The U.S. Global Change Research Program

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The new administration is expressing a great deal of confidence in science and technology to help solve our problems, to improve economic competitiveness, and to provide stimulus for education, among other reasons. There have been a number of critical comments over the years about how previous administrations have viewed and considered science. This administration is taking a number of actions aimed at addressing these criticisms. They have a very active Office of Science and Technology Policy with Dr. Jack Gibbons and others. They have established the National Science and Technology Council and much is going on to make it work. Although the first NSTC meeting has not occurred [it did in June 1994], there have been many working meetings and activities going on underneath.

The President’s Budget includes about $70 to 75 billion for research; that number is going to stay about the same. The budget resolutions that have been passed by Congress provide for no significant change; all of the research money is going to be divided among the NSTC areas [Fig. A-1]. Within each of these areas there are different priorities, so when one subcommittee says we should be putting more funding into global change or into some other area, realize that with a fixed budget, the funding is going to come from somewhere else. The present distribution of funding is about 50 to 55% for national security, the rest in everything else; the President is basically committed to build the non-national security areas up to about 50%. There is therefore some chance for growth in non-security areas, but realize that there are a lot of proposed activities in these other areas -- whether it is clean cars, better manufacturing techniques, economic competitiveness, the human genome and biotechnology, or other areas is not yet clear.

The National Science and Technology Council [Fig. A-2] is led by the President, and is one of the four major councils in the government (the others being the Domestic Policy, National Security Council, and the National Economic Council). Thus, there are four high-level entities that coordinate across the U.S. government. The Deputies Group of the NSTC has been meeting, and has been looking at, among other things, recommendations for the FY 1996 budget process. There have been comments that, in contrast to FCCSET (the former Federal Coordinating Council for Science, Engineering
The National Science and Technology Council (NSTC) is developing research strategies for each of its component efforts:

- Health, Safety, and Food R&D
- Information and Communication R&D
- National Security
- Civilian Industrial Technology
- Fundamental Science
- International Science, Engineering, and Technology
- Environment and Natural Resources Research
- Transportation R&D
- Education and Training R&D

**Figure A-1**

![Diagram of the National Science & Technology Council (NSTC) structure](image)

**Figure A-2**

![Diagram of the NSTC Deputies Group](image)
and Technology), which didn’t meet all that often, this new structure has added a lot of committees. This additional structure has not simplified things; the challenge is to make the new structure work effectively.

The Committee on Environment and Natural Resources Research (CENR), within the NSTC, is responsible for all research relating to global change. Dr. D. James Baker, Administrator of NOAA, is the Chair, the head of the National Biological Survey Dr. Ron Pulliam serving as Co-Chair. The White House Co-Chair is Dr. Robert Watson; his position represents the first time that OSTP has had a Deputy for the Environment. Dr. Tom Lovejoy of the Smithsonian Institution serves as science Vice-Chair. There are also two policy Vice-Chairs: Robert Sussman from EPA and Christine Ervin from DOE. What is particularly interesting throughout CENR is that appointments have both science and policy offices of the agencies represented.

CENR has subdivided all of the government’s environmental research into seven issue-focused areas: air quality, biodiversity and ecosystems, global change, natural disaster reduction, resource use, toxic substances and water resources [Fig. A-3]. Note that there are some areas that are not obvious: Weather research, for example, is included in the natural disaster area. There are also some environmental concerns that do not easily fall into these categories: Radioactive substances, for example, which were a prominent concern ten years ago, are not explicitly listed, but are included under both toxic substances (for wastes) and air quality (for radon).

Each subcommittee includes representatives from a dozen or so agencies, plus about ten other Executive offices. There are representatives from each of the subcommittees to CENR, and “program contacts” for each of them. I serve as program contact for global change. We have weekly meetings to ensure some coordination and to deal with common and overlapping issues.

CENR also has three cross-cutting disciplinary subcommittees: risk assessment, social and economic sciences, and environmental technology and engineering. There was discussion at one time about having some additional interdisciplinary subcommittees (e.g., atmospheric research or ocean research); instead, previously active interagency committees continue.

