Program Announcement
To DOE National Laboratories
LAB 03-15

Ocean Carbon Sequestration Research Program

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 proposals for research on Carbon Sequestration in the Oceans.

DATES: Researchers are strongly encouraged to submit a brief preproposal for programmatic review by January 31, 2003, although later preproposals will still be accepted.

The deadline for receipt of formal proposals is 4:30 p.m., E.S.T., March 20, 2003, to be accepted for merit review and to permit timely consideration for award in Fiscal Year 2003 and early Fiscal Year 2004.

ADDRESSES: Preproposals should be sent e-mail to Dr. Anna Palmisano at anna.palmisano@science.doe.gov.

Formal proposals in response to this solicitation are to be submitted as PDF files on CDs. Eight CDs should be submitted for each proposal. Color images should be submitted as a separate file in PDF format and identified as such. These images should be kept to a minimum due to the limitations of reproducing them. They should be numbered and referred to in the body of the technical scientific proposal as Color image 1, Color image 2, etc.

The CDs, referencing Program Announcement LAB 03-15, should be sent to: Climate Change Research Division, SC-74/Germantown Building, Office of Biological and Environmental Research, Office of Science, U.S. Department of Energy, 1000 Independence Avenue, SW, Washington, D.C. 20585-1290, ATTN: Program Announcement LAB 03-15.

When submitting by U.S. Postal Service Express Mail, any commercial mail delivery service, or when hand carried by the researcher, the following address must be used: Climate Change Research Division, SC-74, Office of Biological and Environmental Research, Office of Science, U.S. Department of Energy, 19901 Germantown Road, Germantown, MD 20874-1290, ATTN: Program Announcement LAB 03-15.

FOR FURTHER INFORMATION CONTACT: Dr. Anna Palmisano, SC-74, Office of Biological and Environmental Research, Germantown Building, U.S. Department of Energy, 1000 Independence Ave., SW, Washington, D.C. 20585-1290, telephone: (301) 903-9963, E-mail: anna.palmisano@science.doe.gov, fax: (301) 903-8519.

SUPPLEMENTARY INFORMATION: Predictions of global energy use in the next century suggest a continued increase in carbon emissions and rising concentrations of carbon dioxide (CO_2) 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. The third way to manage carbon 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.

Any viable system for sequestering carbon must have several key 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 proposals for basic research projects on the purposeful enhancement of carbon sequestration in the oceans. 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 dioxide by ocean biota; and b) scientifically-based analyses of the viability of using the deep ocean to store carbon dioxide that has been already separated, captured, and transported. The proposed research should be fundamental in nature, and address one or more of the technical areas of interest described below. Proposals 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 CO_2 emissions as well as a large potential for purposeful enhancement of the current sink. Two strategies for enhancing carbon sequestration in the ocean are the focus of the DOE Ocean Carbon Sequestration Research Program. One strategy is 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 CO_2 stream to ocean depths greater than 1000 m. Sources of CO_2 for direct injection might include power plants or other industries. This solicitation seeks proposals that specifically address the long term effectiveness and potential environmental consequences of ocean sequestration by these two strategies. 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. Titles and abstracts of research projects currently being funded under the DOE Ocean Carbon Sequestration Research Program may be accessed at http://cdiac2.esd.ornl.gov/ocean.html.

Iron Fertilization

Much has been learned about the important role of iron in photosynthesis over the past 15 years through both laboratory and field experiments on iron enrichment. 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 of the fixed carbon? What are the long term ecological and biogeochemical consequences of fertilization on surface and midwater processes? Basic research is needed on the coupling of iron and carbon cycles in the ocean. Our understanding of the biogeochemistry of iron (its concentrations, sources, sinks and ligands) in marine systems is also insufficient to assess the viability of using iron fertilization as a strategy for enhancing carbon sequestration.

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. The potential impact of iron fertilization on the global carbon budget, as well as verification and duration of carbon sequestration are yet unknown. The complexity of marine ecosystems necessitates careful research on unintended 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.

