Office of Science
Notice 02-11

Ocean Carbon Sequestration Research Program

Department of Energy
Office of Science

Office of Science Financial Assistance Program Notice 02-11: Ocean Carbon Sequestration Research Program

AGENCY: U.S. Department of Energy

ACTION: Notice inviting grant applications.

SUMMARY: The Office of Biological and Environmental Research (OBER) of the Office of Science (SC), U.S. Department of Energy (DOE), hereby announces its interest in receiving applications for research on Carbon Sequestration in the Oceans.

DATES: Applicants are strongly encouraged to submit a brief preapplication for programmatic review no later than January 18, 2002.

The deadline for receipt of formal applications is 4:30 p.m., E.S.T., March 26, 2002, to be accepted for merit review and to permit timely consideration for award in Fiscal Year 2002 and early Fiscal Year 2003.

ADDRESSES: Preapplications should be sent via E-mail to Dr. Anna Palmisano at: anna.palmisano@science.doe.gov.

Formal applications, referencing Program Notice 02-11, should be sent to: U.S. Department of Energy, Office of Science, Grants and Contracts Division, SC-64, 19901 Germantown Road, Germantown, MD 20874-1290, ATTN: Program Notice 02-11. This address must also be used when submitting applications by U.S. Postal Service Express Mail or any other commercial overnight delivery service, or when hand-carried by the applicant.

FOR FURTHER INFORMATION CONTACT: Dr. Anna Palmisano, Environmental Sciences Division, SC-74, Office of Biological and Environmental Research, Office of Science, U.S. Department of Energy, 19901 Germantown Road, Germantown, MD 20874-1290, telephone: (301) 903-9963, E-mail: anna.palmisano@science.doe.gov, fax: (301) 903-8519. The full text of Program Notice 02-11 is available via the Internet using the following web site address: http://www.sc.doe.gov/production/grants/grants.html.

SUPPLEMENTARY INFORMATION: Predictions of global energy use in the next century suggest a continued increase in carbon emissions and rising concentrations of carbon dioxide (CO2) in the atmosphere unless major changes are made in the way we produce and use energy – in particular, how we manage carbon.

One way to manage carbon is to use energy more efficiently to reduce our need for a major energy and carbon source – fossil fuel combustion. A second way is to increase our use of low-carbon and carbon-free fuels and technologies, such as nuclear power and renewable sources such as solar energy, wind power, and biomass fuels.

A third way to manage is by "carbon sequestration": The capture and long term storage of carbon either from the global energy system or directly from the atmosphere in oceanic or terrestrial ecosystems. Although many options exist to capture and sequester carbon dioxide, the focus of this solicitation is on fundamental research that would enable: a) the enhancement of the absorption and retention of atmospheric carbon by ocean biota; and b) the use of the deep ocean to store carbon dioxide that has been already separated, captured, and transported.

Any viable system for sequestering carbon must have a number of characteristics. It must be effective and cost-competitive with alternative means, such as renewable energy. Unintended environmental consequences must be benign compared to alternative solutions, including no action. A carbon sequestration system must be able to be monitored quantitatively and verified, because contributions to carbon sequestration almost certainly need to be measured. Research sponsored by this program could contribute to any of these goals.

This solicitation invites applications for basic research projects on carbon sequestration in the oceans. The proposed research should be fundamental in nature. Applications that test demonstrations of engineered technologies are not relevant to this solicitation.

Technical Areas of Interest

The ocean represents a large current sink for the sequestration of anthropogenic CO2 emissions as well as a large potential for further enhancement. Two strategies for enhancing carbon sequestration in the ocean are the focus of the DOE Ocean Carbon Sequestration Research Program. One strategy is the enhancement of the net oceanic uptake from the atmosphere by fertilization of phytoplankton with micronutrients, such as iron. A second strategy is the direct injection of a relatively pure CO2 stream to ocean depths greater than 1000 m. Sources of CO2 for direct injection might include power plants, industries or other sources. This solicitation seeks applications that specifically address the long term effectiveness and potential environmental consequences of ocean sequestration by these two strategies. Research projects currently being funded under the DOE Ocean Carbon Sequestration Research Program may be accessed at: http://cdiac2.esd.ornl.gov/ocean.html. The program currently funds projects in a wide range of scientific disciplines including marine biology and ecology; biological, physical, and chemical oceanography; computational science and modeling; and physical chemistry and engineering.