Each subcommittee has a chair from a science agency and co-chairs for both science and policy agencies (offices). Dr. Robert Core11 from NSF is the Chair for Global Change research. The Vice-Chair for science is Dr. Charles Kennel from NASA. Dr. Susan Tierney from DOE is the policy Vice-Chair.

These subcommittees have been instructed to develop a program scope that goes all the way from the natural sciences to mitigation and adaptation to
The Committee on Environment and Natural Resources Research (CENR) is organized around both environmental issues and cross-cutting disciplinary areas.

CENR has organized interagency subcommittees on seven environmental issues:

- Air quality
- Biodiversity and ecosystems
- Global change
- Natural disaster reduction
- Resource use and management
- Toxic substances and hazardous and solid wastes
- Water resources, coastal and marine environments

CENR has also organized three cross-cutting interagency subcommittees:

- Risk assessment
- Social and economic sciences
- Technology and engineering

CENR is cooperating with agency policy offices to create an interagency Science and Policy Assessment Group to sponsor national assessments.

A special task force on observations and data management has also been appointed.

Figure A-3
socio-economic and ecological effects. This broad scope of the research is intended to reach out to the policy-relevant aspects of each of these issues.

Borders among the groups are, at least right now, still fuzzy. You can imagine that there are a number of overlap issues that we have to work on. For example does the Biodiversity and Ecosystems subcommittee, which includes the National Biological Survey, focus only on the U.S. or does it treat global issues? Will this subcommittee look at both short-term and long-term aspects?

The CENR structure is basically serving as a “virtual agency.” There have been quite a number of critiques of the organization of environmental science in this country. There are many reports describing what is going well and what is not. This new structure is an attempt to try to coordinate environmental research without combining agencies or centralizing funding (as the National Institute for the Environment proposal suggests), believing that the many ties to the agencies are important and an arbitrary combining of research programs could be very disruptive.

Turning now to the USGCRP. The USGCRP has been organized around a science goal:

to gain a predictive understanding of the interactions among the physical, chemical, geological, economic, social, and human processes that influence and are influenced by the Earth system, and to assess their significance to natural and socio-economic systems (emphasis added).

This assessment portion has not been particularly emphasized in the past. As a result of the scientific advances that have come over the past few decades, particularly over 1980’s and early 1990’s, there is an increased interest in human dimensions, policy relevance and assessment.

Fig. A-4 is a chart that Bob Corell has shown for some time which points out the three major thrusts of the research program. The major thrust of the USGCRP in the past has been contributing to the advancement of scientific understanding. However, with so many international agreements being proposed and signed (e.g., biodiversity, ozone, climate change, forestry, etc.), providing support for development of these national and international agreements has become a much more important aspect of the Program [Fig. A-5]. Realize there’s been an increasing adjustment of the balance among these areas.

I want to offer a few thoughts on what this redirection of emphasis will mean to the USGCRP [Fig. A-6]. When choices in undertaking research are focused most on the scientific issues, the characteristics of such programs
The U.S. and the world community have made and are negotiating commitments to protect the global environment.

International commitments include the following:

- Montreal Protocol on Substances that Deplete the Ozone Layer, and subsequent amendments (calls for halting production of many long-lived chlorine and bromine compounds)
- Framework Convention on Climate Change (calls for limiting emissions of greenhouse gases to avoid dangerous interference with the environment)
- UNCED's Agenda 21
- Convention on Biodiversity
- Global Forestry Agreement
- Regionally focused agreements (e.g., on Antarctica, the Arctic)

To support the information needs of these agreements (and others) requires a more cohesive and comprehensive research program.
Scientific community, NAS, WCRP, IGBP, etc.  
Scientific questions and uncertainties  
USGCRP  
Decisionmakers, policymakers, assessments  
Policy relevant questions and issues  

