

Withdrawal/Redaction Sheet

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DOCUMENT NO. AND TYPE	SUBJECT/TITLE	DATE	RESTRICTION
001. email	Charlie Murray to Lisa Gaisford [partial] (1 page)	9/15/1998	P6/b(6)
~~002. email~~	~~bakerc@osd.pentagon.mil to Sara Laskin, re NPOESS (2 pages)~~	~~9/29/1998~~	~~P5~~ DMS 3/14/14
~~003. email~~	~~Charlie Murray to Lisa Gaisford, re: More Trouble on NPOESS (3 pages)~~	~~10/13/1998~~	~~P5~~ DMS 3/14/14

COLLECTION:

Clinton Presidential Records
Automated Records Management System
Default ([National Polar-Orbiting Environmental Satellite System, NPOESS])
OA/Box Number: 1100000

FOLDER TITLE:

[10/27/1997 - 10/13/1998]

2008-0829-F

wr637

RESTRICTION CODES

Presidential Records Act - [44 U.S.C. 2204(a)]

- P1 National Security Classified Information [(a)(1) of the PRA]
- P2 Relating to the appointment to Federal office [(a)(2) of the PRA]
- P3 Release would violate a Federal statute [(a)(3) of the PRA]
- P4 Release would disclose trade secrets or confidential commercial or financial information [(a)(4) of the PRA]
- P5 Release would disclose confidential advice between the President and his advisors, or between such advisors [(a)(5) of the PRA]
- P6 Release would constitute a clearly unwarranted invasion of personal privacy [(a)(6) of the PRA]

C. Closed in accordance with restrictions contained in donor's deed of gift.

PRM. Personal record misfile defined in accordance with 44 U.S.C. 2201(3).

RR. Document will be reviewed upon request.

Freedom of Information Act - [5 U.S.C. 552(b)]

- b(1) National security classified information [(b)(1) of the FOIA]
- b(2) Release would disclose internal personnel rules and practices of an agency [(b)(2) of the FOIA]
- b(3) Release would violate a Federal statute [(b)(3) of the FOIA]
- b(4) Release would disclose trade secrets or confidential or financial information [(b)(4) of the FOIA]
- b(6) Release would constitute a clearly unwarranted invasion of personal privacy [(b)(6) of the FOIA]
- b(7) Release would disclose information compiled for law enforcement purposes [(b)(7) of the FOIA]
- b(8) Release would disclose information concerning the regulation of financial institutions [(b)(8) of the FOIA]
- b(9) Release would disclose geological or geophysical information concerning wells [(b)(9) of the FOIA]

RECORD TYPE: FEDERAL (TRP NOTES MAIL)

CREATOR: bakerc (bakerc@ousdc.osd.mil@INET@LNGTWY [UNKNOWN])

CREATION DATE/TIME: 27-OCT-1997 07:07:00.00

SUBJECT: Re: OMB Letter

TO: Anthony B. Wu (Anthony B. Wu@EOP [UNKNOWN])

READ: UNKNOWN

TO: Lisa A. Gaisford (Lisa A. Gaisford@EOP [UNKNOWN])

READ: UNKNOWN

TEXT:

Tony and Lisa,

We seem to have some confusion over here in
the Pentagon (see my attempt at clarification below),
but we will get ourselves sorted out promptly.

Charlie

From: Baker, Charlie, , OUSDC

Sent: Friday, October 24, 1997 19:53

To: Haas, John, COL, OUSD/AT

Cc: 'Landon, John'; Skinner, Richard W., , SAF/AQS; McCormick, Dick, ,
SAF/SX; Brooks, James, , OSD/PA&E; Zimmerman, Chris, , OSD/PA&E; Tuley,
John, , SAF/AQSS 001; Seabaugh, Steven, , SAF/AQS001; 'Dorothy.Smith'

Subject: RE: OMB Letter

Mike,

In answer to your questions:

Yes, I do have a tasker from Lisa, and I will send it out
to you, and the Air Force, and PA&E on Monday morning.

You are wrong about the submission to OMB. The DoD
submitted its budget to OMB on Sept 26, 1997, and our

NPOESS number is the same as the DoC NPOESS number. That is the official DoD budget submission, and Lisa is technically correct in how she has characterized our budget. On the other hand, our budgets are more of a moving target than are Commerce's budgets. The Commerce budget can only be changed by a formal budget amendment from Commerce or by an OMB passback. Our budget can be changed by those two processes as well, but the most frequent change is by Program Budget Decision (PBD). There is no counterpart to the PBD process on the Commerce side. Each PBD that we write is coordinated with OMB before it is sent up for signature. If OMB nonconcurs in a proposed adjustment, we either remove the adjustment from the PBD, or we run the risk of having it rammed down our throat by the passback process. Tony and Lisa understand this process, and they know that if OMB's Commerce passback blesses the ExCom recommendation, then DoD will issue a PBD bringing the DoD program into line with Commerce.

Hope this clarifies things. Meanwhile, what Tony and Lisa want us to do is to check the factual accuracy of the description of the two alternative program structures that are shown in the side by side comparison.

Charlie Baker

From: Haas, John, COL, OUSD/AT
Sent: Friday, October 24, 1997 16:46
To: Baker, Charlie, , OUSDC
Subject: OMB Letter

Charlie,

Have you seen a tasker from Lisa on two options for NPOESS? I've heard she has based one on DOC and DOD's budget submission to OMB. Didn't think we submitted to OMB until December? If this is true we need to correct her words.

Both times the AF has presented numbers (at OMB and at your hearings) they have been careful to point out that the numbers they are showing are there to reflect DOC numbers and they would move up (of course within reason and upon approval) to match the DOC numbers. As you recall, AQS confirmed that at your hearings. I don't know if we get to see any of that stuff from Lisa, but we don't need her speaking for DoD in this way which implies the Department concurs with the unilateral program cut in the DOC submission. This is especially true in the light of the Deputy Secretary of Commerce coming on line and saying find the funding.

If their is a tasker such as this, what are our timelines? What product do we owe?

Thanks,

Mike

===== ATTACHMENT 1 =====
ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:

RFC-822-headers:

Received: from conversion.pmdf.eop.gov by PMDF.EOP.GOV (PMDF V5.0-4 #6879)
id <01IPAJXNRGHS00M9NE@PMDF.EOP.GOV>; Mon, 27 Oct 1997 07:10:19 -0500 (EST)
Received: from storm.eop.gov (storm.eop.gov)
by PMDF.EOP.GOV (PMDF V5.0-4 #6879) id <01IPAJXJNU2800L7TX@PMDF.EOP.GOV>; Mon,
27 Oct 1997 07:10:16 -0500 (EST)
Received: from ousdcpol.ousdc.osd.mil ([134.152.99.212])
by STORM.EOP.GOV (PMDF V5.1-7 #6879)
with ESMTP id <01IPAJWS8Z2K000NJQ@STORM.EOP.GOV>; Mon,
27 Oct 1997 07:09:42 -0500 (EST)
Received: from Microsoft Mail (PU Serial #6102) by ousdcpol.ousdc.osd.mil
(PostalUnion/SMTP(tm) v2.1.9g for Windows NT(tm))
id AA-1997Oct27.070143.6102.10913; Mon, 27 Oct 1997 07:07:35 -0500

Organization: Office of the Under Secretary Of Defense (Comptroller)
X-Mailer: Microsoft Mail via PostalUnion/SMTP for Windows NT
===== END ATTACHMENT 1 =====

RECORD TYPE: FEDERAL (TRP NOTES MAIL)

CREATOR: goodrich (goodrich@usgcrp.gov@INET@LNGTWY [UNKNOWN])

CREATION DATE/TIME:10-SEP-1998 11:22:00.00

SUBJECT: First Draft USGCRP Program Implementation Plan

TO: Sarah G. Horrigan (Sarah G. Horrigan@EOP [UNKNOWN])

READ:UNKNOWN

TO: Steven J. Isakowitz (Steven J. Isakowitz@eop [UNKNOWN])

READ:UNKNOWN

TEXT:

Folks,

Attached is a first draft of the USGCRP FY2000 Program Implementation Plan, which will be the primary subject of the SGCR meeting on Friday from 3:00-4:30 at NSF 770. I'd like to thank all of the people who have been working hard on this and to Rick Piltz and Tim Pieper for putting it all together. Now it's time to take a look and see if this accurately represents what we want to go forward to OMB and OSTP on Monday. The "IMPPLAN" files contain the text sections in MS Word 6/95 and basic text, while the "IMPBUDJ" files contains agency budget requests and summary totals in MS Excel. Please call Paula Alley (202-314-2220) or me (202-314-2237) if you need a fax version. We realize that a reformat is in order; please concentrate on the substance of the report in your review.

In the focus area - complete program interchange, I'm concerned that some things have gotten lost. For example, the ongoing line of research on clouds and radiation (ARM, ongoing programs at NSF, etc.) is poorly represented and needs to be fixed. Other examples are surely around. Please bear in mind that the OMB/OSTP request was for a 20-30 page report, and we're at 40 pages; another edit happens on Monday as well.

In your review of these documents, I'd like to call your attention to several things:

1. Overview Section - This is about six pages and will likely be what will get the most attention. Look carefully to see if we have the story straight.

2. Environmental Theme Areas and Integrating Activities (abstracted from Implementation Plans). (1) Does our abstract of your implementation plan

capture the high points? (2) Are the performance measures described here consistent with the specific performance measures that you are submitting independently for your own agency? Note the wide range of specificity of performance measures, from highly detailed (Atmospheric Chemistry and Observations) to none as yet (Ecosystems).

3. Agency Budget Requests - This is what we have as of Tuesday afternoon; no data received yet from DOC/NOAA, EPA or NSF.

Note that detailed Implementation Plans will be included as an appendix to this submission; thus final versions do not need to be in until Monday noon.

There are certainly lots of things that need fixing. Please come Friday with text as well as tomatoes. See you then.

Regards,

Dave Goodrich===== ATTACHMENT 1 =====
ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:

David M. Goodrich
Executive Director
U.S. Global Change Research Program Coordination Office
202-314-2237 (voice)
202-488-8681 (fax)
===== END ATTACHMENT 1 =====

===== ATTACHMENT 2 =====
ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:

RFC-822-headers:
Received: from conversion.pmdf.eop.gov by PMDF.EOP.GOV (PMDF V5.1-9 #29131)
id <01J1N1FLQ9A0007L59@PMDF.EOP.GOV>; Thu, 10 Sep 1998 11:22:59 EDT
Received: from Storm.EOP.GOV by PMDF.EOP.GOV (PMDF V5.1-9 #29131)
with ESMTTP id <01J1N1FBRHLC007LCX@PMDF.EOP.GOV>; Thu,
10 Sep 1998 11:22:48 -0400 (EDT)
Received: from earth.usgcrp.gov ([198.116.134.100])
by STORM.EOP.GOV (PMDF V5.1-12 #29131)
with ESMTTP id <01J1N1EVH7N0000JHG@STORM.EOP.GOV>; Thu,
10 Sep 1998 11:22:25 -0400 (EDT)
Received: from [198.116.134.14] (usgcrp14.usgcrp.gov [198.116.134.14])
by earth.usgcrp.gov (8.8.7/8.8.7) with ESMTTP id LAA07515; Thu,
10 Sep 1998 11:15:23 -0400
X-Sender: goodrich@earth.usgcrp.gov
===== END ATTACHMENT 2 =====

===== ATTACHMENT 3 =====
ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:

Unable to convert ARMS_EXT:[ATTACH.D70]ARMSZZ000SBYE.002 to ASCII,
The following is a HEX DUMP:

FY 1998-2000
U.S. GLOBAL CHANGE RESEARCH PROGRAM
Budget by Agency
(Dollars in Millions)

AGENCY	FY98	FY99	FY00
Scientific Research			
Department of Agriculture (USDA)	58	59	
Department of Commerce (DOC/NOAA, DOC/NIST)	62	71	
Department of Energy (DOE)	106	113	
Department of the Interior (DOI)	29	29	29
Environmental Protection Agency (EPA)	15	21	
Department of Health and Human Services (HHS)	4	5	5
National Aeronautics and Space Administration (NASA)	285	275	319
National Science Foundation (NSF)	167	187	
Smithsonian Institution (SI)	7	7	7
Scientific Research Subtotal	733	767	360
Space-Based Observation Programs			
National Aeronautics and Space Administration (NASA)	1,133	1,097	1174
U.S. Global Change Research Program Total	1,916	1,864	1,533

===== ATTACHMENT 5 =====
 ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:

U.S. Global Change Research Program
 FY 2000 Program Implementation Plan
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U.S. Global Change Research Program
 FY 2000 Program Implementation Plan

Overview

Background

In January 1989, the first edition of Our Changing Planet was submitted to Congress to accompany the President's Budget. The decade of the existence of the U.S. Global Change Research Program brought the advance of predictive understanding of the El Nino -Southern Oscillation and the implementation of the Montreal Protocol for the protection of the stratospheric ozone layer. It also brought support for the Intergovernmental Panel on Climate Change finding that "the balance of evidence suggests a discernible human influence on global climate." In each case, successes were built upon a solid base of scientific understanding developed through decades of focused observation and research. Such findings have had demonstrated effects on our daily lives. Climate information is now used routinely, as demonstrated by the successful prediction of the 1997-98 ENSO event. Countless decisions with substantial practical consequences are now made with climate information as a pivotal ingredient. The phaseout of ozone-depleting substances has both altered the composition of the atmosphere and changed our air conditioning systems. The vigorous policy debate regarding action on greenhouse gases has been a major feature of the political landscape over the last two years.

The anniversary of the Program has stimulated a broad outside look at the USGCRP, summarized in the National Research Council Overview report Global Environmental Change: Research Pathways for the Next Decade. In addition, other programmatic needs have been generated through the National Assessment of the Consequences of Climate Change, which is examining the effects of climate on a regional scale.

These forces have brought a number of new directions for the USGCRP. The Program is in a transition from the broad attack on the issues of global change characterized in the 1985 NASA-sponsored Earth System Science Report to a focus on a relative handful of research areas. These areas are coordinated through both interagency and international mechanisms. In support of this research, we seek the implementation of a global change observing system where continuity of the long-term record is preserved while experimentation with new observing technologies is fostered. In such an observing system, it is critical that the in situ networks, largely outside of the domain of the USGCRP, are not allowed to decline. In modeling, we seek to bring U.S. capabilities back to the level of our international colleagues. In our assessments and applications of global change information, we especially seek the capability to bring useful global change information to the regional and local level.

Program Goals and Objectives

The goal of the USGCRP remains little changed from that articulated in January 1989: to observe, understand and ultimately predict global environmental change. Added shortly thereafter in the Global Change Research Act of 1990 was the requirement for a national scientific assessment of the effects of global change on a range of sectors within the nation. From today's perspective, the goals of the USGCRP are:

- * To observe and document changes in the Earth system
- * To understand why these changes are occurring
- * To improve predictions of future global change
- * To analyze the environmental, socio-economic, and health consequences of global change
- * To support scientifically-based assessments of global change issues

To bring a greater level of specificity to the achievement of these goals, the NRC Pathways Overview presented a series of research imperatives for the next decade, highlighting the frontiers of global change research in the areas of climate, ecosystem response, atmospheric chemistry and the human dimensions of global change. These can be summarized in question form as follows:

[text box]

Key Research Questions for Global Change Research

[abstracted from Pathways Overview]

Climate

- * Can we improve the capability to make El Nio-Southern Oscillation predictions?
- * What is the variability and predictability of the global monsoon systems?
- * What are the effects of large-scale climate variability on local scales? What factors influence floods, droughts, and other extreme weather?
- * Can we describe and understand the patterns of long-term climate variability? Which climate components most influence this variability?
- * How has global climate and Earth's environment changed in the past? How have human activities affected the global environment?
- * What were the causes of the rapid climate change?
- * What are the relationships between land surface processes and climate?

Atmospheric Chemistry

- * Can we predict secular trends in the distribution of stratospheric ozone?
- * What is the coupling between chemistry, dynamics, and radiation in the stratosphere and upper troposphere?
- * What controls the fluxes of greenhouse gases into and out of the earth's systems?
- * How can we better represent current atmospheric oxidants and predict the atmosphere's response to future levels of pollutants?
- * What are the chemical and physical processes that determine the distribution of atmospheric aerosols?

Ecosystems

- * Can we define and predict the global biogeochemical cycles of carbon and nitrogen?
- * What are the responses of ecosystems to multiple stresses, including climate variability?
- * What is the relationship between changing biological diversity and ecosystem function?

Human Dimensions

- * What are the major human causes of changes in the global environment?
- * What are the human consequences of global environmental change on key life support systems?
- * Can we describe the underlying social processes behind the human relationship to the global environment?

Programmatic Responses

In response to a changing set of research imperatives in its second decade, the USGCRP is making a number of changes in how the program is structured. Response to these questions transcends the research, observational or modeling responsibilities of any single agency. It instead requires actions by groups of agencies, in collaboration with a range of other organizations. These programmatic responses, while quite different in their subject areas, share several common traits:

- * Interagency working groups meeting to coordinate respective agency activities;
- * Guidance from and collaboration with the scientific community in setting programmatic direction; and
- * Coordination with international bodies in defining U.S. contributions to maximize partnerships with other national global change efforts.

1. Research

Changes in the research agenda, stimulated in part by the Focus Area planning undertaken jointly with OMB and OSTP, have led to a smaller set of research efforts, each described in more detail later in this document. While involving quite different scientific disciplines, each embodies the programmatic disciplines described above.

Climate - Both scientific and programmatic forces have dictated an end to the division of climate research by time scale. While a focus on the El Nino - Southern Oscillation as a seasonal-to-interannual time scale phenomenon was extraordinarily productive, questions about how ENSO changes on longer time scales, perhaps in response to anthropogenic forcing, are not well served by this approach. Time scale convergence is inherent in the philosophy of the international Programme on Climate Variability and Predictability (CLIVAR), in which the U.S. is rapidly becoming engaged. This is an explicit response to the Pathways recommendation for characterizing climate on time scales relevant to human activities, i.e. over the course of a generation. In keeping with the programmatic disciplines, active interagency and science steering groups are working on the U.S. contribution to CLIVAR, which will be presented at the Intergovernmental CLIVAR Conference in December. In the larger suite of climate problems, progress on the issues of clouds and radiation will be essential in advancing our ability to diagnose and predict climate change.

Also critical in a USGCRP focus on whole-system dynamics is the investigation of how the climate system might completely reorganize itself as a result of the exceedance of some critical threshold. The paleoclimate record has been essential in revealing these reorganizations, and the international Past Global Changes (PAGES) program is essential in defining the conditions for such reorganizations. The ties to CLIVAR have been explicit in its planning.

Atmospheric Chemistry - Many of the central questions for the next decade remain those of atmospheric chemistry, and particularly of atmospheric perturbations to the climate system, including stratospheric ozone depletion, greenhouse gas changes, and changes in the concentration and distribution of aerosols. Conversely, changes in temperature associated with greenhouse gases will likely influence the rate of recovery of stratospheric ozone depletion. We can also anticipate that over the next decade, the issues related to tropospheric ozone levels will become increasingly global rather than regional in scope. These issues are being addressed by an active and longstanding group of agency program managers from NASA, NOAA, EPA, NSF and DOE. On the Federal level, this will lead to increasing interactions with the Subcommittee on Air Quality Research.

Ecosystem Response - It is clear that the issue of multiple stresses on ecosystems will be a dominant question of the coming decade. Ecosystems will be increasingly subject to simultaneous stresses such as climate change, increasing CO2 and ozone, increasing nutrient inputs, and exposure to other pollutants. Thus, a high priority goal for Federal agencies supporting ecosystem effects research will be to develop suitable experimental facilities for studying the individual and combined effects of multiple environmental factors. Across the Federal efforts in ecosystem research, the number and diversity of important ecosystem types under study pose a constraint by diluting the focus of limited resources. Enhancing integration and coordination of these programs across agencies can help focus these limited efforts. In addition, there will be an increasing capability to perform global inventories of land cover and land use from space and to develop the scientific understanding and models necessary to evaluate the consequences of these observed changes.

Carbon Cycle - The policy debates over the last year have demonstrated the need for a scientific basis for evaluating potential carbon sequestration strategies and measurement of net emissions from major regions of the world. From the scientific domain, there has been a major change in our

thinking about the role of the terrestrial biosphere: it can be a significant carbon sink and not a large source. A new interagency program on carbon cycle science can improve the quantitative characterization of past and present sources and sinks for CO₂, understand the relevant exchange processes on the range of relevant time scales, and improve understanding the sinks (ocean and land) for anthropogenic CO₂.

Human Dimensions - The scientific questions addressed through human dimensions research interacts with a range of USGCRP efforts in the natural sciences. It includes both basic research questions related to human and natural systems interactions, and more specific research questions related to the human dimension of climate variability and change and changes in land cover and ecosystems. Certain topical research areas are important to the whole of the global change effort. An emerging joint research agenda includes the candidate areas of land use/land cover; location and relocation of human activities; culture and the environment; environmental change and human health; and adaptation.

Unresolved Questions - Two issues raised by the Pathways Overview and other outside groups are unresolved as of this report: that of the water cycle and of biodiversity. Water is at the heart of climate change and impacts of climate variability, and any assessment of the impacts of climate change must be based significantly around the water cycle. While the directions of a future program on the water cycle are yet unclear, many of the programmatic mechanisms are in place through the Global Energy and Water Cycle Experiment (GEWEX). Less clear are the implications for the study of biodiversity and global change. This would clearly be a major new programmatic emphasis for the USGCRP at a time of level budgets and pressure for focus within the interagency program.

2. Modeling

Most prominent on the agenda of the modeling community is addressing the critical needs in U.S. modeling capability. Over the next decade, needs for climate modeling and assessment are increasingly tied to the need for regional resolution, which generates huge demands on computing capability. Yet all of the U.S. modeling centers are demonstrably far behind European and other international facilities in their ability to do long, spatially detailed integrations of future climate. DOE, with the active support of NSF, NOAA and NASA, is addressing this issue through the Accelerated Climate Prediction Initiative, as part of its overall effort to expand simulation science. This is a critical need for the USGCRP in general. But the crisis that exists in U.S. modeling must be addressed not only with solutions to accelerate progress beyond the year 2000. It also requires an immediate infusion of computer capacity in the near term (two to three years). This need is pervasive in our community, but is particularly acute in modeling centers presently used to support our various assessment and application efforts; this need must be addressed soon for that reason alone.

3. Observations and Data Management

Continuing debate over such issues as the record of tropospheric temperature emphasizes the requirements for the long-term record of global change. We must maintain continuity in both operational and research satellites, while ensuring the maintenance of the long-term in situ record. Much of this domain is outside the purview of the USGCRP and requires coordination at higher levels within the relevant agencies. The planning for the EOS series, the EOS follow-on missions and climate observations to be made from NPOESS must be carefully planned. We must also continue a strong program of experimental observations; for example, remote measurements of soil moisture and atmospheric water vapor are promising candidates. The issue of USGCRP balance between observations, modeling, research and assessment, highlighted in the Pathways Overview, will be a major issue through the fall negotiations of the USGCRP

The near-term goals of the interagency data management program have an emphasis on providing needed data and information produced by both the USGCRP and other programs to both internal and external users. Important gaps include making openly available the wealth of in situ observation data that already exist in agencies, making openly available the data developed by agency assistance and acquisition agreements, and assurance of long-term data archival. Emerging needs include those generated through the USGCRP National Assessment Program and USGCRP actions relative to recent recommendations of the NRC Pathways report.

4. Assessments and Applications

In response to provisions of the Global Change Research Act of 1990, the goal of USGCRP's interagency national assessment activity is to analyze, integrate, evaluate, and interpret current trends and projections of global change and consequent "effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity." To date, international assessments have covered ozone depletion, climate change, and biodiversity. The first national assessment is focusing on the potential consequences of climate variability and change. To ensure that the assessments are useful and informative to policymakers and decisionmakers, the assessments are being undertaken in the context of other pressures and stresses on the public, the environment, and the Nation's resources that are being identified through the workshop process that involves scientists, government representatives and other public and private stakeholder representatives. Emerging measures of success for the ongoing assessment process over the next five years include: (i) building strong involvement and engagement of those whose activities are being affected by or who could take advantage of information about global change (i.e., stakeholders), (ii) enhancing efforts to communicate scientific findings in ways that better link sound scientific information to the concerns of decisionmakers and that can help to increase public awareness of how stakeholders can reduce adverse outcomes, (iii) developing research and evaluation partnerships with stakeholders and local and state agencies, and (iv) refining the federal research agenda to emphasize areas that will have strong payoffs in identifying and moderating adverse consequences of global change while providing the lead time and information needed to take advantage of new opportunities created by global change.

Environmental Theme Areas and Integrating Activities

Introduction

The U.S. Global Change Research Program is based on the premise that an improved understanding of global change will make possible a sustainable relationship between human society and the global environment. To achieve this improved understanding, the USGCRP has focused on four areas of particular scientific and practical importance:

- * Seasonal to Interannual Climate Variability
- * Climate Change Over Decades to Centuries
- * Changes in Ozone, Ultraviolet Radiation, and Atmospheric Chemistry
- * Changes in Land Cover and in Terrestrial and Aquatic Ecosystems

The USGCRP also supports a number of integrative and crosscutting efforts that contribute in varying degrees to all of the priority science issues, including:

- * Observing and Monitoring Global Change
- * Global Change Data, Products, and Information Systems
- * Earth System Science
- * Human Contributions and responses to Global Change
- * International Research Cooperation
- * Global Change Education and Communication

In addition, the Subcommittee on Global Change Research has initiated a national, scientifically based assessment of the potential consequences of climate change and climate variability for the people, environment, and economy of the United States.

