



Integrated Marine Biogeochemistry and
Ecosystem Research



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Ecosystem Research

GLOBAL
I G B P
CHANGE



International Council for Science
Scientific Committee on Oceanic Research



JGOFS era

2003

2009

“Ocean Futures” activity 2000-2001

Draft Framework for Future Research on Biological and Chemical Aspects of Global Change

Ocean Biogeochemistry and Ecosystems Transition Team 2002-2004

to develop a new project to interface closely with the ongoing IGBP projects GLOBEC, SOLAS, and LOICZ.

Open Science Conference, Paris, 2003
to receive ideas from scientific community



2005-2014

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IMBER Science Plan

Vision

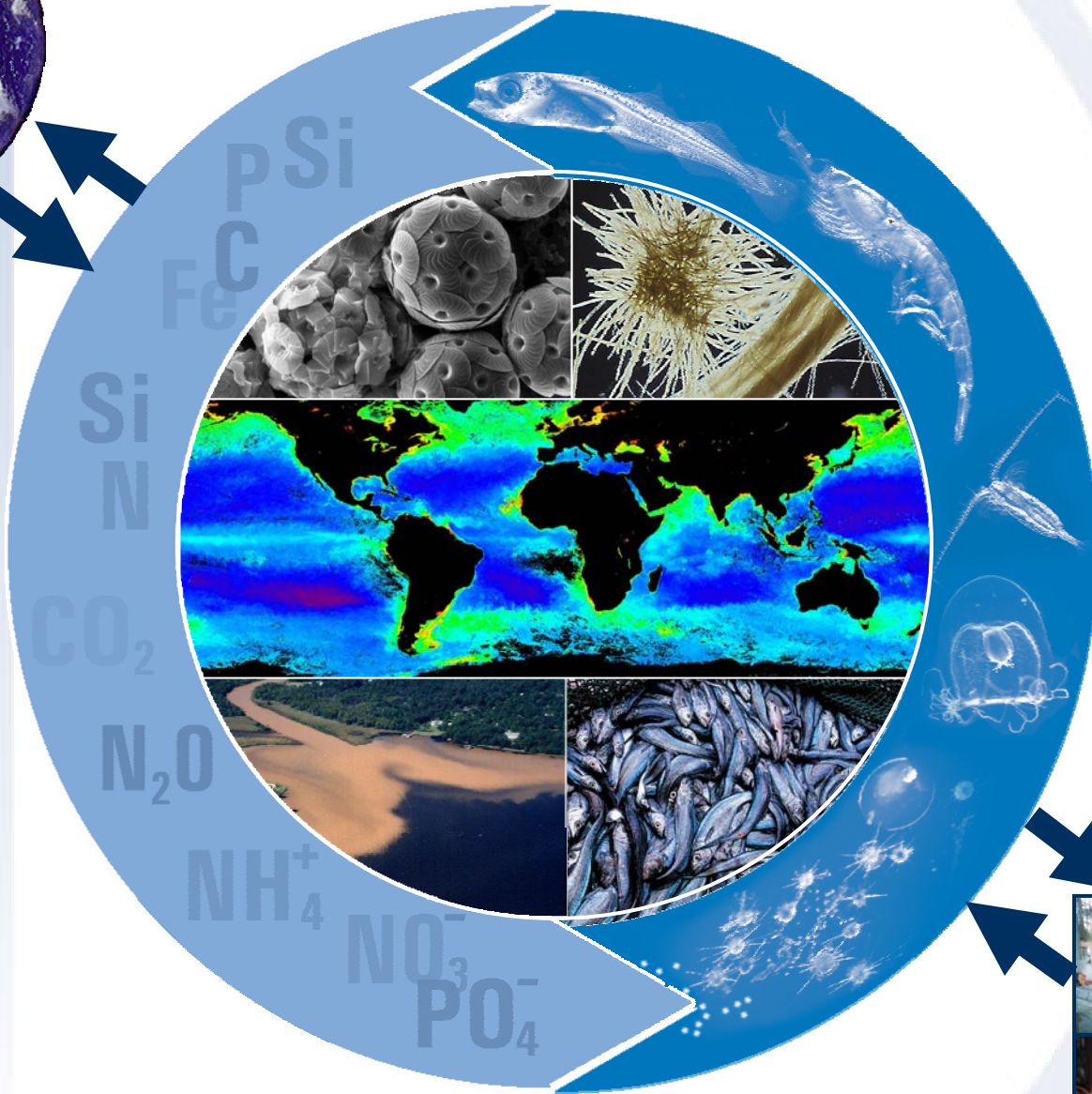
“to provide a comprehensive understanding of and accurate predictive capacity for, ocean responses to accelerating global change and the consequent effects on the Earth System and human society”