Iron Fertilization

Much has been learned about the important role of iron in photosynthesis over the past 15 years through both laboratory and field iron enrichment experiments. Iron deficiency has been shown to limit the efficiency of photosystem II in phytoplankton. Evidence from paleoceanographic samples also links iron supply with marine primary production and carbon flux. However, critical questions remain: How does iron enrichment accelerate carbon flux in high nutrient, low chlorophyll (HNLC), low nutrient, low chlorophyll (LNLC), sub-mixed layer and coastal ecosystems? What are the time scales of remineralization? What are the long term ecological and biogeochemical consequences of fertilization on surface and midwater processes? Basic research is needed on the biogeochemistry of iron and carbon in the ocean. The accurate measure of carbon flux following iron fertilization is critical to the objective evaluation of this strategy for carbon sequestration. We need to understand the regulation of carbon fluxes and the role of mineral ballast in export of organic carbon from the surface to the deep ocean. Our understanding of the concentrations, sources, sinks and ligands of iron in marine systems is also very limited. The complexity of marine ecosystems necessitates careful research on potential environmental consequences of iron fertilization. These consequences may include the potential to impact key oceanic biogeochemical cycles as well as on populations of marine organisms and their trophodynamic interactions.

Examples of relevant research areas for enhancement of the biological pump through iron fertilization include:

1. Environmental consequences of long term ocean fertilization. Research might focus on:

   - Examining changes in structure and function of marine ecosystems including community structure of phytoplankton and zooplankton, ocean food webs and trophodynamics, resulting from ocean fertilization.
   - Examining changes in natural oceanic biogeochemical cycles (carbon, nitrogen, phosphorus, and silicon) resulting from carbon sequestration.

2. Effectiveness of ocean fertilization on a large scale. Research might focus on:

   - Understanding the biological pumping of carbon to deep waters, the export of particulate organic carbon and particulate inorganic carbon to the deep sea, and mineralization or dissolution of all forms at depth. This includes understanding the role of micronutrients (such as iron) and macronutrients (such as nitrogen and phosphorus) in regulation of the biological pump.
   - Determining to what extent increased carbon fixation in surface waters would result in an increase in carbon sequestered in the deep ocean, and how long it would remain sequestered.

Research proposed on iron fertilization should also support the USGCRP Carbon Cycle Science Initiative. For a copy of the Carbon Cycle Science Plan, access the following web site: http://www.gcrio.org/OnLnDoc/pdf/carb_cycle_toc.html. In particular, the proposed research should provide the scientific foundation for estimating the capacity of the ocean to sequester and store carbon dioxide released as a result of human activities.

Direct Injection

The overarching question for this research area is: Can direct CO2 injection effectively sequester CO2 in the ocean with minimal adverse environmental impacts? Fundamental research is needed to assess the efficiency and consequences of direct injection to sequester a maximum level of CO2 while minimizing the impact on deep sea ecosystems. Current scientific literature on the physiology of deep sea animals suggests a high sensitivity of deep sea animals to acidosis and hypercapnia (CO2 stress), however, there are few data on impacts of specific levels of CO2 on animals from various marine habitats. Moreover, there are virtually no data on the potential effects of CO2 on microbially-mediated biogeochemical transformations of nutrients in the deep sea. Models are needed that provide information on the fate of injected CO2, particularly in the 100m to 100km range, from the point of injection. The ultimate goal is to be able to develop a coupled model that can predict the fact of injected CO2 and its chemical, physical and biological effects on marine ecosystems.

Examples of relevant research areas for direct injection of carbon dioxide into the deep ocean include:

1. Environmental consequences of direct injection of CO2 into the ocean in midwater or deep sea habitats. Research might focus on:

- Determining the effects of changes in pH and CO2 on the physiology and survival of organisms (including microbes) from midwater and deep sea habitats.
- Understanding the effects of sustained release of concentrated CO2 on biogeochemical processes, and on ecosystem structure and function. This includes investigations of biogeochemical interactions of seafloor sediments with a hydrated CO2 plume.