Highlights of recent and ongoing research and current program developments in each of these components of the USGCRP are discussed in the FY1999 and other recent editions of Our Changing Planet. This section will present a concise overview of USGCRP FY2000 implementation issues, with a particular emphasis on certain areas in which the program is seeking to enhance strategic coordination.

Climate Research

Seasonal to Interannual Climate Variability

The USGCRP is playing a major role in the ongoing global endeavor to develop and enhance predictions of seasonal and interannual climate fluctuations. Greater understanding of seasonal and interannual climate variability can produce substantial benefits to human society, as indicated by recent and current developments, including improved prediction of El Nio events and their regional impacts, studies of climate variability in North America, and the use of seasonal climate forecasts to reduce costs of impacts.

The goal of the seasonal to interannual climate variability component of the USGCRP is to obtain the understanding and skills needed to forecast short-term climate fluctuations and to use these predictions in social and economic planning and development in the United States and abroad.

Climate Change over Decades to Centuries

Determining the consequences of global change for the environment and for society requires better estimates of the rate, pattern, and magnitude of future climate change. Management of natural resources, the design and planning of long-term infrastructure, and business decisionmaking are all examples of areas where more complete understanding could reduce the potential adverse consequences of climate change.

The past several years have seen considerable progress in advancing our understanding of global climate processes and the climate changes expected in the decades and centuries ahead. Despite this progress, important uncertainties remain, particularly concerning projections of the detailed regional patterns of climate change. USGCRP research activities are dedicated to reducing these uncertainties, in areas including the global carbon cycle, predictive models of climate change, climate change and deep ocean circulation, past climate changes, and understanding the implications of climate change.

The goal of the climate change component of the USGCRP is to understand, predict, and assess changes in the climate that will result from projected changes in population, energy use, land cover, and other natural and human-induced factors; to understand, predict, and assess the consequences of climate change for society and the environment; and to provide the scientific information society needs to address these changes.

Linkages between Seasonal to Interannual Climate Variability and Longer-Term Climate Change

Emerging Focus on Timescale Convergence

It has become increasingly evident over the past several years that an understanding of variability in the Earth system cannot be attained by assuming that it is merely a sum of multiple-timescale processes operating exclusively of one another. The variability we observe in the climate system emerges from a complex web of processes operating simultaneously on different timescales. While some of these modes of variability are more predictable than others, it is only through an examination of how the various processes interact that the true predictability of the system can be determined.

The realization of the importance of timescale convergence has evolved over a period of almost two decades, stemming from a history of research conducted as part of the World Climate Research Program (WCRP), which was established in 1980 with the overall aim of developing the fundamental understanding of the physical climate system and climate processes needed to predict climate variations and to assess the extent of human influence on climate.

WCRP initially supported the concept of a timescale split with three major "streams" of research represented by the GEWEX (Global Energy and Water Cycle Experiment), TOGA (Tropical Ocean and Global Atmosphere), and WOCE (World Ocean Circulation Experiment) Programs. GEWEX, TOGA, and WOCE represent mature whole multi-agency programs with many recent accomplishments (see Climate Appendix). Throughout the last decade, these programs have demonstrated indisputable linkages between the oceans and the atmosphere, between high and low latitudes, across continents and ocean basins, and across timescales. The scientific literature is increasingly demonstrating the unified nature of the global climate system.

The recent El Nio event, as well as the negotiations under the Framework

Convention on Climate Change, have placed a premium on forecasting regional precipitation and temperature variability on both seasonal to interannual and longer-term climate timescales. This will require a greater understanding of:

- 1) how each individual mode within the climate system affects regional temperature and precipitation patterns;
- 2) the interactions among different modes of variability and their effects on short- and long-term regional temperature and precipitation patterns; and
- 3) how anthropogenic activity is influencing the natural variability of the climate system on global and regional scales.

Response to NRC Pathways Overview

The Pathways Overview identifies "issues of climate prediction, including the role of and impacts on human and generational (30 year) timescales and at spatial scales useful for critical public and private policy decisions" as a central crosscutting theme that should emerge in the research priorities of the USGCRP in the next decade. The Pathways Overview states that "elucidating the climate system and possible anthropogenic changes, in addition to natural variability, are paramount goals."

CLIVAR Plus: Goals and Objectives

Evidence of the interaction of variability across timescales has forcefully called into question formerly imposed timescale distinctions, and has led to Vice President Gore's recent suggestion for a convergence of seasonal-to-interannual and longer-term climate research programs. In 1995, the Climate Variability and Predictability (CLIVAR) science plan was introduced as a mechanism to merge several WCRP research efforts occurring on different timescales to obtain a more realistic picture of how the climate system operates. CLIVAR's primary foci are:

- 1) understanding and developing our ability to predict the complex atmosphere-ocean dynamics that drive our global climate system on seasonal to centennial time scales; and
- 2) increasing our understanding of anthropogenic climate change against the backdrop of natural climate variability.

The CLIVAR Program addresses the problem of climate prediction, not along timescales, but rather as a holistic problem with multidisciplinary investigations of ocean, atmosphere, land, and cryospheric processes. CLIVAR, therefore, represents an ideal paradigm to demonstrate the linkages between the USGCRP's Seasonal to Interannual Climate Variability and Long Term Climate Change themes.

This timescale "Convergence" Focus Area is somewhat paradoxical in that the theme of timescale convergence can be interpreted so as to embrace virtually every aspect of the USGCRP. Our implementation plan will, therefore, at times include references to both whole-program agency efforts, as well as to the somewhat narrower program consisting of a single U.S. interagency process that supports joint activities specifically addressing timescale convergence. We refer to this newly emerging timescale convergence program as "CLIVAR Plus." The "Plus" is meant to imply newly established linkages with various other programs within the International Geosphere-Biosphere Program (IGBP) and WCRP. The specific goals and objectives of CLIVAR Plus are as follows:

- 1) To develop an increased understanding of how the global climate system functions on seasonal to centennial timescales;
- 2) To enhance our predictive capability of the climate system on multiple timescales and to apply forecasts on global and regional spatial scales;
- 3) To understand and predict anthropogenic forcing of the climate system on global and regional spatial scales; and
- 4) To develop and maintain strong linkages between producers and users of climate information to ensure ongoing applications of forecast information in various sectors.

Coordination Mechanisms and Collaborative Interagency Efforts

The implementation plan for CLIVAR Plus is driven by a few fundamental questions around which we will build an effective national climate program:

- 1) How does a given regional climate evaluation depend upon multiple timescales? How can these evaluations be pursued?

- 2) How and to what extent are ENSO and greenhouse warming connected? What are the dynamical processes responsible for this connection?
- 3) How do human systems assimilate predictive climate information? How will scientists prepare to provide the information that is required?

In order to succeed, CLIVAR Plus must acquire:

- 1) the ability to encourage and support interdisciplinary research;
- 2) effective interagency machinery;
- 3) a functional symmetry with the international infrastructure; and
- 4) effective producer/user linkages.

The following actions are envisioned:

Interdisciplinary Research

Traditionally, research on the physical climate system has been conducted predominantly by members of the physical meteorology and oceanography communities. CLIVAR Plus must contain a robust atmospheric chemistry component, especially for characterization of anthropogenic forcing. In addition, there is increasing recognition of the importance of paleoclimate research for understanding the full range of variability the climate system is capable of demonstrating and for characterizing the internal dynamics and/or external forcing associated with abrupt climate changes in the past. CLIVAR Plus will issue Announcements of Opportunity and develop appropriate review mechanisms to ensure the support of interdisciplinary research.

Interagency machinery

The implementation of joint announcements of opportunity among U.S. agencies for multiple-timescale climate dynamics research will be critical to the success of this program. From a programmatic perspective, convergence will require the development of effective interagency whole-program infrastructure for a fully integrated program. A significant fraction of existing and all future U.S. CLIVAR resources will be designated for this single national climate program.

Some of the necessary infrastructure will include a U.S. project office for programmatic support, a scientific working group (which the National Research Council Climate Research Committee could oversee) to provide program direction, and a federal interagency working group to interface with the scientific working group. This interagency group will be restricted to a small group of agency principals who control resources in their respective domains. Agency principals will commit a given percentage of their total base resources to this program.

The management structure of this program is contingent upon interagency collaboration, and is designed to develop and maintain a focused U.S. climate program with a single budget. There is agreement among agency principals to pursue a management structure based on the following four criteria:

- * one interagency plan for proposal submissions
- * one interagency advisory source
- * one interagency review process
- * one unified interface with parallel international programs

The program will then tentatively pursue the following three management criteria:

- 1) Balance: The program will allocate its resources to observations, process research, modeling/hardware, and assessments in an effective and consistent way so that the program does not become overly weighted in any particular domain.
- 2) Fencing: The resources that agency principals commit to the program will be used ONLY for this program and will be allocated in a consistent way as described above.
- 3) Ownership: Agency principals will manage the program resources, but it is designed to be a bottom-up program with genuine ownership of the program in the hands of the user community. The program will be designed to respond to the needs of this rapidly growing user community, with the realization that it will be critical to maintain open lines of communication between the agency principals and this much larger ownership base.

International Linkages

To meet its extensive scientific demands and thus attain its full potential, a program as large as CLIVAR Plus will inevitably be compelled to foster linkages with the international scientific community in order to attain symmetry with the international scientific infrastructure. In addition, involvement with international scientific and operational community is required for the implementation and maintenance of an effective global observing system, which is essential to support the needs of both the research community and the operational modeling centers.

Forecasting and Applications Task Team

A fundamental part of this exercise will lie in our ability to provide effective linkages between producers and users in order to keep up with the ever-increasing demands for climate information. The USGCRP is accelerating its efforts to translate research results on climate variability into regionally relevant climate forecasts meaningful to decision makers and the general public. The Forecasting and Applications Task Team was developed for this purpose under the direction of Dr. Ants Leetmaa of the NOAA Climate Prediction Center.

Performance Measures

By FY2000, implementation of the CLIVAR Plus infrastructure described above will be underway. Through these developments, the program will enhance the capacity and efficiency with which the climate research community is able to respond to the increasing demands for climate information. Preliminary infrastructure will involve:

- 1) The convening of a small group of agency principals to manage resources
- 2) The development of a scientific working group to maintain an appropriate scientific focus
- 3) Establishing a U.S. project office to support CLIVAR Plus activities such as meetings, etc.

By FY2004-FY2006, the scientific community will have developed an increased predictive understanding of the global climate system based on process research and increased observational and modeling capabilities, which will include:

- 1) More accurate land characterization in ocean-atmosphere-land surface coupled models (FY2004)
- 2) More accurate cloud parameterization in weather/climate models (FY2004)
- 3) Increased understanding of the role of the cryosphere in the climate system (FY2004)
- 4) Development of a fresh water balance time series to monitor thermohaline circulation (FY2006)
- 5) Operational centers such as CPC and NCEP will have incorporated a new generation of hydrological models into climate and weather forecasts (FY2006).

Changes in Ozone, UV Radiation, and Atmospheric Chemistry

New policy decisions related to atmospheric change loom significantly on the horizon, and a multitude of new and complex research issues are rapidly emerging. With ozone depleting substances nearing their peak anticipated levels in the stratosphere, the ozone layer, already significantly depleted, enters its most vulnerable period, during which newly observed cooling of the stratosphere-which is an expected side effect of both ozone depletion and greenhouse warming-may delay recovery of the ozone layer, and may enhance its vulnerability to new natural or anthropogenic perturbations. Measurements in recent years of the accumulation of greenhouse gases in the atmosphere have revealed stunning and poorly-understood variabilities in their growth rates, rendering uncertain vitally needed predictions of future greenhouse gas levels. Also, a paucity of data on short-lived-and hence inhomogeneously distributed-radiatively active species, such as tropospheric ozone and aerosols, limits predictive capabilities and reveals significant residual uncertainties in the detection and attribution of climate change.

Further complicating the scope of decisionmaking, as scientific and societal awareness of seemingly independent phenomena-e.g., stratospheric ozone depletion, greenhouse warming, and air quality-has evolved, it has become abundantly clear that many environmental issues previously treated

as unrelated are, in fact, interdependent. Nowhere is this interdependence more true than in the atmosphere. The atmosphere does not segregate these chemical phenomena by scientific discipline or governmental funding track. Rather, there is one atmosphere, whose chemical change can be properly understood only within the framework of a comprehensive program which is broad enough to encompass fundamental understanding, but focused enough to respond to elucidation of key issues of pressing scientific and societal importance.

The societal value of focused atmospheric chemistry research findings has never been higher. A methodical, comprehensive, yet focused research approach provides the scientific bedrock upon which sound policy decisions can be built. In this regard, continued vigilance is essential in order to accurately unravel the strands of information from which predictive understanding of the future is derived. Several recent research advances highlight this point (see Appendix for further discussion).

The goal of the atmospheric chemistry element of the USGCRP is to understand and characterize the chemical trends in the atmosphere and their consequences for human and ecological well-being, with specific emphases on:

1. Elucidating the nature and causes of stratospheric ozone layer changes and their consequences;
2. Characterizing global tropospheric chemical processes-including changes in greenhouse gases, aerosols, and photochemical oxidants-and their consequences;
3. Elucidating the couplings among chemical, dynamic, and radiative processes and their impacts on climate; and
4. Assessing this information in terms appropriate to decisionmaking.

Implementation Plan

The Implementation Plan for the research necessary to address these uncertainties accommodates the following considerations:

- 1) The scientific uncertainties that currently limit informed decisions;
- 2) The research partnerships that are required for addressing these uncertainties; and
- 3) The science/policy interface, which provides for effective communication of research findings to the decisionmaking community.

Research Approach

The USGCRP focuses its atmospheric chemical research components in NASA, NOAA, NSF, DOE, EPA, USDA, NIH, on the following central approaches:

1. Global observations of atmospheric change;
2. Elucidation of the processes that cause those changes;
3. Incorporation of that understanding into a predictive capability;
4. Linkages of atmospheric chemical changes to other environmental changes, such as ecological and human health; and
5. Evaluation and assessment of the findings and their integration for use by decisionmakers, including state-of-science assessments of the ozone layer and climate system, as they relate to atmospheric trace gases and associated human impacts.

Together, these studies provide a set of predictive tools and capabilities that can provide information for use by policymakers as they consider various options for mitigating or adapting to global change.

Research Objectives

The USGCRP has designed the following ongoing component objectives in atmospheric chemistry to address the needs of the program (see Atmospheric Chemistry Appendix for further discussion of scientific needs, representative tasks spanning multiple years associated with each objective, and payoffs of the research).

- 1) Monitor stratospheric and tropospheric chemical composition trends and the human-influenced emissions that cause them
- 2) Understand the stratospheric ozone variations during the coming most vulnerable decade
- 3) Monitor changes in surface ultraviolet radiation to quantify exposure to the biosphere
- 4) Develop a predictive understanding of the gas-phase and particulate

chemistry and composition of the global troposphere

- 5) Characterize the link of stratospheric and tropospheric chemical changes to the radiative heating and cooling of the troposphere surface system
- 6) Assess the understanding of the future ozone layer and the role of human-influenced chemistry in climate change.

Coordination Mechanisms and Collaborative Interagency Efforts

USGCRP agencies coordinate their research activities in the area of atmospheric chemistry in numerous ways. Much of this coordination takes place as part of broader cooperation between scientists, both nationally and internationally. In the following section, cooperation within the global change arena is emphasized. It is worth noting, however, that there is increasingly strong cooperation between the global change and air quality disciplines, although the latter is not, for funding purposes, included as part of the USGCRP. (See Appendix for further discussion of coordination and collaborative efforts.)

International Context of Cooperation

There are two major peer-led scientific groups of relevance to atmospheric chemistry. These are the International Global Atmospheric Chemistry (IGAC) program, which is a Core Project of the International Geosphere-Biosphere Program (IGBP), and the Stratospheric Processes and their Role in Climate (SPARC) program, which is part of the World Climate Research Program (WCRP).

Ongoing Partnerships and Relationships

There are several examples of well-established long-term partnerships and relationships between several federal agencies in the area of atmospheric chemistry. These include, for example:

1. Surface Measurements of Long-Lived Trace Constituents
2. Ground-based Remote Sensing Measurements of Atmospheric Chemistry
3. Jointly organized and/or operated aircraft campaigns
4. Joint satellite data sets for ozone
5. Ground-based measurements of surface UV radiation
6. Atmospheric Chemistry Modeling Initiatives.

Management Integration

Integration of management across the different programs takes place through several mechanisms. First, there are two crosscutting activities under the USGCRP: an ozone/atmospheric chemistry group and a task team on UV radiation.

Significant coordination takes place at the manager level. This includes an informal program managers' group on atmospheric aerosols that has been operating for some time, and mutual support of program managers in the peer review process of individual agencies. There is also strong participation by the different agencies in the externally organized assessments (e.g. WMO/UNEP ozone assessment, Intergovernmental Panel on Climate Change assessment, IPCC/ICAO Special Report on Aviation and the Global Atmosphere, etc.). Managers work to assure not only that important scientific viewpoints and results will be part of the assessment process, but to be sure that sufficient resources are in place that these assessments can proceed with adequate support to the participating scientists.

New Directions

Several new areas for increased interagency cooperation in the area of atmospheric chemistry are developing. For example, a number of new space-based measurement programs developed by NASA are expected to begin obtaining data in 1999, and it is becoming clear that the ground-based and lower troposphere measurement capability developed by other federal agencies will play a key role in the validation of these new satellite data. Looking ahead toward the EOS CHEM spacecraft for launch in late 2002 or early 2003, such cooperation is expected to continue; a significant workshop on this subject will be held in 1999. Additional cooperation and joint activity in the area of atmospheric chemical and transport modeling is also likely. Finally, there have been discussions between several agencies about undertaking a joint initiative to understand the potential implications of global climate change on regional air quality. These activities would further strengthen the tie between global change and air quality science noted in the introduction to this section.

(See Appendix for agency-by-agency discussion of implementation priorities, goals and objectives, contributing program elements, and budgets.)

Performance Measures and Milestones

DOE

- * Joint Field Measurements Campaigns (ACP and EMP)
- * Joint Announcement for Aerosol Research with NOAA (ACP)
- * Participation in Multi-Agency Field Measurement Programs; NARSTO (ACP)
- * Preparation for the North American Aerosol Conference with USDA and DOI (ACP)
- * Studies of Transitions Between Stable and Convective Conditions (EMP)
- * First VTMX Results Workshop

NASA

NASA has two major types of performance measures-those associated with well-defined events (e.g., spacecraft launches, completion of airborne campaigns, completion of satellite data set reevaluations/reprocessings), and those that take place slowly over a longer period of time (e.g., improvement of understanding, development of modeling capability).

Well-defined events:

- * Launch the EOS-AM spacecraft with the MOPITT instrument for making first global measurements of vertical distribution of carbon monoxide and total column methane (mid-1999)
- * Launch EOS CHEM spacecraft to make global measurements of vertical profiles of tropospheric ozone, high horizontal and vertical resolution studies of trace constituents near tropopause, and free radical species associated with all key ozone-destroying catalytic cycles (late 2002)
- * Launch first SAGE III instrument to measure global distribution of ozone, aerosols, and selected other trace constituents in stratosphere and upper troposphere (summer, 1999)
- * Carry out major multi-aircraft study of chemistry of Pacific Ocean over tropical Pacific Ocean to improve our understanding of effects of industrial and natural emissions from Asia on atmosphere above the tropical and Western Pacific (Spring, 1999 and 2001)
- * Carry out major multi-aircraft and balloon study of atmospheric chemistry over high northern latitudes from fall to spring to understand potential for wintertime ozone depletion in Arctic; mission will also provide validation and complementary scientific data for SAGE III mission (fall 1999 - spring 2000).

Longer-term studies:

- * Provide >20 year data set for concentration of long-lived industrially-produced source gases, including those regulated by the Montreal Protocol, to help assess compliance and allow for inference of atmospheric lifetimes and interhemispheric transport times (late 1999)
- * Provide long-term (>20 year) data set for stratospheric aerosols and ozone based on combined satellite- and ground-based data sets for identification and understanding of long-term trends (early 2000)
- * Development of modeling capability usable for simulation of ozone composition of global troposphere, including characterization of relative contribution of different sources to tropospheric ozone (early 2001).

NIEHS

The overall performance measures in the NIH GPRA Performance Plan include determining how well NIEHS research accomplishes the following goals:

- * Adds to the body of knowledge on the consequences of UV exposure
- * Improves/develops instruments and technologies for use in research and medicine
- * Develops new and improved methods for preventing or delaying the onset or progression of disease and disability due to UV exposure

In addition, performance is measured by the number of peer-reviewed publications published by NIEHS scientists and grantees.

NOAA

NOAA proposes to measure its performance by the degree to which NOAA's

research is incorporated into the periodic state-of-understanding assessments (e.g., IPCC Climate Change, UNEP/WMO Ozone Depletion), which serve as authoritative scientific input to policymaking by governments and industry. NOAA's quantitative goal is that 90% of its research in the relevant areas of endeavor be incorporated in forthcoming assessments. Examples of Major Milestones:

- * Expand the global atmospheric CO₂ monitoring network to three currently undersampled subcontinental regions. 4th qtr - 2001; 4th qtr - 2002; 4th qtr - 2002; 4th qtr - 2003.
- * Update the understanding of CO₂ trends to better plan the work of the 2005 IPCC Fourth Assessment of Climate Change. 2nd qtr - 2004.
- * Begin regular airborne field measurements of ozone-related species in mid-troposphere of the North Hemisphere to characterize the spatial patterns and temporal variations of the ozone budget. 1st qtr - 2002.
- * Provide an analysis of the role of radiative forcing by tropospheric ozone to better plan the work of the 2005 IPCC Fourth Assessment of Climate Change. 2nd qtr - 2004.
- * Complete an initial characterization of the physical and chemical characteristics of aerosol particles that influence the radiation balance in the North American region. 2nd qtr - 2003.
- * Provide model calculations to update the understanding of the role of aerosols in climate change to better plan the work of the 2005 IPCC Fourth Assessment of Climate Change. 3rd qtr - 2004.

Response to NRC Pathways Report

The NRC Pathways Overview takes a broad view in its atmospheric chemistry studies, so that the "research imperatives" include issues that are considered as global change issues under the Subcommittee on Global Change Research and in the USGCRP budget, but also include air quality issues under the Air Quality Research Subcommittee (AQRS). Therefore, several of the areas identified in the Pathways report (especially toxics and nutrients, as well as some aspects of photochemical oxidants) are dealt with only minimally by the USGCRP agencies as part of their global change research activities. Many of the same agencies have air quality research programs under that report through the AQRS, and there is close linkage within these agencies between their air quality and global change research programs. This strong linkage between atmospheric chemistry global change research and air quality research is clearly indicated in the USGCRP Atmospheric Chemistry implementation plan (see Appendix, sections 2.6 and 2.7). The NRC also addressed some areas typically considered by the long-term climate element of USGCRP (e.g. sources and sinks of carbon dioxide and climate impact of aerosols). The NRC did clearly identify the links between atmospheric chemistry and climate change as priority issues, and these have been noted in the Atmospheric Chemistry implementation plan (see Appendix, sections 2.3, 2.5).

In general, the key global change-related scientific questions identified by the NRC are all being addressed by the USGCRP as part of its atmospheric chemistry efforts. These include understanding of basic chemical and dynamical processes, characterization of long-term atmospheric evolution, development of models for both understanding and predictive capability, all of which are addressed in the above implementation plan.

Changes in Land Cover and In Terrestrial and Aquatic Ecosystems

The biosphere consists of diverse marine and terrestrial ecosystems that vary widely in complexity and productivity, in the extent to which we manage them, and in terms of their value to society. Ecosystems directly provide forage, timber, fish, food and fiber, and clean water as well as recreational opportunities, and wildlife habitat. Issues such as tropical deforestation and the collapse of major marine fisheries have attracted international attention in recent years. In the United States, changes in terrestrial and marine ecosystems, including the loss of productive agricultural land, the severe reductions in salmon populations in the Pacific Northwest, and concerns about the sustainability of important ecosystems have underscored the importance of documenting and understanding ecosystems changes.

Increasing concentrations of atmospheric carbon dioxide and other chemicals and changes in climate will add to the challenges of maintaining the benefits of healthy and productive terrestrial and aquatic ecosystems. To provide society with the information needed to manage and preserve these

ecosystems, researchers must document and understand the human and natural factors that influence land cover and ecological systems.

The goal of the land cover and ecosystems component of the USGCRP is to understand, predict, and assess the causes, magnitude, and consequences of changes in land cover and in terrestrial and aquatic ecosystems, and to strengthen the scientific basis for sustainable environmental and natural resource practices.

Ecosystems Impacts

The proper functioning of ecosystems and sustained use of natural resources may be threatened by a number of global environmental changes. Three interconnected changes have the greatest immediate potential to adversely affect ecosystems, and alter the capability of both terrestrial and marine ecosystems to support humanity: climate change, direct effects of rising CO₂, and changing land use and land cover.

The primary effects of climate change, as we currently understand it, are rising temperatures, changing amounts and patterns of precipitation, and increased variability in weather. Rising atmospheric CO₂ has significant effects on plants, which form the basis of all food chains. And changes in land use and land cover control the capability of ecosystems to respond to effects of both climate and atmospheric chemistry.

Key Questions, Goals and Objectives

The primary goal of research on ecosystems impacts is to provide a stronger scientific basis for understanding, predicting, and responding to the consequences of global environmental changes of both natural and human origin in terrestrial, aquatic, coastal, and marine ecosystems and their ability to provide goods and services and support sustained use.

Short term goals:

1. Understand how changing temperatures, altered patterns and amounts of precipitation, and increased variability in weather affect major terrestrial and marine ecosystems.
2. Develop a predictive understanding of the responses of plants to elevated atmospheric carbon dioxide concentrations, how those effects interact with other environmental changes, and how combined effects alter ecosystem processes and community structure and function.
3. Refine and enhance capabilities to remotely document and monitor global changes in land use and cover at spatial and temporal scales useful for understanding cause and effect, and useful for explaining implications of changes like ecosystem fragmentation. Identify and analyze the implications of factors that lead to changes in land use, cover, and management.

