Collaboration in Mathematical Geosciences (CMG)

Opportunities for Research Collaborations Between the Mathematical Sciences and the Geosciences

Program Solicitation
NSF 05-535
***Replaces Document* NSF 04-508**

National Science Foundation
Directorate for Geosciences
Directorate for Mathematical and Physical Sciences
Division of Mathematical Sciences

Full Proposal Deadline(s) (due by 5 p.m. proposer's local time):

March 14, 2005

February 01, 2006

February 01, 2007

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Collaboration in Mathematical Geosciences (CMG)
Opportunities for Research Collaborations Between the Mathematical Sciences and the Geosciences

Synopsis of Program:

The purposes of the Collaboration in Mathematical Geoscience activity are: (A) [Interdisciplinary Group Research Projects] to enable collaborative research at the intersection of mathematical sciences and geosciences, and to encourage cross-disciplinary education through (B) [Interdisciplinary Post-graduate Summer Training] summer graduate training activities and (C) [Interdisciplinary Post-doctoral Research] opportunities for interdisciplinary post-doctoral research. Research topics under (A) should fall within one of three broad themes: (1) mathematical and statistical modeling of large, complex geosystems, (2) representing uncertainty in geosystems, or (3) analyzing large geoscience data sets. Research projects supported under this activity must be essentially collaborative in nature. Research groups must include at least one mathematical scientist and at least one geoscientist.

Cognizant Program Officer(s):

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Applicable Catalog of Federal Domestic Assistance (CFDA) Number(s):

- 47.050 --- Geosciences
- 47.049 --- Mathematical and Physical Sciences

Eligibility Information

- **Organization Limit:** None Specified.
- **PI Eligibility Limit:** Please see the full text of this solicitation for further information.
- **Limit on Number of Proposals:** None Specified.

Award Information

- **Anticipated Type of Award:** Standard or Continuing Grant
- **Estimated Number of Awards:** 15 to 25
- **Anticipated Funding Amount:** $8,200,000 in FY2005, subject to the availability of funds.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Full Proposal Preparation Instructions:** This solicitation contains information that supplements the standard Grant Proposal Guide (GPG) proposal preparation guidelines. Please see the full text of this solicitation for further information.

B. Budgetary Information

- **Cost Sharing Requirements:** Cost Sharing is not required.
- **Indirect Cost (F&A) Limitations:** Not Applicable.
- **Other Budgetary Limitations:** Other budgetary limitations apply. Please see the full text of this solicitation for further information.

C. Due Dates

- **Full Proposal Deadline Date(s)** (due by 5 p.m. proposer's local time):
  March 14, 2005
  February 01, 2006
  February 01, 2007

Proposal Review Information

- **Merit Review Criteria:** National Science Board approved criteria. Additional merit review considerations apply. Please see the full text of this solicitation for further information.

Award Administration Information

- **Award Conditions:** Standard NSF award conditions apply.
- **Reporting Requirements:** Additional reporting requirements apply. Please see the full text of this solicitation for further information.

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I. INTRODUCTION

In many areas within the geosciences, researchers at the frontiers of theory, experimental science and modeling confront

problems for which currently applied mathematical or statistical approaches are insufficient. In mathematics and statistics, geoscience problems can serve as the impetus for fundamental research in the mathematical sciences. To effectively meet these challenges requires the combined efforts of geoscientists and mathematical scientists.

The Division of Mathematical Sciences (DMS), within the Directorate for Mathematical and Physical Sciences (MPS), and the Directorate for Geosciences (GEO) of the National Science Foundation (NSF) expect to make a number of awards in each of FY 2005, FY 2006 and FY 2007 that will support the activities of groups of investigators working at the frontiers of mathematical geosciences. They also anticipate making one or two awards each year that promote cross-disciplinary graduate student training in mathematical geosciences and several awards each year to support interdisciplinary research opportunities for post-doctoral investigators. This activity is a component of NSF's Mathematical Sciences Priority Area. For a list of awards funded in prior years of the Collaborations in Mathematical Geosciences (CMG) competition, please go to http://www.nsf.gov/awardsearch/index.jsp. (Search for titles containing CMG.) Proposals should bring together scientists from both communities in a truly collaborative effort.

Many potentially fruitful areas of research in mathematical geosciences have been identified by the research community. Proposals in three broad thematic areas are solicited in this competition:

- **Mathematical and statistical modeling of large, complex geosystems**
- **Representing uncertainty in geosystems**
- **Analyzing large geoscience data sets**

II. PROGRAM DESCRIPTION

The primary purposes of the CMG activity are to promote cutting-edge research in areas that require the collaboration of experts in both the geosciences and the mathematical sciences (proposal type A, hereafter) and to promote the training of researchers with skills in both the mathematical sciences and geosciences (proposal types B and C below). We are particularly interested in supporting collaborations in areas where such interdisciplinary collaboration is presently uncommon. We are also particularly interested in supporting collaborations between young investigators.