2. Effectiveness of direct injection of CO2 for carbon sequestration. Research might focus on:

- Understanding the longer-term fate of carbon that is added to the ocean including the carbonate chemistry of mid- and deep-ocean water.
- Addressing weaknesses in Ocean General Circulation Models (OGCMs), specifically their ability to simulate accurately western boundary currents, ocean bottom currents and plume to eddy circulation, and testing models using natural or experimental tracers.
- Coupling near-field with far-field effects of CO2 injection, for example, couple plume modeling at the basin and global scale with ocean circulation models.

Collaboration

Applicants are encouraged to collaborate with researchers in other institutions, such as: universities, industry, non-profit organizations, federal laboratories and Federally Funded Research and Development Centers (FFRDCs), including the DOE National Laboratories, where appropriate, and to include cost sharing and/or consortia wherever feasible. Additional

information on collaboration is available in the Application Guide for the Office of Science Financial Assistance Program that is available via the Internet at: http://www.sc.doe.gov/production/grants/Colab.html.

Program Funding

It is anticipated that up to $1,000,000 will be available for awards in this area during Fiscal Year 2002, contingent upon availability of appropriated funds. An additional $1,000,000 will be available for competition by DOE National Laboratories under a separate solicitation (LAB 02-11). Projects involving single investigators or small groups of investigators may be funded at a level up to $300,000 per year for up to 3 years. Applications for field experiments involving larger groups of investigators will be considered, but must be approved at a preapplication level. Multiple year funding of awards is expected, and is also contingent upon availability of funds, progress of the research, and continuing program need.

Preapplications

An informal preapplication may be submitted by E-mail. The preapplication should identify the institution, Principal Investigator name, address, telephone, fax and E-mail address, title of the project, and proposed collaborators. The preapplication should consist of a one to two page narrative describing the research project objectives and methods of accomplishment. These will be reviewed relative to the scope and research needs of the Ocean Carbon Sequestration Research Program. Preapplications are strongly encouraged prior to submission of a full application, especially for large, field-based collaborations. Notification of a successful preapplication is not an indication that an award will be made in response to the formal application.

Merit Review

Applications will be subjected to scientific merit review (peer review) and will be evaluated against the following evaluation criteria listed in descending order of importance as codified at 10 CFR 605.10(d):

1. Scientific and/or Technical Merit of the Project,
2. Appropriateness of the Proposed Method or Approach,
3. Competency of Applicant's Personnel and Adequacy of Proposed Resources,
4. Reasonableness and Appropriateness of the Proposed Budget.

The evaluation will include program policy factors such as the relevance of the proposed research to the terms of the announcement and the agency's programmatic needs. Note, external peer reviewers are selected with regard to both their scientific expertise and the absence of conflict-of-interest issues. Both non-federal and federal reviewers may be used, and submission of an application constitutes agreement that this is acceptable to the investigator(s) and the submitting institution.

Formal Applications

Information about the development and submission of applications, eligibility, limitations, evaluation, selection process, and other policies and procedures may be found in 10 CFR Part 605, and in the Application Guide for the Office of Science Financial Assistance Program. Electronic access to the Guide and required forms is available via the World Wide Web at: http://www.sc.doe.gov/production/grants/grants.html. DOE is under no obligation to pay for any costs associated with the preparation or submission of applications if an award is not made. The research project description must be 15 pages or less, exclusive of attachments and must contain an abstract or summary of the proposed research. On the SC grant face page, form DOE F 4650.2, in block 15, also provide the PI's phone number, fax number and E-mail address. Attachments include curriculum vitae, a listing of all current and pending federal support, and letters of intent when collaborations are part of the proposed research. Curriculum vitae should be submitted in a form similar to that of NIH or NSF (two to three pages), see for example: http://www.nsf.gov:80/bfa/cpo/gpg/fkit.htm#forms-9.

The Catalog of Federal Domestic Assistance Number for this program is 81.049, and the solicitation control number is ERFAP 10 CFR Part 605.

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for Resource Management

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