Short-term strategies:

- 4) Maintain capability to conduct experiments in which environmental changes are applied as treatments to document ecosystem responses, across a range of scales of system complexity ranging from fundamental biochemistry through small-plot manipulations (several square meters) to large scale manipulations of intact ecosystems (many hectares)
- 5) Enhance capability to observe and develop a predictive understanding of effects of multiple, interacting environmental changes, such as combined effects of elevated CO₂ and higher temperatures, or elevated CO₂ and reduced availability of water in terrestrial ecosystems or increased salinity in marine ecosystems.

Longer-term goals:

- * Improve understanding of direct effects on ecosystems to develop a functional understanding of the processes that control ecosystem resilience and resistance to environmental change. How do ecosystems "survive" these changes, and what must we do to enhance that capability?
- * Relate knowledge about the consequences of environmental changes to sustainable use of natural resources and continued economic development.
- * Develop and test management options for minimizing adverse effects of global change.

Program Implementation: Challenges and Opportunities

Eight USGCRP agencies contribute to research on Changes in Land Cover and

in Terrestrial and Aquatic Ecosystems, and to research on Ecosystems Impacts in particular. The estimated combined FY1999 budget for Ecosystems Impacts research is about \$115M. (See the Ecosystems Impacts Appendix for an agency-by-agency listing and brief description of Ecosystems Impacts program elements and agency funding levels.)

A number of these program elements involve interagency coordination, including, for example:

- * Program for Ecosystem Research: experimental research and modeling, including Terrestrial and Carbon Processes Program
- * Terrestrial Ecosystem and Process Studies: assessments of the ecological consequences of environmental change and predictions of how future environmental conditions may affect natural or managed ecosystems
- * Terrestrial Ecology and Global Change (TECO): long-term, large-scale research on ecosystem and landscape processes, populations, and communities.
- * Land-Use and Land-Cover program: global inventories of land cover and land use from space and development of scientific understanding and models necessary to evaluate consequences of observed changes (contributes to TECO).
- * Terrestrial Ecology program: integration of terrestrial ecosystem process understanding with remote-sensing observations and ecological modeling (contributes to TECO).
- * Global Ocean Ecosystems Dynamics (GLOBEC): improving predictability and management of live marine resources through improved understanding of ecosystem interactions and the coupling between climate change, the ocean's physical environment, and the ecosystem components.
- * Mapped Atmosphere-Plant-Soil-System (MAPSS): simulates effects of disturbances on ecosystem function under current and potential future climates.

To improve strategic coordination of USGCRP Land Cover and Ecosystems research, and in particular research on Ecosystems Impacts, the program faces a number of challenges and gaps in the current research effort, as well as opportunities (see Ecosystems Impacts Appendix for fuller discussion):

Challenges and Gaps

1. The collection of program and efforts across the agencies does not suggest a focused, readily discernable strategy of ecosystems impacts research. Current research programs vary widely whether by scope, scale, and type of ecosystem.
2. Current inability to separate the effects of multiple and simultaneous environmental changes on ecosystems. We lack sufficient scientific knowledge of the interactions between changes in climatic variables to assign cause and effect relationships. The tasks of separating those impacts and attributing effects to specific causes are made more difficult by natural variation in weather on seasonal, annual, and decadal scales, and by variation across time and space in nutrient and water availability, in species composition and structure of communities, and in other characteristics of ecosystems. Overlain upon these effects are changes in land use and land cover, ecosystem fragmentation, and the effects of natural disturbance such as fire and the disturbances associated with utilization and management of most ecosystems.
3. The number and diversity of important ecosystem types that must be addressed pose a constraint by diluting the focus of limited resources. For instance, coordinated, manipulative research by USDA, EPA, and universities indicates that productivity and species composition of desert grasslands and the sagebrush steppe respond very differently to changes in amounts and patterns of rainfall. Such differences are also expected within coniferous and deciduous forests, and are magnified across different biomes such as forest, grassland, cropland, aquatic, coastal, and the many kinds of marine ecosystems.
4. Data bases from representative ecosystems required to improve and test models that predict ecosystem responses to multiple global environmental changes are often lacking. Currently, most ecosystem response models are based on a limited understanding of both the combined effects of multiple factors on ecosystems and the biological and ecological processes controlling responses, including the causal pathways and mechanisms. Virtually none of the ecosystem response models have been rigorously tested and the ability to test them is severely limited by the lack of relevant data.
5. Experimental facilities and capabilities for investigating the combined effects of multiple factors on intact ecosystems are inadequate.

Needs for Improved Coordination and Research Facilities

1. A strategy for integration and coordination of research across the eight agencies (and multiple funding mechanisms, research managers, etc.) is needed to produce a truly coordinated, interrelated ecosystems research program. Improved coordination could help address data gaps mentioned above. Each agency should identify priority research goals and objectives, then provide its perspective on the combined priority research needs identified and rank them in terms of near- and long-term importance. Agencies would then have a better basis for discussing where there are significant opportunities, advantages, and gaps in integration and coordination across agencies. A strategy for integration and coordination of research across agencies could then reach a consensus about the critical research priorities and needs, the kinds of research needed to address the priorities, and the intramural and extramural research capabilities, approaches, and roles of each agency.
2. New experimental facilities and capabilities for investigating the combined effects of multiple factors on intact ecosystems should be a high priority goal for Federal agencies supporting ecosystem effects research. Efforts should be focused on providing additional facilities where manipulative experiments can be conducted at realistic ecosystem scales, with emphasis on simultaneous application of different levels of multiple factors such as temperature, CO₂ level, water and nutrient availability, ozone, and others, located in major North American ecosystems. A pressing need exists for sustained long-term experiments.

Response to NRC Pathways Report

The NRC Pathways Overview identifies a set of "research imperatives" pertaining to land cover and ecosystems:

1. Land Surface and Climate Imperative: Understand the relationships between land surface processes, including land cover change, climate, and weather prediction.
2. Biogeochemistry Imperative: Understand the changing global biogeochemical cycles of carbon and nitrogen,
3. Multiple Stresses Imperative: Understand the responses of ecosystems to multiple stresses.
4. Biodiversity Imperative: Understand the relationship between changing biological diversity and ecosystem function.

USGCRP research objectives on changes in land cover and in ecosystems, and on ecosystems impacts in particular, address many of the scientific questions identified in the NRC Pathways Overview that pertain to these research imperatives (see Ecosystems Impacts Appendix).

The Global Carbon Cycle

We are approaching a period of significant advancement in our ability to measure and model carbon fluxes. However, understanding the complexity of the carbon cycle and the linkages to physical, biogeochemical, and ecological processes and human influences will require a comprehensive research program and a new level of scientific and programmatic integration. The payoff will be the enhanced scientific understanding, baseline data, methodologies, and measurement infrastructure necessary for regional and country level accounting of carbon sources and sinks and offsets.

There has been a major change in our thinking about the role of the terrestrial biosphere—that it can be a significant carbon sink and not a large source. The observed destruction of forests appears to have been approximately compensated by mechanisms of enhanced carbon uptake. There are now seven independent lines of evidence that support this view (see Carbon Cycle Appendix).

Key scientific questions include:

- 1) What has happened to the carbon dioxide that has already been emitted by human activities?
 - 2) What will be the future atmospheric carbon dioxide loading resulting from past and future emissions?
- Implementation Plan

Key management issues include:

- 1) Recognition of the urgent need for a comprehensive carbon cycle research program.
- 2) Development of a management implementation strategy for a new program that would coordinate and integrate activities across seven agencies in the USGCRP and have strong international links.
- 3) Phased implementation of new program, as funding permits.

Current agency contributions: Linkages and coordination

We have identified USGCRP research activities in seven agencies, with a total annual budget of about \$50M, explicitly focused on the biogeochemical cycling of carbon and sources and sinks of anthropogenic CO₂ on land and in the ocean. Other contributing research activities in other focus areas, especially in the Ecosystems Impacts Focus Area, include research and monitoring of ecosystems, land-use change, remote sensing observations, and global climate modeling.

USGCRP activities include field campaigns, modeling, and process studies (see Appendix for inventory of U.S. agency contributions to Carbon Cycle Focus Area). Major flagship programs, such as AmeriFlux, BOREAS, and carbon components of JGOFS, TECO, FACE, and VEMAP, are jointly funded by multiple agencies and all have strong international linkages:

- * AmeriFlux Network: flux measurements at 25 sites in North America
- * Boreal Ecosystem-Atmosphere Study (BOREAS): Remote-sensing and field study of Canadian boreal forest
- * U.S. Joint Global Ocean Flux Study (JGOFS): marine carbon process research
- * Terrestrial Ecology and Global Change (TECO): terrestrial carbon process research
- * Free Air CO₂ Enrichment Experiments (FACE): CO₂-enrichment experiments in cropland and grazingland soils
- * Vegetation/Ecosystem Modeling and Analysis Project (VEMAP): international intercomparison of biogeochemistry and vegetation-type distribution models.

Additional key examples of interagency linkages and coordination include the Carbon and Climate Science Planning Group (developing science plan for new program) and the Carbon Forum (interagency forum to exchange information with interested agency participants). Additional key examples of international linkages and coordination include WOCE, Euroflux, Fluxnet, and the IGBP Terrestrial Carbon Working Group.

FY2000 plans to address questions, issues, and gaps

- 1) Begin phased implementation of enhanced program, as funding permits.
- 2) Facilitate briefings to USGCRP agencies and others as appropriate.
- 3) Preliminary analysis of initial results of the expanded AmeriFlux network, quantifying carbon fluxes at up to 25 sites in North America and at sites in Europe (Euroflux).
- 4) Initial synthesis of global ocean carbon data, providing a basis for comparison between the GEOSECS Program expeditions of the 1970s and WOCE/JGOFS of the 1990s.

Draft Carbon Cycle Science Plan (see Appendix for fuller description)

USGCRP agencies have jointly funded a working group of prominent carbon cycle scientists to develop a science plan for a comprehensive carbon cycle research program. The draft plan was released in early August 1998, and discussed at a recent workshop attended by about 100 scientists and managers, representing a cross-section of the U.S. carbon cycle research community. The strategy identified in the plan includes:

- 1) strengthening the broad research agendas of the agencies through better coordination, focus, conceptual and strategic framework, and articulation of goals; and
- 2) developing a small number of potent new initiatives that are feasible, cost effective, and compelling, to address difficult, linked scientific problems.

The plan addresses physical, biogeochemical, and ecological processes (e.g., improve quantitative characterization of past and present sources and sinks for CO₂; develop models to predict future sources and sinks incorporating the most important mechanisms and providing predictions with enhanced credibility), as well as human contributions and responses (e.g., understanding the consequences of land use/land cover changes; and

providing the scientific information necessary to evaluate the effects of various management strategies, such as deep-ocean CO₂ injection).

The challenge to the research community is to craft programs that focus on key problems, yet maintain enough breadth to reveal new problems and priorities in areas where we are just scratching the surface. The challenge is to find the right balance between testing hypotheses, on the one hand, and observing and discovering on the other. Achieving the goals of a comprehensive carbon cycle science program will require a new level of scientific and programmatic integration.

Scientifically, we must develop a more complete picture of the ocean-land-atmosphere components of the carbon and climate system and a more thorough understanding of the physical and biogeochemical processes that characterize and control that system, including relatively long-term processes that are difficult to study.

Programmatically, we must implement a program that effectively integrates sustained monitoring activities, field and laboratory research, modeling and analytical studies, and targeted assessment activities designed to meet the information needs of society. These goals are attainable and their attainment has an urgency that is increasingly recognized in the policy arena.

Performance Measures

FY2000:

- 7) Begin phased implementation of enhanced program, coordinated with the IGBP, as funding permits.
- 8) Initial results of AmeriFlux network of up to 25 sites in North America quantifying carbon sinks.
- 9) Initial synthesis of global ocean carbon data, providing a basis for comparison between the GEOSECS Program expeditions of the 1970s and WOCE/JGOFS of the 1990s.
- 10) Ongoing CO₂ time series measurements at Mauna Loa, combined with additional tracers such as ¹⁴CO₂, ¹³CO₂ and O₂/N₂ will provide strong constraints on global balance of carbon.

FY2005:

1. Full implementation of enhanced program, as funding permits.
2. Improved quantitative understanding of global sources and sinks, improved regional constraints on sinks, especially NA.
3. Expanded atmospheric observation network, combined with a growing number of local flux measurements like AmeriFlux, enabling scientists to study regional sources and sinks.
4. Improved understanding of opportunities for enhancing sinks (e.g., through forestry and/or agricultural management practices)

FY2010:

7. Establishment of a global monitoring network for atmospheric CO₂, enabling an improved understanding of regional sources and sinks globally, and providing the capability of detecting developing trends and providing enough information to be able to test hypotheses about their causes.
8. Improved integration of local, regional and global scale information leading to an improved integrated understanding of processes and mechanisms.
9. Enhanced-modeling capability integrated with flux network and global atmospheric monitoring network providing improved forecasting capability.

Response to Pathways Report

Development of a coherent, integrated program of carbon cycle research is a high priority recommendation of the NRC Pathways Overview. The Pathways Overview states:

The scientific strength of the case linking release of greenhouse gases to climate change is central to any considered action....Acceptance of the evidence by policy-makers and their constituent communities [will emerge] from carefully executed observations of the physical, chemical and biological variables that track the actual state of the Earth....Knowledge of the global sources and sinks of carbon that are associated with changes in atmospheric concentrations of CO₂, CH₄, and CO is part of the foundation for understanding the physical, chemical and biological processes that control our surroundings, and for understanding the fractional impact of any industrial or agricultural input to that natural system.

The IGBP Terrestrial Carbon Working Group recently echoed this

recommendation and initiated a carbon science planning process.

Human Contributions and Responses to Global Change

The goal of the Human Dimensions component of the USGCRP is to identify, understand, and analyze how human activities contribute to changes in natural systems, how the consequences of natural and human-induced change affect the health and well-being of humans and their institutions, and how humans could respond to problems associated with environmental change. The scientific questions addressed by this component of the USGCRP are broad-based and include both basic research questions related to human and natural systems interactions and more specific research questions related to the Human Dimensions of climate variability and change and changes in land cover and ecosystems.

Implementation Priorities

The USGCRP budget for research on the human contributions and responses to global change is about \$21M (FY1999 request), including the NSF Human Dimensions of Global Change program, the DOE Integrated Assessment program and Human Dimensions research at the National Institute for Global Environmental Change, and the NOAA Economics and Human Dimensions of Climate Fluctuations program. Other USGCRP-supported activities also pertain to Human Dimensions issues but are not identified as such for budgetary purposes or included in this total.

USGCRP-supported Human Dimensions research is progressing on a number of fronts:

- * Through model analysis, the integrated assessment community has identified high-priority research areas that will provide stronger scientific foundations for policy decisions.
- * Within investigations of how individuals, institutions, industries/sectors, and communities adapt to current variability in the climate system, investigators have begun to develop models of how various sectors could potentially gain from the use of climate predictions as an early warning technology in their management decisions. Other analyses are investigating how social, cultural, and institutional factors affect adjustment to climate and the potential use of global change science.
- * The Human Dimensions programs have made significant progress in the integration of the social and natural sciences where necessary to address the complex issues associated with global change issues as they relate to society. For instance, in many cases, social scientists are working with natural and physical scientists to address how society could more easily adapt to current climate variability, as well as long-term climate change.
- * NSF and EPA have completed year four of a joint competition for research on decision-making and valuation for environmental policy. These competitions have supported research on the benefits and costs of environmental policies and programs, ecosystem valuation, and innovations and improvements in environmental decision making.
- * NSF has established a consortium of research centers and research teams in the Human Dimensions of Global Change. Research activities pursued by consortium members include: an examination of the causes, processes, and outcomes of variables associated with changes in forest conditions in the Western Hemisphere; research characterizing the impacts of global change on natural systems, human artifacts, and social systems; the development of techniques for integrated assessment; research aimed at improving methods of integrated regional assessment; research that increases our understanding of the relationships among research, assessment, and management in the global environmental arena; and the development of smart markets for understanding complex problems such as water allocation.
- * NSF continues to support fundamental research in the social and behavioral sciences that has implications for our understanding of the Human Dimensions of global change.

Coordination mechanisms and collaborative interagency efforts

The Human Dimensions component of the USGCRP is a complementary set of research activities. Human Dimensions is a cross cutting effort that supports research on global change questions defined from a social and behavioral science perspective and intended to contribute to inquiry across the four key global change environmental science issue areas of the USGCRP. Research on fundamental social and behavioral science questions that are relevant for the four science areas of the USGCRP as well as for a broader

set of related environmental issues is also supported under the Human Dimensions component.

Coordination across agencies is both implicit and targeted. The considerable breadth of questions that need to be addressed under Human Dimensions, together with the wide range in orientations and missions of the participating agencies, has resulted in a strategy whereby agencies focus on areas most central to their primary mission. This strategy has resulted in a diverse portfolio of research supported under Human Dimensions with minimal overlap in terms of funding priorities.

Areas of common concern to two or more agencies sometimes have been addressed by joint competitions. One notable example of this form of targeted coordination is the NSF/EPA Partnership in Environmental Research. This umbrella activity supports four different special competitions on areas of mutual interest to both agencies, including Water and Watersheds Research and Environmental Statistics. The advantage of joint competitions is that they are visible, focused, and flexible. The Water and Watersheds Research competition, for example, was reoriented in FY1998 to integrate the multiple goals of three agencies: NSF, EPA, and USDA.

This implicit coordination structure that has evolved over the years in fact has allowed agencies to focus on areas of most importance to them while in sum contributing to an overall effort to further development of social science research relevant to global change questions.

Candidate areas for enhanced interagency coordinated research effort

The agencies agree, however, that it is now time to begin enhancing coordination in order to pursue certain topical research areas important to the whole of the global change effort. Although each of these topics is in need of further vetting with the research community, what follows is an initial list of candidate areas. Please note that we do not expect every agency to participate in each and every activity outlined below; indeed, we expect that the extent of any agency's involvement will depend both on the level of new resources available for the activity and the interests of the particular agency.

* Land Use/Land Cover

What are the social driving forces for land use and land cover change? Which human activities can significantly alter the potential for major environmental surprises?

How does institutional structure affect land use and land cover change, particularly with respect to common pool resources.

* Location and Relocation of Human Activities

What are the constituents and determinants of energy use and other environmentally significant consumption in countries and populations at different levels of economic development?

How is consumption likely to change with increasing affluence in low-income countries and populations, and does this change always follow the path that high-income countries and populations have followed?

What policies at the national level lead to greater attention in communities to such issues as urban sprawl, reducing the cost of home-to-work commuting, expansion of green spaces, and enhanced recycling of materials?

* Culture and the Environment

What are the links among land use change, migration, political and economic changes, cultural factors, and household decision making?

* Environmental Change and Human Health

How will environmental and social change affect the transmission and distribution of environmentally-sensitive infectious diseases, and what are the best options for mitigation?

* Adaptation

What are the regional vulnerabilities to and consequences of global change? What are the most effective responses to global change?

What methods can be used to improve decision making about global change?

* Technology and Technology Transfer

How does technological transformation influence global change?

As we work toward developing these topic areas and assembling the appropriate programmatic machinery for interagency coordination, we intend to support activities to synthesize the results of Human Dimensions research across the agencies. Possible mechanisms for achieving such a synthesis include jointly sponsored workshops (such as the NSF/EPA Partnership workshops) or the commissioning of an academic report that

reviews the state of USGCRP funding in the Human Dimensions. It is our hope that a better understanding of the state of Human Dimensions research will inform the process of building topical areas of inquiry that would benefit from more vigorous interagency collaboration.

Performance Measures for FY2000

Scientific:

- * Integrated Assessment Models will be strengthened to include multiple greenhouse gases and the carbon sequestration implications of land use.
- * Models of how society responds to climate variability across a range of sectors, including agriculture, forestry, rangeland management, and fisheries will be developed.
- * Research on adaptation to climate variability will be expended to include decadal and longer-term climate variability and change.

Programmatic:

- * Agency Human Dimensions program managers will identify key scientific questions appropriate to serve as a basis for a coordinated interagency announcement of opportunity.

Response to NRC Pathways Report

The six areas highlighted above as suggestions for topical areas that should be pursued in an interagency enhanced coordination framework have a high degree of overlap with the Human Dimensions research imperatives and scientific questions identified in the Pathways Overview. NOAA has also engaged the National Academy of Sciences in developing a science plan for the Human Dimensions of Seasonal-to-Interannual Climate Variability. The plan is expected to be published by the end of this year.

Predictive Climate Modeling

General Circulation Models (GCMs) provide our best opportunity to predict future climate and to attempt to track why observed changes are occurring and what they portend for the future. The output of these models is used by the IPCC in making its climate change assessments, and provides the bases for the current national climate change assessment. The recent El Nio event highlighted the utility of prediction and serves to accent the potential value inherent in being able to similarly predict potential climate-related problems. These models also provide our best way of characterizing potential long-term climate modifications, such as those produced by greenhouse gases, aerosols emissions, and deforestation.

Over the past 10 years, largely as a result of USGCRP-sponsored research, atmospheric and oceanic general circulation models have improved significantly. There is strong potential for continuing advances through improved representations of critical climate processes and through finer model resolution for regional-scale predictions. A useful vision for climate modeling was stated at the USGCRP/NAS May 1998 retreat (paraphrased from an early 1990s draft of USGCRP "Research Milestones: 1991-2020," section on Earth System Models, 2001-2010):

To build better models that provide credible* predictions of changes and variations in climate on regional to global scales and to apply them to provide useful projections of potential environmental and societal consequences.

(*Where by use of the word credible is meant the usual denotative meaning and in addition the concept that a "credible" prediction includes its level of certainty/uncertainty.)

Key Questions

The key questions currently facing climate change modeling research are defined by the necessity to understand and predict effects of global phenomena on regional scales. Events, particularly over the last few years, have shown that the effects of such events as ENSO cast long shadows over major portions of the globe, bringing diverse effects to various regions depending on little-understood patterns. Understanding these patterns is a primary challenge of climate research, and modeling them with sufficient resolution in both space and in physical dynamics to embrace this understanding is the first of two key questions for climate modeling.

Thus the first key question can be stated as: What are the regional patterns of climate change? Establishing these patterns and codifying their establishment in climate models will provide a tool for building both a public awareness and capability for informed reaction to the foreseeable effects of regional patterns. Such factors as storm frequency and severity, floods, droughts, and even modest changes in precipitation patterns by region or in time have strong human consequences. The problems they present can be reduced significantly if appropriate actions can be taken.

The second key question is similar but with the essentially predictive element of understanding and modeling climate thoroughly enough that environment modifications never seen observationally can be predicted: What can be expected at regional scales as a result of current and projected greenhouse gas concentrations? The economic consequences of action or inaction are currently much-debated. Regional predictions for these changes are critically needed to assess potential problems.

To address these questions effectively will require improvements in model resolution and in the modeling of the phenomena. For regional predictions, we must have coupled models with resolution 10 and 30 km for ocean and atmosphere respectively. Currently, 60 and 300 km are the usual resolution. Models for snow and ice cover and for biogeochemical processes are major areas where new model components are entering GCMS.

Goals and Objectives

The goals related to these two questions aim at providing information in response to these questions:

- 1) Goal: Provide regional level climate prediction.
Objective: Increase the resolution of results.

Storm track and ocean-eddy resolution needed for regional prediction are expected to require resolutions of 1 km for the land surface, 10 km for the ocean, and 30 km for the atmosphere, respectively. Coupled ocean atmosphere models are, or will soon be, capable of handling resolution of 1 km for the land surface, 60 kilometers for the ocean, and 300 km for the atmosphere.

- 2) Goal: Provide credible prediction of climate change resulting from various potential climate-modifying scenarios.
Objective: Increase the validity/credibility of model science.

This is a required continuing effort. Some of the current issues pertain to the reaction of the Earth's hydrologic system, in particular the effects of clouds, on the Earth's radiation budget. Increasing atmospheric concentrations of greenhouse gases and aerosols appear to have counteracting effects. The effects of changing atmosphere composition on biogeochemical dynamics, e.g., leaf transpiration, are currently being explored and modeled as a first step to incorporation in GCMS.

- 3) Goal: Provide statistics for probability of occurrence.
Objective: Analyze ensembles of climate simulation runs.

The variability of weather and its chaotic nature indicate that the best that can be done at this time in climate prediction will be done on a probabilistic basis. This requires ensembles of runs be made and analyzed for the statistics, means, and extremes of the predictions. Ensembles required for meaningful treatment of the statistics is considered to be ten runs for decadal variability (runs for decadal variability approach one hundred years in simulated time).

Implementation

Modeling is an integral part of the USGCRP plan. Every aspect of global change research is related to models, whether in providing data from which models can be initialized and calibrated, or new explanations of processes which, when embodied in the models, provide additional tools for understanding the complexity of global change. Perhaps most importantly, models are used as tools to predict global change, which is especially important in environments which have been hitherto unobserved.

Climate modeling in the United States is sponsored primarily by NASA, NOAA, NSF, and DOE. The support level is about \$80 M/yr and is divided about \$50M/\$30M between funding within the USGCRP and funding not considered part of USGCRP. Activities include 10 non-academic facilities and more than 14 academic facilities, most of which are funded by more than one of the agencies. Development and applications have about equal emphasis at

non-academic institutions. Much more applications than development are done at universities. Workshops and fora, such as the USGCRP Earth System Modeling Workshop and the NAS CRC/USGCRP Forum on Climate Modeling, have examined modeling within the USGCRP. The recommendation to maintain a diverse and distributed program was and is being followed.