Figure A-6

Characteristics:
- Focuses on resolving uncertainties
- Concentrates attention on most familiar uncertainties
- Expansive need for additional programs
- Long time horizon to solution, requiring long-term commitments of resources
- Requires thorough understanding of each uncertainty

Characteristics:
- Focuses on possibilities and probabilities
- Requires at least minimal coverage of all program aspects
- Deals with what information is available
- Wants best answer possible on a continuing basis; requires fluidity in program selection
- Wants balanced understanding of all uncertainties
focus most intensely on resolving uncertainty; there is also perhaps a
tendency to concentrate on those uncertainties with which scientists and
program managers are the most familiar, and to ignore other, less familiar
ones. From this perspective, there is an expansive need for additional
programs, and we are certainly seeing this as many programs are proposed at
international and other levels. There is also a tendency to focus on the long-
time horizon, to try to work to fully resolve scientific uncertainties, and
requests for long-term commitments of resources. There is a preference not
to stop a program until there is a thorough and deep understanding of each
uncertainty.

Decision makers, policy makers, and other stakeholders have different
perspectives. The say, we have to make decisions now if we are going to try to
avoid long-term problems -- we have to decide whether to take or not take
actions now. Instead of focusing on uncertainties, they want to know what
the possibilities are, and have a sense of the probabilities, of what can happen.
In order to have available an understanding of the whole program, they want
to be sure that the USGCRP has at least minimal levels of research going on
in support of all areas. They argue that the USGCRP cannot just research one
aspect and say that ten years from now the USGCRP will start to work on
another aspect. These groups focus on what information is available, and
then try to derive the best answer they can from that information. They
want a balancing in the examination of uncertainties. They want research to
go after the most important uncertainties. For uncertainties that have not
been completely resolved, they might suggest that the program can no longer
afford to keep going, trying to resolve every aspect in quite as much detail.

While retaining its scientific focus, the USGCRP is adapting to include
this new perspective. In our draft plan, we are rephrasing the scientific goal,
making providing scientific and technical information the focus, and putting
policy formulation as the rationale for the research near the top of the
requirements [Fig. A-7]. The U.S. by treaty is now committed to protecting the
climate (more broadly, the environment) for present and future generations
(Climate Convention). It is also interesting that the Climate Convention
includes phrases such as employing policies that encourage sustainable
development.

Scientific and technical information is defined in a draft OSTP
summary document about what CENR/NSTC should be including in its
national research strategy [Fig. A-8]. There is a requirement to understand the
natural system and its susceptibility to change, to understand the socio-
economic dimensions of change and the vulnerability of ecosystems, and to
include issues related to technology, strategies for mitigation, adaptation to
change and others.
Draft USGCRP Goal drawn from CENR draft statement

To provide the scientific and technical information:

- needed for national and international policy formulation and implementation
- required to protect the regional and global environment for present and future generations by
- employing policies and approaches that enable development to proceed in a sustainable manner, while
- preserving ecological diversity, protecting human health and safety, and enhancing the quality and quantity of food, fiber, energy, and water supplies.

Figure A-7

The research needs of the USGCRP

“Scientific and technical information” is taken to include understanding of:

- the state of the natural system including its extreme events and its susceptibility to change by human activities;
- the socioeconomic dimensions of environmental changes;
- the human health consequences of environmental degradation;
- the vulnerability of ecological systems and the goods and services they provide; and
- the development of technologies and strategies to mitigate change, to adapt to change, and to restore damaged ecosystems, in response to human-induced stresses on the system.