PROPOSAL TYPE A: INTERDISCIPLINARY GROUP RESEARCH PROJECTS

Interdisciplinary research proposals in this category may address any of the following: (i) research with a single coherent goal that significantly advances the understanding of an important phenomenon in the geosciences and at the same time requires significant research in one or more areas of the mathematical sciences to provide these advances, (ii) research on an important phenomenon in a domain of geosciences that involves the use of more sophisticated mathematical or statistical approaches than are currently used in that domain, or (iii) research in an area of mathematics or statistics that is prompted by a problem in the geosciences. For a proposal to be appropriate for CMG, the topic must have an intrinsic need for a non-trivial collaboration between at least one geoscientist and at least one mathematical scientist. For example, in a proposal addressing a research problem of type (ii), if the more sophisticated mathematics involved is nevertheless something that is well documented and could easily be applied to the problem at hand by a geoscientist who has read the appropriate literature, without the aid of a mathematician or statistician, reviewers will be expected to rank the proposal as non-competitive. Similar considerations apply to research problems of type (iii).

Research groups must include at least one mathematical scientist and at least one geoscientist. A PI/Co-PI can qualify as a mathematical scientist if he or she holds a doctoral degree in any field of the mathematical sciences, or has a primary affiliation with a mathematical sciences department, or has a well-established publication record in mathematical sciences journals. Projects supported under this activity should be essentially collaborative in nature and depend for their success on the interaction of the researchers in the group.

Projects should be of three to four years duration. It is not the intent of this activity to provide general support for infrastructure.

Proposals are solicited in the following theme areas.

Mathematical and statistical modeling of large, complex geosystems.

A few examples of topics that fall within this theme include:

- Novel deterministic and/or stochastic approaches to representing ranges of dynamically active scales that are not explicitly resolvable.
- New approaches to representing and analyzing high-dimensional dynamical systems.
- Analysis of spatio-temporal pattern formation in geosystems with many degrees of freedom.
- Complex dynamics and critical behavior in discrete models of geosystems such as cellular automata and lattice gases.
- Research that links new insights about the internal dynamics of geosystems and novel methods of analyzing data sets; e.g. detection and representation of lower-dimensional features.
- New approaches to the mathematical modeling of geosystems for which classical methods have failed to yield progress in predictive modeling.
- Innovative approaches to tomography in geophysical settings.
- Coupled multi-domain systems with different processes in different regions.

Representing uncertainty in geosystems.

Some examples of topics falling within this theme include:

- Statistical measures of uncertainty in inverse problems.
- Global optimization methods and uncertainty in parameter estimation.
- Techniques for using observational data and models to characterize the uncertainty not revealed by ensembles of runs of models of geosystems.
- Formal assessments of the uncertainty of the predictions of modern approaches to modeling complex environmental systems.
- Techniques for predicting the reliability of complicated, spatially distributed, geoscience observing systems. General methods for extending observing system design techniques to represent better the role of uncertainty.

Analyzing large geoscience data sets

Some examples of topics falling within this theme include:

- Methods and techniques to analyze the structure of large data sets, to fit models robustly, and to identify and validate patterns.
- Research that links new insights about the internal dynamics of geosystems and novel methods of analyzing data sets; e.g. detection and representation of lower-dimensional features.
- Feature detection and characterization in large, streaming data sets and/or multiple data sets of disparate data types
- Data analysis methods that enhance the utility of geoscience observatory infrastructure.

The main themes are intentionally broad and it is not necessary for proposals to be related to any of the specific examples given above. The aim of the CMG activity is to support projects for which the collective effort by a group of researchers with complementary expertise is necessary to reach the scientific goals. The researchers in the group may come from more than one organization. Awards made under the CMG activity are intended to foster synergy between the disciplines and between the researchers in the group that cannot be easily achieved with individual grants. In particular, researchers supported by this activity are expected to collaborate closely and intensely during the project. Awardees will be required to show evidence of collaboration in their annual progress reports.

Of particular interest for funding are collaborations in areas where such interdisciplinary collaboration is presently uncommon.

It is the intent of the program to develop a broad portfolio across the various topical areas in geosciences and mathematical sciences and so proposals in topical areas that bridge geosciences and mathematical sciences but where there has been little collaborative research to date are encouraged. The term topical area is used to denote something finer-grained than "discipline."

NSF sponsors a number of programs which feature research collaborations, including interdisciplinary collaboration. Prospective investigators in the CMG program should carefully consider whether a planned proposal is best suited for the CMG program or for some other program, keeping in mind that NSF does not normally accept substantially overlapping proposals that are submitted to different programs simultaneously without prior approval. If in doubt, please consult one of the cognizant Program Officers before submitting a proposal.

