

BIO Innovation

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Joann P. Roskoski, Executive Officer for Biological Sciences
National Science Foundation

Advisory Committee for Biological Sciences
30 April 2009

Possibly the biggest challenge:
the organization of most biology
departments (and the BIO directorate)

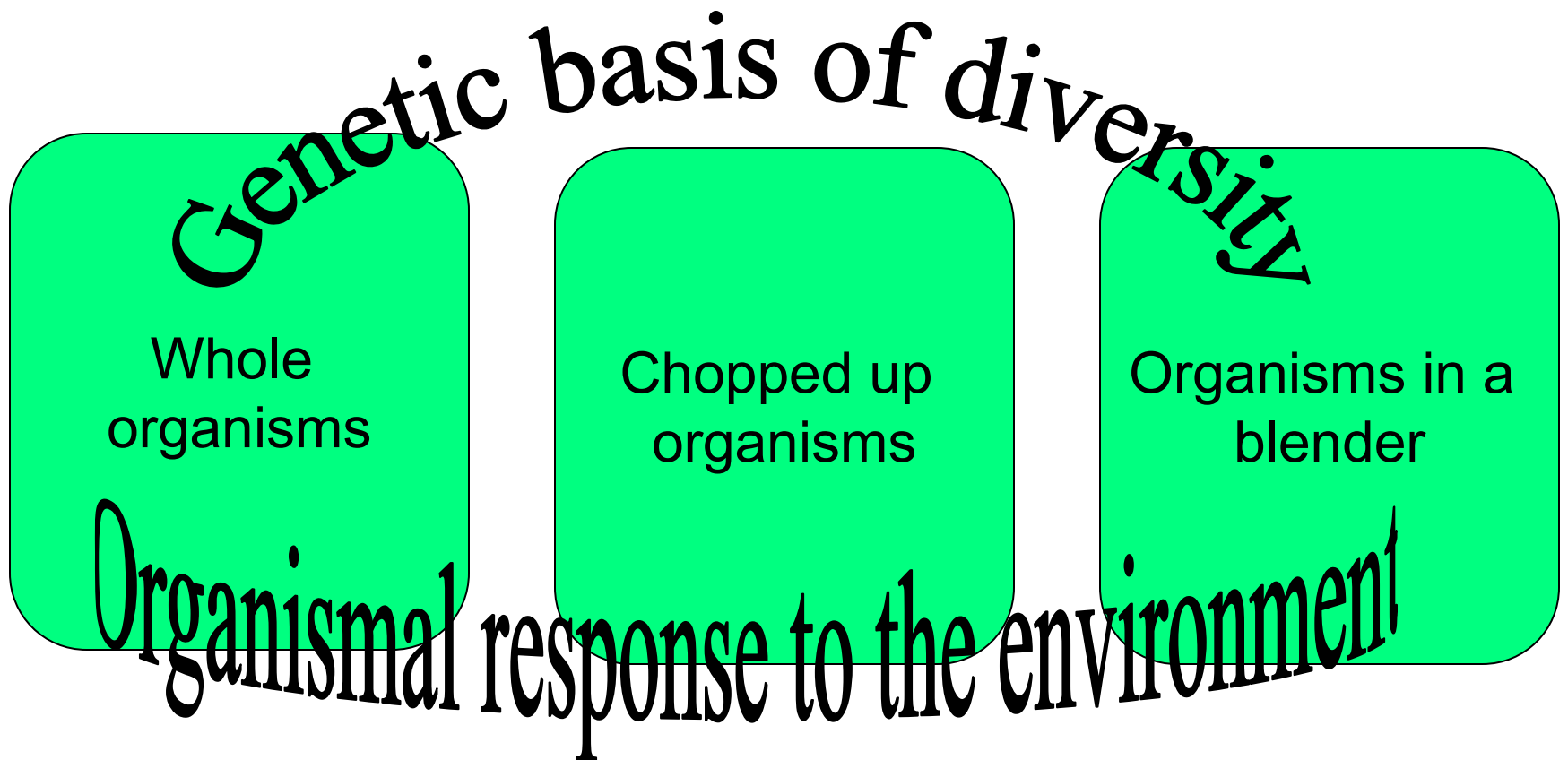


Whole
organisms

Chopped up
organisms

Organisms in a
blender

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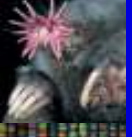
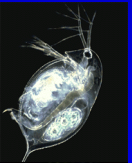