Overall there is considerable interagency sponsorship of climate modeling. There is, as expected, a large number of players, whose activities span the required GCM development and uses quite well. The single most important issue facing climate modelers is the lack of adequate computing resources needed to conduct their research and make predictions and assessments. This deficiency is the limiting impediment to more certain climate predictions. In fact, it is perhaps ironic to note that the strengths in non-U.S. efforts cited by various experts in this area include the capability to utilize both data (frequently U.S. data) and advances in models (also frequently U.S. in origin) more effectively and more rapidly the U.S. can, due to ease of data accessibility, information exchange, and the power of the non-U.S. climate computation centers.

In a JASON review of modeling this summer it was remarked: "Surprisingly, although the U.S. has led the world in climate observations and in pursuing the science embedded in the models, it lags significantly in the exploitation of modeling capabilities." With regard to our participation in IPCC and other international assessment efforts, the NRC Pathways document states: "Currently, the potential exists that the advanced models built in the United States cannot (or will not) be adequately tested and properly applied to key problems, such as national and regional expressions of transient climate variability."

Models are a major proof of understanding in any area of scientific endeavor. At their best they embody the most germane functionality and provide both insight and valid guidance in dealing with the phenomena they embody. Within the USGCRP they represent a very important product in themselves and their product, climate prediction, represents one of the most potentially usable sources of information guiding us on how to cope with the climate aspect of our environment. Given the present situation with regard to climate and international pressures, it seems clear that the U.S., having much at stake in the debate, should be in the forefront with its predictions and scenarios of climate change. This is not currently the case. Perhaps of most concern in this area is the lack of any plans firmly in the budget to address this problem.

Performance Measures

In the short term (FY1999-FY2000), while we will continue to make marginal progress toward the goals listed above without a substantial increase in available computational power, major steps forward in predictive modeling are not expected in the U.S. effort without such increases.

- 1) IPCC Third Assessment Report will be completed late FY2000 (early 2001) with active participation by USGCRP (and non-USGCRP) modeling researchers.
- 2) The simulation of the climate of the 20th Century will be completed in FY1999. The simulations will include changes due to greenhouse gases, aerosols, and solar variability, based on best estimates from observations taken during the last century. They will enable a critical evaluation of the predictive capability of climate models.
- 3) Field experiments and focused model simulations will be initiated in FY1999 to study the effects of tropospheric and stratospheric aerosols on global and regional radiative balances and climate. The observational phase and initial analyses of the data sets will be examined and will help to quantify the influence of natural and human-produced aerosols on future climate. Data will be distributed to modeling centers for model physics development and testing.
- 4) Component models under development for ocean phenomena will reach ~11km resolution in FY2000. Component atmosphere models will reach ~80 km resolution.
- 5) Extensive testing of recently completed coupled models will be made at resolutions of 1 km land, 60 km ocean, and 300 km atmosphere during FY1999-FY2000. Ensemble runs are not yet anticipated.
- 6) The first U.S. National Assessment of the Consequences of Climate Change and Variability for the United States will be completed in late 1999. Climate model simulations will provide predictions of future climates forced by various estimates of future atmospheric greenhouse gases and aerosol concentrations. These will provide the basis for the assessment. Reports describing regional and sectoral analyses and a national synthesis report will be completed in FY 2000.

Response to NRC Pathways Report

Recommendation 6 in the Pathways Overview may provide impetus for a remedy to the present situation: "The USGCRP must foster the development and application of models at the scales of time and space needed to understand and project the specific mechanisms controlling changes in the state of the Earth system thus providing the information required to support important policy processes. The USGCRP must give increased emphasis to models that treat multiple stresses on the system; it must therefore secure adequate computing resources so that large-scale, complex models can be rigorously tested under multiple forcings."

Observing and Monitoring Global Change

The 20th Century has seen a great expansion of the ability to assemble information about the Earth system, using historical records and advancing communications technology. Since World War II, aircraft and weather balloons have provided data on the state of the atmosphere, and ships and buoys have provided regular observations of parts of the ocean. But only with the development of satellites over the past few decades and sophisticated instruments over the past several years, do we have the potential to observe and monitor the atmosphere, the oceans, and the land surface on a global scale.

What might be called the first era of the USGCRP observations and monitoring program has included the development and implementation of a range of remote-sensing activities, including, for example, the Total Ozone Mapping Spectrometer (TOMS), the Upper Atmosphere Research Satellite (UARS), Landsat, and TOPEX/Poseidon (Ocean Topography Experiment); and surface-based measurement activities such as the Tropical Ocean Global Atmosphere/Coupled Ocean Atmosphere Research Experiment (TOGA/COARE); the Atmospheric Radiation Measurements Program (ARM), the ENSO Observing System (made up of complementary networks including the Tropical Atmosphere/Ocean (TAO) array of deep-ocean moorings), the AmeriFlux network, and the Surface UV Monitoring Network.

A new era of satellite observations of the Earth is beginning, as crucial data from the first of several Earth Observing System (EOS) missions start to become available. The first mission in the EOS era, the Tropical Rainfall Measuring Mission (TRMM), was launched in 1997. The EOS AM-1 satellite will be launched in FY1999, to be followed by EOS PM-1 and EOS CHEM-1. The EOS spacecraft are a key component of a long-term, coordinated research effort to study the Earth as a global system and the effects of natural and human-induced changes on the global environment. The EOS missions will provide data that will make significant contributions to research being conducted throughout the USGCRP.

Even as this second, EOS era of the observations and monitoring program gets underway, USGCRP strategic planning must address the question of beginning a transition to a third era, in which we obtain needed global change measurements via an operational as distinguished from a research mode. Questions of planning for this transition will engage the USGCRP in the coming period.

Goals and Objectives

The overall goal of the USGCRP Observations and Monitoring Program is to ensure the availability of long-term, high-quality observational records of the state of the Earth system, its natural variability, its past history, and changes that are occurring over a broad range of spatial and temporal scales. Observations and monitoring are essential for defining the current state of the system and for establishing a benchmark against which future changes can be compared. This task requires both space- and surface-based systems and networks.

Recent advances in observing, data processing, and communications technologies have provided unprecedented opportunities for the development of an integrated global observing system. At the same time, existing key measurements must be maintained to the extent possible to minimize avoidable gaps in the data records. Such gaps reduce the ability to estimate trends and to predict and assess global change and its associated impacts.

The overall goal of the Observations and Monitoring Program embraces the following objectives:

- 1) To adopt a strategy that will improve the coordination of national and international space-based and in situ systems for observing and monitoring the Earth's environment and natural resources;
- 2) To coordinate the contributions of the Federal agencies in implementing the U.S. space-based and in situ components (both operational and experimental) of an internationally coordinated global observing strategy that meets the scientific needs of the USGCRP; and
- 3) To promote the development and demonstration of innovative cost-effective instruments and observing techniques for providing critical environmental information in the future.

Observations Strategy and Program Implementation

Observations Strategy

The USGCRP Observations and Monitoring strategy is formulated to provide information needed for testing scientific hypotheses associated with unanswered global change scientific questions, to support national and international scientific assessments, and for use in developing environmental policy and impact response strategies. The strategy relies on:

- 1) Operational and quasi-operational space-based systems to meet global change monitoring requirements for continuous stable global measurements of key variables;
- 2) National and international surface-based networks for reference in situ measurements to provide information on important quantities including those not directly measurable by remote sensing from space (e.g., sub-surface ocean variables), as well as for satellite cal/val;
- 3) Support of Earth System Science Pathfinders (ESSP) missions for discovery and innovative studies of global change physical, chemical, and biological processes;
- 4) Integration of space-based and in situ components with the goal of defining an optimal observing system;
- 5) Coordination of national and international field measurement campaigns in support of process-oriented research, as planned and implemented within the principal scientific themes of the USGCRP; and
- 6) Initiation of planning of EOS-second phase mission concepts for systematic global change measurement missions; addressing the gap between EOS in general and particularly EOS PM-1, EOS-CHEM and NPOESS.

The Observations and Monitoring Program supports all of the USGCRP key global change environmental science issue areas, including climate variability and change, changes in ozone, UV radiation, and atmospheric chemistry, and changes in land cover and ecosystems. (see Appendix for listing and discussion of recent accomplishments in these areas). The program has numerous mechanisms for interagency and international coordination, and numerous collaborative interagency efforts, including interagency coordinated data sets, coordinated field campaigns and experiments, and coordinated global observing in situ reference networks. The USGCRP is substantially involved in international scientific programs, networks, projects, and coordinating groups, through both research and efforts related to verification of international conventions and protocols (see Appendix for listing and descriptions).

Scientific, Technical, and Programmatic Issues and Challenges

The existing operational and experimental observing system is powerful and already provides a large part of the needed observations. However, it needs fine tuning and further expansion (e.g., meeting the need for operational ocean observations). New observations are required to better understand important global change processes (e.g., cloud and aerosol microphysics, carbon cycle, mid- and deep- ocean circulation, the hydrological cycle, climate feedbacks). Ensuring a role for the scientific community in prioritizing scientific requirements, planning observational strategies, and evaluating new techniques for integration into future observing systems is crucial to the success of the program.

Examples of key issues that must be addressed by the USGCRP include:

- 1) Degradation in operational networks. Examples of USGCRP-essential measurements in jeopardy due to lack of investment in maintenance and upgrading of such networks include:

- * Upper Air radiosonde/rawinsonde network

* Surface climate stations

-NOAA's capability to monitor decadal to centennial changes in temperature and precipitation is at risk.

-NOAA's capability to monitor precipitation to serve the general community on a short-term basis and to assess long term variability in precipitation over North America is at risk of major loss in capability.

* Similar degradations are reportedly occurring with the in-situ networks of other (than NOAA) agencies to observe key variables such as river flow/stage, etc. due to budget reductions. International coordination and data exchange is seriously lacking for in-situ observations.

2) Upgrading existing operational in-situ and satellite observation and data systems to meet scientific measurement requirements for long-term continuity, absolute calibration, and stability of measurements and value-added products.

3) Institutionalizing mechanisms for transfer of high priority experimental observational capabilities to operational programs. Ensuring the stability and improvement of the operational space- and ground-based observing systems is critical to meeting USGCRP science objectives. However, no federal agency is chartered with responsibilities for the transition of research measurements into operational status, nor does any interagency mechanism exist for implementation. This matter is further exacerbated by the fact that virtually no space-based or ground-based operational observing systems are accountable to the USGCRP.

4) Maintaining long-term measurement continuity and data quality.

5) Meeting the scientific requirements for calibration and validation of measurements.

6) Striving to establish a more effective process for coordinating interagency planning and program implementation.

7) Streamlining the interaction with NRC in order to balance advice to the USGCRP vs. specific advice to the individual federal agencies.

8) Addressing the Carbon Cycle/Carbon Budget and Ecosystems Impacts issues.

Measurements of various components of the carbon cycle and carbon budget are embedded in the thematic areas of the USGCRP. The recent and next generation of space-based technology will substantially improve these estimates on a global basis--there is no simple alternative. However, considerable improvements are also required in in-situ measurements and the coordination of the international data exchange for these measurements. The same is true for observations of ecosystem changes and impacts of global climate change. That is, satellite technology provides the only means by which the global planetary domain can be observed. But extensive in-situ observations are also required on a long-term basis.

Systems for the measurement and international data exchange pertaining to global ecosystems and/or carbon do not presently exist. They need to be established through coordination and funding via the UN system of agencies and thereby member countries. U.S. leadership is needed. We are equally familiar with the complexity of the scientific subject and the international negotiations and processes required to quantitatively and definitively address this important issue. SIMBIOS is an excellent model.

Performance Measures-FY2000

Seasonal-to-Interannual Climate Variability

1) Continue improvements in a data assimilation system to make it state-of-art for assimilating all kinds of atmospheric and land surface data with a focus on the use of existing and new satellite data. Prepare the system for assimilation of EOS-PM satellite data when it is launched. Add the assimilation of ocean surface data to the assimilation system. The goals remain the same.

2) In collaboration with the EOS MODIS and MISR instrument science teams, conduct measurements of the production and radiative properties of aerosols produced by biomass burning in Africa. This field experiment will be similar to a field experiment previously conducted in Brazil (SCAR-B). The field experiment is identified as SAFARI 2000 and includes extensive international collaboration. It is estimated that biomass burning in Africa contributes about one half of the global amount.

3) Combining TRMM measurements with rainfall measurements from other sources will allow us to set a benchmark for rainfall in the tropics. We will obtain maps of diurnal cycle of precipitation (which cannot be obtained from sun-synchronous sensors). The insight gained from this exercise will be used to reprocess 10 years of SSM/I data for climate record. This 10-year data set and ongoing TRMM measurements will be used to validate climate models as well as demonstrate the impact of rainfall in

assimilation and weather forecast schemes.

4) Launch of joint NASA-CNES Jason-1 satellite altimetry mission. This follow-on to TOPEX/Poseidon aims to achieve 1 cm level accuracy in measuring ocean basin-scale sea level variability. This capability is one order of magnitude better than that specified for TOPEX/Poseidon. This will be accomplished by a mission planning time, cost, spacecraft weight and size less than half that of TOPEX/Poseidon.

5) First basin-scale high resolution estimate of the state of the Pacific Ocean as part of NASA Ocean Data Assimilation Project. This is part of an international Global Ocean Data Assimilation Experiment (GODAE) planned for 2003-2005. The project will demonstrate capabilities in ocean state estimation and its application to climate, coastal zone management, and interdisciplinary science problems in the Pacific basin.

Climate Change over Decades to Centuries

1) Atmospheric Radiation Measurement program (ARM): (1) ARM will complete tropical warm pool characterization in order to improve GCM performance in representing radiative and cloud process in and around the tropical warm pool; (2) ARM will apply newly available solar radiation measurements taken with high resolution and banded spectrometric instruments to modeling atmospheric shortwave radiation, with an improvement in the error bars of shortwave models by about 50%; (3) ARM will develop the relationships between cloud formation processes and bulk cloud/atmospheric characteristics through detailed in-situ measurements and routine application of retrieval algorithms and will determine the level of cloud microphysics that must be included to adequately simulate the behavior of clouds (and associated radiative microphysics) in GCMs; (4) The ARM coordinated GVAP network will implement new techniques for measuring water vapor that improve error bars by 50%; (5) The ARM Program will develop unique experience in how to evaluate GCM parameterizations through the use of observations and single-column models. Advances in understanding gained from such evaluations will improve how well atmospheric processes are represented in the GCMs.

2) Analysis of the CERES measurements to achieve a further reduction in the uncertainty in the determination of top-of-the-atmosphere radiative fluxes through the integration of measurements provided by the CERES instruments on the TRMM satellite and the EOS-AM satellite. FY2000 analyses will be performed on TRMM and more complete EOS-AM1 data.

3) Publish first detailed estimates of thickening/thinning rates for all the major ice-drainage basins of the Greenland ice sheet, derived from repeated airborne laser-altimetry surveys. These measurements also represent a baseline data set for comparison with early measurements by the EOS Geoscience Laser Altimeter System (GLAS), to be launched in July 2001. Initiate a program of airborne mapping of layers within the Greenland ice sheet.

4) NASA, in collaboration with the Canadian Space Agency, will acquire a second set of high-resolution radar data over all of Antarctica for comparison with the baseline data set acquired in 1997, in order to identify changes on the ice sheet. Emphasis for this second mapping will be acquisition of data suitable for interferometric analysis, with timing of the survey coincident with acquisition of early GLAS data.

5) Demonstrate capability to remotely sense surface salinity at the 0.1 PSU level from aircraft. After initial demonstrations in FY99, instrument development and modeling activity will bring measurement accuracies to desired level - one order of magnitude better than in FY98. Aircraft demonstration is considered proof of concept that will lead to satellite-borne sensors specifically designed to resolve salinity signals from orbital altitude.

Changes in Ozone, UV Radiation and Atmospheric Chemistry

1) Implementation of the SAGE III Ozone Loss and Validation Experiment (SOLVE). Measurements will be made during the time frame of October 1999 - March 2000 in the Arctic and high-latitude region in winter using the NASA DC-8 and ER-2 aircraft, as well as balloon platforms. The mission will also acquire correlative data needed to validate the Stratospheric Aerosol and Gas Experiment (SAGE) III satellite measurements that will be used to quantitatively assess high-latitude ozone loss.

2) Complete the analysis and publication of the PEM-Tropics-B field experiment and will complete the next phases of the instrument size and weight reduction initiative, applying it to the last remaining large payload. A major new mission to be conducted in 2001 over three western Pacific to study the transport and evolution of the Asian pollution plume will be planned.

- 3) Launch TOMS/SAGE Meteor-3M Mission: The next instrument in the series of Total Ozone Mapping Spectrometer (TOMS) instruments is scheduled for launch in 2000 aboard a Russian Meteor-3M spacecraft; SAGE in 1999. This will continue the series of TOMS and SAGE measurements of ozone, sulfur dioxide, surface UV radiation, and tropospheric aerosol loading made with the Nimbus 7 (1978-1993), Meteor-3 (1991-1994), Earth Probe (1996-present), and ADEOS (1996-1997) TOMS instruments. This will also lead to a first ever climatology of vertical profiles of NO₃ and OCLO made by SAGE using lunar occultation techniques.
- 4) Continued monitoring and assessment of the impact of the Montreal Protocol and the Framework Convention on Climate Change with globally distributed measurements of the surface level concentrations of long-lived trace gases regulated under the Montreal Protocol, and other biogenically-produced gases such as methane and nitrous oxide. (based on NASA AGAGE, NOAA/CMDL flask sampling network). Concentrations of total atmospheric burden of halogen breakdown products will be measured by the Network for Detecting of Stratospheric Change.
- 5) Complete acquisition of first ever global climatology of vertical profiles of carbon monoxide (CO) to improve knowledge of its surface sources, photochemical destruction, and how it is transported by tropospheric wind systems (based on first year of MOPITT data).
- 6) Carry out detailed process-oriented aircraft measurements of the chemistry of the high latitude stratosphere in winter using the DC-8 and ER-2, as well as balloons; obtain correlative data for SAGE III concurrently in unified mission.
- 7) Carry out detailed process-oriented aircraft missions of the chemistry of the remote Tropical Pacific troposphere, focusing on chemical contributions to this otherwise unpolluted area from human activities (industrial pollution, biomass burning) taking place long distances away (Asia, South America, etc.).

Changes in Land-Cover and in Terrestrial and Marine Ecosystems

- 1) First National Assessment of the Potential Consequences of Climate Variability and Change will be completed. This will include production of the climate scenario information, support of the National Synthesis, several of the regional analyses, and supporting research for several sectoral studies.
- 2) Near-real-time fire monitoring will be coupled with the Landsat-based and EOS-based inventory and process monitoring to provide an observational foundation for monitoring changes in ecosystem productivity and disturbance.
- 3) SIMBIOS will merge MODIS ocean color data into the global ocean color time series, which began with OCTS and SeaWiFS. Multi-year time series of ocean color data will be used to understand and predict the response of marine ecosystems to climate change.

Response to NRC Pathways Report Recommendations

The Pathways Overview makes several recommendations pertaining to the need for a coherent observational strategy, technical innovations, and data systems. These recommendations are being addressed as part of the USGCRP strategic planning process. Briefly (see Appendix for fuller discussion):

Recommendation #3: "The strategy for obtaining long-term observations designed to define the magnitude and character of Earth system change must be reassessed...."

Response: The need to identify and obtain accurate data on key variables has been well recognized and re-iterated many times over the years. To the extent technologically possible all key variables are either measured or plans are in progress to attempt accomplishing this. More focused reviews of requirements have been recently initiated to select those parameters that are critical as well as technologically viable under the research programs of the USGCRP.

Long-term accuracy and continuity: The USGCRP recognizes that "operational needs" must inevitably drive operational systems-a priority underestimated by the NRC. Nevertheless, there is a need to realize the potential of operational observing and data management systems for long-term monitoring for documenting climate change. We must maintain continuity, access, and funded analysis of operational data and ensure that the intellectual resources for analysis exist. We need to maintain a balance between data collection, data analysis, and incorporation into models. There will be and should be gaps between research and operational systems. Proven and tested research systems that are operationally required (for other purposes than fundamental research) have been gradually transitioned to operational

systems. The USGCRP recognizes the need for a mechanism to facilitate this transition and proposes institutional structure to accomplish the same.

The scientific community still needs to organize the means to extract the widest possible range of scientific information from the multiplicity of data sources. In the NASA experience, Mission Science Teams have provided oversight for instrument development and analysis. This would be a good model for the climate observations issue.

Recommendation #4: "The restructured national strategy for Earth observations must more aggressively employ technical innovation...."

Response: The USGCRP recognizes the need for relying on complementary space-based and in situ measurements, as well as the need for opportunities for incorporating new technology. Many climate processes require improved satellite sensor technology and carefully instrumented in situ-based networks and studies to advance understanding within the constraints and mandate of individual agency programs. The best available microelectronics and materials will be used, as also robotics and the like.

The USGCRP 10-year observations strategy will highlight opportunities for further development of instrumentation for land- and ocean-based instrumentation. It must be recognized, however, that most in-situ operational systems are not explicitly accounted for within the USGCRP budget. Instead, they form the backbone operational systems of various national and international agencies. These operational systems make an essential contribution over a broad range of USGCRP research activities, even if not identified as line-item program elements in the GCRP budget. Thus, the balance between space-based systems and in-situ systems as reflected in the USGCRP budget is somewhat artificial. The USGCRP plans to review the adequacy of existing and planned operational systems from the standpoint of global change research, and develop specific recommendations for the protection or enhancement of selected systems and networks, as well as the establishment of a carefully selected network of reference or baseline stations and observing platforms.

Recommendation #5: "The USGCRP must revitalize its strategy for the data systems used for global change research...."

Response: The USGCRP will ensure maintenance of short-term active archives and long-term repositories for global change data. The importance of integrating scientific oversight into data management functions is recognized. The EOSDIS Federation concept places responsibilities for data curatorship on the science community to strengthen the capability for reprocessing and broaden utilization. It is critical that very long-term (exceeding generational life spans) maintenance of the data sets be ensured. It is not clear that the Federation concept alone will be able to achieve this. Decentralized data processing, analysis and data management on the short term for research and applications purposes will need to be buttressed with a cross-migration of key data sets to a centralized Federally funded system which would ensure permanent, and accessible, archives. The USGCRP Data Management Working Group will oversee the U.S. component of GCDIS and will provide pointers to all repositories of critical data. An important issue is that data storage capabilities are not keeping up with needs (e.g. reanalysis products, assessments). These aspects will also be addressed by the USGCRP.

Global Change Data, Products, and Information Services

The goal of the data management component of the USGCRP is to provide all users with ready and affordable access in useful forms to the full spectrum of global change data, products, and information. The USGCRP data program and implementation plans have both been endorsed by OSTP, as has its "full and open" data access principles. Its planning has been coordinated with related efforts outside the USGCRP, e.g., the Federal Geographic Data Committee. The importance of the cooperation of agency programs that are outside the USGCRP but are needed by the USGCRP's focused programs cannot be overemphasized.

The data program's near-term performance measures have particular emphasis on filling program gaps and meeting newly developing imperatives while assuring that the data and information produced by the program are made readily available. In accord with NRC recommendations, these performance measures include giving increased emphasis to providing assurance for the long-term archiving of data, including data collected by the NASA Earth Observing System, and the wealth of data and information obtained from in situ observations.

Program Objectives

The data program has the following objectives:

1) Data Location Capability: Provide a coordinated means by which users can readily find the global change data, products, and information they need. Significant progress has been made through GCDIS, an Internet-based Global Change Data and Information System. However, there are two major program gaps: data from past in situ observations and data obtained using federal funds that lack a requirement for unrestricted government use.

2) Data Access: Ensure that the data, products, and information are quickly available and affordable. The user finds no benefits in discovering data and information exists if they cannot be obtained in time to meet the user's needs or if it is not affordable.

3) Long-Term Data Availability: Ensure that data, products, and information are documented, archived, and have long-term availability. Without adequate attention to documenting and archiving data, such data are lost or rendered unusable to future users. This problem is being exacerbated by decreasing agency budgets for such work coupled with the increasing amounts of data.

4) Meet USGCRP Needs: Meet the specific data, product, and information needs of the scientific community for information needed to conduct USGCRP-related research, monitoring, and assessment activities. As an integrated and coordinated program, the USGCRP depends upon the data, product, and information services component of the USGCRP to provide data sets and derived products needed to monitor the environment.

5) User Satisfaction: Be responsive to the data, product, and information needs identified by the user community and its representatives, including the education community. The relationship with the National Academy of Sciences' Committee on Geophysical and Environmental Data as a representative of the scientific user community will be continued.

6) Coordination Outside USGCRP: Coordinate global change data management activities with related activities being carried out nationally and internationally. The data and information collected for understanding global change are part of the much larger amount of data and information being collected and used for other purposes.

Performance Measures

Data location capability:

- * Encourage programs outside the USGCRP to initiate programs to locate, document, and make available in useful forms the data and information from in situ federal observations that relate to global change. An objective of completing this process in about 3-5 years for existing data should be established to guide agency budgeting.

- * Promote the open availability of the global-change-related data produced by agency grant-type instruments to researchers and others by FY2000. The need for such agency action is increasing with recent database protection efforts.

Data access:

- * Develop policy guidance to provide GCDIS working interfaces with private sector and other nongovernmental data, products, and information.

- * Develop a larger number of GCDIS access points in other countries, particularly through CEOS.

Long-term data availability:

- * A special interagency effort is needed to provide assurance that the critical global change research data sets are protected from loss as necessary.

Meet USGCRP needs:

- * Work with all the focused program elements of the USGCRP to identify and produce (within available resources) the interagency data products they most need.

User satisfaction:

- * Further improve GCDIS, including expanding its on-line user evaluation capability, links to commercial data producers, and increased number of data sets available. Success will be measured by the increase in GCDIS use.