Research that pursues an already established research agenda will be **less competitive** in the CMG activity and should be directed to the appropriate existing NSF disciplinary program(s). Proposals whose primary applicability is petroleum engineering and/or geo-technical engineering are not appropriate for CMG; however, proposals on related topics that also have significant and articulated applicability to problems that fall within the purview of the Directorate for Geosciences will be accepted for review. Proposers are encouraged to request support for, and provide mentoring to, research students and/or post-doctoral researchers in their proposals. The submission of collaborative proposals by small groups of young investigators with novel ideas is also encouraged.

Research groups are expected to disseminate the results of their work in a timely and effective way.

PROPOSAL TYPE B: INTERDISCIPLINARY POST-GRADUATE SUMMER TRAINING

To foster the development of new researchers who can make substantial contributions to interdisciplinary topics at the interface of mathematical sciences and geosciences, the Division of Mathematical Sciences and the Directorate for Geosciences would like to make one or two awards each year to support interdisciplinary training activities for graduate students in the summer following the year of the award. These should bring together graduate students in geosciences and mathematical sciences from multiple institutions in a program built around an important research theme, or set of themes, that is relevant to both disciplines. Successful activities should create an environment that provides stimulating pedagogical material in areas relevant to the interdisciplinary theme of the summer program. They should convey the importance and excitement of interdisciplinary research in the program's theme area, provide strong mentoring support and prepare participating students to be contributors to such research.

The make-up of the summer program's "student body" is left to the discretion of the organizers. However, the proposal must contain a clear description of how potential students will be recruited and the criteria that will be used to select student participants. This description should include information about how the summer program will be advertised. The intent is that these summer training programs should help expand and diversify the pool of talented U.S. researchers at the forefront of interdisciplinary research in the mathematical sciences and the geosciences. Reviewers will be asked to comment on the degree to which the recruitment and selection plan is consistent with this goal.

PROPOSAL TYPE C: INTERDISCIPLINARY POST-DOCTORAL RESEARCH

To foster the development of new researchers who can make substantial contributions to interdisciplinary topics at the interface of mathematical sciences and geosciences, the Division of Mathematical Sciences and the Directorate for Geosciences would like to make several awards each year to support interdisciplinary research experiences for post-doctoral investigators. Such awards are intended to provide support for a post-doctoral investigator trained in one of the mathematical sciences to work with a mentor in one of the geosciences or for a post-doc in one of the geosciences to work with a mentor in one of the mathematical sciences. Such awards may be of up to two years in duration. Depending on university policies, either the mentor or the post-doc may act as the PI on such proposals, even if the support is entirely for the post-doctoral researcher. The proposal must be submitted by the institution at which the post-doc would be employed during the period of the proposed award. The program would like to encourage post-doctoral research in which the post-doc joins a research group in a university other than that at which she or he obtained their Ph.D. Except in exceptional circumstances, proposals in which the post-doc intends to stay at the university of his or her Ph.D. will have low priority for funding. Any exceptional circumstances should be described in the project description section of the proposal.

The research topic addressed in a type C proposal should fall under one of the three broad themes described under type A

proposals, above. Type A and type C proposals will be reviewed using a similar process.

In a type C proposal, the person who is to be the post-doctoral investigator is not required to have a Ph.D. at the time of proposal submission but must have completed all of the requirements for the award of a Ph.D. in a relevant discipline by the July 15th immediately following the deadline to which the proposal was submitted. The person who is to be the post-doctoral investigator should be no more than eighteen months past the award of his or her most recent Ph.D. at the time of the solicitation deadline to which the proposal is submitted.

III. ELIGIBILITY INFORMATION

The categories of proposers identified in the Grant Proposal Guide are eligible to submit proposals under this program announcement/solicitation. Specific classes of NSF-funded research centers are eligible to submit. The NSF-funded University Corporation for Atmospheric Research (UCAR) and mathematical sciences institutes funded by the Division of Mathematical Sciences are eligible to submit proposals that are responsive to this solicitation, provided that these do not include costs already covered by other NSF awards.

Proposals involving investigators from more than one institution are encouraged and should be submitted as collaborative proposals (see instructions below). Prospective applicants are strongly urged to contact the Program Officers listed in this document for guidance.

Unaffiliated scientists are not eligible to submit a proposal as a Principal Investigator, but may be eligible for support through a sub-award.

In a type C proposal, the person who is to be the post-doctoral investigator is not required to have a Ph.D. at the time of proposal submission but must have completed all of the requirements for a Ph.D. in a relevant discipline by the July 15th immediately following the deadline to which the proposal was submitted. The person who is to be the post-doctoral investigator should be no more than eighteen months past the award of his or her most recent Ph.D. at the time of the solicitation deadline to which the proposal is submitted.