Possibly the biggest challenge:
the organization of most biology
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Leading Edges: Laying The Tracks of Technology Ahead of the Biological Locomotive

- Genomics tools to study ancient cultural practices
 - “Forensic Genomics”
- Miniaturization of tracking devices to study social networks for organisms of all sizes
 - From charismatic megafauna to microbes
- Visualization tools to study molecular-level networks
 - From fish to flagellates, and back again
- Synthesis of existing technologies to enable simultaneous tracking, monitoring, and analysis



➤ Science Priorities

A Time of Change

➤ Impacts on NSF Budget

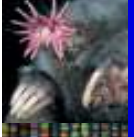
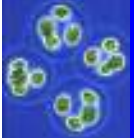
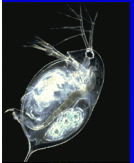
A Time of Opportunity

➤ Biological Sciences at NSF

A Shifting Landscape of Ideas

➤ Managing the Biological Sciences at NSF

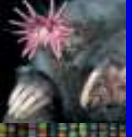
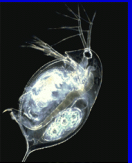
Sustaining Innovation



➤ Managing the Biological Sciences at NSF

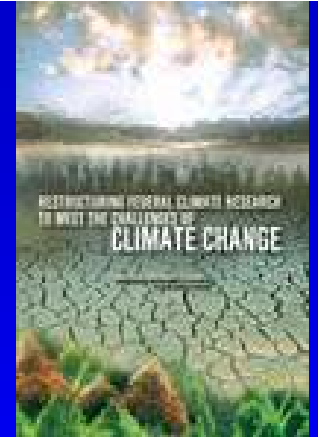
Sustaining Innovation

- Climate Change & Sustainable Energy Priorities
 - Life In Transition DCL
 - Integrated Global System Science (IGSS)
- Emerging Frontiers: Experiments in Innovation



NATIONAL RESEARCH COUNCIL OF THE NATIONAL ACADEMIES

RESTRUCTURING FEDERAL CLIMATE RESEARCH TO MEET THE CHALLENGES OF CLIMATE CHANGE



- Reorganize the program around integrated scientific-societal issues to facilitate crosscutting research focused on understanding the interactions among the climate, human, and environmental systems and on supporting societal responses to climate change.
- Establish a U.S. climate observing system, defined as including physical, biological, and social observations, to ensure that data needed to address climate change are collected or continued.
- Develop the science base and infrastructure to support a new generation of coupled Earth system models
- Strengthen research on adaptation, mitigation, and vulnerability.



National Science Board

Building a Sustainable Energy Future

April 10, 2009 DRAFT FOR PUBLIC COMMENT

Priority Guidance: The National Science Foundation should continue to increase emphasis on innovation in sustainable energy technologies and education as a top priority.

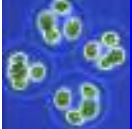
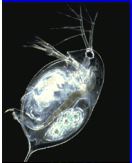


The Board offers the following specific guidance to NSF:


“Strengthen systems approaches in research programs”

“Develop and strengthen interdisciplinary “systems” approaches for research programs in the natural and social sciences that focus on environmental, social, and economic issues fundamental to the future energy economy.”





Life in Transition (LiT)




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Life in Transition (LiT) Dear Colleague Letter

Available Formats: [HTML](#) | [PDF](#) | [TXT](#)
Document Type: Program Announcements & Information
Document Number: nsf08078

Public Comment: The Biological Sciences Directorate (BIO) is augmenting funding to support emerging areas of interdisciplinary research, many of which lie at the intersection of the life and physical sciences. Priority will be given to projects that address fundamental questions about Life in Transition (LiT) This activity is not a special competition or new program.

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NSF in Transition

Encouraging Program Co-review

Sustaining Interdisciplinary Programs

Science and Engineering
Directorates Map to Traditional
Academic Disciplines

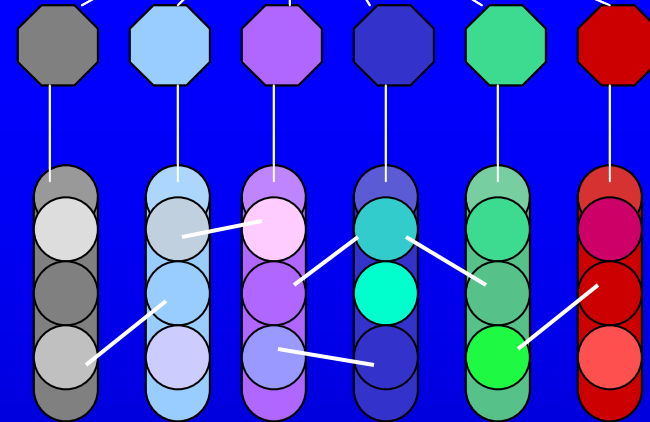
- Math and Physical Sciences
- **Biological Sciences**
- Geosciences
- **Engineering**
- Social and Behavioral Sciences
- Computer and Information Science
- Education and Human Resources