Figure A-8
Within the global change program, we have started to define the elements of what such a program should be [Fig. A-9]. One element is certainly focused on the climate and the climate system. In fact one of the passages in the Climate Convention talks about protecting the climate system from "dangerous anthropogenic interference." Nobody has quite figured out what these words mean, but a conference in October has been scheduled to try to more closely define the terms. There are also other aspects of the USGCRP, including how local and regional land use and management practices affect the global environment, including leading to deforestation and desertification, for example, and how these uses and practices affect ecosystems. As for protecting the climate, the Climate Convention language can be extended to include protecting the composition of the atmosphere and ocean from "dangerous anthropogenic interference." It is interesting that some policymakers have the view that they have "solved" the stratospheric ozone problem which has resulted in the rephrasing that is used. There is also an element of the USGCRP looking at the societal resilience to dealing with climatic extremes and variations, including ENSO events and other activities. In addition, there are elements and there is a need to improve overall understanding, especially because there are many other issues that may arise and there is a need to focus on comprehensive understanding of what the anthropogenic influences might be. The USGCRP also needs to have elements related to understanding what the social driving forces and mechanisms are and also improving public awareness.

These elements can be summarized in terms of a science question asking basically how vulnerable the Earth system is to change, including the vulnerability of both the natural environment and human systems [Fig. A-10].

In organizing the program, there are several crosscutting issues to be considered [Fig. A-11]. We need to consider the balance among the research that we have been doing, including how we are focusing on physical, chemical, ecological and social sciences. There are certainly issues to keep in mind about avoiding such a strong focus on the policy-driven part that we miss out on the whole range of issues that arise from curiosity-driven research. We have to make sure that we have a balance between PI-driven research and research based on integrated-assessments (possibly in centers). We have to make sure that we have a balance across the natural sciences into the policy relevant areas. We are responsible to Congress for putting together a multi-year program plan that will update the plan that written in FY 1991. We are working out the approach to this plan now.

The FY1995 *Our Changing Planet*, the annual report to Congress on the USGCRP, represents a start in restructuring the Program. The Program activities are subdivided among various elements [Fig. A-12], and the research
Critical elements of the policy-relevant goal statement

- To protect the climate system from "dangerous anthropogenic interference" as the result of the emissions of greenhouse gases and aerosols
- To ensure that local and regional use and management practices associated with terrestrial and aquatic resources have minimal adverse effects on long-term sustainability
- To protect the composition of the atmosphere and oceans from adverse anthropogenic interference
- To improve societal resilience to and preparation for dealing with climatic extremes and variations
- To improve understanding of Earth system behavior in order to ensure comprehensive identification of adverse anthropogenic influences and to enable effective policy formulation and development
- To improve understanding of the mechanisms and social forces that are inducing global change to occur and how they can be managed
- To improve public awareness of global environmental trends and projections and of their causes and the relationship of global change to sustainability and the standard and quality of life

Figure A-9

Establishing threshold levels at which adverse anthropogenic interference will occur is central to meeting the USGCRP goal

The policy relevant science question proposed as the focus of the USGCRP is:

*How vulnerable is the Earth system, including the natural environment, human systems, and the full range of societal activities, to natural variations in and to anthropogenic influences on global and regional environments?*

Supporting questions include:

- What are the factors causing global change?
- What, when, and by how much will the environment be changed by human activities?
- How will natural and human systems respond and be affected by change?
- What are the present and prospective technical options and policy responses for mitigation and/or adaptation?
- What are the institutional barriers to implementing available options, and what will be the costs of implementations and delay?

Figure A-10
effort is organized into six interagency working groups [Fig. A-13] that focus on common thematic issues.

Four working groups (WGs) have already been part of the structure of the USGCRP:

- Observations and Monitoring: While the USGCRP WG has been active, the observation activity has been taken up by the CENR as a cross-cutting issue to try to think about what the national contribution should be to both national and international observations and monitoring systems across all of those issues under CENR purview. This would include coordinating what is being done for air quality with what is being done for global change, for example. A special task force of the CENR has been formed to help work on this issue.

- Data and Information Management: The data and information research activity has been a reasonably strong interagency effort under the Interagency Working Group on Data Management for Global Change. The implementation plan for the Global Change Data and Information System (GCDIS) is now out for review (at the agency level); it proposes a common format for approaching data and information needs.