IV. AWARD INFORMATION

NSF anticipates that approximately $8,200,000 will be available for making type A, B and C awards in FY 2005, subject to the availability of funds. Similar amounts are anticipated in FY 2006 and FY 2007.

Proposals of type A may be for up to four years duration. PIs are encouraged to submit proposals for projects with durations of three to four years. The anticipated date of funding recommendations is August of each year. The final number of awards will depend on the quality of submissions and the availability of funds.

The total amount of funds requested in a proposal of type B should not exceed $200,000. Funds may be requested to cover stipends and travel to the site of the program for the participating students, as well as travel and reasonable participant support costs for senior personnel actively participating in the program as mentors or teachers. For non-employees, these should be listed under participant support costs (see GPG, Chapter II.C.2.g.v.). The award duration will be two years and the award instrument will be a standard grant. Each award is intended to cover a single program in the summer of the year following the year of the award. The awards will be made in the summer following the proposal deadline. It is expected that a successful summer program will require at least a year of preparation. Preference will be given to new interdisciplinary summer programs. NSF anticipates that up to a total of $400,000 will be available for type B awards in each year. The number of awards will depend on the quality of submissions and the availability of funds.

Proposals of type C may be for up to two years duration. The salary requested for the post-doctoral investigator should be at least $50,000 per annum for proposals submitted for the 2005 deadline, $51,000 per annum for proposals submitted for the 2006 deadline and $52,000 per annum for proposals submitted for the 2007 deadline. The proposal budget may include some salary support for the mentor to work with the post-doc. Reasonable direct costs to support the post-doc's research

may be included. Large equipment purchases should not be included. More complex proposals requiring salary support for additional personnel beyond the post-doc and his or her mentor, or large equipment purchases, should not be submitted under category C. Instead they may be submitted as proposals of type A. The anticipated date of funding recommendations is August of each year. The final number of awards will depend on the quality of submissions and the availability of funds. The program does not expect to make more than five such awards in any one year and may make as few as zero.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Full Proposal Instructions:

Proposals submitted in response to this program announcement/solicitation should be prepared and submitted in accordance with the general guidelines contained in the NSF *Grant Proposal Guide* (GPG). The complete text of the GPG is available electronically on the NSF Website at: http://www.nsf.gov/cgi-bin/getpub?gpg. Paper copies of the GPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from pubs@nsf.gov.

Proposers are reminded that both Broader Impacts and Intellectual Merits must be addressed explicitly in both the Project Summary and the Project Description.

1. **Proposal (Type A)**

   All proposals of type A must be submitted via FastLane by 5:00 PM, proposer's local time, on one of the proposal deadlines listed on the front page of this solicitation. Proposals received after that will be returned without review.

   Proposals involving investigators from more than one organization should be submitted as collaborative proposals. Proposers should consult the GPG Section II.D.3., "Collaborative Proposals."

   a. Cover page - To facilitate timely processing, the title of the proposed project should begin with the string "CMG RESEARCH:" or "CMG COLLABORATIVE RESEARCH:". The latter form should be used for multi-organizational proposals.

   b. Project Description, not to exceed fifteen pages, including the following items:
      i. Proposed Research. (Narrative)
         - An explanation of the scientific context and timeliness of the proposed project.
         - A description of the proposed research.
         - A justification for why a collaborative effort is necessary to carry out the proposed project.
         - A timeline for the planned work and a justification for the duration.
         - Plans for disseminating the results.
         - Results from prior NSF support, whether or not applicable to the proposed activity. If not applicable, please explain why.
      ii. Statement of eligibility for CMG. The proposal must include an explanation, clearly identified and not to exceed one page, within the 15-page project description, stating why the proposed research (a) is innovative and state-of-the-art, (b) lies in the interdisciplinary region in which the nature of the research problem addressed challenges both mathematical scientists and geoscientists, (c) requires a true collaboration between one or more mathematical scientists and one or more geoscientists. Reviewers will be asked to pay close attention to this explanation.
      iii. Management Plan. Provide a management plan, describing how the group effort will be coordinated.
      iv. Modes of Collaboration and Training. The following components are optional and can be

included if appropriate:

- A description of new modes of collaboration.
- A description of new modes of training graduate students, postdoctoral researchers, or undergraduates.
- A description of planned workshops and a list of tentative participants.

c. Biographical sketches. For all key personnel, please provide a brief biographical sketch. Do not exceed two pages per person for the sketch. Up to five publications most closely related to the proposal and up to five other significant publications may be included, including those accepted for publication. For each individual, up to one additional page describing how that individual will contribute to the project may also be included. **Biographical Sketches must conform to the guidelines described in the GPG. Program Officers will pay close attention to whether sufficient information has been provided to permit the screening of potential reviewers for possible conflicts of interest.**

d. A full description of the total level of current and pending support from all sources for the key personnel. It is important to identify the number of salary-months covered by each source and whether these are summer, academic or calendar months.

e. A description of the facilities (including laboratories and computational facilities) that will be made available to the project.

