of better assessments of carbon budget and of carrying capacity of the area, as well as the evaluation of the relative importance of top-down versus bottom-up control in plankton dynamic and generation, composition and accumulation of DOC.

ECOMADR experimental design includes monthly sampling of physical parameters on a regular grid of 20 points, and of chemical and water quality parameters along two orthogonal transects (9 stations, 3 depths). Structural and functional biological parameters are collected at one station, including the identification of viral abundances, abundance and composition of autotrophic and heterotrophic pico, nano, and microplankton fractions and of mesozooplankton, the determination of primary and secondary production, respiration, and bacterial activity. Furthermore, we determine the yearly variation of diet and daily ration of sardines and anchovies, by simultaneously sampling fish and prey every 4-6 hours over 24 hours. The analysis of stomach contents provides specific information about the predator-prey relationship. Mussel dynamic is investigated by monthly

monitoring biometric parameters of 2 cohorts, displaced in experimental ropes in an aquaculture farm. Analysis of stomach content of mussel provide information on their diet, and enable estimate of their energetic requirement.. Since water column is not very deep, upper sediment is considered too, by measuring nutrients and DOC fluxes, primary production, respiration, bacterial production and esoenzymatic activity, as well as abundance and composition of microphytobenthos, meio and macro zoo-benthos. Specific experiments are planned to investigate short-term variability of specific plankton components, including microbial diversity by means of genetic methodologies.

The integration of numerical models, satellite images and geostatistical analysis of observed data, provides a characterization of the

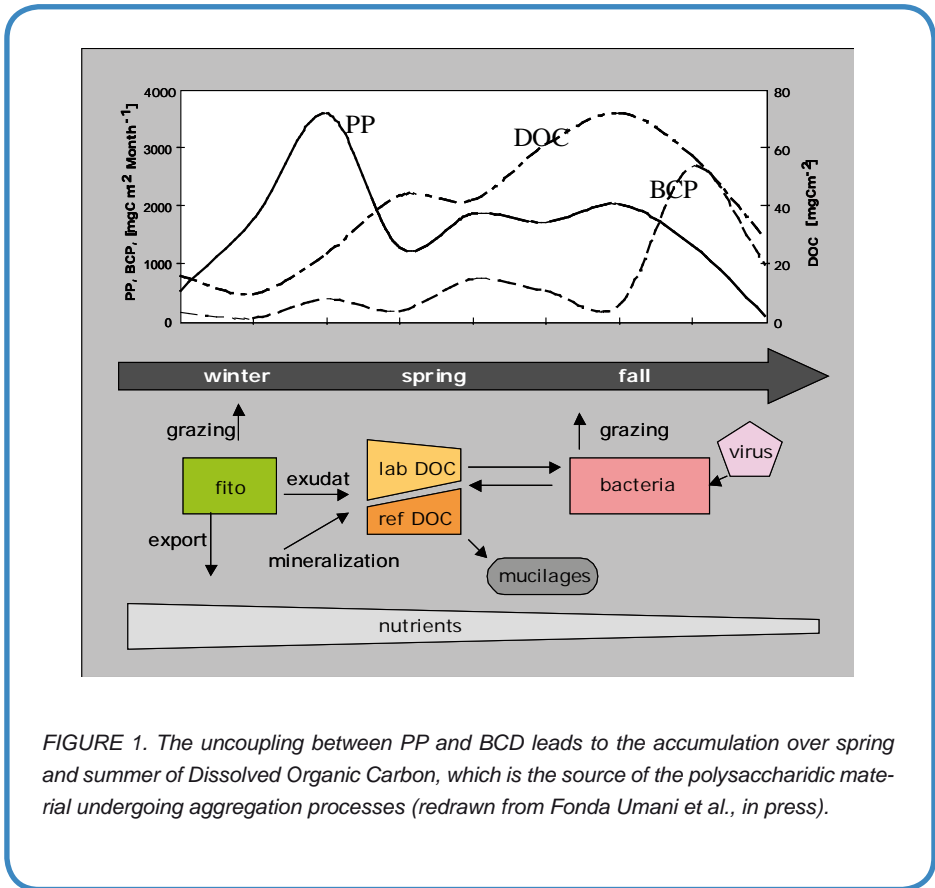


FIGURE 1. The uncoupling between PP and BCD leads to the accumulation over spring and summer of Dissolved Organic Carbon, which is the source of the polysaccharidic material undergoing aggregation processes (redrawn from Fonda Umani et al., in press).

sampling area. A combination of statistical analysis (artificial neural network, geostatistic and standard multivariate techniques such as ordination and cluster analysis) and coupled transport-biogeochimical model simulations contributes to the analysis of space and time variability of the major biogeochemical properties. Bioenergetic models for small pelagic fishes and mussels, and a mass balanced food web model are additional tools under development (fig. 2).