Integrated Marine Biogeochemistry and
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Goal

“to investigate the sensitivity of marine biogeochemical cycles and ecosystems to global change, on time scales ranging from years to decades”



IMBER Themes

Theme 1:

Interactions between biogeochemical cycles and marine food webs

Theme 2:

Sensitivity to Global Change

Theme 3:

Feedbacks to the Earth System

Theme 4:

Responses of Society

Theme 1. Interactions between biogeochemical cycles and marine food webs.

What are the key marine biogeochemical cycles, ecosystem processes, and their interactions, that will be impacted by global Change?

Issues:

1. Transformation of organic matter in marine food webs
2. Transfers of matter across ocean interfaces
3. End-to-end food webs and material flows

Theme 2. Sensitivity to Global Change

What are the responses of key marine biogeochemical cycles, ecosystems and their interactions with global change?

Issues:

1. Impacts of climate-induced changes through physical forcing and variability.
2. Effects of increasing anthropogenic CO₂ and changing pH on marine biogeochemical cycles and their interactions.
3. Effects of changing supplies of macro- and micronutrients
4. Impacts of harvesting on end-to-end food webs and biogeochemical cycles.

Theme 3. Feedbacks to the Earth System

What is the role of ocean biogeochemistry and ecosystems in regulating climate?

Issues:

Issue 1. Oceanic storage of anthropogenic CO₂

Issue 2. Ecosystem feedback on ocean physics and climate

Theme 4: Responses of Society

What are the relationships between marine biogeochemical cycles, ecosystems, and the human system?

Theme 4 is the least developed of the themes. There will be a workshop held in early 2006 to bring the natural and social sciences communities together to develop the issues and questions to be addressed in this theme.

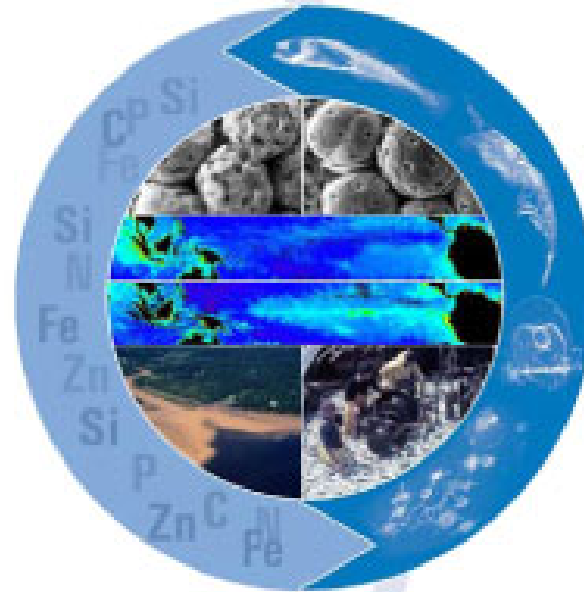
Implementation of IMBER science

- Sustained long term observations
- Repeat hydrographic lines and basin scale transects
- Field-based process studies
- Mesocosm experiments
- Laboratory based experiments
- Use of palaeo-proxies



IGBP Report 5X / SCOR Report XX

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Science Plan and
Implementation Strategy

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1. GLOBEC is focused on physical forcings
2. GLOBEC really only considers the upper trophic levels
3. IMBER is focused on the interaction between ecosystems and biogeochemical cycles there is no consideration of biogeochemistry in GLOBEC.
4. IMBER and GLOBEC together will consider end to end food webs

IMBER IPO

- Brest, France
- Funded three years by CNRS, IRD, University of Brittany, Region of Brittany
- Office opened in August
- Executive Officer is Sylvie Roy
- Deputy Executive Officer is Sophie Beauvais
- Administrative Assistant is Elena Fily