- * Cooperate in having GCDIS evaluations by the focused elements of the USGCRP.

Coordination outside USGCRP:

- * Strengthen GCDIS links to international global observation programs and broaden application of a "full and open" data access policy.

National Assessment

Goal of the National Assessment

The overall goal of the National Assessment is to analyze and evaluate what is known about the potential consequences of climate variability and change for the Nation in the context of other pressures on the public, the environment, and the Nation's resources. The Assessment is being carried out under the auspices of the U.S. Global Change Research Program (USGCRP), which is mandated by statute with the responsibility to undertake scientific assessments of the potential consequences of global change. The Global Change Research Act of 1990 (P.L. 101-606) states that the Federal government "shall prepare and submit to the President and the Congress an assessment which -

1. Integrates, evaluates, and interprets the findings of the Program and discusses the scientific uncertainties associated with such findings;
2. Analyzes the effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity; and
3. Analyzes current trends in global change, both human-induced and natural, and projects major trends for the subsequent 25 to 100 years."

Implementation

Eighteen of 20 planned regional scoping workshops have taken place as the first step in conducting regional assessments (the first workshop was held in May 1997; the final two will take place in September and October, 1998). These workshops have sought to engage regional stakeholders in identifying questions and priorities for assessments in each region. All 20 regions where workshops are being held are invited to participate in the next phase of the assessment pending funding support. This next phase will involve quantitative analysis of 2-3 key issues and continuous cultivation of regional stakeholders.

Teams have also been organized for five sectoral assessments (water, health, agriculture, forests, coastal/marine), and a FACA-chartered Synthesis Team has been appointed to prepare the Synthesis Report to submit to Congress which will bring together regional and sectoral findings. Each of the sectors will be led by a pair of co-chairs-one from government and one from outside of government

The Synthesis Team is to provide overall intellectual oversight of the National Assessment and has specific responsibility for the Synthesis Report, for defining national scenarios, for providing advice and oversight of the sectoral analyses, and for recommending guidelines for the regional analysis templates. There are currently 10 members, including the co-chairs, although a couple more may be added in the near future.

Coordination Mechanisms and Collaborative Interagency Efforts

More than any other element of the USGCRP, assessment requires and is premised on interagency coordination. No one agency has the breadth to effectively deliver the information to address adequately the diversity of environmental issues being identified in the regions as important to their future sustainability.

The National Assessment is facilitated by federal sponsorship of different assessment elements: each region is sponsored by one or more federal agencies; each sector is sponsored by one federal agency; support of the Coordination Office (NACO) and individual Synthesis Team members is provided by different federal agencies. Federal participation in the National Assessment is coordinated by the SGCR National Assessment Working Group (NAWG). The NAWG has broad responsibilities for federal participation in the design and conduct of the national effort, and specifically will:

- * Provide advice and counsel to the National Assessment Synthesis Team as

they develop the National Assessment Plan;

- * Coordinate federal participation to implement the National Assessment Plan;
- * Facilitate implementation of regional assessments, to ensure adherence to the guiding principles of the assessment process; the adoption and use of methodologies; and compliance with the process, schedule and timetable for delivery of products;
- * Annually prepare a comprehensive plan for funding the National Assessment activities; and
- * Identify federal R&D and monitoring programs that are required for or contribute to assessments.

Opportunities for improvement include the challenge to foster and promote a true public-private partnership in the end-to-end process, including prioritization, funding, conduct, and delivery of science.

Performance Measures

The timetable for this phase of the National Assessment is driven primarily by the deadline for the Synthesis Report of January 1, 2000. Most regional and sectoral reports will be ready to enter their review process in the fall of 1999, and will be available at the time the Synthesis Report is released. Some will be on a delayed timetable and will be published a few months later in the year 2000. However, they will still have opportunities to provide information into the Synthesis Report.

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U.S. Global Change Research Program
FY 2000 Program Implem
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Overview

Background

In January 1989, the first edition of Our

Changing Planet was submitted to Congress to accompany the Presidents Budget. The decade of the existence of the U.S. Global Change Research Program brought the advance of predictive understanding of the El Nino Southern Oscillation and the implementation of the Montreal Protocol for the protection of the stratospheric ozone layer. It also brought support for the Intergovernmental Panel on Climate Change finding that the balance of evidence suggests a discernible human influence on global climate. In each case, successes were built upon a solid base of scientific understanding developed through decades of focused observation and research. Such findings have had demonstrated effects on our daily lives. Climate information is now used routinely, as demonstrated by the successful prediction of the 1997-98 ENSO event. Countless decisions with substantial practical consequences are now made with climate information as a pivotal ingredient. The phaseout of ozone-depleting substances has both altered the composition of the atmosphere and changed our air conditioning systems. The vigorous policy debate regarding action on greenhouse gases has been a major feature of the political landscape over the last two years.

The anniversary of the Program

has stimulated a broad outside look at the USGCRP, summarized in the National Research Council Overview report Global Environmental Change: Research Pathways for the Next Decade. In addition, other programmatic needs have been generated through the National Assessment of the Consequences of Climate Change, which is examining the effects of climate on a regional scale.

These forces have brought

a number of new directions for the USGCRP. The Program is in a transition from the broad attack on the issues of global change characterized in the 1985 NASA-sponsored Earth System Science Report to a focus on a relative handful of research areas. These areas are coordinated through both interagency and international mechanisms. In support of this research, we seek the implementation of a global change observing system where continuity of the long-term record is preserved while experimentation with new observing technologies is fostered. In such an observing system, it is critical that the in situ networks, largely outside of the domain of the USGCRP, are not allowed to decline. In modeling, we seek to bring U.S. capabilities back to the level of our international colleagues. In our assessments and applications of global change information, we especially seek the capability to bring useful global change information to the regional and local level.

Program Goals and Objectives

The goal of the USGCRP

remains little changed from that articulated in January 1989: to observe, understand and ultimately predict global environmental change. Added shortly thereafter in the Global Change Research Act of 1990 was the requirement for a national scientific assessment of the effects of global change on a range of sectors within the nation. From today's perspective, the goals of the USGCRP are:

- To observe and document changes in the Earth system
- To understand why these changes are occurring
- To improve predictions of future global change
- To analyze the environmental, socio-economic, and health consequences of global change
- To support scientifically-based assessments of global change issues

To bring a greater

level of specificity to the achievement of these goals, the NRC Pathways Overview presented a series of research imperatives for the next decade, highlighting the frontiers of global change research in the areas of climate, ecosystem response, atmospheric chemistry and the human dimensions of global change. These can be summarized in question form as follows:

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Key Research Questions for Global Change Research

[abstracted from Pathways Overview]

Climate

Can

we improve the capability to make El Nio-Southern Oscillation predictions?

What

is the variability and predictability of the global monsoon systems?

What are

the effects of large-scale climate variability on local scales? What factors influence floods, droughts, and other extreme weather?

Can we describe and understand

the patterns of long-term climate variability? Which climate components most influence this variability?

How has global climate and Earth's environment

changed in the past? How have human activities affected the global environment?

What were the causes of the rapid climate change?

What are the relationships

between land surface processes and climate?

Atmospheric Chemistry

Can we predict

secular trends in the distribution of stratospheric ozone?

What is the coupling

between chemistry, dynamics, and radiation in the stratosphere and upper troposphere?

What controls the fluxes of greenhouse gases into and out of the Earth's systems?

How can we better represent current atmospheric oxidants and predict the atmosphere's response to future levels of pollutants?

What are the chemical

and physical processes that determine the distribution of atmospheric aerosols?

Ecosystems

Can we define and predict the global biogeochemical cycles of carbon and nitrogen?

What are the responses of ecosystems to multiple stresses, including climate variability?

What is the relationship between biological diversity and ecosystem function?

Human Dimensions

What are the major human

causes of changes in the global environment?

What are the human consequences

of global environmental change on key life support systems?

Can we describe

the underlying social processes behind the human relationship to the global environment?

Programmatic Responses

In response to a changing set of research imperatives in its second decade, the USGCRP is making a number of changes in how the program is structured. Response to these questions transcends the research, observational or modeling responsibilities of any single agency. It instead requires actions by groups of agencies, in collaboration with a range of other organizations. These programmatic responses, while quite different in their subject areas, share several common traits:

Interagency working groups meeting

to coordinate respective agency activities;

Guidance from and collaboration with

the scientific community in setting programmatic direction; and

Coordination

with international bodies in defining U.S. contributions to maximize partnerships with other national global change efforts.

1. Research

Changes in the research

agenda, stimulated in part by the Focus Area planning undertaken jointly with OMB and OSTP, have led to a smaller set of research efforts, each described in more detail later in this document. While involving quite different scientific

ntific disciplines, each embodies the programmatic disciplines described above.

Climate Both scientific and programmatic forces have dictated an end to the division of climate research by time scale. While a focus on the El Nino Southern Oscillation as a seasonal-to-interannual time scale phenomenon was extraordinarily productive, questions about how ENSO changes on longer time scales, perhaps in response to anthropogenic forcing, are not well served by this approach. Time scale convergence is inherent in the philosophy of the international Programme on Climate Variability and Predictability (CLIVAR), in which the U.S. is rapidly becoming engaged. This is an explicit response to the Pathways recommendation for characterizing climate on time scales relevant to human activities, i.e. over the course of a generation. In keeping with the programmatic disciplines, active interagency and science steering groups are working on the U.S. contribution to CLIVAR, which will be presented at the Intergovernmental CLIVAR Conference in December. In the larger suite of climate problems, progress on the issues of clouds and radiation will be essential in advancing our ability to diagnose and predict climate change.

Also critical in a USGCRP focus on whole-system dynamics is the investigation of how the climate system might completely reorganize itself as a result of the exceedance of some critical threshold.

The paleoclimate record has been essential in revealing these reorganizations, and the international Past Global Changes (PAGES) program is essential in defining the conditions for such reorganizations. The ties to CLIVAR have been explicit in its planning.

Atmospheric Chemistry Many of the central questions for the next decade remain those of atmospheric chemistry, and particularly of atmospheric perturbations to the climate system, including stratospheric ozone depletion, greenhouse gas changes, and changes in the concentration and distribution of aerosols. Conversely, changes in temperature associated with greenhouse gases will likely influence the rate of recovery of stratospheric ozone depletion. We can also anticipate that over the next decade, the issues related to tropospheric ozone levels will become increasingly global rather than regional in scope. These issues are being addressed by an active and longstanding group of agency program managers from NASA, NOAA, EPA, NSF and DOE. On the Federal level, this will lead to increasing interactions with the Subcommittee on Air Quality Research.

Ecosystem Response It is clear that the issue of multiple stresses on ecosystems will be a dominant question of the coming decade. Ecosystems will be increasingly subject to simultaneous stresses such as climate change, increasing CO₂ and ozone, increasing nutrient inputs, and exposure to other pollutants. Thus, a high priority goal for Federal agencies supporting ecosystem effects research will be to develop suitable experimental facilities for studying the individual and combined effects of multiple environmental factors. Across the Federal efforts in ecosystem research, the number and diversity of important ecosystem types under study pose a constraint by diluting the focus of limited resources. Enhancing integration and coordination of these programs across agencies can help focus these limited efforts. In addition, there will be an increasing capability to perform global inventories of land cover and land use from space and to develop the scientific understanding and models necessary to evaluate the consequences of these observed changes.

Carbon Cycle The policy debates over the last year have demonstrated the need for a scientific basis for evaluating potential carbon sequestration strategies and measurement of net emissions from major regions of the world. From the scientific domain, there has been a major change in our thinking about the role of the terrestrial biosphere: it can be a significant carbon sink and not a large source. A new interagency program on carbon cycle science can improve the quantitative characterization of past and present sources and sinks for CO₂, understand the relevant exchange processes on the range of relevant time scales, and improve understanding the sinks (ocean and land) for anthropogenic CO₂.

Human Dimensions - The scientific questions addressed through human dimensions research interacts with a range of USGCRP efforts in the natural sciences. It includes both basic research questions related to human and natural systems interactions, and more specific research questions related to the human dimension of climate variability and change and changes in land cover and ecosystems. Certain topical research areas are important to the whole of the global change effort. An emerging joint research agenda includes the candidate areas of land use/land cover; location and relocation of human activities; culture and the environment; environmental ch

ange and human health; and adaptation.

Unresolved Questions Two issues raised

by the Pathways Overview and other outside groups are unresolved as of this report: that of the water cycle and of biodiversity. Water is at the heart of climate change and impacts of climate variability, and any assessment of the impacts of climate change must be based significantly around the water cycle. While the directions of a future program on the water cycle are yet unclear, many of the programmatic mechanisms are in place through the Global Energy and Water Cycle Experiment (GEWEX). Less clear are the implications for the study of biodiversity and global change. This would clearly be a major new programmatic emphasis for the USGCRP at a time of level budgets and pressure for focus within the interagency program.

2. Modeling

Most prominent on the agenda of the modeling

community is addressing the critical needs in U.S. modeling capability. Over the next decade, needs for climate modeling and assessment are increasingly tied to the need for regional resolution, which generates huge demands on computing capability. Yet all of the U.S. modeling centers are demonstrably far behind European and other international facilities in their ability to do long, spatially detailed integrations of future climate. DOE, with the active support of NSF, NOAA and NASA, is addressing this issue through the Accelerated Climate Prediction Initiative, as part of its overall effort to expand simulation science. This is a critical need for the USGCRP in general. But the crisis that exists in U.S. modeling must be addressed not only with solutions to accelerate progress beyond the year 2000. It also requires an immediate infusion of computer capacity in the near term (two to three years). This need is pervasive in our community, but is particularly acute in modeling centers presently used to support our various assessment and application efforts; this need must be addressed soon for that reason alone.

3. Observations and Data Management

Continuing

debate over such issues as the record of tropospheric temperature emphasizes the requirements for the long-term record of global change. We must maintain continuity in both operational and research satellites, while ensuring the maintenance of the long-term in situ record. Much of this domain is outside the purview of the USGCRP and requires coordination at higher levels within the relevant agencies. The planning for the EOS series, the EOS follow-on missions and climate observations to be made from NPOESS must be carefully planned. We must also continue a strong program of experimental observations; for example, remote measurements of soil moisture and atmospheric water vapor are promising candidates. The issue of USGCRP balance between observations, modeling, research and assessment, highlighted in the Pathways Overview, will be a major issue through the fall negotiations of the USGCRP.

The near-term goals of the interagency

data management program have an emphasis on providing needed data and information produced by both the USGCRP and other programs to both internal and external users. Important gaps include making openly available the wealth of in situ observation data that already exist in agencies, making openly available the data developed by agency assistance and acquisition agreements, and assurance of long-term data archival. Emerging needs include those generated through the USGCRP National Assessment Program and USGCRP actions relative to recent recommendations of the NRC Pathways report.

4. Assessments and Applications

In response

to provisions of the Global Change Research Act of 1990, the goal of USGCRP's interagency national assessment activity is to analyze, integrate, evaluate, and interpret current trends and projections of global change and consequent effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity." To date, international assessments have covered ozone depletion, climate change, and biodiversity. The first national assessment is focusing on the potential consequences of climate variability and change. To ensure that the assessments are useful and informative to policymakers and decisionmakers, the assessments are being undertaken in the context of other pressures and stresses on the public, the environment, and the Nation's resources that are being identified through the workshop process that

t involves scientists, government representatives and other public and private stakeholder representatives. Emerging measures of success for the ongoing assessment process over the next five years include: (i) building strong involvement and engagement of those whose activities are being affected by or who could take advantage of information about global change (i.e., stakeholders), (ii) enhancing efforts to communicate scientific findings in ways that better link sound scientific information to the concerns of decisionmakers and that can help to increase public awareness of how stakeholders can reduce adverse outcomes, (iii) developing research and evaluation partnerships with stakeholders and local and state agencies, and (iv) refining the federal research agenda to emphasize areas that will have strong payoffs in identifying and moderating adverse consequences of global change while providing the lead time and information needed to take advantage of new opportunities created by global change.

Environmental Theme Areas and Integrating Activities

Introduction

The U.S. Global Change Research Program is based on the premise that an improved understanding of global change will make possible a sustainable relationship between human society and the global environment. To achieve this improved understanding, the USGCRP has focused on four areas of particular scientific and practical importance:

Seasonal to Interannual Climate Variability
Climate Change Over Decades to Centuries
Changes in Ozone, Ultraviolet Radiation, and Atmospheric Chemistry
Changes in Land Cover and in Terrestrial and Aquatic Ecosystems

The USGCRP also supports a number of integrative and crosscutting efforts that contribute in varying degrees to all of the priority science issues, including:

Observing and Monitoring Global Change
Global Change Data, Products, and Information Systems
Earth System Science
Human Contributions and Responses to Global Change
International Research Cooperation
Global Change Education and Communication

In addition, the Subcommittees on Global Change Research have initiated a national, scientifically based assessment of the potential consequences of climate change and climate variability for the people, environment, and economy of the United States.

Highlights of recent and ongoing research and current program developments in each of these components of the USGCRP are discussed in the FY1999 and other recent editions of Our Changing Planet. This section will present a concise overview of USGCRP FY2000 implementation issues, with a particular emphasis on certain areas in which the program is seeking to enhance strategic coordination.

Climate Research Seasonal to Interannual Climate Variability

The USGCRP is playing a major role in the ongoing global endeavor to develop and enhance predictions of seasonal and interannual climate fluctuations. Greater understanding of seasonal and interannual climate variability can produce substantial benefits to human society, as indicated by recent and current developments, including improved prediction of El Niño events and their regional impacts, studies of climate variability in North America, and the use of seasonal climate forecasts to reduce costs of impacts.

The goal of the seasonal to interannual climate variability

ty component of the USGCRP is to obtain the understanding and skills needed to forecast short-term climate fluctuations and to use these predictions in social and economic planning and development in the United States and abroad.

Climat e Change over Decades to Centuries

Determining the consequences of global change for the environment and for society requires better estimates of the rate, pattern, and magnitude of future climate change. Management of natural resources, the design and planning of long-term infrastructure, and business decisionmaking are all examples of areas where more complete understanding could reduce the potential adverse consequences of climate change.

The past several years have seen considerable progress in advancing our understanding of global climate processes and the climate changes expected in the decades and centuries ahead. Despite this progress, important uncertainties remain, particularly concerning projections of the detailed regional patterns of climate change. USGCRP research activities are dedicated to reducing these uncertainties, in areas including the global carbon cycle, predictive models of climate change, climate change and deep ocean circulation, past climate changes, and understanding the implications of climate change.

The goal of the climate change component of the USGCRP is to understand, predict, and assess changes in the climate that will result from projected changes in population, energy use, land cover, and other natural and human-induced factors; to understand, predict, and assess the consequences of climate change for society and the environment; and to provide the scientific information society needs to address these changes.

Linkages between Seasonal to Interannual Climate Variability and Longer-Term Climate Change

Emerging Focus on Timescale Convergence

It has become increasingly evident over the past several years that an understanding of variability in the Earth system cannot be attained by assuming that it is merely a sum of multiple-timescale processes operating exclusively of one another. The variability we observe in the climate system emerges from a complex web of processes operating simultaneously on different timescales. While some of these modes of variability are more predictable than others, it is only through an examination of how the various processes interact that the true predictability of the system can be determined.

The realization of the importance of timescale convergence has evolved over a period of almost two decades, stemming from a history of research conducted as part of the World Climate Research Program (WCRP), which was established in 1980 with the overall aim of developing the fundamental understanding of the physical climate system and climate processes needed to predict climate variations and to assess the extent of human influence on climate.

WCRP initially supported the concept of a timescale split with three major streams of research represented by the GEWEX (Global Energy and Water Cycle Experiment), TOGA (Tropical Ocean and Global Atmosphere), and WOCE (World Ocean Circulation Experiment) Programs. GEWEX, TOGA, and WOCE represent mature whole multi-agency programs with many recent accomplishments (see Climate Appendix). Throughout the last decade, these programs have demonstrated indisputable linkages between the oceans and the atmosphere, between high and low latitudes, across continents and ocean basins, and across timescales. The scientific literature is increasingly demonstrating the unified nature of the global climate system.

The recent El Niño event, as well as the negotiations under the Framework Convention on Climate Change, have placed a premium on forecasting regional precipitation and temperature variability on both seasonal to interannual and longer-term climate timescales. This will require a greater understanding of:

how each individual mode within the climate system affects regional temperature and precipitation patterns; the interactions among different modes of variability and their effects on short- and long-

ng-term regional temperature and precipitation patterns; and
 how anthropogenic
 activity is influencing the natural variability of the climate system on global and regional scales.

Response to NRC Pathways Overview

The Pathways Overview

ew identifies issues of climate prediction, including the role of and impacts on human and generational (30 year) timescales and at spatial scales useful for critical public and private policy decisions as a central crosscutting theme that should emerge in the research priorities of the USGCRP in the next decade. The Pathways Overview states that elucidating the climate system and possible anthropogenic changes, in addition to natural variability, are paramount goals.

CLIVAR Plus: Goals and Objectives

Evidence of the interaction of variability across timescales has forcefully called into question formerly imposed timescale distinctions, and has led to Vice President Gore's recent suggestion for a convergence of seasonal-to-interannual and longer-term climate research programs. In 1995, the Climate Variability and Predictability (CLIVAR) science plan was introduced as a mechanism to merge several WCRP research efforts occurring on different timescales to obtain a more realistic picture of how the climate system operates. CLIVAR's primary foci are:

- understanding and developing our ability to predict the complex atmosphere-ocean dynamics that drive our global climate system on seasonal to centennial time scales; and
- increasing our understanding of anthropogenic climate change against the backdrop of natural climate variability.

The CLIVAR Program addresses the problem of climate prediction, not along timescales, but rather as a holistic problem with multidisciplinary investigations of ocean, atmosphere, land, and cryospheric processes. CLIVAR, therefore, represents an ideal paradigm to demonstrate the linkages between the USGCRP's Seasonal to Interannual Climate Variability and Long Term Climate Change themes.

This timescale Convergence Focus Area is somewhat paradoxical in that the theme of timescale convergence can be interpreted so as to embrace virtually every aspect of the USGCRP. Our implementation plan will, therefore, at times include references to both whole-program agency efforts, as well as to the somewhat narrower program consisting of a single U.S. interagency process that supports joint activities specifically addressing timescale convergence. We refer to this newly emerging timescale convergence program as CLIVAR Plus. The Plus is meant to imply newly established linkages with various other programs within the International Geosphere-Biosphere Program (IGBP) and WCRP. The specific goals and objectives of CLIVAR Plus are as follows:

- To develop and increase our understanding of how the global climate system functions on seasonal to centennial timescales;
- To enhance our predictive capability of the climate system on multiple timescales and to apply forecasts on global and regional spatial scales;
- To understand and predict anthropogenic forcing of the climate system on global and regional spatial scales; and
- To develop and maintain strong linkages between producers and users of climate information to ensure ongoing applications of forecast information in various sectors.

Coordination Mechanisms and Collaborative Interagency Efforts

The implementation plan for CLIVAR Plus is driven by a few fundamental questions around which we will build an effective national climate program:

- How does a given regional climate evaluation depend upon multiple timescales? How can these evaluations be pursued?
- How and to what extent are ENSO and greenhouse warming connected? What are the dynamical processes responsible?

nsible for this connection?

How do human systems assimilate predictive climate information? How will scientists prepare to provide the information that is required?

In order to succeed, CLIVAR Plus must acquire:

the ability to encourage and support interdisciplinary research; effective interagency machinery; a functional symmetry with the international infrastructure; and effective producer/user linkages.

The following actions are envisioned:

Interdisciplinary Research

Traditionally, research on the physical climate system has been conducted predominantly by members of the physical meteorology and oceanography communities. CLIVAR Plus must contain a robust atmospheric chemistry component, especially for characterization of anthropogenic forcing. In addition, there is increasing recognition of the importance of paleoclimate research for understanding the full range of variability the climate system is capable of demonstrating and for characterizing the internal dynamics and/or external forcing associated with abrupt climate changes in the past. CLIVAR Plus will issue Announcements of Opportunity and develop appropriate review mechanisms to ensure the support of interdisciplinary research.

Interagency machinery

The implementation of joint announcements of opportunity among U.S. agencies for multiple-timescale climate dynamics research will be critical to the success of this program. From a programmatic perspective, convergence will require the development of effective interagency whole-program infrastructure for a fully integrated program. A significant fraction of existing and all future U.S. CLIVAR resources will be designated for this single national climate program.

Some of the necessary infrastructure will include a U.S. project office for programmatic support, a scientific working group (which the National Research Council Climate Research Committee could oversee) to provide program direction, and a federal interagency working group to interface with the scientific working group. This interagency group will be restricted to a small group of agency principals who control resources in their respective domains. Agency principals will commit a given percentage of their total base resources to this program.

The management structure of this program is contingent upon interagency collaboration, and is designed to develop and maintain a focused U.S. climate program with a single budget. There is agreement among agency principals to pursue a management structure based on the following four criteria:

- one interagency plan for proposal submissions
- one interagency advisory source
- one interagency review process
- one unified interface with parallel international programs

The program will then tentatively pursue the following three management criteria:

Balance: The program will allocate its resources to observations, process research, modeling/hardware, and assessments in an effective and consistent way so that the program does not become overly weighted in any particular domain.

Fencing: The resources that agency principals commit to the program will be used ONLY for this program and will be allocated in a consistent way as described above.

Ownership: Agency principals will manage the program resources, but it is designed to be a bottom-up program with genuine ownership of the program in the hands of the user community. The

program will be designed to respond to the needs of this rapidly growing user community, with the realization that it will be critical to maintain open lines of communication between the agency principals and this much larger ownership base.