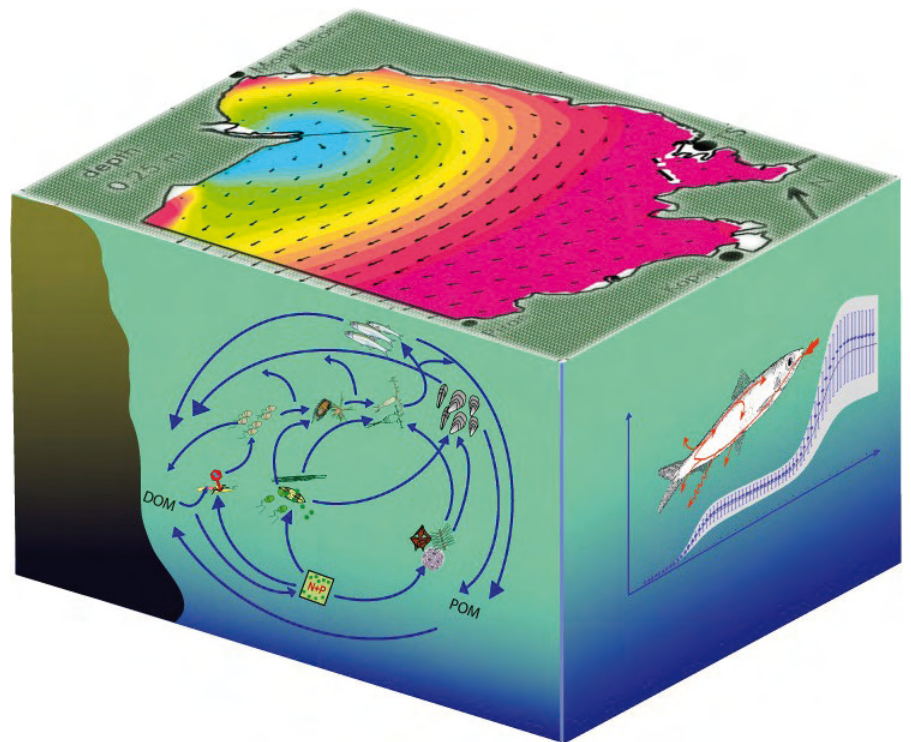
The integration of these models, statistical analysis and empirical observations will provide a means of interpreting ecosystem dynamic, framing and integrating our findings in the context of pre-existing knowledge, and possibly in speculating about likely responses of this ecosystem to variations in anthropogenic stressors or external forcing.

The project will end in September 2007 and hopefully evolve into an IMBER North Adriatic Study.

ECOMADR is a project promoted by "Regione Friuli Venezia Giulia" in the frame of EU INTERREG IIIA Italy-Slovenia cross-border cooperation. It is coordinated by the Italian national institute for Oceanography and Experimental Geophysics – OGS. The Nationalni Inštitut za Biologijo; (Slovenija) and the Italian National Research Council CNR (Istituto di Scienze Marine) are partners of the project.

We would like to acknowledge ECOMADR's team:

A. Beran, P. Berger, M. Cabrini, B. Cataletto, A. De Olazabal, P. Del Negro, C. De Vittor, M. Monti, R. Mosetti, V. Mosetti, M. Lipizer, S. Lorenzon, V. Tirelli, G. Barbieri, D.



The project aims to the identification of ecological role of key components of the 'end to end' trophic web of North Adriatic Sea by integrating observed data, results of statistical analysis, and simulations performed with a hierarchic set of models (transport, biogeochemical, bioenergetics, mass balanced food web).

Borme, N. Burba, A. Bussani, N. Caressa, M. Celussi, T. Cibic, C. Comici, G. Cossarini, E. Crevatin, F. Cummaudo, M. Doz, C. Fabbro, C. Falconi, D. Fornasaro, G. Frangipane, B. Guardiani, A. Karuza, C. Larato, S. Legovini, S. Libralato, C. Manno, M. Minocci, A. Paoli, S. Trevisani, A. Valeri, D. Virgilio, F. Voltolina.

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Fonda Umani S, Tirelli V, Beran A, Guardiani B (2005) Relationships between microzooplankton and mesozooplankton: competition vs predation on natural assemblages in the Gulf of Trieste (northern Adriatic Sea). *J Plankton Res*, 27(10): 973 – 986.

Fonda Umani S, Del Negro P, Larato C, De Vittor C, Cabrini M, Celio M, Falconi C, Tamberlich F, Azam F. Major inter-annual variations in microbial dynamics in the Gulf of Trieste (Northern Adriatic Sea) and their ecosystem implications. In press *Aquat. Microbial Ecol.*

Working Groups

Data Management Committee at work!

by *Sophie Beauvais and Raymond Pollard*

The IMBER Data Management Committee (DMC) was officially formed during the 3rd IMBER Scientific Steering Committee which took place in Brest (10-12th May 2006). The DMC will be chaired by Raymond Pollard (NOC, UK). The SSC also appointed the IMBER Deputy Executive Officer, Dr. Sophie Beauvais, as the IMBER DLO. Part of her role is to support the Data Management Committee (DMC). It was also recommended that every IMBER project should appoint or identify a Data Specialist.

Raymond and Sophie met with Roy Lowry at the British Oceanographic Data Centre (BODC) in Liverpool, UK on 3-4th August 2006, in order to seek expert advice on some of the Data Management issues. The first task of the DMC will be to develop IMBER data management policies and metadata guidelines for IMBER endorsed projects. The overall objective is to ensure creation of full metadata and access to, sharing of, and long term preservation of IMBER metadata.

The initial task is to appoint members of the DMC, which will be composed of observationalists, modellers, data specialists and the DLO. It is hoped that the DMC will start its discussions, mostly by email, in October. On the longer term, the DMC and the DLO will together 1) ensure that the strategy is well implemented, 2) ensure that IMBER endorsed projects adhere to the policies developed by the DMC

and appoint or identify a data specialist; and 3) keep track of IMBER metadata and make them available to the global community, via the IMBER website.

Regional programmes

International Symposium on “Parameterisation of Trophic Interactions in Ecosystem Modelling” March 20-23, Cadiz, Spain

Michael St. John¹, Patrick Monfray² and Javier Ruiz³

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Background:

Global change, the result of changes in natural and anthropogenic forcing, influences the composition of marine food webs and their ability to provide services such as fish stocks and the sequestration of green house gases. **Critical under global change**, these services depend on physical, chemical and biological processes which are modified by, and in turn modify, marine food webs. Based on this clear societal need to predict how global change impacts marine food webs, how these changes feed back to ecosystem services in the short term and to global climate in the long term, predictive models serve as our state of the art in understanding and forecasting global change impacts. However, these predictive models suffer from a number of weaknesses in the parameterisation of trophic levels, and more critically of interactions between trophic levels (as highlighted in figure 1) thereby limiting their utility.

