Ocean Carbon Cycling and Climate Impacts on Marine Ecosystems

Third Annual Ocean Carbon and Biogeochemistry Summer Science Workshop 2008; Woods Hole, Massachusetts, 21–24 July 2008

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The Ocean Carbon and Biogeochemistry (OCB) program is a coordinating body for the U.S. research community that focuses on the ocean's role as a component of the global Earth system, bringing together research in geochemistry, ocean physics, and ecology to advance our understanding of ocean biogeochemistry. The third annual OCB summer science workshop, sponsored by the U.S. National Science Foundation, took place at Woods Hole Oceanographic Institution, convening 147 participants.

Daily plenary and poster sessions focused on three interdisciplinary themes: (1) climate sensitivity of ecosystem structure and associated impacts on biogeochemical cycles, (2) carbon uptake and storage, and (3) temporal trends in ecosystem variability.

Using observations and models, speakers from theme 1 addressed impacts of climate variability, climate change, and ocean acidification on marine calcifiers, pelagic food-web dynamics, benthic fauna, fluxes to the deep ocean, and oxygen minimum zone extent and evolution.

Presentations from theme 2 summarized recent ocean carbon flux trends and key controlling processes in critical regions such as the Southern Ocean, the northern oceans, and the Gulf of Mexico. One speaker described a new tracer-based back-calculation method for reconstructing anthropogenic carbon uptake in the world's oceans.

Presentations in theme 3 focused on how satellite- and ocean-based time series, paleoclimate records, and regional programs such as Global Ocean Ecosystem Dynamics (GLOBEC) advance our understanding of marine biogeochemical cycling and feedbacks between climate and marine ecosystems and provide critical data to improve complex ecosystem models.

Breakout sessions provided a forum for discussing field-based, remote sensing, and modeling strategies to address knowledge gaps. Two common threads emerged repeatedly throughout the workshop: (1) the importance of the Southern Ocean in the global carbon cycle and (2) the need to expand observational capabilities for the OCB community by leveraging underway ship systems, autonomous platforms, and the Ocean Observatories Initiative (OOI). Specific observational challenges include improved quantification of planktonic functional group distributions, lateral transport, benthic-pelagic coupling, and air-sea CO_2 fluxes and food-web changes.

Additional highlights included a planning session for OCB coordination of a coastal synthesis as part of the North American Carbon Program's interim synthesis activities, a presentation of exciting new results on the spring 2008 plankton bloom as part of the North Atlantic Bloom Experiment, a plenary discussion of OCB's leadership role in defining future carbon cycle research directions, and plenary discussions following up on two recent OCB scoping workshops (one on ocean acidification and one on terrestrial and coastal carbon fluxes and exchanges in the Gulf of Mexico).

For further information (meeting agenda, list of participants, talks, live webcasts, etc.), please visit http://www.whoi.edu/sites/ocbworkshop2008.

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Bioturbation From Square Millimeter to Global Scales

Bioturbation: An Update on Darwin's Last Idea; Renesse, Netherlands, 23–27 August 2008

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Marine sediments occupy about 70% of the Earth's surface and represent one of the most important interfaces in the Earth system because they regulate the transfer of carbon from the biosphere to the geosphere. A crucial control on carbon processing is exerted by the animals inhabiting the ocean floor, which extensively rework and oxygenate sediments while feeding and moving, a process referred to as bioturbation.

The significance of bioturbation was first realized by Charles Darwin, who devoted his final book to the subject. Recently, the second international meeting on bioturbation was organized in the Netherlands, following upon the success of the first meeting, in France (Marseille), in 2004. The purpose of this meeting was to provide a multidisciplinary update on the importance of bioturbation in sediment biogeochemistry, ecosystem functioning, and global biogeochemical cycles. Sixty scientists from 16 countries came together to address the physics, chemistry, geology, and biology of bioturbation in sediments and soils, in both the present and the past.

Talks addressed the impact of bioturbation from square millimeter to global scales, on land, in lakes, and in the oceans. Results from novel observation technologies were shown, particularly featuring planar optodes, which use chemical transducers to optically measure properties of specific substances. This enables the real-time observation of two-dimensional dissolved oxygen, acidity, dissolved iron, the presence of hydrogen sulfide, and carbon dioxide distributions in sediments, thus allowing an unprecedented characterization of submillimeter-scale heterogeneity. These novel observation tools are complemented with a variety of modeling techniques, including those based on continuous time random walks and individual-based computer simulations.

Sediments are composite media comprising not only particles of various size and water-filled pores, but also many organisms of variable size (from microbes to large animals). The mechanical properties are largely unknown, and novel insights were presented at the meeting on how bioturbating worms crack sediments and how organisms generate pressure waves while ventilating their burrow structures.

Finally, bioturbation research has traditionally been executed independent of biodiversity studies. This is unfortunate, and some talks highlighted how biodiversity links to bioturbation and to organic matter mineralization in sediments. This new line of research will need further development because the biodiversity loss of organisms near the ocean floor (e.g., due to increasing coastal hypoxia) will have major consequences for bioturbation and sediment biogeochemistry. Several talks and posters presented at the meeting illustrated that burrow construction by large animals can result in new niches for smaller animals and microbes, emphasizing the strong link between bioturbation-induced heterogeneity and biodiversity maintenance, and the need for further targeted studies on this topic.

The meeting was organized by Bob Aller (Marine Sciences Research Center, State University of New York at Stony Brook), Erik Kristensen (Institute of Biology, University of Southern Denmark, Odense), Frank Gilbert (Laboratoire d'Ecologie des Hydrosystèmes, Université Paul Sabatier (Toulouse III), France), Jack Middelburg (Netherlands Institute of Ecology, Yerseke), and Filip Meysman (Earth System Science Group at Vrije Universiteit Brussel, Belgium) under the umbrella of Nereis Park, the Internet portal of an international association of bioturbation researchers (http://www.nereispark.org/). The meeting was