Integrated Marine Biogeochemistry and Ecosystem Research (IMBER)

Planning for the IMBER (Integrated Marine Biogeochemical and Ecosystem Research) project was initiated by SCOR and IGBP in 2001, to address the gaps that exist in the available knowledge of the ocean system. The IMBER project will identify the key interactions between marine biogeochemical cycles and ecosystems, and how these interactions may respond to complex, natural and anthropogenic forcing in the ocean (Figure 1). Important forcings include large-scale climatic variations, changing physical and biological dynamics, changes in carbon system chemistry, and changing nutrient fluxes. Anticipated changes in marine biogeochemical cycles and ecosystems also have consequences for the broader Earth System, with negative feedbacks, for example, on oceanic storage of anthropogenic CO₂. Dramatic reductions in the top marine predators (fish stocks such as tuna) will impact the dynamics of lower trophic levels, thus impacting marine biogeochemistry and associated global feedbacks. Advancing our knowledge and quantification of these interactions and feedbacks are central to the goal of IMBER.



Figure 1. Schematic depiction of the essential features of the IMBER project. These include impacts of natural climatic and anthropogenic influences on marine biogeochemical cycles and ecosystems, their interactions, and feedbacks to the Human and Earth Systems.

The IMBER Science Plan has been developed around four major themes. Theme 1 focuses on identifying and characterizing interactions of the key biogeochemical and ecosystem processes that will be impacted by global change. Theme 2 considers the sensitivity of these key processes and interactions to global change, with an emphasis on prediction and quantification. Theme 3 investigates the role of ocean biogeochemistry and ecosystems in impacting the larger earth system through direct and indirect feedbacks. Finally, Theme 4 draws findings from the previous three themes to investigate key interactions with the human system and the policies that must be developed to mitigate or adapt to the impacts of global change on marine biogeochemical cycles and ecosystems. Each theme identifies a series of priority issues to be considered.

The IMBER themes and issues are:

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?

- Issue 1. Transformation of organic matter in marine food webs
- Issue 2. Transfers of matter across ocean interfaces
- Issue 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 to global change?

- Issue 1. Impacts of climate-induced changes through physical forcing and variability.
- Issue 2. Effects of increasing CO₂ and changing *p*H.
- Issue 3. Effects of changing supplies of macro- and micronutrients.
- Issue 4. Impacts of harvesting.

Theme 3: Feedbacks to the Earth System: What is the role of ocean biogeochemistry and ecosystems in regulating climate?

- Issue 1 : Change in global oceanic storage of carbon
- Issue 2: Ecosystem feedbacks on ocean physics and climate

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

- Issue 1: Human lifestyle effects on the state of the ocean
- Issue 2: Mitigation or adaptive policies that could reduce the impact of global change on society