2. **Proposal (Type B)**

All proposals of type B must be submitted via FastLane by 5:00 PM, proposer's local time, on one of the proposal deadlines listed on the front page of this solicitation. Proposals received after that will be returned without review.

Proposals involving investigators from more than one organization should be submitted as collaborative proposals. Proposers should consult the GPG Section II.D.3., "Collaborative Proposals."

a. Cover page - To facilitate timely processing, the title of the proposed project should begin with the string "CMG TRAINING:", or "CMG COLLABORATIVE TRAINING:" if the project involves multi-organizational proposals.

b. Project Description - Narrative, not to exceed fifteen pages including the following items:

- An explanation of the scientific context and timeliness of the proposed program topic.
- A description of the design of the summer program, including the intended number of students and senior participants, the intended pedagogical activities and personnel involved, the scope of student activities, the structure of the mentoring to be provided to the students, and the senior personnel who will be involved in mentoring. It is not necessary that all senior personnel who will be involved in the pedagogical or mentoring activities be co-PIs on the proposal but see (j) below.
- A description of how students will be recruited and selected. (See Program Description.)
- A timeline for and description of the advance preparation for the summer program.
- Results from prior NSF support, whether or not applicable to the proposed activity. If not applicable, please explain why.

c. Biographical sketches. For all key personnel, please provide a brief biographical sketch. Do not exceed two pages per person for the sketch. Up to five publications most closely related to the proposal and up to five other significant publications may be included, including those accepted for publication. For each individual, up to one additional page describing how that individual will contribute to the project, may be included. **Biographical Sketches must conform to the guidelines described in the GPG. Program Officers will pay close attention to whether sufficient information has been provided to permit the screening of potential reviewers for possible conflicts of interest.**

d. A full description of the total level of current and pending support from all sources for the key

personnel.

e. A description of the facilities (including laboratories and computational facilities) that will be made available to the project.

f. Letters of commitment to participate in the project from key personnel involved in the pedagogical and mentoring activities who are not co-PIs on the proposal.

3. **Proposal (Type C)**

All proposals of type C must be submitted via FastLane by 5:00 PM, proposer's local time, on one of the proposal deadlines listed on the front page of this solicitation. Proposals received after that will be returned without review.

Proposals should be submitted by a single institution. This should be the institution at which the post-doc will be employed. Either the mentor or the post-doc may be the PI, subject to institutional policies on eligibility to submit proposals. If the post-doc is the PI, the mentor should be included as a co-PI. If the mentor is the PI, the post-doc should be included as a co-PI if institutional policies permit this. If the post-doc does not appear on the cover page of the proposal, then a letter of commitment from the post-doc must be included in the Supplementary Documents section (see below).

a. Cover page - To facilitate timely processing, the title of the proposed project should begin with the string "CMG POST-DOC:".

b. Project Description - Narrative, not to exceed fifteen pages including the following items:

- An explanation of the scientific context and timeliness of the proposed post-doctoral research topic.
- A description of the proposed research.
- An explanation, clearly identified, stating why the proposed research (a) is innovative and state-of-the-art, (b) lies in the interdisciplinary region in which the nature of the research problem addressed challenges both mathematical scientists and geoscientists, (c) requires a true collaboration between a post-doc who is a mathematical scientist and a mentor who is a geoscientist or vice versa.
- If the post-doctoral investigator's Ph.D. was or will be obtained at the same institution as the primary institution of the mentor, please include an explanation of why this collaboration is unusually strong or otherwise particularly noteworthy.
- Results from prior NSF support for the mentor, whether or not applicable to the proposed activity. If not applicable, please explain why.
- Clear explanations of the roles that the post-doc and mentor will each play in the proposed research.

c. Biographical sketches. For all key personnel (the mentor **and** the post-doc), please provide a brief biographical sketch. Do not exceed two pages per person for the sketch. Up to five publications most closely related to the proposal and up to five other significant publications may be included, including those accepted for publication. **Biographical Sketches must conform to the guidelines described in the GPG. Program Officers will pay close attention to whether sufficient information has been provided to permit the screening of potential reviewers for possible conflicts of interest.**

d. A full description of the total level of current and pending support from all sources for the key personnel.

e. A description of the facilities (including laboratories and computational facilities) that will be made available to the project.

f. A letter of commitment to participate in the project from the post-doc if he or she is not a co-PI on the proposal.

g. A letter from the post-doctoral candidate's Ph.D. advisor describing the post-doc candidate's training, expertise and research abilities.