With this at the background, from the 20th to the 23rd of March 2007, an international symposium on “Parameterisation of Trophic Interactions in Ecosystem Modelling” will be held in Cadiz, Spain. This meeting is jointly organised by EUR-OCEANS WP4 (Eco-

systems end-to-end) and WP3.1 (Model Interfacing) and is supported by IMBER and GLOBEC as well as GODAE. The symposium will be hosted by Javier Ruiz (CSIC) in Cadiz, Spain.

The objectives of this symposium are to:

- identify weaknesses in our approaches to the parameterisation of ecosystem modelling tools,
- highlight gaps in our understanding of trophic interactions,
- aid in the development of best practices for their future development and application,
- provide a vision for the evolution of ecosystem and biogeochemical modelling.

This meeting is intended to foster productive interactions among researchers working on parameterisation of vital rates and limits within and between trophic

levels of the marine food webs for implementation in coupled modelling approaches. The symposium will be convened by Mike St. John and Patrick Monfray and consists of eight sessions on four days organised around key speakers who will provide information regarding the state-of-the-art on key interfaces. The meeting will be held in plenary and poster presentations by participants who are strongly encouraged to stimulate discussions beyond the presented state-of-the-art. In total up to 60 participants including keynote speakers, experimental biologists/ ecologists and modellers are expected. Arrangements for the publication of keynote lectures have been initiated.

Please note that interested scientists are requested to register in advance: Registration will open in September and deadlines will be officially announced on the EUR-OCEANS' web site (<http://www.eur-oceans.org>).

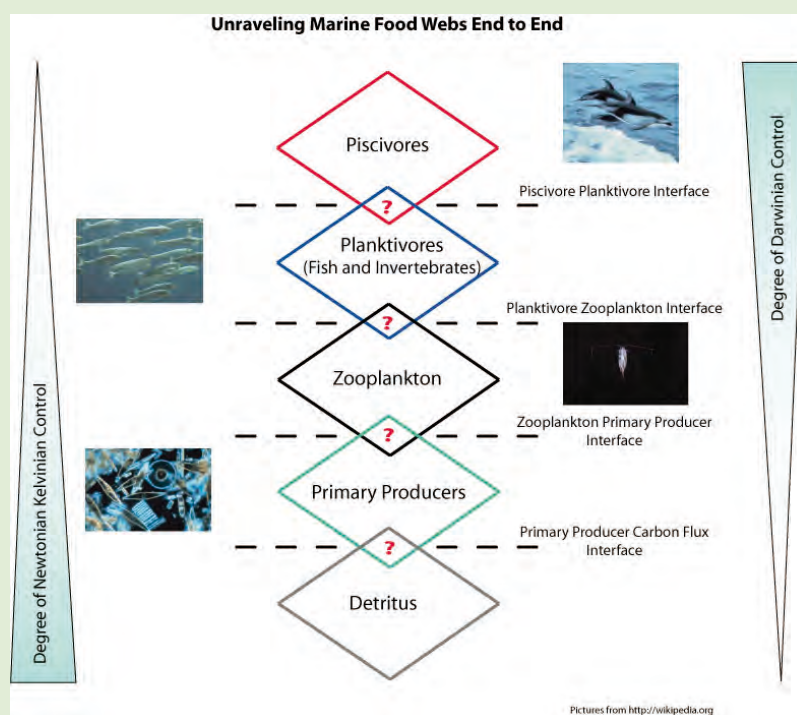


Figure 1. Marine food webs are structure based on the position that an organism occupies in a food chain - what it eats, and what eats it. Each species in an ecosystem is affected to a greater or lesser extent by the other species in the web with interactions typically strongest between neighboring trophic levels. Here each trophic level including the detritus which includes the decomposers is represented by a series of overlapping rhomboids. Unraveling the effects of global change on marine food webs requires the resolution and parameterisation of key processes limiting the dynamics of neighboring trophic levels here depicted as the overlaps between trophic compartments and in particular the key biogeochemical and ecosystem species in each trophic level. Over the trophic spectrum of marine ecosystems, the influence of forcing varies based on the organism's ability to control its environment relative to the physical conditions it experiences. Planktonic trophic levels (phytoplankton, zooplankton and larval fish) are more strongly influenced by physical variables and processes than higher trophic levels (adult fish, marine mammals), where Darwinian controls and individual motion dominate over physical processes. This is not only because planktonic

organisms are directly influenced by advection and spreading but also because both light and turbulence are physical variables that particularly influence plankton and to a lesser degree organisms that control their position in the sea. (St John et al., in review)

Itinerary:

(all speakers confirmed)

Day 1

From Climate to Phytoplankton

- Session 1: Climate and biological interactions: Ragu Murtugudde

- Session 2: Dynamics of phytoplankton functional types: Frede Thingstad

Day 2

Microplankton/Mesozooplankton Coupling

- Session 3: Coupling PP models with complex ecosystem models and structured population models: Denis McGillicuddy (to be confirmed)

- Session 4: Changes in food quality and Redfield Stoichiometry affecting species/groups along blooms: Kevin Flynn

Day 3

Zooplankton Fish Coupling

- Session 5: Forage control on predator dynamics: Patrick Lehodey
- Session 6: Predator control on prey dynamics: Geir Huse

Day 4

Ecosystem Modelling: Visions and limitations

- Session 7: Simplicity vs. complexity in the modelling of trophic levels, benefits and limitations: Charles Hannah
- Session 8: A vision to model the global change of marine ecosystems: Cisco Werner

For more information: see: <http://www.eur-oceans.org/index2.php?action=fiche&fiche=318>

Comparing Virtual Biogeochemistry – An Online Tool for Modellers

by Ivo Grigorov & Patrick Monfray

Our ability to understand and predict the responses of the Ocean System to anthropogenic pressure is underpinned by the use of robust 3D global ocean models. The complexity of the ocean system however, inherently results in compartmentalization of the scientific efforts, either geographically or by focusing on one trophic level at a time (see also related article on “Parameterisation of Trophic Interactions in Ecosystem Modelling” International Symposium in this issue).

