

## DOE CENTER FOR RESEARCH ON OCEAN CARBON SEQUESTRATION

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### RESEARCH OBJECTIVES

Increased energy efficiency, decarbonization of fuels and carbon sequestration are three research areas that the U.S. Department of Energy (DOE) is investigating for managing levels of CO<sub>2</sub> gas in the atmosphere. Carbon sequestration is the storage of CO<sub>2</sub> in terrestrial ecosystems and soils, geological formations and in the ocean. Ocean carbon sequestration is a viable option for investigation since the oceans are already a sizable reservoir of carbon.

In July 1999, DOE's Office of Science announced the formation of the DOE Center for Research on Ocean Carbon Sequestration (DOCS). The center is jointly shared between Lawrence Berkeley National Laboratory (J. Bishop, co-director) and Lawrence Livermore National Laboratory (K. Caldeira, co-director) and includes participants from six outside groups from across the nation.

### APPROACH

The center is performing research necessary to evaluate the feasibility, effectiveness and environmental acceptability of ocean carbon sequestration by:

- addressing ocean fertilization and direct injection, and other ocean carbon sequestration strategies;
- advancing understanding of the biological, chemical and physical processes that are critical to the ocean carbon cycle;
- understanding the effects of proposed sequestration strategies on this system;
- training graduate students and post doctoral investigators;
- interacting with the larger community to advance the state of ocean sequestration science;
- providing accurate information on ocean carbon sequestration for the government, other researchers and the public.

### ACCOMPLISHMENTS

The center has identified key gaps in the understanding of ocean sequestration. For example, great uncertainty exists in the fate of biologically produced carbon in the upper ocean as it sinks into the deep sea. Furthermore, significant variability of the ocean carbon system occurs on day-to-day time scales — the growth times of marine plants — yet this variability is unsampled in many of the biologically dynamic regions of the ocean. Such information is required for accurate representation of biological processes in ocean models being developed at LLNL. Similarly, there remain uncertainties on the fate of liquid CO<sub>2</sub> injected into mid-depth ocean waters. LBNL is addressing these gaps by developing methods to observe ocean carbon variability using robotic autonomous observing systems. Key elements of needed research have been identified and communicated in scientific and public forums.

### RELATED PUBLICATIONS

Bishop, J.K., S.E. Calvert and M.Y.-S. Soon, Spatial and temporal variability

Figure 1. SeaWiFS ocean color image of plant biomass in the waters of the southern ocean. Ocean fertilization of the nutrient rich waters of the Southern Ocean has been proposed as a way to stimulate vertical transport of CO<sub>2</sub> from the atmosphere to the deep sea.

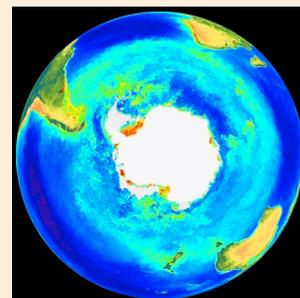
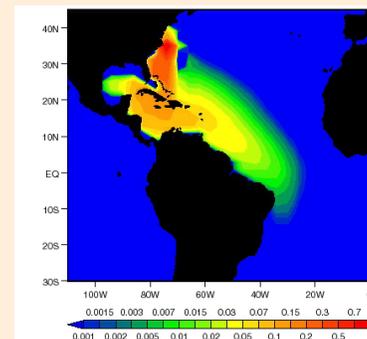


Figure 2. Lawrence Livermore National Laboratory model simulation of the fate of liquid CO<sub>2</sub> injected at a depth of 1700 m near New York City. Direct CO<sub>2</sub> injection uses CO<sub>2</sub> captured at a central site of fossil fuel usage, for example, a power plant.



of POC in the northeast subarctic Pacific, Deep-Sea Research II, 46(11-12) 2699-2733, 1999.

Fung, I.Y., S.K. Meyn, I. Tegen, S.C. Doney, J.G. John and J.K.B. Bishop, Iron supply and demand in the upper ocean, Global Biogeochemical Cycles, 14(N1):281-295, 2000.

Bensen, S., T. Dorchak, G. Jacobs, J. Ekmann, J.K.B. Bishop and T. Grahame, Carbon dioxide reuse and sequestration: the state of the art today, ENERGY 2000, The State of the Art, P. Catania, ed., Publ. Balaban International Science Services, L'Aquila, Italy. pp 205-226, ISBN 086689-05-56, 2000.

### ACKNOWLEDGEMENTS

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