Proposers are reminded to identify the program announcement/solicitation number (05-535) in the program announcement/ solicitation block on the proposal Cover Sheet. Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.

B. Budgetary Information

Cost Sharing:

Cost sharing is not required in proposals submitted under this Program Solicitation.

Other Budgetary Limitations:

For proposals of type B, award size may be up to a total of $200,000 spread over two years. See Section IV. Award Information for further details.

For proposals of type C, the post-doc salary requested should be at least $50,000, $51,000 or $52,000 per annum for proposals submitted for the 2005, 2006 or 2007 deadlines, respectively.

C. Due Dates

Proposals must be submitted by the following date(s):

Full Proposal Deadline(s) (due by 5 p.m. proposer's local time):

March 14, 2005

February 01, 2006

February 01, 2007

D. FastLane Requirements

Proposers are required to prepare and submit all proposals for this announcement/solicitation through the FastLane system. Detailed instructions for proposal preparation and submission via FastLane are available at: https://www.fastlane.nsf.gov/a1/newstan.htm. For FastLane user support, call the FastLane Help Desk at 1-800-673-6188 or e-mail fastlane@nsf.gov. The FastLane Help Desk answers general technical questions related to the use of the FastLane system. Specific questions related to this program announcement/solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this announcement/solicitation.

Submission of Electronically Signed Cover Sheets. The Authorized Organizational Representative (AOR) must electronically sign the proposal Cover Sheet to submit the required proposal certifications (see Chapter II, Section C of the Grant Proposal Guide for a listing of the certifications). The AOR must provide the required electronic certifications within five working days following the electronic submission of the proposal. Proposers are no longer required to provide a paper copy of the signed Proposal Cover Sheet to NSF. Further instructions regarding this process are available on the FastLane Website at: http://www.fastlane.nsf.gov

VI. PROPOSAL REVIEW INFORMATION

A. NSF Proposal Review Process

Reviews of proposals submitted to NSF are solicited from peers with expertise in the substantive area of the proposed research or education project. These reviewers are selected by Program Officers charged with the oversight of the review process. NSF invites the proposer to suggest, at the time of submission, the names of appropriate or inappropriate reviewers. Care is taken to ensure that reviewers have no conflicts with the proposer. Special efforts are made to recruit reviewers from non-academic institutions, minority-serving institutions, or adjacent disciplines to that principally addressed in the proposal.

The National Science Board approved revised criteria for evaluating proposals at its meeting on March 28, 1997 (NSB 97-72). All NSF proposals are evaluated through use of the two merit review criteria. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

On July 8, 2002, the NSF Director issued Important Notice 127, Implementation of new Grant Proposal Guide Requirements Related to the Broader Impacts Criterion. This Important Notice reinforces the importance of addressing both criteria in the preparation and review of all proposals submitted to NSF. NSF continues to strengthen its internal processes to ensure that both of the merit review criteria are addressed when making funding decisions.

In an effort to increase compliance with these requirements, the January 2002 issuance of the GPG incorporated revised proposal preparation guidelines relating to the development of the Project Summary and Project Description. Chapter II of the GPG specifies that Principal Investigators (PIs) must address both merit review criteria in separate statements within the one-page Project Summary. This chapter also reiterates that broader impacts resulting from the proposed project must be addressed in the Project Description and described as an integral part of the narrative.

Effective October 1, 2002, NSF will return without review proposals that do not separately address both merit review criteria within the Project Summary. It is believed that these changes to NSF proposal preparation and processing guidelines will more clearly articulate the importance of broader impacts to NSF-funded projects.

The two National Science Board approved merit review criteria are listed below (see the Grant Proposal Guide Chapter III.A for further information). The criteria include considerations that help define them. These considerations are suggestions and not all will apply to any given proposal. While proposers must address both merit review criteria, reviewers will be asked to address only those considerations that are relevant to the proposal being considered and for which he/she is qualified to make judgments.

What is the intellectual merit of the proposed activity?
How important is the proposed activity to advancing knowledge and understanding within its own field or across different fields? How well qualified is the proposer (individual or team) to conduct the project? (If appropriate, the reviewer will comment on the quality of the prior work.) To what extent does the proposed activity suggest and explore creative and original concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?

What are the broader impacts of the proposed activity?
How well does the activity advance discovery and understanding while promoting teaching, training, and learning? How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)? To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships? Will the results be disseminated broadly to enhance scientific and technological understanding? What may be the benefits of the proposed activity to society?

NSF staff will give careful consideration to the following in making funding decisions:

Integration of Research and Education
One of the principal strategies in support of NSF's goals is to foster integration of research and education through the programs, projects, and activities it supports at academic and research institutions. These institutions provide abundant opportunities where individuals may concurrently assume responsibilities as researchers, educators, and students and where all can engage in joint efforts that infuse education with the excitement of discovery and enrich research through the diversity of learning perspectives.