In an effort to stimulate interfacing of existing modeling tools for the purpose of end-to-end ecosystem modeling, WorkPackage 3.1 on Model Interfacing within EUR-OCEANS (an IMBER contributing project), is working on a prototype Model Shopping Tool for ocean ecosystem model developers (www.eur-oceans.org/models).

What is the “Model Shopping Tool”?

A database review of the coupled ocean ecosystem models-in-use within the EUR-OCEANS Network. It includes, but is not limited to, detailed descriptions of focus, approach and philosophy as provided directly

by the developers, and with source references and documentation where available.

What can it do?

A first attempt to list the global 3D biogeochemistry models-in-use, is already showing the variety of approaches and philosophies adopted.

In addition to model descriptions however, equations of biogeochemical processes can be compared across models. Currently based on PISCES, ERSEM-PELAGOS and now PlankTOM (product of the Dynamic Green Ocean Project), the prototype can display and compare, for example, the mathematical notations for the plankton functional groups used across these models.

The ultimate goal is to provide quick, and hopefully direct, comparison of the variety of virtual representations of ocean biogeochemistry and ecosystems, as the archive grows up the trophic levels as well.

In conjunction with EUR-OCEANS WorkPackage 4 for Biogeochemistry, an add-on database for computed organism vital rates is also in development. When ready, the vital rates database will be open access for input and sharing of data and can provide a first-stop for model development and refinement with respect to representing specific functional groups.

Perspectives

The Model Shopping Tool is a step toward identifying coupling capacity of the existing modeling tools for end-to-end ocean ecosystem modeling. Parallel to providing quick and easy access to model equations, the identification of key interface variables for coupling different trophic levels, is also a priority.

Eventually the aim is to provide a shared knowledge platform for exchange of expertise and approach, across modeling teams and trophic levels. The tool is very much in its initial stages of development and its evolution will be steered by developers’ needs within and beyond the EUR-OCEANS Network. Developers’ input wanted!

Contribute to the project:

1. Share your expertise and your modeling tools with the community -

submit your profile, documentation and approach into the EUR-OCEANS Model Interfacing database: www.eur-oceans.org/models

2. Identify key Interface Variables for end-to-end ecosystem models -

What are the key interface variables across which current trophic levels can be coupled? What variables are current global 3D biogeochemical models failing to provide for medium and upper trophic levels coupling? How to optimize on the multi-plankton functional type (PFT) approach to better model fish recruitment and fish bioenergetics?

www.eur-oceans.org/interface_variables

Addresses:

Model Shopping Tool

www.eur-oceans.org/models

Eur-OCEANS Network of Excellence for Ocean Ecosystem Analysis

www.eur-oceans.org

How to use the Shopping Tool

1 START - You enter at the summary page of the NoE's coupled models. Data is entered by the developers and visualized in real time.

2 FILTER DATA: Select to view model by their application or dimension.

3 SORT DATA by any column of interest.

4 SELECT A MODEL you are interested in for a detailed description.

5 'MODEL DESCRIPTION' and 'SCHEMATIC' tabs are activated after a model is selected (4). If equations for the model are entered, these will appear under the 'EQUATIONS' tab (PISCES, PlankTOM and ERSEM-PELAGOS only).

6 Equation Search by the process they represent & compare with other models

7 Enter & Update Your Profile

Development Status of Modelling Tools provides ranking of the models with operational models at the top. Colour contrast is verified for Vischeck colour vision impairment.

A quick tour around the Model Shopping Tool prototype (www.eur-oceans.org/models)

The Atlantic Meridional Transect programme (AMT)

by Carol Robinson

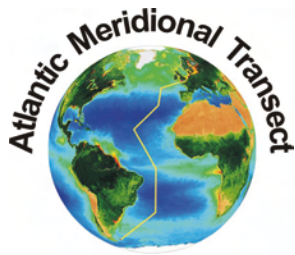
The Atlantic Meridional Transect programme is an open ocean in situ observing system that aims to improve understanding of the structure and functioning of marine ecosystems, the interactions between physical, ecological and biogeochemical processes, and the impact of global change on the Atlantic Ocean. Biological, chemical and physical data are collected in order to quantify the nature and causes of ecological and biogeochemical variability in planktonic ecosystems, and to assess the effects of this variability on the biological carbon pump and on air-sea exchange of radiatively active gases. The programme began in 1995, utilising the passage of scientific research vessels between the UK and the S Atlantic (50°N to 52°S), southwards in September and northwards in April each year. As well as collecting an internally consistent set of 'core' ecological and biogeochemical measurements, AMT also provides the contextual and educational infrastructure for UK and international scientists and students to participate in open ocean cruises to enhance their science. AMT is thus both a 'basin scale observatory' monitoring the health of Atlantic Ocean ecosystems and a 'floating University' training the next genera-

tion of oceanographers. Eighteen 40 day 13,500 km cruises have been completed so far, involving 180 scientists from 11 countries measuring up to 70 parameters each day to produce 140 peer reviewed publications and contribute to 68 PhD theses.