IMBER National-Regional Activities

China has newly funded 5-year programme

Euro Oceans, CarbOcean

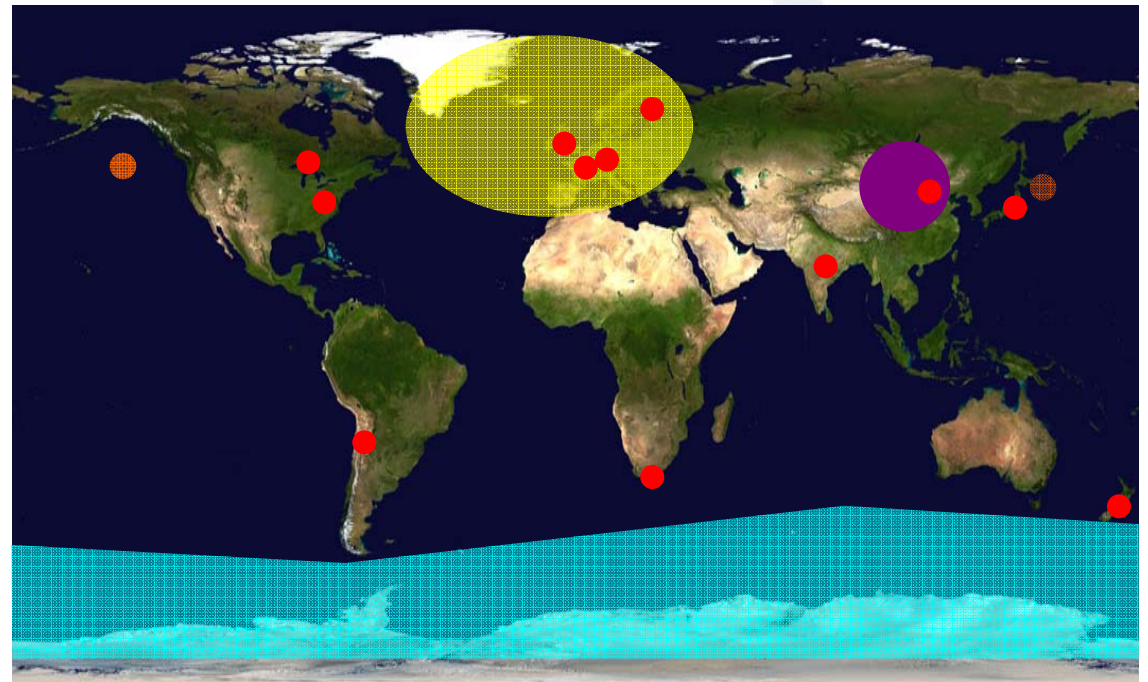
Canada, Chile, Germany, France, India, Japan, New Zealand, Netherlands, South Africa, UK, USA, Finland

Regional Activities

ICED, Southern Ocean

OECOS, Subarctic

Pacific



One of the motivations to develop the IMBER is from JGOFS project. JGOFS found:

- 1) Marine food-web components, structure and their functional role are still not well understood. Finding new species or new functional roles are still common from the marine ecosystem,
- 2) To understand the BGC cycles, integrated study of marine ecosystem and biogeochemistry is essential
- 3) Processes in marine ecosystem and BGC cycles, and their interaction is sensitive to natural and anthropogenic forcings.

IMBER themes are based on these findings. To reach the IMBER goal, multidisciplinary studies, including meteorology, physical oceanography, marine chemistry, biogeochemistry, biological oceanography, fisheries oceanography, social sciences, etc., are essential, and which need quite large efforts from marine scientists.

PICES has been led marine sciences in the North Pacific and taken an initiative of the multidisiplinary scientific activities. CCCC is one of the examples. Close coupling of IMBER and PICES and/or developing a joint scientific programme may greatly proceed the North Pacific marine sciences and helps to reaching the IMBER goal. As the North Pacific has a unique characteristics in physics, chemistry and biology compared with the other oceans. IMBER-PICES joint activities also proceed intercomparisons of ocean systems such as the North Atlantic.



IMBER would like to work in close collaboration with PICES in the North Pacific region, e.g., FISP.