Integrating Diversity into NSF Programs, Projects, and Activities
Broadening opportunities and enabling the participation of all citizens -- women and men, underrepresented minorities, and persons with disabilities -- is essential to the health and vitality of science and engineering. NSF is committed to this principle of diversity and deems it central to the programs, projects, and activities it considers and supports.

Additional Review Criteria:

Proposals of type A (interdisciplinary group research projects)

In addition to the National Science Board merit review criteria, reviewers will be asked to apply several specific criteria when reviewing CMG proposals. These criteria include:

- The extent to which the proposed research goes beyond existing approaches or ideas
- Extent to which the whole of the proposed group project will be greater than the sum of its parts
- Extent to which the group effort is focused on a cohesive, well-delineated goal
- Timeliness of the planned work
- Likelihood of substantial progress
- Long-term scientific impact of the proposed activity
- Appropriateness of the group members and group structure for the task
- Appropriateness of the proposed modes of collaboration
- Adequacy and appropriateness of the proposed timeline
- Adequacy of the management plan
- Adequacy of the plans for dissemination
- Adequacy and appropriateness of the budget

Proposals of type B (interdisciplinary post-graduate summer training)

In addition to the National Science Board merit review criteria, reviewers will be asked to apply several specific criteria when reviewing CMG proposals for graduate summer training programs. These criteria include:

- Timeliness of the planned topic
- The degree to which the program does not duplicate opportunities already available in standard academic settings
- Long-term impact of the proposed activity
- The quality of the pedagogical and research opportunities for the participating students
- Appropriateness of the proposed senior personnel
- Adequacy of the plan for advance preparation for the program, including the process for recruiting and selecting student participants.
- Adequacy and appropriateness of the budget

Proposals of type C (interdisciplinary post-doctoral research)

- Does the research topic lie in the interdisciplinary region in which the nature of the research problem addressed challenges both mathematical science and geoscience

*These documents may be accessed electronically on NSF's Website at http://www.nsf.gov/home/grants/grants_gac.htm. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from pubs@nsf.gov.

More comprehensive information on NSF Award Conditions is contained in the NSF *Grant Policy Manual* (GPM) Chapter II, available electronically on the NSF Website at http://www.nsf.gov/cgi-bin/getpub?gpm. The GPM is also for sale through the Superintendent of Documents, Government Printing Office (GPO), Washington, DC 20402. The telephone number at GPO for subscription information is (202) 512-1800. The GPM may be ordered through the GPO Website at http://www.gpo.gov.

C. Reporting Requirements

For all multi-year grants (including both standard and continuing grants), the PI must submit an annual project report to the cognizant Program Officer at least 90 days before the end of the current budget period.

In their annual and final project reports, recipients of awards made in response to proposals of type (A) must explicitly describe the ways in which the mathematical scientists and geoscientists involved have collaborated and the products of this collaboration.

Within 90 days after the expiration of an award, the PI also is required to submit a final project report. Failure to provide final technical reports delays NSF review and processing of pending proposals for the PI and all Co-PIs. PIs should examine the formats of the required reports in advance to assure availability of required data.

PIs are required to use NSF's electronic project reporting system, available through FastLane, for preparation and submission of annual and final project reports. This system permits electronic submission and updating of project reports, including information on project participants (individual and organizational), activities and findings, publications, and other specific products and contributions. PIs will not be required to re-enter information previously provided, either with a proposal or in earlier updates using the electronic system.

VIII. CONTACTS FOR ADDITIONAL INFORMATION

General inquiries regarding this program should be made to:

- Stephen Meacham, Directorate for Geosciences, Division of Atmospheric Sciences, 775 S, telephone: (703) 292-8527, fax: (703) 292-9022, email: smeacham@nsf.gov
- Xuming He, Directorate for Mathematical & Physical Sciences, Division of Mathematical Sciences, 1025 N, telephone: (703) 292-4876, fax: (703) 292-9032, email: xhe@nsf.gov
- Wen C. Masters, Directorate for Mathematical & Physical Sciences, Division of Mathematical Sciences, 1025 N, telephone: (703) 292-4871, email: wmasters@nsf.gov
- Robin Reichlin, Directorate for Geosciences, Division of Earth Sciences, 785 S, telephone: (703) 292-8556, fax: (703) 292-9025, email: rreichli@nsf.gov
- Thomas F. Russell, Directorate for Mathematical & Physical Sciences, Division of Mathematical Sciences, 1025 N, telephone: (703) 292-4863, fax: (703) 292-9032, email: trussell@nsf.gov
- B. Mete Uz, Directorate for Geosciences, Division of Ocean Sciences, 725 N, telephone: (703) 292-8582, email:

buz@nsf.gov

- Junping Wang, Directorate for Mathematical & Physical Sciences, Division of Mathematical Sciences, 1025 N, telephone: (703) 292-4488, fax: (703) 292-4856, email: jwang@nsf.gov

- William J. Wiseman, Jr., Office of the Director, Office of Polar Programs, 740 S, telephone: (703) 292-4750, fax: (703) 292-9082, email: wwiseman@nsf.gov

General FastLane Contact:

- Division of Mathematical Sciences, Directorate for Mathematical and Physical Sciences, Room 1005, telephone: 703-292-8808, e-mail: dmsfl@nsf.gov.