Research may focus on experimental/observational studies and/or predictive modeling. Integrative studies that couple experimental observations and numerical modeling approaches are encouraged. Such studies should develop, improve, and test models that can be used to simulate and predict quantities of carbon sequestered from iron fertilization. Relevant focus areas for enhancement of the biological pump through iron fertilization may include:

1. Improving the effectiveness of ocean fertilization as a strategy for long term (decades, centuries) carbon sequestration.

- 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. This includes quantifying the export of particulate organic carbon and particulate inorganic carbon to the deep sea, and mineralization or dissolution of all forms at depth.
- Understanding the role of micronutrients (such as iron) and macronutrients (such as nitrogen and phosphorus) in regulation of the biological pump. Research on coupling of iron and carbon cycles might include studies of photo-oxidation, complexation adsorption/desorption, export and mineralization.
- Developing numerical models (regional or global) for carbon sequestration, especially those that provide a measurable output that allows for model testing. Models might be used to predict the efficiency of sequestration as a function of mid and deep water transport of carbon and remineralization.

2. Determining environmental consequences of long term ocean fertilization.

- Examining changes in structure and functioning of marine ecosystems (composition of phytoplankton and zooplankton communities, ocean food webs and trophodynamics), resulting from ocean fertilization.
- Examining changes in natural oceanic biogeochemical cycles (carbon, nitrogen, phosphorus, and silicon) resulting from iron fertilization.
- Developing numerical models at an ecosystem level that predict downstream effects of fertilization on productivity and nutrient removal.

Research proposed on iron fertilization should also support the USGCRP Carbon Cycle Science Initiative (http://www.gcrio.org/OnLnDoc/pdf/carb_cycle_toc.html). In particular, the proposed research should provide the scientific foundation for assessing both the viability of using iron fertilization to enhance sequestration and storage of carbon dioxide and/or the potential for unintended effects of this carbon sequestration strategy.

Direct Injection

The overarching questions for this area of research are: Can direct CO2 injection effectively sequester CO2 in the ocean with minimal adverse environmental impacts? How and where might direct injection of CO2 be most effective as a carbon sequestration strategy? What are the plume dynamics and hydrate behavior at depth? Fundamental research is needed to: assess the efficiency and consequences of direct injection; calculate the maximum ability of the ocean to sequester a maximum tolerable level of CO2, while minimizing the impact on marine 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 fate of injected CO2 and its chemical, physical and biological effects on marine ecosystems.

Research may focus on experimental/observational studies and/or predictive modeling. Integrative studies that couple both experimental and numerical modeling are encouraged, especially those incorporate feedback between experiments and models. Such projects should involve experimental studies to test and improve models, and modeling studies to help identify and design experiments needed to fill key gaps in our understanding. Examples of relevant research areas for direct injection of carbon dioxide into the deep ocean include:

1. Determining the environmental consequences of direct injection of CO2 into the ocean in midwater or deep sea habitats.

- Determining the effects of changes in pH and CO2 on the physiology and survival of organisms (including microbes) from midwater and deep sea habitats. These studies might include lethal or sublethal effects on organisms.

- Understanding the effects of sustained release of concentrated CO2 on biogeochemical processes, and on ecosystem structure and function. This might include investigations of biogeochemical interactions of seafloor sediments with a hydrated CO2 plume.
- Effects of secondary of contaminants on plume and/or hydrate physical/chemical properties, and related effects on indigenous fauna.

2. Improving the effectiveness of direct injection of CO2 for carbon sequestration.

- Understanding the longer-term fate of carbon that is added to the ocean including the carbonate chemistry of mid- and deep-ocean water.
- Investigation of physico-chemical behavior of a dense phase hydrate stream. Research might focus on such characteristics as determination of hydrate dissolution rates for a concentrated swarm, and calculation of plume dispersion and perturbation to state variables at depth.
- Addressing weaknesses in aspects of the Ocean General Circulation Models (OGCMs), specifically their ability to simulate accurately western boundary currents, ocean bottom currents, plume to eddy circulation; and testing models using natural or experimental tracers.
- Coupling near-field with far-field effects of CO2 injection, for example, coupling plume modeling at the basin and global scale with ocean circulation models.