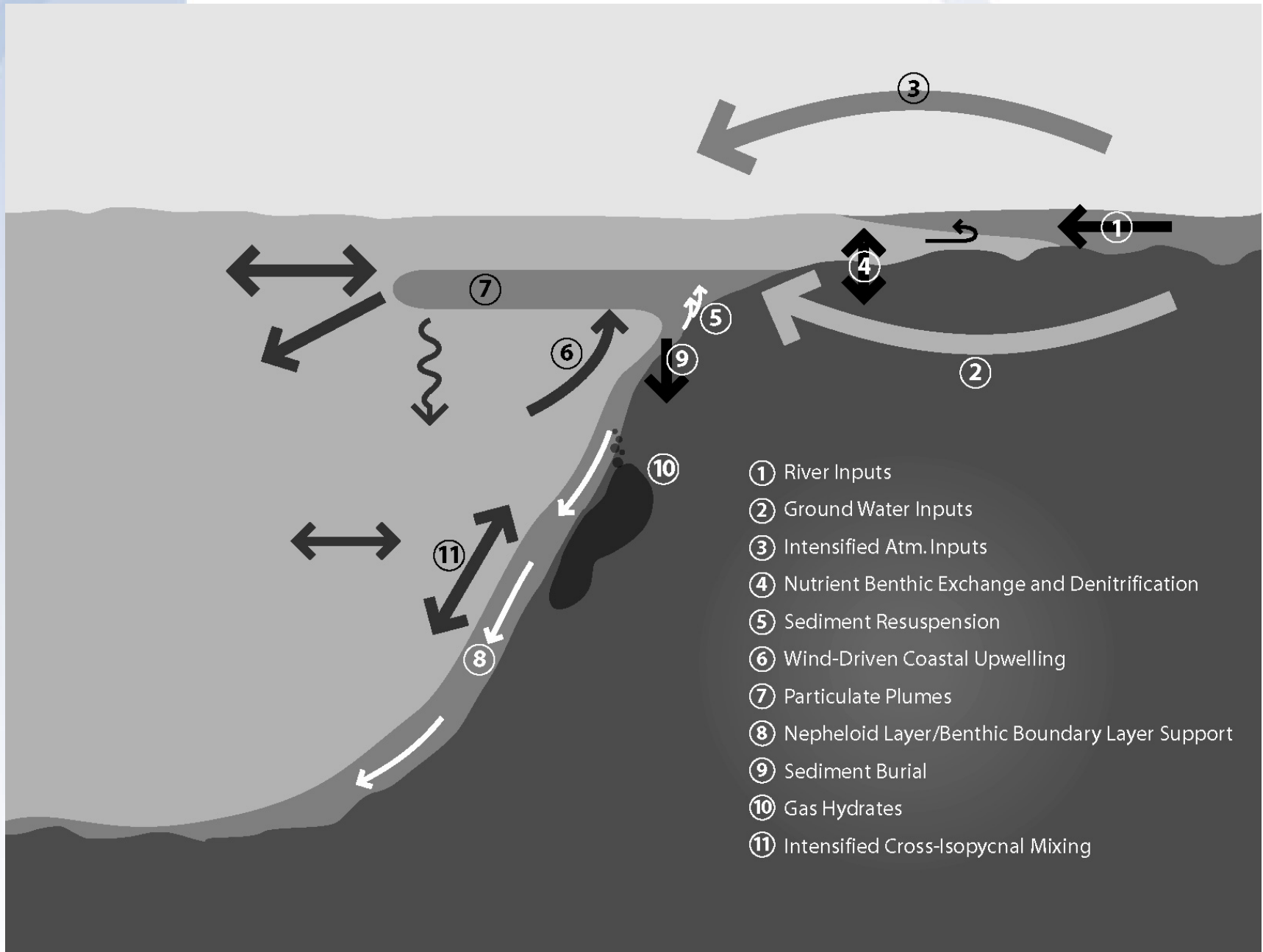
Planned Activities

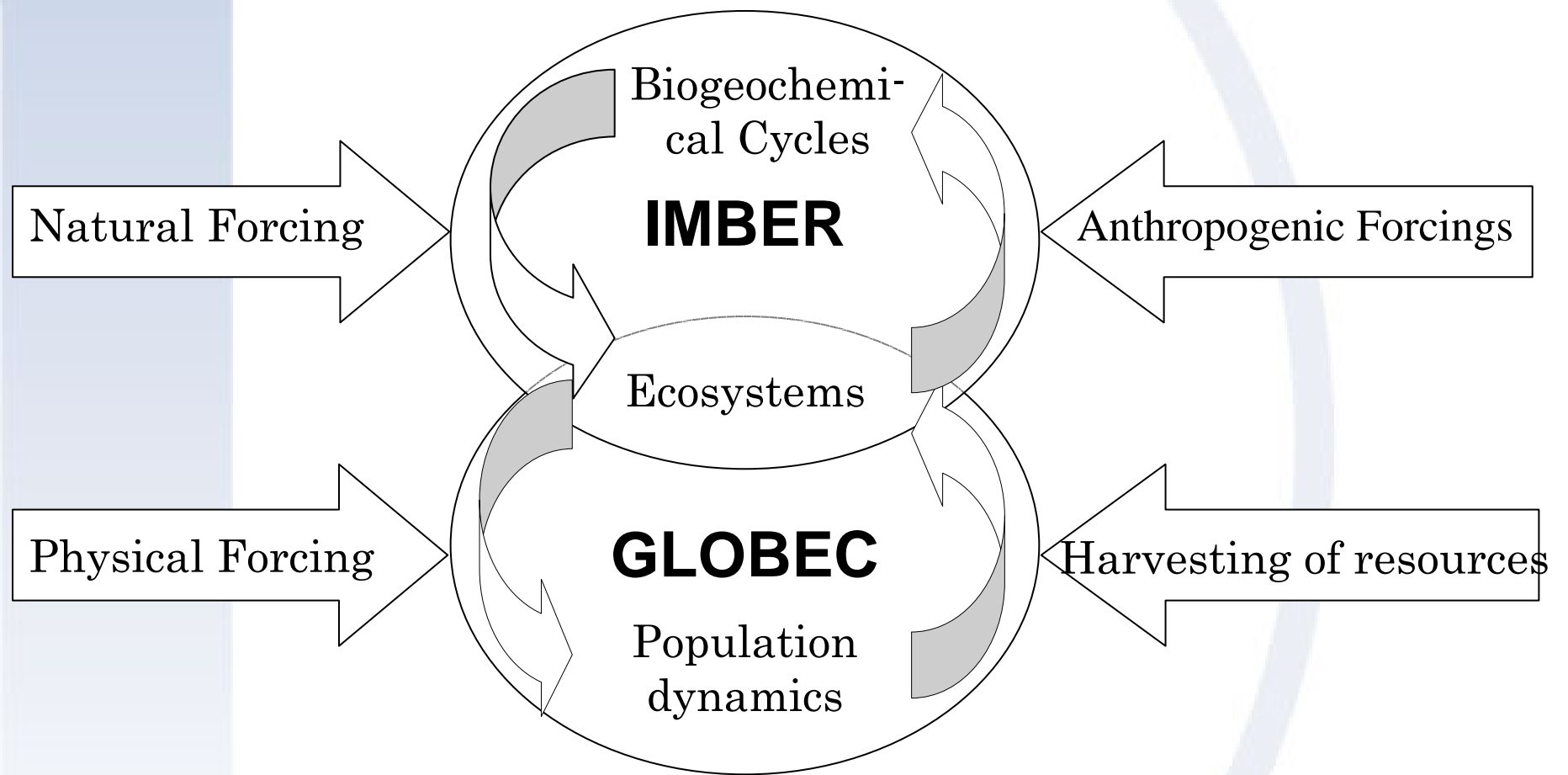
- **2005**
 - Carbon Working Group Meeting, joint IMBER/SOLAS
 - End to end food webs Working Group Meeting, joint IMBER/GLOBEC
 - Executive meeting jointly with GLOBEC Executive Committee
- **2006**
 - Human Dimensions Working Group Meeting