The programme held a successful meeting at the Royal Society in London in July 2006 sponsored or endorsed by the IGBP National Committee and EUR-OCEANS. Poster and oral presentations from the meeting which included talks by Patrick Holligan, Tim Jickells, Carlos Duarte, Nick Bates and Emilio Mananon are available from the AMT website. The Scientific Committee on Oceanic Research (SCOR) sponsored two young researchers from Chile and Argentina to attend this meeting and then participate in a workshop aimed at increasing awareness of and use of the unique decadal AMT dataset.



Papers arising from results collected on recent AMT cruises are to be published in two special issues of Deep-Sea Research II in 2006 and 2007, and a proposal to continue AMT until 2012 has been submitted and is currently under review.



www.amt-uk.org

IMBER national
activities

India IMBER
activities

by Wajih Naqvi

National Programmes

On the recommendations of the Indian National Committee for IGBP, SOLAS and IMBER are being implemented together as a single national programme. Most project proposals received by the Task Force that was constituted to initiate this programme are still in review by the government funding agencies. In the meantime, an eleven-member SOLAS-IMBER National Committee with Dr. M. Dileep Kumar of National Institute of Oceanography (NIO), Goa, as its Convenor has been constituted by the Indian National Science Academy to oversee SOLAS-IM-

BER research in the country. The first meeting of the Committee will be held at NIO on October 5, 2006.

Most of the ongoing SOLAS-IMBER activities at NIO are covered by a CSIR (Council of Scientific & Industrial Research)-funded "Network" project entitled, "Impact of anthropogenic perturbations on oceanographic – atmospheric processes in and around India in the context of Global Change". This project, being coordinated by NIO comprises three activities:

- Transport and transformations of nitrogenous fertilizers from agricultural field to the ocean: Impact on coastal ecosystem and exchanges with atmosphere
- Reconstruction of upwelling intensity/anoxia on seasonal to centennial time scales from coral and sedimentary records
- Long-term time-series measurements including calibration of critical atmospheric and oceanographic parameters

For the time-series work, the coastal section off Goa (consisting of five stations to a depth of 28 m), repeatedly occupied by NIO since 1997, is now being extended offshore. In addition, two open ocean stations will be sampled on cruises to be conducted once every 2/3 months. At the time-series stations including the shallow one off Goa [the Candolim Time Series (CATS), 15°31'N, 73°39'E], moored instruments including automated sampling devices and current meters are being deployed to record high frequency changes. The work plan also includes de-

ployment of sediment traps at the two open ocean time-series locations (15°N, 72°E and 17°N, 68°E). While the data collected under this programme include most routine biological parameters, the project also has strong links with another in-house project of NIO (viz. Marine Biodiversity and Ecosystem Functioning).

The Department of Science & Technology (DST) has recently approved funding of another time series investigation along the east coast of India. This project entitled, "Biogeochemical response of coastal waters off Visakhapatnam to extreme climatic events and human interference" will be very similar to the above mentioned ongoing study off Goa.

The Centre for Marine Living Resources and Ecology (CMLRE), Cochin, under the Ministry of Earth Sciences is currently supporting a project on Marine Living Resources under which dedicated cruises using the R/V *Sagar Sampada* are being conducted throughout the year focusing on biogeochemical processes and fisheries resources of the Indian exclusive economic zone (EEZ). The project, being implemented with the Regional Centre of NIO at Cochin serving as the nodal agency, among other things, includes studies of the Arabian Sea suboxic zone which supports an amazingly large biomass (~100 million tonnes) of mesopelagic fish (myctophids), which probably contributes significantly to biogeochemical fluxes in the region.

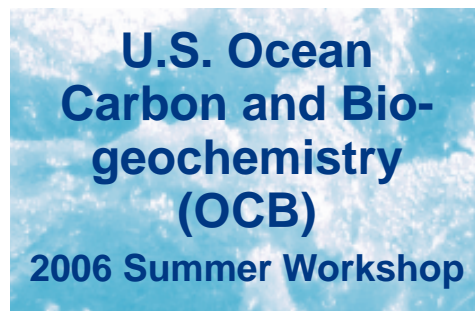
A sizable expansion of biogeochemical research activities is expected during the Eleventh Five-Year Plan beginning April 1, 2007. Among the various proposals being submitted by NIO, there is one on Iron Fertilization in the

Southern Ocean to be implemented as a "CSIR Network Project" in collaboration with Centre for Cellular and Molecular Biology (Hyderabad) CSIR Centre for Mathematical Modelling and Computer Simulation (Bangalore), and National Environmental Engineering Research Institute (Nagpur). Prof. Victor Smetacek (Alfred-Wegener Institute of Polar and Marine Research, Bremerhaven, Germany) will be a co-Principal Investigator of the project.

Regional/International Initiatives

A multi-national project is in advanced stages of development with potential participation of scientists from NIO, Sultan Qaboos University (Oman) and several institutions from USA (Woods Hole Oceanographic Institution, University of Southern California, Princeton University, University of Washington). Results of a joint cruise on board R/V *Sagar Kanya* in August-September 2004 that indicated, among other things, possible limitation of primary productivity by iron and a link between N and Fe cycles led to the formulation of a more ambitious programme that will hopefully be launched in 2007. These efforts are expected to receive a further boost by an international Workshop, "Sustained Indian Ocean Biogeochemical and Ecological Research (SIBER)" to be held in Goa during 3-7 October (<http://ian.umces.edu/siber/>). SIBER is sponsored in part by SCOR and IMBER, and is expected to contribute toward the implementation of IMBER in the Indian Ocean region with active participation of groups from outside the region. Another study focusing on nitrogen cycling involves collaboration between scientists from NIO

in India and Max-Planck Institute for Marine Microbiology (Bremen), Centre for Tropical Marine Ecology (Bremen) and Baltic Sea Research Institute (Warnemünde) from Germany. It aims at quantification of rates and evaluation of relative importance of the anaerobic ammonium oxidation and denitrification in sediments and water column of the Arabian Sea and understanding the isotopic effects of the processes.