Collaboration

Researchers 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 (per year) will be available for awards in this area during Fiscal Year 2003, contingent upon availability of appropriated funds. 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. Integrative studies, multi-investigator studies that combine experimental/observational approaches with numerical modeling may be funded at a level of up to $400,000 per year for 3 years. Proposals for field experiments involving larger groups of investigators will be considered, but must be approved at a preproposal level. Multiple year funding of awards is expected, and is also contingent upon availability of funds, progress of the research, and continuing program need. DOE is under no obligation to pay for any costs associated with the preparation or submission of proposals if an award is not made.

Preproposals

An informal preproposal may be submitted by E-mail. The preproposal should identify the institution, Principal Investigator name, address, telephone, fax and E-mail address, title of the project, and proposed collaborators. The preproposal 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. Preproposals are strongly encouraged prior to submission of a full proposal, especially for large, field-based collaborations. Notification of a successful preproposal is not an indication that an award will be made in response to the formal proposal.

Formal Proposals

Peer Review

For renewals, progress on previous DOE-funded research will be an important criterion for evaluation. The evaluation will include program policy factors such as the relevance of the proposed research to the terms of the announcement, the agency's programmatic needs, and the uniqueness of approach. 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 a proposal constitutes agreement that this is acceptable to the investigator(s) and the submitting institution.

The research project description must be 20 pages or less, exclusive of attachments and must contain an abstract or summary of the proposed research. Researchers who have had prior Ocean Carbon Sequestration Research Program support must include a Progress Section with a brief description of results and a list of publications derived from that funding. On the proposal cover page 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).

The instructions and format described below should be followed. Reference Program Announcement LAB 03-15 on all submissions and inquiries about this program.

OFFICE OF SCIENCE
GUIDE FOR PREPARATION OF SCIENTIFIC/TECHNICAL PROPOSALS
TO BE SUBMITTED BY NATIONAL LABORATORIES

Proposals from National Laboratories submitted to the Office of Science (SC) as a result of this program announcement will follow the Department of Energy Field Work Proposal process with additional information requested to allow for scientific/technical merit review. The following guidelines for content and format are intended to facilitate an understanding of the requirements necessary for SC to conduct a merit review of a proposal. Please follow the guidelines carefully, as deviations could be cause for declination of a proposal without merit review.

1. Evaluation Criteria

Proposals will be subjected to formal merit review (peer review) and will be evaluated against the following criteria which are listed in descending order of importance:

Scientific and/or technical merit of the project

Appropriateness of the proposed method or approach

Competency of the personnel and adequacy of the proposed resources

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, the uniqueness of the proposer's capabilities, and demonstrated usefulness of the research for proposals in other DOE Program Offices as evidenced by a history of programmatic support directly related to the proposed work.

2. Summary of Proposal Contents

Field Work Proposal (FWP) Format (Reference DOE Order 5700.7C) (DOE ONLY)
Proposal Cover Page
Table of Contents
Abstract
Narrative
Literature Cited
Budget and Budget Explanation
Other support of investigators
Biographical Sketches
Description of facilities and resources
Appendix

2.1 Number of Copies to Submit

An original and seven copies of the formal proposal/FWP must be submitted. (Unless otherwise instructed in this Program Announcement.)

3. Detailed Contents of the Proposal

Proposals must be readily legible, when photocopied, and must conform to the following three requirements: the height of the letters must be no smaller than 10 point with at least 2 points of spacing between lines (leading); the type density must average no more than 17 characters per inch; the margins must be at least one-half inch on all sides. Figures, charts, tables, figure legends, etc., may include type smaller than these requirements so long as they are still fully legible.

3.1 Field Work Proposal Format (Reference DOE Order 5700.7C)
(DOE ONLY)

The Field Work Proposal (FWP) is to be prepared and submitted consistent with policies of the investigator's laboratory and the local DOE Operations Office. Additional information is also requested to allow for scientific/technical merit review.

Laboratories may submit proposals directly to the SC Program office listed above. A copy should also be provided to the appropriate DOE operations office.

3.2 Proposal Cover Page

The following proposal cover page information may be placed on plain paper. No form is required.