International Linkages

To meet its extensive scientific demands and thus

attain its full potential, a program as large as CLIVAR Plus will inevitably be compelled to foster linkages with the international scientific community in order to attain symmetry with the international scientific infrastructure. In addition, involvement with international scientific and operational community is required for the implementation and maintenance of an effective global observing system, which is essential to support the needs of both the research community and the operational modeling centers.

Forecasting and Applications Task Team

A fundamental part of this exercise will lie in our ability to provide effective linkages between producers and users in order to keep up with the ever-increasing demands for climate information. The USGCRP is accelerating its efforts to translate research results on climate variability into regionally relevant climate forecasts meaningful to decision makers and the general public. The Forecasting and Applications Task Team was developed for this purpose under the direction of Dr. Ants Leetmaa of the NOAA Climate Prediction Center.

Performance Measures

By FY2000, implementation of the CLIVAR Plus infrastructure described above will be underway. Through these developments, the program will enhance the capacity and efficiency with which the climate research community is able to respond to the increasing demands for climate information. Preliminary infrastructure will involve:

- The convening of a small group of agency principals to manage resources
- The development of a scientific working group to maintain an appropriate scientific focus
- Establishing a U.S. project office to support CLIVAR Plus activities such as meetings, etc.

By FY2004-FY2006, the scientific community will have developed an increased predictive understanding of the global climate system based on process research and increased observational and modeling capabilities, which will include:

- More accurate land characterization in ocean-atmosphere-land surface coupled models (FY2004)
- More accurate cloud parameterization in weather/climate models (FY2004)
- Increased understanding of the role of the cryosphere in the climate system (FY2004)
- Development of a freshwater balance time series to monitor thermohaline circulation (FY2006)
- Operational centers such as CPC and NCEP will have incorporated a new generation of hydrological models into climate and weather forecasts (FY2006).

Changes in Ozone, UV Radiation, and Atmospheric Chemistry

New policy decisions related to atmospheric change loom significantly on the horizon, and a multitude of new and complex research issues are rapidly emerging. With ozone depleting substances nearing their peak anticipated levels in the stratosphere, the ozone layer, already significantly depleted, enters its most vulnerable period, during which newly observed cooling of the stratosphere which is an expected side effect of both ozone depletion and greenhouse warming may delay recovery of the ozone layer, and may enhance its vulnerability to new natural or anthropogenic perturbations. Measurements in recent years of the accumulation of greenhouse gases in the atmosphere have revealed stunning and poorly-understood variabilities in their growth rates, rendering uncertain vitally needed predictions of future greenhouse gas

levels. Also, a paucity of data on short-lived and hence inhomogeneously distributed radiatively active species, such as tropospheric ozone and aerosols, limits predictive capabilities and reveals significant residual uncertainties in the detection and attribution of climate change.

Further complicating the scope of decisionmaking, as scientific and societal awareness of seemingly independent phenomena (e.g., stratospheric ozone depletion, greenhouse warming, and air quality) has evolved, it has become abundantly clear that many environmental issues previously treated as unrelated are, in fact, interdependent. Nowhere is this interdependence more true than in the atmosphere. The atmosphere does not segregate these chemical phenomena by scientific discipline or governmental funding track. Rather, there is one atmosphere, whose chemical change can be properly understood only within the framework of a comprehensive program which is broad enough to encompass fundamental understanding, but focused enough to respond to elucidation of key issues of pressing scientific and societal importance.

The societal value of focused atmospheric chemistry research findings has never been higher. A methodical, comprehensive, yet focused research approach provides the scientific bedrock upon which sound policy decisions can be built. In this regard, continued vigilance is essential in order to accurately unravel the strands of information from which predictive understanding of the future is derived. Several recent research advances highlight this point (see Appendix for further discussion).

The goal of the atmospheric chemistry element of the USGCRP is to understand and characterize the chemical trends in the atmosphere and their consequences for human and ecological well-being, with specific emphases on:

- Elucidating the nature and causes of stratospheric ozone layer changes and their consequences;
- Characterizing global tropospheric chemical processes including changes in greenhouse gases, aerosols, and photochemical oxidants and their consequences;
- Elucidating the couplings among chemical, dynamic, and radiative processes and their impacts on climate; and
- Assessing this information in terms appropriate to decisionmaking.

Implementation Plan

The Implementation Plan for the research necessary to address these uncertainties accommodates the following considerations:

- The scientific uncertainties that currently limit informed decisions;
- The research partnerships that are required for addressing these uncertainties; and
- The science/policy interface, which provides for effective communication of research findings to the decisionmaking community.

Research Approach

The USGCRP focuses its atmospheric chemical research components in NASA, NOAA, NSF, DOE, EPA, USDA, NIH, on the following central approaches:

- Global observations of atmospheric change;
- Elucidation of the processes that cause those changes;
- Incorporation of that understanding into a predictive capability;
- Linkages of atmospheric chemical changes to other environmental changes, such as ecological and human health; and
- Evaluation and assessment of the findings and their integration for use by decisionmakers, including state-of-science assessments of the ozone layer and climate system, as they relate to atmospheric trace gases and associated human impacts.

Together, these studies provide a set of predictive tools and capabilities that can provide information for use by policymakers.

akers as they consider various options for mitigating or adapting to global change.

Research Objectives

The USGCRP has designed the following ongoing component objectives in atmospheric chemistry to address the needs of the program (see Atmospheric Chemistry Appendix for further discussion of scientific needs, representative tasks spanning multiple years associated with each objective, and payoffs of the research).

Monitor stratospheric and tropospheric chemical composition trends and the human-influenced emissions that cause them
Understand the stratospheric ozone variations during the coming most vulnerable decade
Monitor changes in surface ultraviolet radiation to quantify exposure to the biosphere
Develop a predictive understanding of the gas-phase and particulate chemistry and composition of the global troposphere
Characterize the link of stratospheric and tropospheric chemical changes to the radiative heating and cooling of the troposphere surface system
Assess the understanding of the future ozone layer and the role of human-influenced chemistry in climate change.

Coordination Mechanisms and Collaborative Interagency Efforts

USGCRP agencies coordinate their research activities in the area of atmospheric chemistry in numerous ways. Much of this coordination takes place as part of broader cooperation between scientists, both nationally and internationally. In the following section, cooperation within the global change arena is emphasized. It is worth noting, however, that there is increasingly strong cooperation between the global change and air quality disciplines, although the latter is not, for funding purposes, included as part of the USGCRP. (See Appendix for further discussion of coordination and collaborative efforts.)

International Context of Cooperation

There are two major peer-led scientific groups of relevance to atmospheric chemistry. These are the International Global Atmospheric Chemistry (IGAC) program, which is a Core Project of the International Geosphere-Biosphere Program (IGBP), and the Stratospheric Processes and their Role in Climate (SPARC) program, which is part of the World Climate Research Program (WCRP).

Ongoing Partnerships and Relationships

There are several examples of well-established long-term partnerships and relationships between several federal agencies in the area of atmospheric chemistry. These include, for example:

- Surface Measurements of Long-Lived Trace Constituents
- Ground-based Remote Sensing Measurements of Atmospheric Chemistry
- Jointly organized and/or operated aircraft campaigns
- Joint satellite data sets for ozone
- Ground-based measurements of surface UV radiation
- Atmospheric Chemistry Modeling Initiatives.

Management Integration

Integration of management across the different programs takes place through several mechanisms. First, there are two crosscutting activities under the USGCRP: an ozone/atmospheric chemistry group and a task team on UV radiation.

Significant coordination takes place at the manager level. This includes an informal program managers group on atmospheric aerosols that has been operating for some time, and mutual support of program managers in the peer review process of individual agencies. There is a

also strong participation by the different agencies in the externally organized assessments (e.g. WMO/UNEP ozone assessment, Intergovernmental Panel on Climate Change assessment, IPCC/ICAO Special Report on Aviation and the Global Atmosphere, etc.). Managers work to assure not only that important scientific viewpoints and results will be part of the assessment process, but to be sure that sufficient resources are in place that these assessments can proceed with adequate support to the participating scientists.

New Directions

Several new areas for

increased interagency cooperation in the area of atmospheric chemistry are developing. For example, a number of new space-based measurement programs developed by NASA are expected to begin obtaining data in 1999, and it is becoming clear that the ground-based and lower troposphere measurement capability developed by other federal agencies will play a key role in the validation of these new satellite data. Looking ahead toward the EOS CHEM spacecraft for launch in late 2002 or early 2003, such cooperation is expected to continue; a significant workshop on this subject will be held in 1999. Additional cooperation and joint activity in the area of atmospheric chemical and transport modeling is also likely. Finally, there have been discussions between several agencies about undertaking a joint initiative to understand the potential implications of global climate change on regional air quality. These activities would further strengthen the tie between global change and air quality science noted in the introduction to this section.

(See Appendix for agency-by-agency discussion of implementation priorities, goals and objectives, contributing program elements, and budgets.)

Performance Measures and Milestones

DOE

Joint Field Measurements Campaigns (ACP and EMP)

Joint Announcement for Aerosol Research with NOAA (ACP)

Participation in Multi-Agency Field Measurement Programs; NARSTO (ACP)

Preparation for

the North American Aerosol Conference with USDA and DOI (ACP)

Studies of Transitions Between Stable and Convective Conditions (EMP)

First VTMX Results Workshop

op

NASA

NASA has two major types of performance measures those associated with well-defined events (e.g., spacecraft launches, completion of airborne campaigns, completion of satellite data set reevaluations/reprocessings), and those that take place slowly over a longer period of time (e.g., improvement of understanding, development of modeling capability).

Well-defined events:

Launch the

EOS-AM spacecraft with the MOPITT instrument for making first global measurements of vertical distribution of carbon monoxide and total column methane (mid-1999)

Launch EOS CHEM spacecraft to make global measurements of vertical profiles of tropospheric ozone, high horizontal and vertical resolution studies of trace constituents near tropopause, and free radical species associated with all key ozone-destroying catalytic cycles (late 2002)

Launch first SAGE III instrument

to measure global distribution of ozone, aerosols, and selected other trace constituents in stratosphere and upper troposphere (summer, 1999)

Carry out major

or multi-aircraft study of chemistry of Pacific Ocean over tropical Pacific Ocean to improve our understanding of effects of industrial and natural emissions from Asia on atmosphere above the tropical and Western Pacific (Spring, 1999 and 2001)

Carry out major multi-aircraft and balloon study of atmospheric chemistry over high northern latitudes from fall to spring to understand potential for wintertime ozone depletion in Arctic; mission will also provide validation and

complementary scientific data for SAGE III mission (fall 1999 - spring 2000).

Longer-term studies:

Provide >20 year data set for concentration of long-live
d industrially-produced source gases, including those regulated by the Montreal
Protocol, to help assess compliance and allow for inference of atmospheric lif
etimes and interhemispheric transport times (late 1999)
Provide long-term (>20
year) data set for stratospheric aerosols and ozone based on combined satellite
- and ground-based data sets for identification and understanding of long-term
trends (early 2000)
Development of modeling capability usable for simulation of
ozone composition of global troposphere, including characterization of relativ
e contribution of different sources to tropospheric ozone (early 2001).

NIEHS

The overall performance measures in the NIH GPRA Performance Plan include dete
rmining how well NIEHS research accomplishes the following goals:

Adds to the
body of knowledge on the consequences of UV exposure
Improves/develops instrume
nts and technologies for use in research and medicine
Develops new and improved
methods for preventing or delaying the onset or progression of disease and dis
ability due to UV exposure

In addition, performance is measured by the number
of peer-reviewed publications published by NIEHS scientists and grantees.

NOA

A

NOAA proposes to measure its performance by the degree to which NOAAs resear
ch is incorporated into the periodic state-of-understanding assessments (e.g.,
IPCC Climate Change, UNEP/WMO Ozone Depletion), which serve as authoritative sc
ientific input to policymaking by governments and industry. NOAAs quantitative
goal is that 90% of its research in the relevant areas of endeavor be incorpora
ted in forthcoming assessments.
Examples of Major Milestones:

Expand the glob
al atmospheric CO2 monitoring network to three currently undersampled subcontin
ental regions. 4th qtr - 2001; 4th qtr - 2002; 4th qtr - 2002; 4th qtr - 2003.

Update the understanding of CO2 trends to better plan the work of the 2005 IP
CC Fourth Assessment of Climate Change. 2nd qtr - 2004.

Begin regular airborne
e field measurements of ozone-related species in mid-troposphere of the North H
emisphere to characterize the spatial patterns and temporal variations of the o
zone budget. 1st qtr - 2002.

Provide an analysis of the role of radiative for
cing by tropospheric ozone to better plan the work of the 2005 IPCC Fourth Asse
ssment of Climate Change. 2nd qtr - 2004.

Complete an initial characterizatio
n of the physical and chemical characteristics of aerosol particles that influe
nce the radiation balance in the North American region. 2nd qtr - 2003.

Provi
de model calculations to update the understanding of the role of aerosols in cl
imate change to better plan the work of the 2005 IPCC Fourth Assessment of Clim
ate Change. 3rd qtr - 2004.

Response to NRC Pathways Report

The NRC Pathways

Overview takes a broad view in its atmospheric chemistry studies, so that the
research imperatives include issues that are considered as global change issues
under the Subcommittee on Global Change Research and in the USGCRP budget, but
also include air quality issues under the Air Quality Research Subcommittee (A
QRS). Therefore, several of the areas identified in the Pathways report (especi
ally toxics and nutrients, as well as some aspects of photochemical oxidants) a
re dealt with only minimally by the USGCRP agencies as part of their global cha
nge research activities. Many of the same agencies have air quality research pr

programs under that report through the AQRS, and there is close linkage within these agencies between their air quality and global change research programs. This strong linkage between atmospheric chemistry global change research and air quality research is clearly indicated in the USGCRP Atmospheric Chemistry implementation plan (see Appendix, sections 2.6 and 2.7). The NRC also addressed some areas typically considered by the long-term climate element of USGCRP (e.g. sources and sinks of carbon dioxide and climate impact of aerosols). The NRC did clearly identify the links between atmospheric chemistry and climate change as priority issues, and these have been noted in the Atmospheric Chemistry implementation plan (see Appendix, sections 2.3, 2.5).

In general, the key global change-related scientific questions identified by the NRC are all being addressed by the USGCRP as part of its atmospheric chemistry efforts. These include understanding of basic chemical and dynamical processes, characterization of long-term atmospheric evolution, development of models for both understanding and predictive capability, all of which are addressed in the above implementation plan.

Changes in Land Cover and In Terrestrial and Aquatic Ecosystems

The biosphere consists of diverse marine and terrestrial ecosystems that vary widely in complexity and productivity, in the extent to which we manage them, and in terms of their value to society. Ecosystems directly provide forage, timber, fish, food and fiber, and clean water as well as recreational opportunities, and wildlife habitat. Issues such as tropical deforestation and the collapse of major marine fisheries have attracted international attention in recent years. In the United States, changes in terrestrial and marine ecosystems, including the loss of productive agricultural land, the severe reductions in salmon populations in the Pacific Northwest, and concerns about the sustainability of important ecosystems have underscored the importance of documenting and understanding ecosystem changes.

Increasing concentrations of atmospheric carbon dioxide and other chemicals and changes in climate will add to the challenges of maintaining the benefits of healthy and productive terrestrial and aquatic ecosystems. To provide society with the information needed to manage and preserve these ecosystems, researchers must document and understand the human and natural factors that influence land cover and ecological systems.

The goal of the land cover and ecosystems component of the USGCRP is to understand, predict, and assess the causes, magnitude, and consequences of changes in land cover and in terrestrial and aquatic ecosystems, and to strengthen the scientific basis for sustainable environmental and natural resource practices.

Ecosystems Impacts

The proper functioning of ecosystems and sustained use of natural resources may be threatened by a number of global environmental changes. Three interconnected changes have the greatest immediate potential to adversely affect ecosystems, and alter the capability of both terrestrial and marine ecosystems to support humanity: climate change, direct effects of rising CO₂, and changing land use and land cover.

The primary effects of climate change, as we currently understand it, are rising temperatures, changing amounts and patterns of precipitation, and increased variability in weather. Rising atmospheric CO₂ has significant effects on plants, which form the basis of all food chains. And changes in land use and land cover control the capability of ecosystems to respond to effects of both climate and atmospheric chemistry.

Key Questions, Goals and Objectives

The primary goal of research on ecosystems impacts is to provide a stronger scientific basis for understanding, predicting, and responding to the consequences of global environmental changes of both natural and human origin in terrestrial, aquatic, coastal, and marine ecosystems and their ability to provide goods and services and support sustained use.

Short term goals:

Understand how changing temperatures, altered patterns and amounts of precipitation, and increased variability in weather affect major terrestrial and marine ecosystems.

Develop a predictive understanding of the responses of plants to elevated atmospheric carbon dioxide concentrations, how those effects interact with other environmental changes, and how combined effects alter ecosystem processes and community structure and function.

Refine and enhance capabilities to remotely document and monitor global changes in land use and cover at spatial and temporal scales useful for understanding cause and effect, and useful for explaining implications of changes like ecosystem fragmentation. Identify and analyze the implications of factors that lead to changes in land use, cover, and management.

Short-term strategies:

Maintain capability to conduct experiments in which environmental changes are applied as treatments to document ecosystem responses, across a range of scales of system complexity ranging from fundamental biochemistry through small-plot manipulations (several square meters) to large scale manipulations of intact ecosystems (many hectares)

Enhance capability to observe and develop a predictive understanding of effects of multiple, interacting environmental changes, such as combined effects of elevated CO₂ and higher temperatures, or elevated CO₂ and reduced availability of water in terrestrial ecosystems or increased salinity in marine ecosystems.

Longer-term goals:

Improve understanding of direct effects on ecosystems to develop a functional understanding of the processes that control ecosystem resilience and resistance to environmental change. How do ecosystems survive these changes, and what must we do to enhance that capability?

Relate knowledge about the consequences of environmental changes to sustainable use of natural resources and continued economic development.

Develop and test management options for minimizing adverse effects of global change.

Program

Implementation: Challenges and Opportunities

Eight USGCRP agencies contribute

to research on Changes in Land Cover and in Terrestrial and Aquatic Ecosystems, and to research on Ecosystems Impacts in particular. The estimated combined FY1999 budget for Ecosystems Impacts research is about \$115M. (See the Ecosystems Impacts Appendix for an agency-by-agency listing and brief description of Ecosystems Impacts program elements and agency funding levels.)

A number of these

program elements involve interagency coordination, including, for example:

Program

for Ecosystem Research: experimental research and modeling, including Terrestrial and Carbon Processes Program

Terrestrial Ecosystem and Process Studies:

assessments of the ecological consequences of environmental change and predictions of how future environmental conditions may affect natural or managed ecosystems

Terrestrial Ecology and Global Change (TECO): long-term, large-scale research on ecosystem and landscape processes, populations, and communities.

Land-Use

and Land-Cover program: global inventories of land cover and land use from space and development of scientific understanding and models necessary to evaluate consequences of observed changes (contributes to TECO).

Terrestrial Ecology

program: integration of terrestrial ecosystem process understanding with remote-sensing observations and ecological modeling (contributes to TECO).

Global Ocean

and Ecosystems Dynamics (GLOBEC): improving predictability and management of live marine resources through improved understanding of ecosystem interactions and the coupling between climate change, the oceans physical environment, and the ecosystem components.

Mapped Atmosphere-Plant-Soil-System (MAPSS): simulates effects of disturbances on ecosystem function under current and potential future climates.

To improve strategic coordination of USGCRP Land Cover and Ecosystem research, and in particular research on Ecosystems Impacts, the program faces a number of challenges and gaps in the current research effort, as well as opportunities (see Ecosystems Impacts Appendix for fuller discussion):

Challenges and Gaps

The collection of program and efforts across the agencies does not suggest a focused, readily discernable strategy of ecosystems impacts research. Current research programs vary widely whether by scope, scale, and type of ecosystem.

Current inability to separate the effects of multiple and simultaneous environmental changes on ecosystems. We lack sufficient scientific knowledge of the interactions between changes in climatic variables to assign cause and effect relationships. The tasks of separating those impacts and attributing effects to specific causes are made more difficult by natural variation in weather on seasonal, annual, and decadal scales, and by variation across time and space in nutrient and water availability, in species composition and structure of communities, and in other characteristics of ecosystems. Overlain upon these effects are changes in land use and land cover, ecosystem fragmentation, and the effects of natural disturbance such as fire and the disturbances associated with utilization and management of most ecosystems.

The number and diversity of important ecosystem types that must be addressed pose a constraint by diluting the focus of limited resources. For instance, coordinated, manipulative research by USDA, EPA, and universities indicates that productivity and species composition of desert grasslands and the sagebrush steppe respond very differently to changes in amounts and patterns of rainfall. Such differences are also expected within coniferous and deciduous forests, and are magnified across different biomes such as forest, grassland, cropland, aquatic, coastal, and the many kinds of marine ecosystems.

Data bases from representative ecosystems required to improve and test models that predict ecosystem responses to multiple global environmental changes are often lacking. Currently, most ecosystem response models are based on a limited understanding of both the combined effects of multiple factors on ecosystems and the biological and ecological processes controlling responses, including the causal pathways and mechanisms. Virtually none of the ecosystem response models have been rigorously tested and the ability to test them is severely limited by the lack of relevant data.

Experimental facilities and capabilities for investigating the combined effects of multiple factors on intact ecosystems are inadequate.

Needs for Improved Coordination and Research Facilities

A strategy for integration and coordination of research across the eight agencies (and multiple funding mechanisms, research managers, etc.) is needed to produce a truly coordinated, interrelated ecosystems research program.

Improved coordination could help address data gaps mentioned above. Each agency should identify priority research goals and objectives, then provide its perspective on the combined priority research needs identified and rank them in terms of near- and long-term importance. Agencies would then have a better basis for discussing where there are significant opportunities, advantages, and gaps in integration and coordination across agencies. A strategy for integration and coordination of research across agencies could then reach a consensus about the critical research priorities and needs, the kinds of research needed to address the priorities, and the intramural and extramural research capabilities, approaches, and roles of each agency.

New experimental facilities and capabilities for investigating the combined effects of multiple factors on intact ecosystems should be a high priority goal for Federal agencies supporting ecosystem effects research. Efforts should be focused on providing additional facilities where manipulative experiments can be conducted at realistic ecosystem scales, with emphasis on simultaneous application of different levels of multiple factors such as temperature, CO₂ level, water and nutrient availability, ozone, and others, located in major North American ecosystems. A pressing need exists for sustained long-term experiments.

Response to NRC Pathways Report

The NRC Pathways

Overview identifies a set of research imperatives pertaining to land cover and

ecosystems:

Land Surface and Climate Imperative: Understand the relationships between land surface processes, including land cover change, climate, and weather prediction.

Biogeochemistry Imperative: Understand the changing global biogeochemical cycles of carbon and nitrogen,

Multiple Stresses Imperative: Understand the responses of ecosystems to multiple stresses.

Biodiversity Imperative: Understand the relationship between changing biological diversity and ecosystem function.

USGCRP research objectives on changes in land cover and in ecosystems, and on ecosystems impacts in particular, address many of the scientific questions identified in the NRC Pathways Overview that pertain to these research imperatives (see Ecosystems Impacts Appendix).

The Global Carbon Cycle

We are approaching a period of significant advancement in our ability to measure and model carbon fluxes. However, understanding the complexity of the carbon cycle and the linkages to physical, biogeochemical, and ecological processes and human influences will require a comprehensive research program and a new level of scientific and programmatic integration. The payoff will be the enhanced scientific understanding, baseline data, methodologies, and measurement infrastructure necessary for regional and country level accounting of carbon sources and sinks and offsets.

There has been a major change in our thinking about the role of the terrestrial biosphere that it can be a significant carbon sink and not a large source. The observed destruction of forests appears to have been approximately compensated by mechanisms of enhanced carbon uptake. There are now seven independent lines of evidence that support this view (see Carbon Cycle Appendix).

Key scientific questions include:

What has happened to the carbon dioxide that has already been emitted by human activities?
What will be the future atmospheric carbon dioxide loading resulting from past and future emissions?
Implementation Plan

Key management issues include:

Recognition of the urgent need for a comprehensive carbon cycle research program.
Development of a management implementation strategy for a new program that would coordinate and integrate activities across seven agencies in the USGCRP and have strong international linkages.
Phased implementation of new program, as funding permits.

Current agency contributions: Linkages and coordination

We have identified USGCRP research activities in seven agencies, with a total annual budget of about \$50M, explicitly focused on the biogeochemical cycling of carbon and sources and sinks of anthropogenic CO₂ on land and in the ocean. Other contributing research activities in other focus areas, especially in the Ecosystems Impacts Focus Area, include research and monitoring of ecosystems, land-use change, remote sensing observations, and global climate modeling.

USGCRP activities include field campaigns, modeling, and process studies (see Appendix for inventory of U.S. agency contributions to Carbon Cycle Focus Area). Major flagship programs, such as AmeriFlux, BOREAS, and carbon components of JGOFS, TECO, FACE, and VEMAP, are jointly funded by multiple agencies and all have strong international linkages:

AmeriFl

ux Network: flux measurements at 25 sites in North America
 Boreal Ecosystem-Atm
 osphere Study (BOREAS): Remote-sensing and field study of Canadian boreal fores
 t
 U.S. Joint Global Ocean Flux Study (JGOFS): marine carbon process research
 T
 errestrial Ecology and Global Change (TECO): terrestrial carbon process research
 h
 Free Air CO2 Enrichment Experiments (FACE): CO2-enrichment experiments in cro
 pland and grazingland soils
 Vegetation/Ecosystem Modeling and Analysis Project
 (VEMAP): international intercomparison of biogeochemistry and vegetation-type d
 istribution models.

Additional key examples of interagency linkages and coord
 ination include the Carbon and Climate Science Planning Group (developing scien
 ce plan for new program) and the Carbon Forum (interagency forum to exchange in
 formation with interested agency participants). Additional key examples of int
 ernational linkages and coordination include WOCE, Euroflux, Fluxnet, and the I
 GBP Terrestrial Carbon Working Group.