President



Director



Division programs
with Co-Review





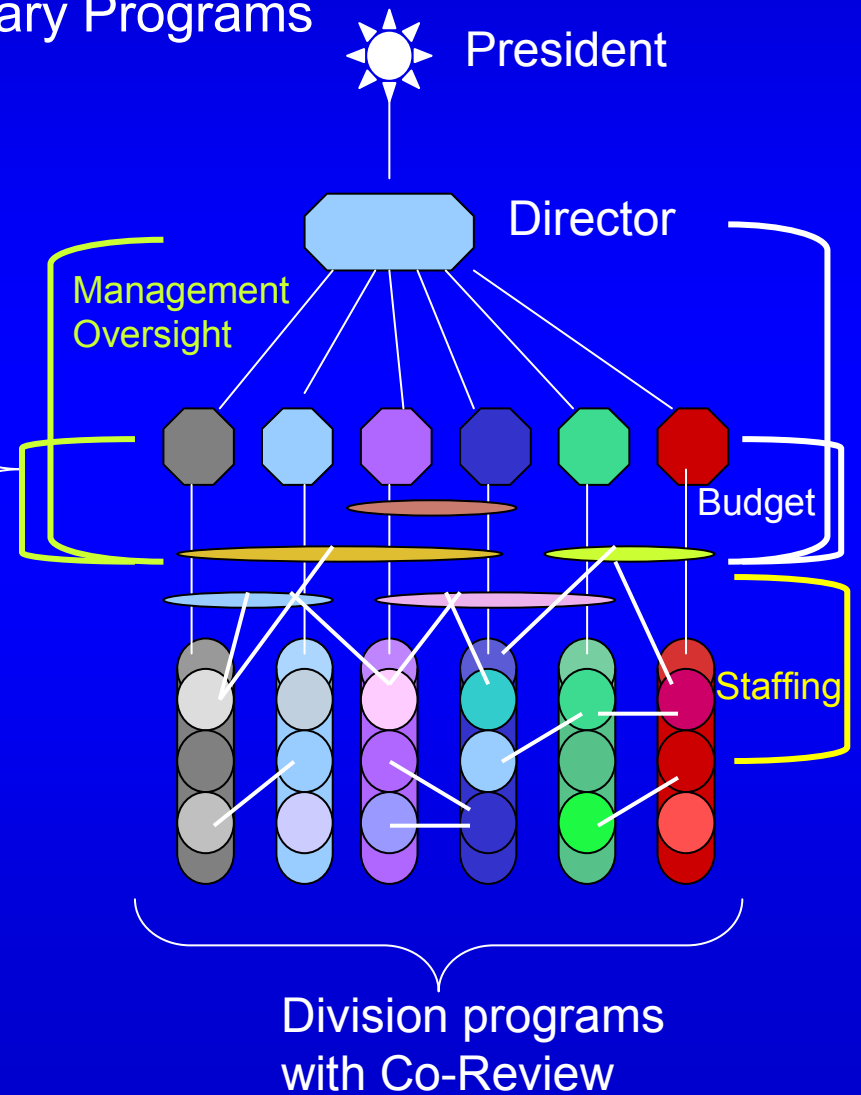
NSF in Transition

Encouraging Program Co-review

Sustaining Interdisciplinary Programs

Science and Engineering
Directorates Map to Traditional
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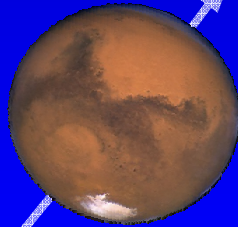




Making New Connections

In an Increasingly Connected World

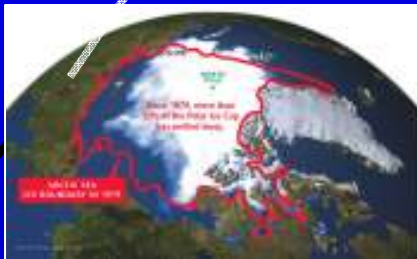
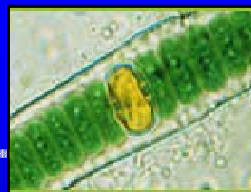
An absence of life?