*Scott C. Doney and David M. Glover
Woods Hole Oceanographic Institution,
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The recently formed U.S. Ocean Carbon and Biogeochemistry (OCB) program held its inaugural science workshop in July, 2006 in Woods Hole, MA, USA. The scientific focus of the OCB is ocean biogeochemistry, especially on the ocean's role as a component of the global Earth system. The overall program goals are to promote, plan, and coordinate collaborative, multidisciplinary research opportunities within the U.S. research community and with international partners. Important OCB-related activities currently include: the Ocean Carbon and Climate Change (OCCC) and the North American Carbon Program (NACP); U.S. contributions to

IMBER, SOLAS, CARBOOCEAN; and numerous U.S. single-investigator and medium-size research projects funded by NASA, NOAA, and NSF.

The objectives of the OCB summer 2006 workshop were to highlight recent scientific findings in ocean biogeochemistry and related ecological and physical research, foster improved communication among existing ocean biogeochemistry observing programs and process studies, and discuss applications of emerging observational technologies in marine biogeochemistry. About 80 U.S. and international scientists participated in the four-day meeting, which was supported by the U.S. National Science Foundation (NSF). Electronic versions of the full agenda, poster abstracts, and many of the plenary talks and discussion sessions are available through the workshop web page (<http://ocb.whoi.edu/workshops.html>).

The meeting was organized around several major science themes:

- atmosphere-ocean CO₂ exchange;
- marine ecosystem-biogeochemical dynamics;
- ocean carbon cycle and climate.

In each theme, a series of plenary talks was given synthesizing both field-based and modeling results and in particular emphasizing new findings and unresolved science issues. Here we present a selection of some of the more noteworthy material:

- New independent estimates of Southern Ocean air-sea CO₂ fluxes based on an expanded synthesis of surface pCO₂ data and numerical inversions of ocean carbon interior data

show relatively small mean net uptake, much lower than previous observational and model calculations;

- Model simulations suggest substantial interannual variability in Southern Ocean air-sea CO₂ fluxes associated with the Southern Annular Mode, highlighting the need for more high latitude ocean biogeochemical observations and time-series;
- Better instrumentation (e.g., Lagrangian floating sediment traps) and focused process studies are beginning to shed light on biogeochemical transport and remineralization in the mesopelagic region just below the base of the euphotic zone. Organic matter remineralization length scales appear to differ considerably from a subtropical and subpolar site, perhaps linked to temperature;
- Innovative stochastic modeling approaches are being developed to explore competitive exclusion and phytoplankton niches in 3-D models. These techniques offer an objective approach for assessing the required complexity of ecological/geochemical functional group models;
- Physical observational and numerical studies illustrate the significant variability on horizontal distances smaller than those associated with meso-scale eddies (~100-300 km). The effect of the resulting large submesoscale vertical velocity variations and lateral stirring on large-scale nutrient fluxes and biological rates and patterns need to be better characterized;
- Detection and attribution of the long-term temporal trends in ocean biogeochemistry associated with anthropogenic carbon uptake and climate change are substantially hampered by sub-annual to interannual variability. Studies are underway to assess the skill of various numerical, modeling and remote sensing techniques to address these problems;
- Dramatic and rapid advances are occurring in marine microbial genomics. For example, new findings suggest a much greater prokaryotic and eukaryotic diversity than previously thought. New conceptual models and methods are needed to bridge between the emerging wealth of genomic data and more traditional ecological and biogeochemical approaches;
- Exciting new capabilities were demonstrated using *in situ* chemical and biooptical sensors on autonomous platforms (profiling floats, moorings, and gliders). These observing technologies will be central to addressing biogeochemical science questions in the upcoming U.S. NSF-funded ORION initiative;
- A synthesis of paleoceanographic data was presented in support of a new conceptual model to explain the 80-100 ppm drawdown in atmospheric CO₂ from interglacial to glacial periods. The hypothesis involves a long intermediate glacial period where atmospheric CO₂ was only about 40 ppm lower than pre-industrial levels caused by changes in ocean physics and temperature and a full glacial state driven by changes in the ocean alkalinity inventory;
- A new interpretation was presented to explain the diurnal variations in *in situ* variable fluorescence data from pump/probe instruments. This may provide useful measures of nitrogen and iron stress on phytoplankton physiology and has important implications for traditional ocean color remote sensing;

Special discussion sessions were also held on future research opportunities related to:

- ocean acidification (see also a new report *Impacts of Ocean Acidification on Coral Reefs and Other Marine Calcifiers Report: A Guide for Future Research*; <http://www.isse.ucar.edu/florida/>);
- the Southern Ocean Gas Exchange Experiment (Gas-Ex III; http://duck-rabbit.ideo.columbia.edu/so_gasex/);
- other Southern Ocean physical and biogeochemical field cam-

- paigns (DIMES, ACE/CSIRO)
- the EU CARBOOCEAN project (<http://www.carboocean.org>)
- the Hawaii Ocean Time-Series (HOT; <http://hahana.soest.hawaii.edu/hot/hot.html>);
- and the Ocean Research Interactive Observatory Networks (ORION; www.orionprogram.org/).