 - Continental Margins OSC
- **2007**
 - Theme 2 Issue 2 (Nutrients) OSC
 - Theme 2 Issue 1 (Physical drivers) OSC
 - ICCED OSC
- **2008**
 - IMBER Open Science Conference



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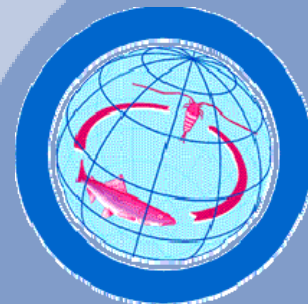
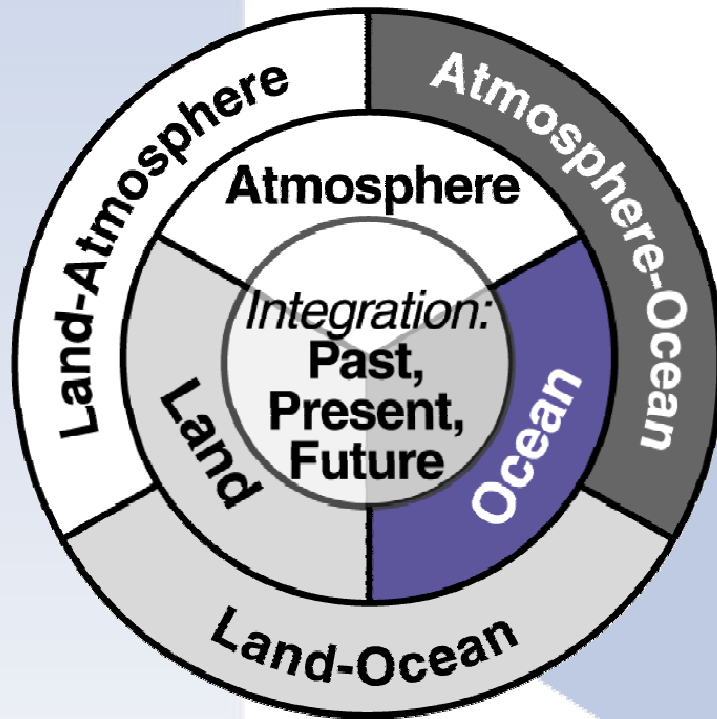