FY2000 plans to address questions, issue
 s, and gaps

Begin phased implementation of enhanced program, as funding permit
 s.
 Facilitate briefings to USGCRP agencies and others as appropriate.
 Prelimina
 ry analysis of initial results of the expanded AmeriFlux network, quantifying c
 arbon fluxes at up to 25 sites in North America and at sites in Europe (Euroflu
 x).
 Initial synthesis of global ocean carbon data, providing a basis for compar
 ison between the GEOSECS Program expeditions of the 1970s and WOCE/JGOFS of the
 1990s.

Draft Carbon Cycle Science Plan (see Appendix for fuller description)

USGCRP agencies have jointly funded a working group of prominent carbon cycle
 scientists to develop a science plan for a comprehensive carbon cycle research
 program. The draft plan was released in early August 1998, and discussed at a r
 ecent workshop attended by about 100 scientists and managers, representing a cr
 oss-section of the U.S. carbon cycle research community. The strategy identifie
 d in the plan includes:

strengthening the broad research agendas of the agenci
 es through better coordination, focus, conceptual and strategic framework, and
 articulation of goals; and
 developing a small number of potent new initiatives
 that are feasible, cost effective, and compelling, to address difficult, linke
 d scientific problems.

The plan addresses physical, biogeochemical, and ecolog
 ical processes (e.g., improve quantitative characterization of past and present
 sources and sinks for CO2; develop models to predict future sources and sinks
 incorporating the most important mechanisms and providing predictions with enha
 nced credibility), as well as human contributions and responses (e.g., understa
 nding the consequences of land use/land cover changes; and providing the scient
 ific information necessary to evaluate the effects of various management strate
 gies, such as deep-ocean CO2 injection).

The challenge to the research commu
 nity is to craft programs that focus on key problems, yet maintain enough bread
 th to reveal new problems and priorities in areas where we are just scratching
 the surface. The challenge is to find the right balance between testing hypoth
 eses, on the one hand, and observing and discovering on the other. Achieving th
 e goals of a comprehensive carbon cycle science program will require a new leve
 l of scientific and programmatic integration.

Scientifically, we must develop
 a more complete picture of the ocean-land-atmosphere components of the carbon
 and climate system and a more thorough understanding of the physical and biogeo
 chemical processes that characterize and control that system, including relativ
 ely long-term processes that are difficult to study.

Programmatically, we mu

st implement a program that effectively integrates sustained monitoring activities, field and laboratory research, modeling and analytical studies, and targeted assessment activities designed to meet the information needs of society. These goals are attainable and their attainment has an urgency that is increasingly recognized in the policy arena.

Performance Measures

FY2000:

Begin phase
d implementation of enhanced program, coordinated with the IGBP, as funding permits.
Initial results of AmeriFlux network of up to 25 sites in North America quantifying carbon sinks.
Initial synthesis of global ocean carbon data, providing a basis for comparison between the GEOSECS Program expeditions of the 1970s and WOCE/JGOFS of the 1990s.
Ongoing CO₂ time series measurements at Mauna Loa, combined with additional tracers such as ¹⁴CO₂, ¹³CO₂ and O₂/N₂ will provide strong constraints on global balance of carbon.

FY2005:

Full implementation of enhanced program, as funding permits.
Improved quantitative understanding of global sources and sinks, improved regional constraints on sinks, especially NA.
Expanded atmospheric observation network, combined with a growing number of local flux measurements like AmeriFlux, enabling scientists to study regional sources and sinks.
Improved understanding of opportunities for enhancing sinks (e.g., through forestry and/or agricultural management practices)

FY2010:

Establishment of a global monitoring network for atmospheric CO₂, enabling an improved understanding of regional sources and sinks globally, and providing the capability of detecting developing trends and providing enough information to be able to test hypotheses about their causes.
Improved integration of local, regional and global scale information leading to an improved integrated understanding of processes and mechanisms.
Enhanced-modeling capability integrated with flux network and global atmospheric monitoring network providing improved forecasting capability.

Response to Pathways Report

Development of a coherent, integrated program of carbon cycle research is a high priority recommendation of the NRC Pathways Overview. The Pathways Overview states:

The scientific strength of the case linking release of greenhouse gases to climate change is central to any considered action. Acceptance of the evidence by policy-makers and their constituent communities [will emerge] from carefully executed observations of the physical, chemical and biological variables that track the actual state of the Earth. Knowledge of the global sources and sinks of carbon that are associated with changes in atmospheric concentrations of CO₂, CH₄, and CO is part of the foundation for understanding the physical, chemical and biological processes that control our surroundings, and for understanding the fractional impact of any industrial or agricultural input to that natural system.

The IGBP Terrestrial Carbon Working Group recently echoed this recommendation and initiated a carbon science planning process.

Human Contributions and Responses to Global Change

The goal of the Human Dimensions component of the USGCRP is to identify, understand, and analyze how human activities contribute to changes in natural systems, how the consequences of natural and human-induced change affect the health and well-being of humans and their institutions, and how humans could respond to problems associated with environmental change. The scientific questions address

essed by this component of the USGCRP are broad-based and include both basic research questions related to human and natural systems interactions and more specific research questions related to the Human Dimensions of climate variability and change and changes in land cover and ecosystems.

Implementation Priorities

The USGCRP budget for research on the human contributions and responses to global change is about \$21M (FY1999 request), including the NSF Human Dimensions of Global Change program, the DOE Integrated Assessment program and Human Dimensions research at the National Institute for Global Environmental Change, and the NOAA Economics and Human Dimensions of Climate Fluctuations program. Other USGCRP-supported activities also pertain to Human Dimensions issues but are not identified as such for budgetary purposes or included in this total.

USGCRP

-supported Human Dimensions research is progressing on a number of fronts:

Th

rough model analysis, the integrated assessment community has identified high-priority research areas that will provide stronger scientific foundations for policy decisions.

Within investigations of how individuals, institutions, industries/sectors, and communities adapt to current variability in the climate system, investigators have begun to develop models of how various sectors could potentially gain from the use of climate predictions as an early warning technology in their management decisions. Other analyses are investigating how social, cultural, and institutional factors affect adjustment to climate and the potential use of global change science.

The Human Dimensions programs have made significant progress in the integration of the social and natural sciences where necessary to address the complex issues associated with global change issues as they relate to society. For instance, in many cases, social scientists are working with natural and physical scientists to address how society could more easily adapt to current climate variability, as well as long-term climate change.

NSF

and EPA have completed year four of a joint competition for research on decision-making and valuation for environmental policy. These competitions have supported research on the benefits and costs of environmental policies and programs, ecosystem valuation, and innovations and improvements in environmental decision making.

NSF has established a consortium of research centers and research teams in the Human Dimensions of Global Change. Research activities pursued by consortium members include: an examination of the causes, processes, and outcomes of variables associated with changes in forest conditions in the Western Hemisphere; research characterizing the impacts of global change on natural systems, human artifacts, and social systems; the development of techniques for integrated assessment; research aimed at improving methods of integrated regional assessment; research that increases our understanding of the relationships among research, assessment, and management in the global environmental arena; and the development of smart markets for understanding complex problems such as water allocation.

NSF continues to support fundamental research in the social and behavioral sciences that has implications for our understanding of the Human Dimensions of global change.

Coordination mechanisms and collaborative interagency efforts

The Human Dimensions component of the USGCRP is a complementary set of research activities. Human Dimensions is a cross cutting effort that supports research on global change questions defined from a social and behavioral science perspective and intended to contribute to inquiry across the four key global change environmental science issue areas of the USGCRP. Research on fundamental social and behavioral science questions that are relevant for the four science areas of the USGCRP as well as for a broader set of related environmental issues is also supported under the Human Dimensions component.

Coordination across

agencies is both implicit and targeted. The considerable breadth of questions that need to be addressed under Human Dimensions, together with the wide range in orientations and missions of the participating agencies, has resulted in a strategy whereby agencies focus on areas most central to their primary mission. This strategy has resulted in a diverse portfolio of research supported under H

Human Dimensions with minimal overlap in terms of funding priorities.

Areas of

common concern to two or more agencies sometimes have been addressed by joint competitions. One notable example of this form of targeted coordination is the NSF/EPA Partnership in Environmental Research. This umbrella activity supports four different special competitions on areas of mutual interest to both agencies, including Water and Watersheds Research and Environmental Statistics. The advantage of joint competitions is that they are visible, focused, and flexible. The Water and Watersheds Research competition, for example, was reoriented in FY 1998 to integrate the multiple goals of three agencies: NSF, EPA, and USDA.

There is

implicit coordination structure that has evolved over the years in fact has allowed agencies to focus on areas of most importance to them while in sum contributing to an overall effort to further development of social science research relevant to global change questions.

Candidate areas for enhanced interagency coordinated research effort

The agencies agree, however, that it is now time

to begin enhancing coordination in order to pursue certain topical research areas important to the whole of the global change effort. Although each of these topics is in need of further vetting with the research community, what follows is an initial list of candidate areas. Please note that we do not expect every agency to participate in each and every activity outlined below; indeed, we expect that the extent of any agency's involvement will depend both on the level of new resources available for the activity and the interests of the particular agency.

Land Use/Land Cover

What are the social driving forces for land use and land cover change?

Which human activities can significantly alter the potential for major environmental surprises?

How does institutional structure affect land

and use and land cover change, particularly with respect to common pool resources.

Location and Relocation of Human Activities

What are the constituents and determinants of energy use and other environmentally significant consumption in

countries and populations at different levels of economic development?

How is consumption

likely to change with increasing affluence in low-income countries and populations, and does this change always follow the path that high-income countries and populations have followed?

What policies at the national level lead

to greater attention in communities to such issues as urban sprawl, reducing the cost of home-to-work commuting, expansion of green spaces, and enhanced recycling of materials?

Culture and the Environment

What are the links among land use

change, migration, political and economic changes, cultural factors, and household decision making?

Environmental Change and Human Health

How will environmental

and social change affect the transmission and distribution of environmentally-sensitive infectious diseases, and what are the best options for mitigation?

Adaptation

What are the regional vulnerabilities to and consequences of global change?

What are the most effective responses to global change?

What methods

can be used to improve decision making about global change?

Technology and Technology Transfer

How does technological transformation influence global change?

As we work toward developing these topic areas and assembling the appropriate programmatic machinery for interagency coordination, we intend to support activities to synthesize the results of Human Dimensions research across the agencies. Possible mechanisms for achieving such a synthesis include jointly sponsored

red workshops (such as the NSF/EPA Partnership workshops) or the commissioning of an academic report that reviews the state of USGCRP funding in the Human Dimensions. It is our hope that a better understanding of the state of Human Dimensions research will inform the process of building topical areas of inquiry that would benefit from more vigorous interagency collaboration.

Performance Measures for FY2000

Scientific:

Integrated Assessment Models will be strengthened to include multiple greenhouse gases and the carbon sequestration implications of land use. Models of how society responds to climate variability across a range of sectors, including agriculture, forestry, rangeland management, and fisheries will be developed. Research on adaptation to climate variability will be expanded to include decadal and longer-term climate variability and change.

Programmatic:

Agency Human Dimensions program managers will identify key scientific questions appropriate to serve as a basis for a coordinated interagency announcement of opportunity.

Response to NRC Pathways Report

The six areas highlighted above as suggestions for topical areas that should be pursued in an interagency enhanced coordination framework have a high degree of overlap with the Human Dimensions research imperatives and scientific questions identified in the Pathways Overview. NOAA has also engaged the National Academy of Sciences in developing a science plan for the Human Dimensions of Seasonal-to-Interannual Climate Variability. The plan is expected to be published by the end of this year.

Predictive Climate Modeling

General Circulation Models (GCMs) provide our best opportunity to predict future climate and to attempt to track why observed changes are occurring and what they portend for the future. The output of these models is used by the IPCC in making its climate change assessments, and provides the bases for the current national climate change assessment. The recent El Niño event highlighted the utility of prediction and serves to accent the potential value inherent in being able to similarly predict potential climate-related problems. These models also provide our best way of characterizing potential long-term climate modifications, such as those produced by greenhouse gases, aerosols emissions, and deforestation.

Over the past 10 years, largely as a result of USGCRP-sponsored research, atmospheric and oceanic general circulation models have improved significantly. There is strong potential for continuing advances through improved representations of critical climate processes and through finer model resolution for regional-scale predictions. A useful vision for climate modeling was stated at the USGCRP/NAS May 1998 retreat (paraphrased from an early 1990s draft of USGCRP Research Milestones: 1991-2020, section on Earth System Models, 2001-2010):

To build better models that provide credible predictions of changes and variations in climate on regional to global scales and to apply them to provide useful projections of potential environmental and societal consequences.

(*Where by use of the word credible is meant the usual denotative meaning and in addition the concept that a "credible prediction includes its level of certainty/uncertainty.")

Key Questions

The key questions currently facing climate change modeling research are defined by the necessity to understand and predict effects of global phenomena on regional scales. Events, particularly over the last few years, have shown that the effects of such events as ENSO cast long shadows over major portions of the globe, bringing diverse effects

fects to various regions depending on little-understood patterns. Understanding these patterns is a primary challenge of climate research, and modeling them with sufficient resolution in both space and in physical dynamics to embrace this understanding is the first of two key questions for climate modeling.

Thu

s the first key question can be stated as: What are the regional patterns of climate change? Establishing these patterns and codifying their establishment in climate models will provide a tool for building both a public awareness and capability for informed reaction to the foreseeable effects of regional patterns. Such factors as storm frequency and severity, floods, droughts, and even modest changes in precipitation patterns by region or in time have strong human consequences. The problems they present can be reduced significantly if appropriate actions can be taken.

The second key question is similar but with the essentially predictive element of understanding and modeling climate thoroughly enough that environment modifications never seen observationally can be predicted: What can be expected at regional scales as a result of current and projected greenhouse gas concentrations? The economic consequences of action or inaction are currently much-debated. Regional predictions for these changes are critically needed to assess potential problems.

To address these questions effectively will require improvements in model resolution and in the modeling of the phenomena. For regional predictions, we must have coupled models with resolution 10 and 30 km for ocean and atmosphere respectively. Currently, 60 and 300 km are the usual resolution. Models for snow and ice cover and for biogeochemical processes are major areas where new model components are entering GCMs.

Goals and Objectives

The goals related to these two questions aim at providing information in response to these questions:

Goal: Provide regional level climate prediction.

Objective: Increase the resolution of results.

Storm track and ocean-eddy resolution needed for regional prediction are expected to require resolutions of 1 km for the land surface, 10 km for the ocean, and 30 km for the atmosphere, respectively. Coupled ocean atmosphere models are, or will soon be, capable of handling resolution of 1 km for the land surface, 60 kilometers for the ocean, and 300 km for the atmosphere.

Goal: Provide credible prediction of climate change resulting from various potential climate-modifying scenarios.

Objective: Increase the validity/credibility of model science.

This is a required continuing effort. Some of the current issues pertain to the reaction of the Earth's hydrologic system, in particular the effects of clouds, on the Earth's radiation budget. Increasing atmospheric concentrations of greenhouse gases and aerosols appear to have counteracting effects. The effects of changing atmosphere composition on biogeochemical dynamics, e.g., leaf transpiration, are currently being explored and modeled as a first step to incorporation in GCMs.

Goal: Provide statistics for probability of occurrence.

Objective: Analyze ensembles of climate simulation runs.

The variability of weather and its chaotic nature indicate that the best that can be done at this time in climate prediction will be done on a probabilistic basis. This requires ensembles of runs be made and analyzed for the statistics, means, and extremes of the predictions. Ensembles required for meaningful treatment of the statistics is considered to be ten runs for decadal variability (runs for decadal variability approach one hundred years in simulated time).

Implementation

Modeling is an integral part of the USGCRP plan.

Every aspect of global change research is related to models, whether in providing

ing data from which models can be initialized and calibrated, or new explanations of processes which, when embodied in the models, provide additional tools for understanding the complexity of global change. Perhaps most importantly, models are used as tools to predict global change, which is especially important in environments which have been hitherto unobserved.

Climate modeling in the United States

Climate modeling in the United States is sponsored primarily by NASA, NOAA, NSF, and DOE. The support level is about \$80 M/yr and is divided about \$50M/\$30M between funding within the USGCRP and funding not considered part of USGCRP. Activities include 10 non-academic facilities and more than 14 academic facilities, most of which are funded by more than one of the agencies. Development and applications have about equal emphasis at non-academic institutions. Much more applications than development are done at universities. Workshops and fora, such as the USGCRP Earth System Modeling Workshop and the NAS CRC/USGCRP Forum on Climate Modeling, have examined modeling within the USGCRP. The recommendation to maintain a diverse and distributed program was and is being followed.

Overall there is considerable interagency sponsorship of climate modeling. There is, as expected, a large number of players, whose activities span the required GCM development and uses quite well. The single most important issue facing climate modelers is the lack of adequate computing resources needed to conduct their research and make predictions and assessments. This deficiency is the limiting impediment to more certain climate predictions. In fact, it is perhaps ironic to note that the strengths in non-U.S. efforts cited by various experts in this area include the capability to utilize both data (frequently U.S. data) and advances in models (also frequently U.S. in origin) more effectively and more rapidly than the U.S. can, due to ease of data accessibility, information exchange, and the power of the non-U.S. climate computation centers.

In a JASON review of modeling this summer it was remarked: Surprisingly, although the U.S. has led the world in climate observations and in pursuing the science embedded in the models, it lags significantly in the exploitation of modeling capabilities. With regard to our participation in IPCC and other international assessment efforts, the NRC Pathways document states: Currently, the potential exists that the advanced models built in the United States cannot (or will not) be adequately tested and properly applied to key problems, such as national and regional expressions of transient climate variability.

Models are a major proof of understanding in any area of scientific endeavor. At their best they embody the most germane functionality and provide both insight and valid guidance in dealing with the phenomena they embody. Within the USGCRP they represent a very important product in themselves and their product, climate prediction, represents one of the most potentially usable sources of information guiding us on how to cope with the climate aspect of our environment. Given the present situation with regard to climate and international pressures, it seems clear that the U.S., having much at stake in the debate, should be in the forefront with its predictions and scenarios of climate change. This is not currently the case. Perhaps of most concern in this area is the lack of any plans firmly in the budget to address this problem.

Performance Measures

In the short term (FY1999-FY2000), while we will continue to make marginal progress toward the goals listed above without a substantial increase in available computational power, major steps forward in predictive modeling are not expected in the U.S. effort without such increases.

IPCC Third Assessment Report

will be completed late FY2000 (early 2001) with active participation by USGCRP (and non-USGCRP) modeling researchers.

The simulation of the climate of the 21st Century will be completed in FY1999. The simulations will include changes due to greenhouse gases, aerosols, and solar variability, based on best estimates from observations taken during the last century. They will enable a critical evaluation of the predictive capability of climate models.

Field experiments and

focused model simulations will be initiated in FY1999 to study the effects of tropospheric and stratospheric aerosols on global and regional radiative balance and climate. The observational phase and initial analyses of the data sets will be examined and will help to quantify the influence of natural and human-produced aerosols on future climate. Data will be distributed to modeling centers for model physics development and testing.

Component models under development for ocean phenomena will reach ~11km resolution in FY2000. Component atmosphere models will reach ~80 km resolution.

Extensive testing of recently completed coupled models will be made at resolutions of 1 km land, 60 km ocean, and 300 km atmosphere during FY1999-FY2000. Ensemble runs are not yet anticipated.

The first

U.S. National Assessment of the Consequences of Climate Change and Variability for the United States will be completed in late 1999. Climate model simulations will provide predictions of future climates forced by various estimates of future atmospheric greenhouse gases and aerosol concentrations. These will provide the basis for the assessment. Reports describing regional and sectoral analyses and a national synthesis report will be completed in FY 2000.

Response to

NRC Pathways Report

Recommendation 6 in the Pathways Overview may provide impetus for a remedy to the present situation: The USGCRP must foster the development and application of models at the scales of time and space needed to understand and project the specific mechanisms controlling changes in the state of the Earth system thus providing the information required to support important policy processes. The USGCRP must give increased emphasis to models that treat multiple stresses on the system; it must therefore secure adequate computing resources so that large-scale, complex models can be rigorously tested under multiple forcings.

Observing and Monitoring Global Change

The 20th Century has seen

a great expansion of the ability to assemble information about the Earth system, using historical records and advancing communications technology. Since World War II, aircraft and weather balloons have provided data on the state of the atmosphere, and ships and buoys have provided regular observations of parts of the ocean. But only with the development of satellites over the past few decades and sophisticated instruments over the past several years, do we have the potential to observe and monitor the atmosphere, the oceans, and the land surface on a global scale.

What might be called the first era of the USGCRP observation and monitoring program has included the development and implementation of a range of remote-sensing activities, including, for example, the Total Ozone Mapping Spectrometer (TOMS), the Upper Atmosphere Research Satellite (UARS), Landsat, and TOPEX/Poseidon (Ocean Topography Experiment); and surface-based measurement activities such as the Tropical Ocean Global Atmosphere/Coupled Ocean Atmosphere Research Experiment (TOGA/COARE); the Atmospheric Radiation Measurements Program (ARM), the ENSO Observing System (made up of complementary networks including the Tropical Atmosphere/Ocean (TAO) array of deep-ocean moorings), the AmeriFlux network, and the Surface UV Monitoring Network.

A new era of satellite

observations of the Earth is beginning, as crucial data from the first of several Earth Observing System (EOS) missions start to become available. The first mission in the EOS era, the Tropical Rainfall Measuring Mission (TRMM), was launched in 1997. The EOS AM-1 satellite will be launched in FY1999, to be followed by EOS PM-1 and EOS CHEM-1. The EOS spacecraft are a key component of a long-term, coordinated research effort to study the Earth as a global system and the effects of natural and human-induced changes on the global environment. The EOS missions will provide data that will make significant contributions to research being conducted throughout the USGCRP.

Even as this second, EOS era of the

observations and monitoring program gets underway, USGCRP strategic planning must address the question of beginning a transition to a third era, in which we obtain needed global change measurements via an operational as distinguished from a research mode. Questions of planning for this transition will engage the USGCRP in the coming period.

Goals and Objectives

The overall goal of the US

GCRP Observations and Monitoring Program is to ensure the availability of long-term, high-quality observational records of the state of the Earth system, its natural variability, its past history, and changes that are occurring over a broad

oad range of spatial and temporal scales. Observations and monitoring are essential for defining the current state of the system and for establishing a benchmark against which future changes can be compared. This task requires both space- and surface-based systems and networks.

Recent advances in observing, data processing, and communications technologies have provided unprecedented opportunities for the development of an integrated global observing system. At the same time, existing key measurements must be maintained to the extent possible to minimize avoidable gaps in the data records. Such gaps reduce the ability to estimate trends and to predict and assess global change and its associated impacts.

The overall goal of the Observations and Monitoring Program embraces the following objectives:

- To adopt a strategy that will improve the coordination of national and international space-based and in situ systems for observing and monitoring the Earth's environment and natural resources;
- To coordinate the contributions of the Federal agencies in implementing the U.S. space-based and in situ components (both operational and experimental) of an internationally coordinated global observing strategy that meets the scientific needs of the USGCRP; and
- To promote the development and demonstration of innovative cost-effective instruments and observing techniques for providing critical environmental information in the future.

Observations Strategy and Program Implementation

Observations Strategy

The USGCRP Observations and Monitoring strategy is formulated to provide information needed for testing scientific hypotheses associated with unanswered global change scientific questions, to support national and international scientific assessments, and for use in developing environmental policy and impact response strategies. The strategy relies on:

- Operational and quasi-operational space-based systems to meet global change monitoring requirements for continuous stable global measurements of key variables;
- National and international surface-based networks for reference in situ measurements to provide information on important quantities including those not directly measurable by remote sensing from space (e.g., sub-surface ocean variables), as well as for satellite calibration;
- Support of Earth System Science Pathfinders (ESSP) missions for discovery and innovative studies of global change physical, chemical, and biological processes;
- Integration of space-based and in situ components with the goal of defining an optimal observing system;
- Coordination of national and international field measurement campaigns in support of process-oriented research, as planned and implemented within the principal scientific themes of the USGCRP; and
- Initiation of planning of EOS-second phase mission concepts for systematic global change measurement missions; addressing the gap between EOS in general and particularly EOS PM-1, EOS-CHEM and NPOESS.

The Observations and Monitoring Program supports all of the USGCRP key global change environmental science issue areas, including climate variability and change, changes in ozone, UV radiation, and atmospheric chemistry, and changes in land cover and ecosystems. (see Appendix for listing and discussion of recent accomplishments in these areas). The program has numerous mechanisms for interagency and international coordination, and numerous collaborative interagency efforts, including interagency coordinated data sets, coordinated field campaigns and experiments, and coordinated global observing in situ reference networks. The USGCRP is substantially involved in international scientific programs, networks, projects, and coordinating groups, through both research and efforts related to verification of international conventions and protocols (see Appendix for listing and descriptions).

Scientific, Technical, and Programmatic Issues and Challenges

The existing operational and experimental observing system is powerful and already provides a large part of the needed observations. However, it needs fine tuning and further expansion (e.g., meeting the need for operational ocean observations). New observations are required to better understand important global change processes (e.g., cloud and aerosol microphysics, carbon cycle, mid- and deep- ocean circulation, the hydrological cycle, climate feedbacks). Ensuring a role for the scientific community in prioritizing scientific requirements, planning observational strategies, and evaluating new techniques for integration into future observing systems is crucial to the success of the program.