- Processes Research: The processes research working group has been trying to pick up on a number of specific areas that need an enhancement of effort. One has to do with terrestrial ecology, asking where the carbon is going and why (the biogeochemical aspects), asking how ecosystems will be affected by climate change, and asking how ecosystem change may affect the climate. Another major focus is ensuring that the U.S. is adequately supporting the full set of international programs, including those of the IGBP and the WCRP.

- Integrative modeling and prediction (IMAP): This WG includes several elements. One is the seasonal to interannual prediction issue (not the focus of the current workshop), trying to build upon the successes in this area. The most important focus is on the issue of longer-term climatic change, which will be considered below.

Two new working groups have been formed this year to address increasingly important themes:

- Consequences and Adaptation: This WG is focusing on consequences, adaptation mechanisms, and mitigation. The first activity for this group is to develop a strategy for researching these issues, and then to organize these kinds of efforts. The IPCC Working Group II is summarizing research on consequences, including on the agricultural lands and forests of the world. The USGCRP Consequences WG will be considering, for
## Cross-cutting issues for consideration

1. Balance among program elements
2. Balance between programmatic/directed research and curiosity-driven research
3. Balance between individual PI-research and focused, center-based activities
4. Management adjustments needed in moving from natural science-based program to policy-relevant science program
5. Design of the multi-year program plan as both a science document and policy-relevant program description for Congress and the public.

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**Figure A-11**
<table>
<thead>
<tr>
<th>Elements of the USGCRP research framework</th>
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<tr>
<td>(from the FY1995 <em>Our Changing Planet</em>)</td>
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### A. OBSERVING GLOBAL CHANGE
- 1. Space-based Earth Observing System
- 2. Additional Space-based Observations
- 3. Land- and Ocean-based Observations

### B. MANAGING GLOBAL CHANGE DATA AND INFORMATION

### C. UNDERSTANDING GLOBAL CHANGE PROCESSES
- 1. Climate Dynamics and Hydrologic Systems
- 2. Chemistry and Biogeochemical Dynamics
- 3. Ecological Systems and Dynamics
- 4. Human Interactions and Influences
- 5. Earth System History
- 6. Solid Earth Interactions
- 7. Solar Influences

### D. PREDICTING GLOBAL CHANGE
- 1. Earth System Modeling and Long-Term Prediction
- 2. Seasonal to Interannual Forecasting
- 3. Attribution and Reconciliation with Observations

### E. ANALYZING GLOBAL CHANGE CONSEQUENCES AND MITIGATION STRATEGIES
- 1. Environmental Impacts and Adaptation Mechanisms
- 2. Societal Impacts and Adaptation Mechanisms
- 3. Mitigation Strategies

### F. ASSESSING POLICIES AND OPTIONS
- 1. Social, Economic, and Policy Sciences Research
- 2. Integrated Assessment Capabilities
- 3. Decision Tools and Information
- 4. Resource Use and Management Tools

Figure A-12
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<th>USGCRP Working Groups</th>
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<td><strong>THEMATIC WORKING GROUPS:</strong></td>
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<td>Observations (and Monitoring)</td>
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<tr>
<td>Data and Information Research</td>
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<tr>
<td>Process Research</td>
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<tr>
<td>Integrative Modeling and Prediction</td>
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<td>Consequences, Adaptation Mechanisms and Mitigation</td>
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<td>Assessment Methodologies and Policy Sciences Research</td>
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<td><strong>CROSSCUTTING WORKING GROUPS:</strong></td>
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<td>International Linkages</td>
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<td>Education and Communication</td>
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Figure A-13
example, whether it would be appropriate to look at the U.S. by regions, by sectors, or by other subdivisions. We will be considering how to look at the vulnerability of ecosystems and the impacts on agriculture.

- Assessment Methodologies and Policy Sciences: This WG is developing a research agenda for considering the socio-economic implications of global change. There is a rather strong effort looking at assessment methodologies and at the policy sciences research agenda. This area is proposed for 100% growth in the President’s FY95 Budget request.

Two crosscutting committees have also been formalized. One is international linkages, which deals with international data policies, exchange protocols, and international research institutes, builds on earlier efforts. The second WG focused on education and communication, seeking to assemble and coordinate a range of activities and programs.