Atmosphere
+
Geosphere
+
Biosphere



+
Anthroposphere



Integrating across drivers, responses, scales, and disciplines to reduce uncertainty about the future of life on Earth



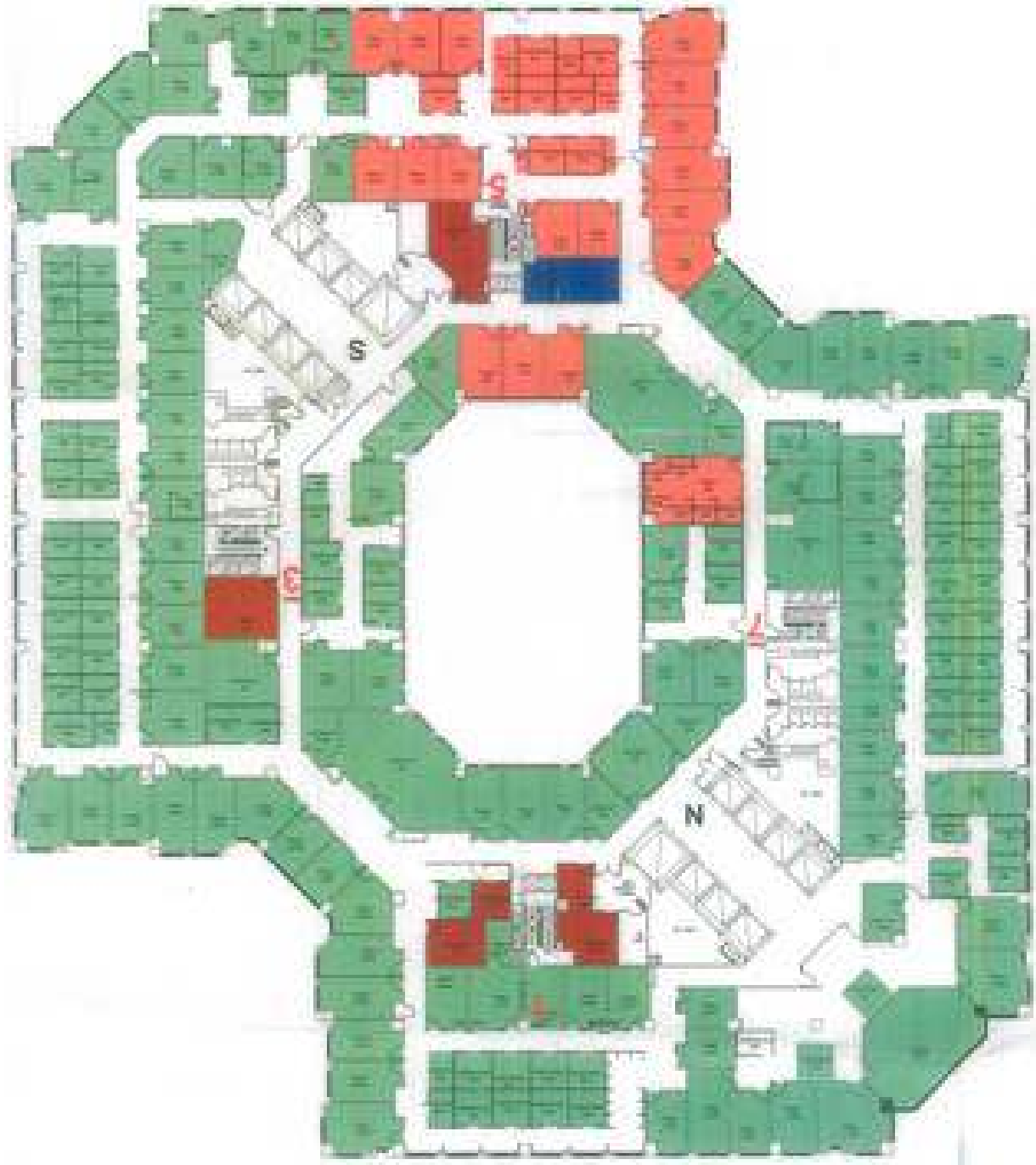


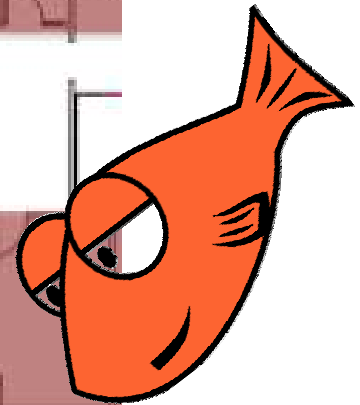
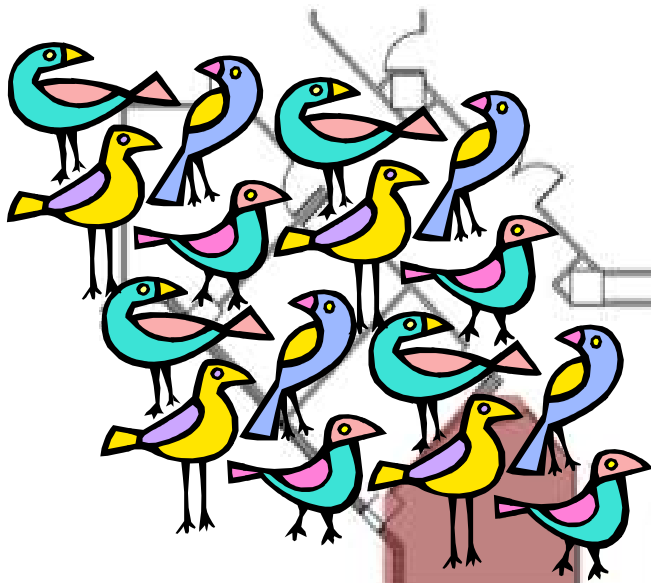
Integrated Global System Science (IGSS)

- Initial Elements

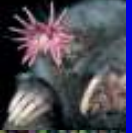
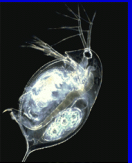
- BIO – GEO Collaboratory
- Distinguished Speaker Series
- Dear Colleague Letters
- Eminent Catalysts
- ???







SUITE 675



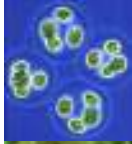
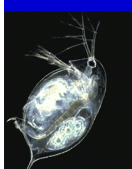
IGSS: Distinguished Speaker Series

➤ Distinguished Speaker Series

- First held in April 2009 (BIO/GEO), next planned for June 2009. Chris Field (BIO) and Peter Brewer (GEO)

- Highlight the interfaces between disciplines and prospects for furthering interdisciplinary research in IGSS.

- Serve as a springboard for other interdisciplinary conversations that will engage NSF staff on subjects at the interface of the bio- and geosciences.



Joint BIO-GEO activity in Biogeochemical Cycles



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Dear Colleague Letter: Update: Emerging Topics in Biogeochemical Cycles (ETBC)

February, 2009

Directorate for Geosciences and Directorate for Biological Sciences
NSF 09-030
(Replaces [NSF 07-049](#))

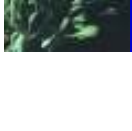
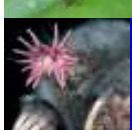
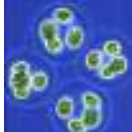
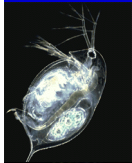
Dear Colleague:


The Directorate for Geosciences (GEO) and the Directorate for Biological Sciences (BIO) are enhancing support for interdisciplinary research which bridges across the biological, atmospheric, geological, oceanographic and hydrological sciences, in the area of biogeochemical cycles and processes.

We seek to support research that will advance our quantitative and/or mechanistic understanding of **biogeochemical cycles, including the water cycle**. Competitive proposals should integrate physical, geological, chemical, and/or hydrologic processes with biological processes over various temporal and/or spatial scales and/or various levels of biological organization. Proposals should be interdisciplinary and address biogeochemical processes and dynamics within and/or across one or more of the following systems: terrestrial, aquatic, and/or atmospheric. We encourage proposals that focus on nonlinear dynamics and/or on interactions and thresholds in climate, ecological, and/or hydrological systems. Goals of this effort are to increase our understanding of how biological systems respond to changing physical and chemical conditions and how biological systems influence the physical and chemical characteristics of soils and sediments, air, or water.