Another Ocean Carbon and Biogeochemistry science workshop will be held in the summer of 2007, the exact dates and location to be announced via email and on the OCB website (<http://ocb.whoi.edu>).

New Zealand IMBER Activities

by Cliff Law and Julie Hall

In the past 18 months New Zealand scientists along with international collaborators have undertaken two research cruises north west of New Zealand. In this region the Tasman Front divides warmer water that remains largely oligotrophic in the north from cooler water to the south that is seasonally oligotrophic with detectable nutrients in surface waters through spring, with North-South differences in the timing, duration and magnitude of primary production. It is unclear how these sub-tropical oligotrophic ecosystems will respond to climate change. Models suggest that the northern Tasman is susceptible to warming, with potential increases in shoaling and stratification of the surface mixed layer that would alter surface-subsurface nutrient

exchange, community composition and carrying capacity. Other climate impacts in this region include potential increases in deposition of dust originating from Australia. The focus of the two cruises has been to develop an understanding of the ecosystem and biogeochemical interactions in this region so that the impacts of climate change can be predicted.

COST (Characterising Oligotrophic Sub-Tropical systems, February 2005) was the first cruise in this region, and focused on establishing the spatial extent and magnitude of oligotrophy in the Tasman Sea, by determining lateral biological and biogeochemical variability in waters north and south of the Tasman Front. The voyage determined that both systems were nitrogen-limited, with no detectable nitrate in surface waters and significant increases in productivity and biomass in response to nitrate addition in incubations. The region was characterised by smaller phytoplankton (*Synechococcus*, *Prochlorococcus*) and high bacterial numbers, comprising a typical "recycling" microbial community, with a northerly increase in diazotroph numbers and nitrogen fixation rates. A strong internal tide in the northern Tasman maintained nitrogen supply to the deep chlorophyll maximum, whereas the plankton in the surface layer were reliant upon N fixation and dust input for new nitrogen.

The COST study provided the background data for site selection for the second cruise, Ncycle, (March 2006) which aimed to establish the processes and controls on the flux and cycling of nitrogen at a single site within a Lagrangian study framework. The focus was state and rate

measurements based around a Lagrangian thermistor chain deployment framework, and included deployment of sediment traps, turbulence / microstructure sensors, dye tracers and MOCNESS plankton tows. These were augmented by diel studies to examine short-term temporal variability, and deck incubations for process rate measurements. One of two diel studies took place during a major storm event associated with a tropical cyclone, with hydrodynamic forcing resulting in major changes in the biogeochemistry during a 24-hr period. The storm was followed within two days by a surface bloom of the colonial diazotroph, *Trichodesmium*, which prompted additional studies to determine the factors responsible for the bloom and the fate of the fixed nitrogen. Multi-factorial perturbation experiments (using NO₃-N, NH₄-N, PO₄-P, Fe, DOC and dust amendments) were undertaken to establish both proximal and ultimate limiting nutrients on different components of the ecosystem. Additional incubations were carried out to examine the impact of elevated pCO₂ on community composition and process rates. The internal tide was identified as a major driver of ecosystem structure with an amplitude that caused the depth of the deep chlorophyll a maximum to vary by 30-40m.

Initial data analysis and interpretation will focus upon the controls and fate of N fixation in this region, followed by development of a nitrogen budget for the permanently oligotrophic system that constrains inputs, fluxes and pools.

Report on the latest IMBER Executive Committee meeting

The IMBER Executive Committee meeting was held at the Plymouth Marine Laboratory in Plymouth (UK) on September 27-29th. This meeting also included a joint session between the IMBER and GLOBEC Executive Committees. The aims of the meeting were to review the implementation of IMBER through the IMBER working groups, regional and national activities, contributing projects and to identify priorities for IMBER and the IPO.

IMBER has now five established working groups or task teams.

The joint IMBER/GLOBEC End-to-End task team has prepared an opinionated review focused on end-to-end food web research to be submitted to a refereed journal. In conjunction with this activity, IMBER is co-sponsoring the International Symposium on "Parameterization of trophic Interactions in Ecosystem Modelling" in March 2007, in Cadiz Spain. This symposium will provide a review, and synthesis, of the present understanding of trophic interactions at key interfaces and provide a vision for the development of future modelling strategies.

Among the activities underway within the joint SOLAS/IMBER Carbon Research Group is the preparation of a white paper proposing the addition of oxygen sensors on the Argo floats. This group is also contributing to the Surface pCO₂ and vulnerability Workshop to be held in Paris in April 2007.

The joint IMBER/LOICZ Continental Margin task team is organising an Open Science Conference to be held in September 2007 in Shanghai. This conference will focus on mid to outer continental shelves, shelf breaks and upper slopes and exchanges between adjacent ecosystems. The outcome of this conference will be a strategy for implementation of Continental Margins research in the two projects.

An IMBER data management committee comprising observationalists, modellers and data specialists has been formed. The first tasks of this group are to prepare a metadata policy and guidelines for the management of the IMBER metadata. The IMBER Deputy Executive Officer Sophie Beauvais has been appointed as the IMBER data liaison officer at the IPO to support the Data Management Committee.

Finally, the Capacity Building task team has developed a capacity building strategy and implementation plan for IMBER. The main objectives of the strategy are to enhance research capabilities in developing countries, enhance research capabilities globally in IMBER activities that have few practitioners and to strengthen graduate education in ocean sciences.

IMBER is also planning a joint conference with CLIVAR focused on climate variability, impacts (of what?) and the marine environment. A planning meeting for this conference will be held in London in December.