For questions related to the use of FastLane, contact:

- Brian E. Dawson, Directorate for Geosciences, 705 N, telephone: (703) 292-4727, fax: (703) 292-9042, email: bdawson@nsf.gov

IX. OTHER PROGRAMS OF INTEREST

The NSF *Guide to Programs* is a compilation of funding for research and education in science, mathematics, and engineering. The NSF *Guide to Programs* is available electronically at http://www.nsf.gov/cgi-bin/getpub?gp. General descriptions of NSF programs, research areas, and eligibility information for proposal submission are provided in each chapter.

Many NSF programs offer announcements or solicitations concerning specific proposal requirements. To obtain additional information about these requirements, contact the appropriate NSF program offices. Any changes in NSF's fiscal year programs occurring after press time for the *Guide to Programs* will be announced in the NSF E-Bulletin, which is updated daily on the NSF Website at http://www.nsf.gov/home/ebulletin, and in individual program announcements/solicitations. Subscribers can also sign up for NSF's Custom News Service (http://www.nsf.gov/home/cns/start.htm) to be notified of new funding opportunities that become available.

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The National Science Foundation (NSF) funds research and education in most fields of science and engineering. Awardees are wholly responsible for conducting their project activities and preparing the results for publication. Thus, the Foundation does not assume responsibility for such findings or their interpretation.

NSF welcomes proposals from all qualified scientists, engineers and educators. The Foundation strongly encourages women, minorities and persons with disabilities to compete fully in its programs. In accordance with Federal statutes, regulations and NSF policies, no person on grounds of race, color, age, sex, national origin or disability shall be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving financial assistance from NSF, although some programs may have special requirements that limit eligibility.

Facilitation Awards for Scientists and Engineers with Disabilities (FASED) provide funding for special assistance or equipment to enable persons with disabilities (investigators and other staff, including student research assistants) to work on NSF-supported projects. See the GPG Chapter II, Section D.2 for instructions regarding preparation of these types of proposals.

The National Science Foundation promotes and advances scientific progress in the United States by competitively awarding grants and cooperative agreements for research and education in the sciences, mathematics, and engineering.

To get the latest information about program deadlines, to download copies of NSF publications, and to access abstracts of awards, visit the NSF Website at http://www.nsf.gov

- **Location:** 4201 Wilson Blvd. Arlington, VA 22230
- **For General Information** (NSF Information Center)**:** (703) 292-5111
- **TDD (for the hearing-impaired):** (703) 292-5090
- **To Order Publications or Forms:**

  Send an e-mail to: pubs@nsf.gov

  or telephone: (703) 292-7827
- **To Locate NSF Employees:** (703) 292-5111

PRIVACY ACT AND PUBLIC BURDEN STATEMENTS

The information requested on proposal forms and project reports is solicited under the authority of the National Science Foundation Act of 1950, as amended. The information on proposal forms will be used in connection with the selection of qualified proposals; project reports submitted by awardees will be used for program evaluation and reporting within the Executive Branch and to Congress. The information requested may be disclosed to qualified reviewers and staff assistants as part of the proposal review process; to applicant institutions/grantees to provide or obtain data regarding the proposal review process, award decisions, or the administration of awards; to government contractors, experts, volunteers and researchers and educators as necessary to complete assigned work; to other government agencies needing information as part of the review process or in order to coordinate programs; and to another Federal agency, court or party in a court or Federal administrative proceeding if the government is a party. Information about Principal Investigators may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records," 63 Federal Register 267 (January 5, 1998), and NSF-51, "Reviewer/Proposal File and Associated Records," 63 Federal Register 268 (January 5, 1998). Submission of the information is voluntary. Failure to provide full and complete information, however, may reduce the possibility of receiving an award.

An agency may not conduct or sponsor, and a person is not required to respond to an information collection unless it displays a valid OMB control number. The OMB control number for this collection is 3145-0058. Public reporting burden for this collection of information is estimated to average 120 hours per response, including the time for reviewing instructions. Send comments regarding this burden estimate and any other aspect of this collection of information, including suggestions for reducing this burden, to: Suzanne Plimpton, Reports Clearance Officer, Division of Administrative Services, National Science Foundation, Arlington, VA 22230.

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