IMBER role in Ocean Carbon Research, in relation to other projects.

Topic	IMBER Role	Project Links
Vertical and Horizontal fluxes	Major	SOLAS
Continental Shelf/Open Ocean exchange	Major	SOLAS/LOICZ
Benthic/Pelagic Coupling	Major	LOICZ
Continental margin carbon cycling	Shared	LOICZ/SOLAS
Carbon fixation/respiration and vertical transport	Major	SOLAS
Food web Dynamics	Major	GLOBEC
Anthropogenic carbon accumulation	Shared	SOLAS/LOICZ
pH and ecosystems	Shared	SOLAS
Temperature effects on photosynthesis and respiration	Major	SOLAS
Impact of macro/micronutrient relationships on vertical export and ecosystems	Major	GLOBEC/SOLAS

Ocean Projects in IGBP II



Issue 1: Transformation of organic matter in marine food webs

Priority Questions:

- What controls the stoichiometry and form of “bioreactive” elements in space and time?
- What controls production, transformation, and breakdown of organic matter in marine food webs?

Issue 2: Transfers of matter across ocean interfaces

Priority Questions:

- What are the time and space scales of remineralisation of organic matter in the mesopelagic layer?
- How does nutrients exchange between continental margins and the ocean interior impact biogeochemical cycles?
- How exchange between the seafloor and the water column impact food web structure and function?

Issue 3: End-to-end food webs and material flows

Priority Questions:

- How do food web dynamics affect nutrient availability?
- How do key functional groups, species, and genes affect biogeochemical cycles?
- How do species biodiversity and species interactions affect food web functioning and biogeochemical cycling?
- How are the interactions between biogeochemical processes and food webs recorded in palaeoproxies?

Issue 1: Impacts of climate-induced changes through physical forcing and variability.

Priority Questions:

- What is the impact of changes in circulation, ventilation and stratification?
- What are the direct effects of changes in ocean temperature and light environment?
- What are the impacts of changes in frequency and intensity of extreme and episodic events?

Issue 2: Effects of increasing anthropogenic CO₂ and changing pH on marine biogeochemical cycles, ecosystems and their interactions

Priority Questions:

- What are the effects of CO₂ driven changes in carbonate chemistry?
- What are the effects of pH-driven changes in nutrient and trace metal speciation?
- Which organisms and biological processes are most sensitive to pH and CO₂ changes, what are the consequences, and to what extent can organisms adapt in response to these changes?

Issue 3: Effects of changing supplies of macro- and micronutrients

Priority Questions:

- How will changes in macro- and micronutrient inputs to the ocean affect the cycles of these elements?
- How will changes in the abundance, distribution, and stoichiometry of nutrient elements affect food web structure and function?
- How will increases in hypoxia and anoxia affect food webs and cycles of key macro- and micronutrients?

Issue 4: Impacts of Harvesting

Priority Questions:

- How do harvesting-induced changes in food web structure impact biogeochemical cycles?
- What are the impacts of harvesting living marine resources on end-to-end food webs?

Issue 1. Oceanic storage of anthropogenic CO₂

Priority Questions:

- What are the spatial and temporal scales of storage of CO₂ in the ocean interior?
- What is the role of the continental margins in ocean carbon storage under global change?

Issue 2: Ecosystem feedbacks on ocean physics and climate

Priority Questions:

- How do marine food web structure and variability affect ocean and ice physics, and large-scale climate and its variability, via the upper ocean heat budget?
- What will be the effect of global changes in oxygen minimum zones on sources, transport and out gassing of N₂O?