The IMBER IPO is working actively to improve the visibility of the program, and has developed a brochure and a poster. The IMBER newsletter "IMBER update" is published quarterly. These promotion

tools are available on the IMBER website (www.IMBER.info) or on request directly at the IPO.

The next IMBER SSC meeting will be held in Victoria (BC) Canada in May-June 2007.

Announcements

Joint LOICZ / IMBER Continental Margins Task Team

by Nancy Rabalais and Jack Middelburg

A working group of ocean scientists is developing a joint LOICZ and IMBER Continental Margins Open Science Conference to be held in Shanghai in September 2007. The geographic focus of the conference will be the mid to outer continental shelves, shelf breaks and upper slopes and exchanges between adjacent ecosystems. The important forcings across these seascapes are global (atmospheric and open ocean-shelf exchange) and local (land-ocean interaction) and interactively modify shelf ecosystems. The conference, while building on biogeochemical advances from programs such as JGOFS and LOICZ, aims to take the next step linking ecosystems to biogeochemical processes and incorporating response/prediction to the global and local changes.

Co-chairs of the Task Team are Jack Middelburg (Netherlands) and Nancy Rabalais (USA), with members Katja Fennel (USA), Burke Hales (USA), K. K. Liu (Taiwan), Isabelle Niang Diop (Sen-

egal), Helmuth Thomas (Canada), Paul Wassman (Norway), Kai Wirtz (Germany) and Jing Zhang (P.R. China). For further information see the IMBER website www.imber.info

New IMBER brochure and poster

A new **IMBER brochure** is now available and will be distributed widely in the coming month as well as during meetings and conferences. The brochure was designed as a communication tool to promote the IMBER program. Copies are available on request at the IPO and downloadable on the IMBER website (www.IMBER.info/useful-downloads.html).

An IMBER poster is also available for downloading at the same address.



IMBER related conferences and workshops

2006

Sustained Indian Ocean Biogeochemical and Ecological Research workshop

October 3-6, Goa, India

<http://www.ian.umces.edu/siber>

GODAE symposium on Ocean Data Assimilation and Prediction in Asia-Oceania

October 16-18, Beijing, China

http://ctwf.iap.ac.cn/godae2006/OtherNews_show.asp?id=1

Workshop on Oxygen Minimum Systems in the Ocean: Distribution, Diversity and Dynamics

October 24-26, Concepcion, Chile

<http://www.copas.udec.cl>

Rapid Climate Change International Conference

October 24-27, Birmingham, UK

<http://www.noc.soton.ac.uk/rapid/rapid2006/>

Earth Science System Partnership Open Science Conference

Global Environmental Change: Regional Challenges

November 9-12, Beijing, China

<http://www.essp.org/ESSP2006/index.html>

SPIE's International Asia-Pacific Remote Sensing Symposium

November 13-17, Goa, India.

Call for papers "Remote Sensing of the Marine Environment"

<http://spie.org/conferences/calls/06/ae/>

AGU Fall meeting

December 11-15, San Francisco, USA

<http://www.agu.org/meetings/fm06/>

GLOBEC-CLIOTOP workshop

November 14-17, 2006, Honolulu, Hawaii

The role of squid in pelagic marine ecosystems.

http://www.globec.org/structure/regional/cliotop/squid_announce.pdf

START Advanced training workshop on southeast Asia regional carbon and water issues

November 14-25, Chung-Li and Kaohsiung, Taiwan

<http://www.sarcs.org/>

Contact: Olga Huang, olga@sarcs.org.tw

ICES/GLOBEC workshop on long-term variability in SW Europe

November 20-24 Lisbon, Portugal

Contact: Juergen Alheit, juergen.alheit@io-warnemuende.de

IMBER/CLIVAR Planning meeting: Impact of Climate Variability Patterns on the Marine Environment

7 December 2006, London, UK

2nd SCOR meeting on coordination of International Marine Research Projects

7-9 December 2006, London, UK

<http://www.jhu.edu/~scor/ProjCoord.htm>

2007**Austral Summer Institute VII**

January 2-26, Concepción, Chile

Arctic Frontiers - An international conference

January 21-26 Tromsø, Norway

Contact : Paul Wassmann (paulw@nfh.uit.no)

SOLAS Open Science Conference

March 6-9, Xiamen, China

<http://www.solas-int.org/>

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

March 20-23, Cadiz, Spain

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

Surface pCO₂ and Ocean Vulnerabilities workshop

April 11-14, Paris, France

http://www.ioc.unesco.org/ioccp/pco2_2007.htm

EGU General Assembly

April 15-20, Vienna, Austria

<http://meetings.copernicus.org/egu2007/>

4th International Zooplankton Production Symposium

May 28-June 1, Hiroshima, Japan

http://www.pices.int/meetings/international_symposia/2007_symposia/4th_Zooplankton/4th_Zoopl.aspx

5th Study Conference on BALTEX

June 4-8, Kuressaare, Saaremaa, Estonia

Contact : Christian MÖLLMANN (christian.moellmann@uni-hamburg.de)

2nd Global Conference on Large Marine Ecosystems

September 11-13, Qingdao, China

http://www.imber.info/jobs-announcements/LMEs_first_announcement.pdf

1st CLIOTOP Symposium: Climate impacts on oceanic top predators

3-7 December 2007 La Paz, Mexico

<http://web.pml.ac.uk/globec/structure/regional/cliotop/symposium.htm>

INSTRUCTIONS TO CONTRIBUTORS

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

ARTICLES

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

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

Contributions should be sent to elena.fily@univ-brest.fr

The Science Plan and Implementation Strategy is available on request at imber@univ-brest.fr and is downloadable from the website, www.imber.info/SPIS.html

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