Title of proposed project
SC Program announcement title
Name of laboratory
Name of principal investigator (PI)
Position title of PI
Mailing address of PI
Telephone of PI
Fax number of PI
Electronic mail address of PI
Name of official signing for laboratory*
Title of official
Fax number of official
Telephone of official
Electronic mail address of official
Requested funding for each year; total request
Use of human subjects in proposed project:
    If activities involving human subjects are not planned at any time during the proposed project period, state "No"; otherwise state "Yes", provide the IRB Approval date and Assurance of Compliance Number and include all necessary information with the proposal should human subjects be involved.
Use of vertebrate animals in proposed project:
    If activities involving vertebrate animals are not planned at any time during this project, state "No"; otherwise state "Yes" and provide the IACUC Approval date and Animal Welfare Assurance number from NIH and include all necessary information with the proposal.
Signature of PI, date of signature
Signature of official, date of signature*

*The signature certifies that personnel and facilities are available as stated in the proposal, if the project is funded.

3.3 Table of Contents

Provide the initial page number for each of the sections of the proposal. Number pages consecutively at the bottom of each page throughout the proposal. Start each major section at the top of a new page. Do not use unnumbered pages and do not use suffices, such as 5a, 5b.

3.4 Abstract

Provide an abstract of no more than 250 words. Give the broad, long-term objectives and what the specific research proposed is intended to accomplish. State the hypotheses to be tested. Indicate how the proposed research addresses the SC scientific/technical area specifically described in this announcement.

3.5 Narrative

The narrative comprises the research plan for the project and is limited to 20 pages. It should contain the following subsections:

Background and Significance: Briefly sketch the background leading to the present proposal, critically evaluate existing knowledge, and specifically identify the gaps which the project is intended to fill. State concisely the importance of the research described in the proposal. Explain the relevance of the project to the research needs identified by the Office of Science. Include references to relevant published literature, both to work of the investigators and to work done by other researchers.

Preliminary Studies: Use this section to provide an account of any preliminary studies that may be pertinent to the proposal. Include any other information that will help to establish the experience and competence of the investigators to pursue the proposed project. References to appropriate publications and manuscripts submitted or accepted for publication may be included.

Research Design and Methods: Describe the research design and the procedures to be used to accomplish the specific aims of the project. Describe new techniques and methodologies and explain the advantages over existing techniques and methodologies. As part of this section, provide a tentative sequence or timetable for the project.

Subcontract or Consortium Arrangements: If any portion of the project described under "Research Design and Methods" is to be done in collaboration with another institution, provide information on the institution and why it is to do the specific component of the project. Further information on any such arrangements is to be given in the sections "Budget and Budget Explanation", "Biographical Sketches", and "Description of Facilities and Resources".

3.6 Literature Cited

List all references cited in the narrative. Limit citations to current literature relevant to the proposed research. Information about each reference should be sufficient for it to be located by a reviewer of the proposal.

3.7 Budget and Budget Explanation

A detailed budget is required for the entire project period, which normally will be three years, and for each fiscal year. It is preferred that DOE's budget page, Form 4620.1 be used for providing budget information*. Modifications of categories are permissible to comply with institutional practices, for example with regard to overhead costs.

A written justification of each budget item is to follow the budget pages. For personnel this should take the form of a one-sentence statement of the role of the person in the project. Provide a detailed justification of the need for each item of permanent equipment. Explain each of the other direct costs in sufficient detail for reviewers to be able to judge the appropriateness of the amount requested.

Further instructions regarding the budget are given in section 4 of this guide.

* Form 4620.1 is available at web site: http://www.sc.doe.gov/production/grants/Forms.html

3.8 Other Support of Investigators

Other support is defined as all financial resources, whether Federal, non-Federal, commercial or institutional, available in direct support of an individual's research endeavors. Information on active and pending other support is required for all senior personnel, including investigators at collaborating institutions to be funded by a subcontract. For each item of other support, give the organization or agency, inclusive dates of the project or proposed project, annual funding, and level of effort devoted to the project.