Joint BIO-GEO activity in Multi-Scale Modeling





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Dear Colleague Letter: Multi-scale Modeling (MSM)

February, 2009

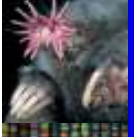
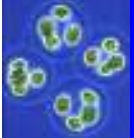
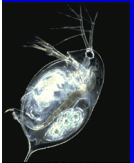
Directorate for Geosciences and Directorate for Biological Sciences
NSF 09-032

Dear Colleague:

The Directorate for Geosciences (GEO) and the Directorate for Biological Sciences (BIO) are enhancing support for interdisciplinary research which bridges from the biological to the earth system sciences in the area of multi-scale modeling.

We seek to support projects that focus on the **development and/or integration of environmental models that link local, regional and global scales**. Competitive projects should address key problems linking biological and Earth system processes over a variety of spatial and temporal scales. These projects will develop theoretical foundations for the modeling and simulations of existing data and data collected by the *new and envisioned NSF environmental observatories*. [These include, for example, EarthScope, Critical Zone Observatories (CZO), the National Ecological Observatory Network (NEON), the Ocean Observatories Initiative (OOI), and many other projects and centers.] Proposals are encouraged that have the potential to dramatically improve our understanding of how small and large scale processes lead to non-linearities and activation thresholds as well as to improve our predictive capabilities. Projects could address, but are not limited to, topics such as the carbon cycle, climate, population dynamics, foodwebs, biodiversity, biogeochemical cycles, and hydrological processes.

These types of emerging and challenging problems require integration of concepts and observations across diverse fields.



➤ Managing the Biological Sciences at NSF

Sustaining Innovation

- Climate Change & Sustainable Energy Priorities
 - Life In Transition
 - Integrated Global System Science (IGSS)
- Emerging Frontiers: Experiments in Innovation



Emerging Frontiers: Experiments in Innovation

The Directorate for Biological Sciences has sought new ways to apply the ingenuity that derives from human curiosity to create opportunities for the interdisciplinary research needed to understand life on earth.

➤ **Stimulating Interdisciplinary Activities:**

➤ **Building on existing links and exploring new partnerships across Divisions, Directorates, Agencies, NGOs and international organizations, e.g.:**

➤ **Integrated Global Systems Science (IGSS)**

➤ **Dynamics of Coupled Natural and Human Systems (CNH)**

➤ **Ecology of Infectious Diseases (EID)**

➤ **National Institute for Mathematical and Biological Sciences (NIMBioS)**

➤ **Centers for the Environmental Impact of Nanotechnology (CEIN)**

➤ **Basic Research to Enable Agricultural Development (BREAD)**





Emerging Frontiers: Experiments in Innovation

➤ Establishing Collaboratories

- Beginning in 2009 BIO and GEO will co-locate 17 BIO and GEO Program Directors and 3 support staff members in a dedicated collaboration space and provide resources to encourage and support transdisciplinary activities in climate change research.

➤ Capitalizing the BIO Office of Emerging Frontiers (EF)

- To develop and implement new forms of peer review and mechanisms to support transformative research and stimulate creativity, and
- To identify and implement thematic research areas that transcend scientific disciplines and/or advance the conceptual foundations of biology (e.g., LiT; ATB).





Emerging Frontiers: Experiments in Innovation

➤ Employing Sandpits:

- A process that couples novel/high risk research project development with real-time peer review.
- Novel characteristics of the sandpit process include:
 - Challenges attitudes of risk-averse or collaboration-averse communities
 - Focuses at the intersections of disciplines
 - Uses facilitation techniques to promote creative thinking
 - Implemented at a level that can fully engage non-domain experts
 - Has the potential for high impact on research, industry/business and the economy, quality of life, policy etc.





Emerging Frontiers: Experiments in Innovation

- Exploring Novel Processes for Problem Solving.
 - Crowd sourcing/bloggng – posting a problem or challenge on the internet and inviting the community to respond with their best ideas/solutions
(<http://en.wikipedia.org/wiki/Crowdsourcing>)
 - Clean slate – evaluating an existing problem or project independent of past performance or results; i.e., as if designing an approach or program from the beginning
(<http://cleanslate.stanford.edu/>)





Emerging Frontiers: Experiments in Innovation

- Exploring Novel Processes for Problem Solving.
 - Creativity training (PDs) and creativity sabbaticals (PIs)
 - Synthesis Centers – leveraging extant data/information to address questions and summarize state of knowledge in order to identify future research directions (e.g., National Center for Ecological Analysis and Synthesis: <http://www.nceas.ucsb.edu/>)





Where discoveries begin