Actual assessments (in contrast to research on assessment methodologies) must include input and interactions with all of these areas. This responsibility is to be handled at level of the Executive Committee of the Subcommittee on Global Change Research. We are trying to develop a mechanism for not just performing international science reviews, but for also establishing a U.S. mechanism to support assessment activities. We are seeking to create an open process, involving everyone in the assembling of the basic information that policy-makers need. The agency policy shops would then have responsibility for assessments on policy implementation (for example, whether to support a carbon tax, a gas tax, or other measures) that have political as well as scientific implications.

The appendix of the FY1995 Our Changing Planet provides a summary of the proposed budget [Fig. A-14]. About 60% of the budget is devoted to observing change and data management (which include the Earth Observing System, EOSDIS and the supporting satellite programs); about 30% is devoted to understanding and processes research; the other parts of the Program are funded at very modest levels. If anyone is interested in finding out more about the program (including budget and other information), the Global Change Research Information Office (GCRIO, internet: gbarton@gcrio.org), which was established in response to Congressional guidance, has this information available through internet. Available information includes one-page descriptions of each of the 130-140 programs making up the USGCRP as well as budget figures and tables. The one page descriptions were prepared to assist in the preparation of the FY1995 budget, and include brief supporting statements on the scientific merit, stakeholders and linkages to other parts of the program, policy relevance, and contact for the various programs. This represents the first time such information is being made available so fully and easily.
FY1994-1995 USGCRP Budget by Framework Component

Figure A-14
Finally, a few comments on trends in Washington. First, I have been emphasizing that there is a tight budget. It is going to be hard for programs to grow. If you go back to the bargain on which Mike Hall was commenting Sunday night (at the opening reception) about having a chance to receive additional funding where it makes a difference, there is an opportunity; but the new research must be focused on guidance and input for the policy process. This does not mean providing answers with no uncertainties; but the research must provide the best estimates that can be made.

Another thing that has happened, again by Congressional mandate, and something you all are likely to become more involved in, has to do with milestones and measurables. In addition to those milestones that might come from individual research projects and programs, the Program as a whole is being asked about milestones. In trying to figure out what that means, we have identified at least four types of milestones.

1. Programmatic milestones describe what a program does. Examples include: launching a satellite, sending a ship to make measurements in the Pacific, and coupling models together. The agencies are in charge of keeping track of these kinds of milestones.

2. Scientific milestones describe improvements to the answers to a scientific question that matters to people. Where is the missing carbon going? What is the sensitivity of climate change? It is hard to predict progress in a scientific area, but there is a need to make sure that a research program (or set of programs) is focused on such questions. Progress in achieving such milestones would depend on reviews by national and international scientific bodies to get an estimate of how much progress is being made.

3. Policy-related, or policy-relevant, milestones would be used to mark achieving better answers to questions of interest to decision makers. What is the effect of global change on U.S. food production? What is the effect of global change on water resources? These are questions that really matter to the public, and we have to figure out a mechanism to indicate that we are making progress on such milestones. This will probably occur through integrated assessments.

4. Research “process” milestones, which describe progress in organizing to carry out a program or to perform research or assessment activities. Do we have structures in place to conduct assessments? Do we have a balanced research program? Do we have a human dimensions program?

The multi-year plan that we are preparing needs to include milestones; and we are trying to figure out exactly what kinds of milestones to include.
An earlier compilation of programmatic milestones alone was not particularly useful. While probably interested in scientific milestones, Congress seems most interested in policy-related and process milestones, which have generally been ignored in the past. This meeting is in part to help identify some of the research process milestones with respect to modeling, to explore getting a structure in place to improve and encourage the modeling program.

As we develop the USGCRP research plan and appropriate milestones, we will be soliciting your comments. Please do not be shy about sending in comments; we look forward to hearing from you. For the draft strategy document that some of you helped to review we continue to receive helpful comments. We encourage your continuing involvement.

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