3.9 Biographical Sketches

This information is required for senior personnel at the laboratory submitting the proposal and at all subcontracting institutions. The biographical sketch is limited to a maximum of two pages for each investigator.

3.10 Description of Facilities and Resources

Describe briefly the facilities to be used for the conduct of the proposed research. Indicate the performance sites and describe pertinent capabilities, including support facilities (such as machine shops) that will be used during the project. List the most important equipment items already available for the project and their pertinent capabilities. Include this information for each subcontracting institution, if any.

3.11 Appendix

Include collated sets of all appendix materials with each copy of the proposal. Do not use the appendix to circumvent the page limitations of the proposal. Information should be included that may not be easily accessible to a reviewer.

Reviewers are not required to consider information in the Appendix, only that in the body of the proposal. Reviewers may not have time to read extensive appendix materials with the same care as they will read the proposal proper.

The appendix may contain the following items: up to five publications, manuscripts (accepted for publication), abstracts, patents, or other printed materials directly relevant to this project, but not generally available to the scientific community; and letters from investigators at other institutions stating their agreement to participate in the project (do not include letters of endorsement of the project).

4. Detailed Instructions for the Budget
(DOE Form 4620.1 "Budget Page" may be used)

4.1 Salaries and Wages

List the names of the principal investigator and other key personnel and the estimated number of person-months for which DOE funding is requested. Proposers should list the number of postdoctoral associates and other professional positions included in the proposal and indicate the number of full-time-equivalent (FTE) person-months and rate of pay (hourly, monthly or annually). For graduate and undergraduate students and all other personnel categories such as secretarial, clerical, technical, etc., show the total number of people needed in each job title and total salaries needed. Salaries requested must be consistent with the institution's regular practices. The budget explanation should define concisely the role of each position in the overall project.

4.2 Equipment

DOE defines equipment as "an item of tangible personal property that has a useful life of more than two years and an acquisition cost of $25,000 or more." Special purpose equipment means equipment which is used only for research, scientific or other technical activities. Items of needed equipment should be individually listed by description and estimated cost, including tax, and adequately justified. Allowable items ordinarily will be limited to scientific equipment that is not already available for the conduct of the work. General purpose office equipment normally will not be considered eligible for support.

4.3 Domestic Travel

The type and extent of travel and its relation to the research should be specified. Funds may be requested for attendance at meetings and conferences, other travel associated with the work and subsistence. In order to qualify for support, attendance at meetings or conferences must enhance the investigator's capability to perform the research, plan extensions of it, or disseminate its results. Consultant's travel costs also may be requested.

4.4 Foreign Travel

Foreign travel is any travel outside Canada and the United States and its territories and possessions. Foreign travel may be approved only if it is directly related to project objectives.

4.5 Other Direct Costs

The budget should itemize other anticipated direct costs not included under the headings above, including materials and supplies, publication costs, computer services, and consultant services (which are discussed below). Other examples are: aircraft rental, space rental at research establishments away from the institution, minor building alterations, service charges, and fabrication of equipment or systems not available off-the-shelf. Reference books and periodicals may be charged to the project only if they are specifically related to the research.

a. Materials and Supplies

The budget should indicate in general terms the type of required expendable materials and supplies with their estimated costs. The breakdown should be more detailed when the cost is substantial.

b. Publication Costs/Page Charges

The budget may request funds for the costs of preparing and publishing the results of research, including costs of reports, reprints page charges, or other journal costs (except costs for prior or early publication), and necessary illustrations.

c. Consultant Services

Anticipated consultant services should be justified and information furnished on each individual's expertise, primary organizational affiliation, daily compensation rate and number of days expected service. Consultant's travel costs should be listed separately under travel in the budget.

d. Computer Services

The cost of computer services, including computer-based retrieval of scientific and technical information, may be requested. A justification based on the established computer service rates should be included.

e. Subcontracts

Subcontracts should be listed so that they can be properly evaluated. There should be an anticipated cost and an explanation of that cost for each subcontract. The total amount of each subcontract should also appear as a budget item.

4.6 Indirect Costs

Explain the basis for each overhead and indirect cost. Include the current rates.