Examples of key issues that must be addressed by the USGCRP include:

- Degradation in operational networks.
- Examples of USGCRP-essential measurements in jeopardy due to lack of investment in maintenance and upgrading of such networks include:
 - Upper Air radiosonde/rainsonde network
 - Surface climate stations
 - NOAAs capability to monitor decadal to centennial changes in temperature and precipitation is at risk.
 - NOAAs capability to monitor precipitation to serve the general community on a short-term basis and to assess long term variability in precipitation over North America is at risk of major loss in capability.
- Similar degradations are reportedly occurring with the in-situ networks of other (than NOAA) agencies to observe key variables such as river flow/stage, etc. due to budget reductions. International coordination and data exchange is seriously lacking for in-situ observations.
- Upgrading existing operational in-situ and satellite observation and data systems to meet scientific measurement requirements for long-term continuity, absolute calibration, and stability of measurements and value-added products.
- Institutionalizing mechanisms for transfer of high priority experimental observational capabilities to operational programs. Ensuring the stability and improvement of the operational space- and ground-based observing systems is critical to meeting USGCRP science objectives. However, no federal agency is chartered with responsibilities for the transition of research measurements into operational status, nor does any interagency mechanism exist for implementation. This matter is further exacerbated by the fact that virtually no space-based or ground-based operational observing systems are accountable to the USGCRP.
- Maintaining long-term measurement continuity and data quality.
- Meeting the scientific requirements for calibration and validation of measurements.
- Striving to establish a more effective process for coordinating interagency planning and program implementation.
- Streamlining the interaction with NRC in order to balance advice to the USGCRP vs. specific advice to the individual federal agencies.
- Addressing the Carbon Cycle/Carbon Budget and Ecosystems Impacts issues.

Measurements of various components of the carbon cycle and carbon budget are embedded in the thematic areas of the USGCRP. The recent and next generation of space-based technology will substantially improve these estimates on a global basis--there is no simple alternative. However, considerable improvements are also required in in-situ measurements and the coordination of the international data exchange for these measurements. The same is true for observations of ecosystem changes and impacts of global climate change. That is, satellite technology provides the only means by which the global planetary domain can be observed. But extensive in-situ observations are also required on a long-term basis.

Systems for the measurement and international data exchange pertaining to global ecosystems and/or carbon do not presently exist. They need to be established through coordination and funding via the UN system of agencies and thereby member countries. U.S. leadership is needed. We are equally familiar with the complexity of the scientific subject and the international negotiations and processes required to quantitatively and definitively address this important issue. SIMBIOS is an excellent model.

Performance Measures FY2000

Seasonal-to-Interannual Climate Variability

Continue improvements in a data assimilation system to make it state-of-art for assimilating all kinds of atmospheric and land surface data with a focus on the use of existing and new satellite data. Prepare the system for assimilation of EOS-PM satellite data when it is launched. Add the assimilation of ocean surface data to the assimilation system. The goals remain the same.

In collabora

tion with the EOS MODIS and MISR instrument science teams, conduct measurements of the production and radiative properties of aerosols produced by biomass burning in Africa. This field experiment will be similar to a field experiment previously conducted in Brazil (SCAR-B). The field experiment is identified as SAFARI 2000 and includes extensive international collaboration. It is estimated that biomass burning in Africa contributes about one half of the global amount.

C

ombining TRMM measurements with rainfall measurements from other sources will allow us to set a benchmark for rainfall in the tropics. We will obtain maps of diurnal cycle of precipitation (which cannot be obtained from sun-synchronous sensors). The insight gained from this exercise will be used to reprocess 10 years of SSM/I data for climate record. This 10-year data set and ongoing TRMM measurements will be used to validate climate models as well as demonstrate the impact of rainfall in assimilation and weather forecast schemes.

Launch of joint

NASA-CNES Jason-1 satellite altimetry mission. This follow-on to TOPEX/Poseidon aims to achieve 1 cm level accuracy in measuring ocean basin-scale sea level variability. This capability is one order of magnitude better than that specified for TOPEX/Poseidon. This will be accomplished by a mission planning time, cost, spacecraft weight and size less than half that of TOPEX/Poseidon.

First bas

in-scale high resolution estimate of the state of the Pacific Ocean as part of NASA Ocean Data Assimilation Project. This is part of an international Global Ocean Data Assimilation Experiment (GODAE) planned for 2003-2005. The project will demonstrate capabilities in ocean state estimation and its application to climate, coastal zone management, and interdisciplinary science problems in the Pacific basin.

Climate Change over Decades to Centuries

Atmospheric Radiation

Measurement program (ARM): (1) ARM will complete tropical warm pool characterization in order to improve GCM performance in representing radiative and cloud processes in and around the tropical warm pool; (2) ARM will apply newly available solar radiation measurements taken with high resolution and banded spectrometric instruments to modeling atmospheric shortwave radiation, with an improvement in the error bars of shortwave models by about 50%; (3) ARM will develop the relationships between cloud formation processes and bulk cloud/atmospheric characteristics through detailed in-situ measurements and routine application of retrieval algorithms and will determine the level of cloud microphysics that must be included to adequately simulate the behavior of clouds (and associated radiative microphysics) in GCMs; (4) The ARM coordinated GVAP network will implement new techniques for measuring water vapor that improve error bars by 50%; (5)

The ARM Program will develop unique experience in how to evaluate GCM parameterizations through the use of observations and single-column models. Advances in understanding gained from such evaluations will improve how well atmospheric processes are represented in the GCMs.

Analysis of the CERES measurements to achieve

ieve a further reduction in the uncertainty in the determination of top-of-the-atmosphere radiative fluxes through the integration of measurements provided by the CERES instruments on the TRMM satellite and the EOS-AM satellite. FY2000 analyses will be performed on TRMM and more complete EOS-AM1 data.

Publish first

detailed estimates of thickening/thinning rates for all the major ice-drainage basins of the Greenland ice sheet, derived from repeated airborne laser-altimetry surveys. These measurements also represent a baseline data set for comparison with early measurements by the EOS Geoscience Laser Altimeter System (GLAS), to be launched in July 2001. Initiate a program of airborne mapping of layers within the Greenland ice sheet.

NASA, in collaboration with the Canadian Space

Agency, will acquire a second set of high-resolution radar data over all of Antarctica for comparison with the baseline data set acquired in 1997, in order to identify changes on the ice sheet. Emphasis for this second mapping will be aquisition of data suitable for interferometric analysis, with timing of the survey coincident with acquisition of early GLAS data.

Demonstrate capability to

remotely sense surface salinity at the 0.1 PSU level from aircraft. After init

ial demonstrations in FY99, instrument development and modeling activity will bring measurement accuracies to desired level - one order of magnitude better than in FY98. Aircraft demonstration is considered proof of concept that will lead to satellite-borne sensors specifically designed to resolve salinity signals from orbital altitude.

Changes in Ozone, UV Radiation and Atmospheric Chemistry

Implementation of the SAGE III Ozone Loss and Validation Experiment (SOLVE). Measurements will be made during the time frame of October 1999 - March 2000 in the Arctic and high-latitude region in winter using the NASA DC8 and ER2 aircraft, as well as balloon platforms. The mission will also acquire correlative data needed to validate the Stratospheric Aerosol and Gas Experiment (SAGE) II satellite measurements that will be used to quantitatively assess high-latitude ozone loss.

Complete the analysis and publication of the PEM-Tropics-B field experiment and will complete the next phases of the instrument size and weight reduction initiative, applying it to the last remaining large payload. A major new mission to be conducted in 2001 over three western Pacific to study the transport and evolution of the Asian pollution plume will be planned.

Launch TOMS

/SAGE Meteor-3M Mission: The next instrument in the series of Total Ozone Mapping Spectrometer (TOMS) instruments is scheduled for launch in 2000 aboard a Russian Meteor-3M spacecraft; SAGE in 1999. This will continue the series of TOMS and SAGE measurements of ozone, sulfur dioxide, surface UV radiation, and tropospheric aerosol loading made with the Nimbus 7 (1978-1993), Meteor-3 (1991-1994), Earth Probe (1996-present), and ADEOS (1996-1997) TOMS instruments. This will also lead to a first ever climatology of vertical profiles of NO₃ and OClO made by SAGE using lunar occultation techniques.

Continued monitoring and assessment

ent of the impact of the Montreal Protocol and the Framework Convention on Climate Change with globally distributed measurements of the surface level concentrations of long-lived trace gases regulated under the Montreal Protocol, and other biogenically-produced gases such as methane and nitrous oxide. (based on NASA AGAGE, NOAA/CMDL flask sampling network). Concentrations of total atmospheric burden of halogen breakdown products will be measured by the Network for Detecting of Stratospheric Change.

Complete acquisition of first ever global climatology

atology of vertical profiles of carbon monoxide (CO) to improve knowledge of its surface sources, photochemical destruction, and how it is transported by tropospheric wind systems (based on first year of MOPITT data).

Carry out detailed

process-oriented aircraft measurements of the chemistry of the high latitude stratosphere in winter using the DC-8 and ER-2, as well as balloons; obtain correlative data for SAGE III concurrently in unified mission.

Carry out detailed process-oriented aircraft missions

of the chemistry of the remote Tropical Pacific troposphere, focusing on chemical contributions to this otherwise unpolluted area from human activities (industrial pollution, biomass burning) taking place long distances away (Asia, South America, etc.).

Changes in Land-Cover and in Terrestrial and Marine Ecosystems

First National Assessment of the Potential

Consequences of Climate Variability and Change will be completed. This will include production of the climate scenario information, support of the National Synthesis, several of the regional analyses, and supporting research for several sectoral studies.

Near-real-time fire monitoring will be coupled with the Landsat-based and EOS-based inventory and process monitoring

to provide an observational foundation for monitoring changes in ecosystem productivity and disturbance.

SIMBIOS will merge MODIS ocean color data into the global ocean color time series, which began with OCTS and SeaWiFS. Multi-year time series of ocean color data will be used to understand and predict the response of marine ecosystems to climate change.

Response to NRC Pathways Report Recommendations

The Pathways

Overview makes several recommendations pertaining to the need for a coherent observational strategy, technical innovations, and data systems. These recommendations are being addressed as part of the USGCRP strategic planning process.

Briefly (see Appendix for fuller discussion):

Recommendation #3: The strategy

for obtaining long-term observations designed to define the magnitude and character of Earth system change must be reassessed.

Response: The need to identify

and obtain accurate data on key variables has been well recognized and reiterated many times over the years. To the extent technologically possible all key variables are either measured or plans are in progress to attempt accomplishing this. More focused reviews of requirements have been recently initiated to select those parameters that are critical as well as technologically viable under the research programs of the USGCRP.

Long-term accuracy and continuity: The

USGCRP recognizes that operational needs must inevitably drive operational systems a priority underestimated by the NRC. Nevertheless, there is a need to realize the potential of operational observing and data management systems for long-term monitoring for documenting climate change. We must maintain continuity, access, and funded analysis of operational data and ensure that the intellectual resources for analysis exist. We need to maintain a balance between data collection, data analysis, and incorporation into models. There will be and should be gaps between research and operational systems. Proven and tested research systems that are operationally required (for other purposes than fundamental research) have been gradually transitioned to operational systems. The USGCRP recognizes the need for a mechanism to facilitate this transition and proposes institutional structure to accomplish the same.

The scientific community still needs

to organize the means to extract the widest possible range of scientific information from the multiplicity of data sources. In the NASA experience, Mission Science Teams have provided oversight for instrument development and analysis. This would be a good model for the climate observations issue.

Recommendation

#4: The restructured national strategy for Earth observations must more aggressively employ technical innovation.

Response: The USGCRP recognizes the need

for relying on complementary space-based and in situ measurements, as well as the need for opportunities for incorporating new technology. Many climate processes require improved satellite sensor technology and carefully instrumented in situ-based networks and studies to advance understanding within the constraints and mandate of individual agency programs. The best available microelectronics and materials will be used, as also robotics and the like.

The USGCRP 10-year

observations strategy will highlight opportunities for further development of instrumentation for land- and ocean-based instrumentation. It must be recognized, however, that most in-situ operational systems are not explicitly accounted for within the USGCRP budget. Instead, they form the backbone operational systems of various national and international agencies. These operational systems make an essential contribution over a broad range of USGCRP research activities, even if not identified as line-item program elements in the GCRP budget. Thus, the balance between space-based systems and in-situ systems as reflected in the USGCRP budget is somewhat artificial. The USGCRP plans to review the adequacy of existing and planned operational systems from the standpoint of global change research, and develop specific recommendations for the protection or enhancement of selected systems and networks, as well as the establishment of a carefully selected network of reference or baseline stations and observing platforms.

Recommendation #5: The USGCRP must revitalize its strategy for the data systems used for global change research.

Response: The USGCRP will ensure maintenance

of short-term active archives and long-term repositories for global change data. The importance of integrating scientific oversight into data management functions is recognized. The EOSDIS Federation concept places responsibilities for data curatorship on the science community to strengthen the capability for reprocessing and broaden utilization. It is critical that very long-term (exceeding generational life spans) maintenance of the data sets be ensured. It is not clear that the Federation concept alone will be able to achieve this. Decentralized data processing, analysis and data management on the short term for research and applications purposes will need to be buttressed with a cross-migration of key data sets to a centralized Federally funded system which would ensure permanent, and accessible, archives. The USGCRP Data Management Working Group will oversee the U.S. component of GCDIS and will provide pointers to all repository

sitories of critical data. An important issue is that data storage capabilities are not keeping up with needs (e.g. reanalysis products, assessments). These aspects will also be addressed by the USGCRP.

Global Change Data, Products, and Information Services

The goal of the data management component of the USGCRP is to provide all users with ready and affordable access in useful forms to the full spectrum of global change data, products, and information. The USGCRP data program and implementation plans have both been endorsed by OSTP, as has its "full and open" data access principles. Its planning has been coordinated with related efforts outside the USGCRP, e.g., the Federal Geographic Data Committee. The importance of the cooperation of agency programs that are outside the USGCRP but are needed by the USGCRP's focused programs cannot be overemphasized.

The data program's near-term performance measures have particular emphasis on filling program gaps and meeting newly developing imperatives while assuring that the data and information produced by the program are made readily available. In accord with NRC recommendations, these performance measures include giving increased emphasis to providing assurance for the long-term archiving of data, including data collected by the NASA Earth Observing System, and the wealth of data and information obtained from in situ observations.

Program Objectives

The data program has the following objectives:

Data Location Capability: tc "ADVANCE \d 6Objective 1\: Data Location Capability " \l 2tc "ADVANCE \d 6Objective 1\: Data Location Capability " \l 2Provide a coordinated means by which users can readily find the global change data, products, and information they need. C. Se
Significant progress has been made through GCDIS, an Internet-based Global Change Data and Information System. However, there are two major program gaps: data from past in situ observations and data obtained using federal funds that lack a requirement for unrestricted government use.

Data Access: tc "ADVANCE \d 6Objective 2\: Data Access " \l 2Ensure that the data, products, and information are quickly available and affordable.
The user finds no benefits in discovering data and information exists if they cannot be obtained in time to meet the user's needs or if it is not affordable.

Long-Term Data Availability: tc "ADVANCE \d 6Objective 3\: Long-Term Data Availability " \l 2Ensure that data, products, and information are documented, archived, and have long-term availability.
Without adequate attention to documenting and archiving data, such data are lost or rendered unusable to future users. This problem is being exacerbated by decreasing agency budgets for such work coupled with the increasing amounts of data.

Meet USGCRP Needs

RP Needs: tc "ADVANCE \d 6Objective 4\: Meet USGCRP Needs " \l 2Meet the specific data, product, and information needs of the scientific community for information needed to conduct USGCRP-related research, monitoring, and assessment activities.

As an integrated and coordinated program, the USGCRP depends upon the data, product, and information services component of the USGCRP to provide data sets and derived products needed to monitor the environment.

User Satisfaction

n: Be responsive to the data, product, and information needs identified by the user community and its representatives, including the education community.

The relationship with the National Academy of Sciences' Committee on Geophysical and Environmental Data as a representative of the scientific user community will be continued.

Coordination Outside USGCRP: tc "ADVANCE \d 6Objective 6\: Coordination Outside USGCRP " \l 2Coordinate global change data management activities with related activities being carried out nationally and internationally
The

data and information collected for understanding global change are part of the much larger amount of data and information being collected and used for other purposes.

Performance Measures

Data location capability:

Encourage programs

outside the USGCRP to initiate programs to locate, document, and make available in useful forms the data and information from in situ federal observations that relate to global change. An objective of completing this process in about 3-5 years for existing data should be established to guide agency budgeting.

Promote

the open availability of the global-change-related data produced by agency grant-type instruments to researchers and others by FY2000. The need for such a agency action is increasing with recent database protection efforts.

Data access

S:

Develop policy guidance to provide GCDIS working interfaces with private sector and other nongovernmental data, products, and information.

Develop a larger

number of GCDIS access points in other countries, particularly through CEOs.

Long-term data availability:

A special interagency effort is needed to provide

assurance that the critical global change research data sets are protected from loss as necessary.

Meet USGCRP needs:

Work with all the focused program elements

of the USGCRP to identify and produce (within available resources) the interagency data products they most need.

User satisfaction:

Further improve GCDIS

, including expanding its on-line user evaluation capability, links to commercial data producers, and increased number of data sets available. Success will be measured by the increase in GCDIS use.

Cooperate in having GCDIS evaluations by

the focused elements of the USGCRP.

Coordination outside USGCRP:

Strengthen

GCDIS links to international global observation programs and broaden application of a "full and open" data access policy.

National Assessment

Goal of the National

Assessment

The overall goal of the National Assessment is to analyze and evaluate what is known about the potential consequences of climate variability and change for the Nation in the context of other pressures on the public, the environment, and the Nations resources. The Assessment is being carried out under the auspices of the U.S. Global Change Research Program (USGCRP), which is mandated by statute with the responsibility to undertake scientific assessments of the potential consequences of global change. The Global Change Research Act of 1990 (P.L. 101-606) states that the Federal government shall prepare and submit to the President and the Congress an assessment which

Integrates, evaluates,

and interprets the findings of the Program and discusses the scientific uncertainties associated with such findings;

Analyzes the effects of global change

on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity; and

Analyzes current trends in global change, both

human-induced and natural, and projects major trends for the subsequent 25 to 100 years.

Implementation

Eighteen of 20 planned regional scoping workshops

have taken place as the first step in conducting regional assessments (the first workshop was held in May 1997; the final two will take place in September and October, 1998). These workshops have sought to engage regional stakeholders

in identifying questions and priorities for assessments in each region. All 20 regions where workshops are being held are invited to participate in the next phase of the assessment pending funding support. This next phase will involve quantitative analysis of 2-3 key issues and continuous cultivation of regional stakeholders.

Teams have also been organized for five sectoral assessments (water, health, agriculture, forests, coastal/marine), and a FACA-chartered Synthesis Team has been appointed to prepare the Synthesis Report to submit to Congress which will bring together regional and sectoral findings. Each of the sectors will be led by a pair of co-chairs one from government and one from outside of government.

The Synthesis Team is to provide overall intellectual oversight of the National Assessment and has specific responsibility for the Synthesis Report, for defining national scenarios, for providing advice and oversight of the sectoral analyses, and for recommending guidelines for the regional analysis templates. There are currently 10 members, including the co-chairs, although a couple more may be added in the near future.

Coordination Mechanisms and Collaborative Interagency Efforts

More than any other element of the USGCRP, assessment requires and is premised on interagency coordination. No one agency has the breadth to effectively deliver the information to address adequately the diversity of environmental issues being identified in the regions as important to their future sustainability.

The National Assessment is facilitated by federal sponsorship of different assessment elements: each region is sponsored by one or more federal agencies; each sector is sponsored by one federal agency; support of the Coordination Office (NACO) and individual Synthesis Team members is provided by different federal agencies. Federal participation in the National Assessment is coordinated by the SGCN National Assessment Working Group (NAWG).

The NAWG has broad responsibilities for federal participation in the design and conduct of the national effort, and specifically will:

- Provide advice and counsel to the National Assessment Synthesis Team as they develop the National Assessment Plan;
- Coordinate federal participation to implement the National Assessment Plan;
- Facilitate implementation of regional assessments, to ensure adherence to the guiding principles of the assessment process; the adoption and use of methodologies; and compliance with the process, schedule and timetable for delivery of products;
- Annually prepare a comprehensive plan for funding the National Assessment activities; and
- Identify federal R&D and monitoring programs that are required for or contribute to assessments.

Opportunities for improvement include the challenge to foster and promote a true public-private partnership in the end-to-end process, including prioritization, funding, conduct, and delivery of science.

Performance Measures

The timetable for this phase of the National Assessment is driven primarily by the deadline for the Synthesis Report of January 1, 2000. Most regional and sectoral reports will be ready to enter their review process in the fall of 1999, and will be available at the time the Synthesis Report is released. Some will be on a delayed timetable and will be published a few months later in the year 2000. However, they will still have opportunities to provide information into the Synthesis Report.

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===== END ATTACHMENT

6

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Subcommittee on Global Change Research
Budget by Agency
Total Dollars in Millions

DOC	Program Title	FY98	FY99	FY00
NIST	Global Change	2.4	9.4	
NOAA	Aerosols	1.1	1.1	
NOAA	Atmospheric Chemistry Project	6.8	7.0	
NOAA	Climate Change Data & Detection	4.0	4.1	
NOAA	Climate Dynamics & Experimental Prediction	15.6	16.1	
NOAA	Climate Observations	6.1	6.4	
NOAA	Climate Variability (CLIVAR-GOALS, ACCP/WOCE)	10.6	11.0	
NOAA	Economics and Human Dimensions of Climate Fluctuations	1.8	1.9	
NOAA	Global Energy and Water Cycle Experiment (GEWEX)	5.2	5.4	
NOAA	Health of the Atmosphere*	0.7	0.7	
NOAA	Ocean-Atmosphere Carbon Exchange Study (OACES/JGOI)	4.1	4.2	
NOAA	Paleoclimatology (PAGES)	4.0	4.1	
	NOAA Sub-Total	60.0	62.0	
	DOC TOTAL	62.4		
	President's Request	62.3	71.4	

* Not formally part of the NOAA Climate and Global Change Program.
Funding is transferred to the NOAA Health of the Atmosphere Program.

Subcommittee on Global Change Research
Budget by Agency
Total Dollars in Millions

DOD	Program Title	FY98	FY99 Request	FY00
ONR	Boundary Layer Dynamics/Marine Aerosols	1.0	1.0	
ONR	Boundary Layer Dynamics/Ocean Ecological Dynamics	0.0	0.0	
ONR	High Latitude Dynamics/Arctic Acoustic Prop.	0.0	0.0	
ONR	High Latitude Dynamics/Arctic Ice Dynamics	0.5	0.5	
ONR	High Latitude Dynamics/Arctic Marine Sediments	0.0	0.0	
ONR	High Latitude Dynamics/SCICEX Submarine Data Collectior	0.7	1.0	
ONR	Ocean Measurements/Coastal Remote Sensing	1.0	2.0	
ONR	Ocean Measurements/MEDEA Data Declassification	0.8	0.0	
ONR	Ocean Measurements/North Pacific Acoustic Lab	1.0	0.5	
CRREL	Regional Resolving Models/Coupled Hydrologic & Thermal I	0.0	0.2	
ONR	Regional Resolving Models/Coupled Ocean-Atmosphere Mc	1.5	1.5	
	DOD Total	6.5		
	President's Request	5.7	6.7	
* Funded above FY98 Budget Request				

Subcommittee on Global Change Research
 Budget by Agency
 Total Dollars in Millions

DOE	Program Title	FY98	FY99 Request	FY00
	OBER Atmospheric Chemistry & Carbon Cycle	20.7	24.9	not availat
	OBER Climate & Hydrology	63.1	64.1	not availat
	OBER Ecological Processes	13.1	12.0	not availat
	OBER Human Interactions	8.9	9.2	not availat
	OBER SBIR/STTR		3.0	not availat
	DOE Total	105.8		
	President's Request	110.1	113.2	not availat

Subcommittee on Global Change Research
 Budget by Agency
 Total Dollars in Millions

DOI	Program Title	FY98	FY99 Request	FY00
	USGS Global Change Research	29.2	29.2	29.2
	DOI TOTAL	29.2		
	President's Request	28.5	29.2	29.2

Subcommittee on Global Change Research
 Budget by Agency
 Total Dollars in Millions

EPA	Program Title	FY98	FY99 Request	FY00
ORD	Assessment of Consequences	2.8	7.5	
ORD	Developing Predictive Models	0.0	0.0	
ORD	Ecosystem Services	4.8	6.0	
ORD	Indicators of Change	6.0	7.0	
ORD	Integrated Assessment Research	0.0	0.0	
ORD	Regional Vulnerabilities	1.0	0.0	
ORD	Stratospheric Ozone Depletion	0.0	0.0	
	EPA TOTAL	14.6		
	President's Request	21.1	20.5	

Subcommittee on Global Change Research
 Budget by Agency
 Total Dollars in Millions

HHS	Program Title	FY98	FY99 Request	FY00
	NIEHS Human Health Effects of Exposure to UV Radiation	4.3	4.5	4.8
	HHS Total	4.3		
	President's Request	4.3	4.5	4.8

Automated Records Management System
 Hex-Dump Conversion

Subcommittee on Global Change Research
Budget by Agency
Total Dollars in Millions

NASA	Program Title	FY98	FY99 Request	FY00
ES	Airborne Science Program	20.7	20.1	21.4
ES	Applications Research Program	21.6	4.6	4.6
ES	Atmospheric Chemical Modeling	6.5	6.5	6.5
ES	Atmospheric Dynamics & Remote Sensing	5.3	5.3	5.3
ES	Biological Oceanography	4.8	4.8	4.8
ES	Ecological Processes	16.4	16.4	16.4
ES	EOS Science	41.4	40.9	76.0
ES	Geodynamics and Geopotential Fields	13.6	13.6	13.6
ES	Geology	5.3	5.3	5.3
ES	Global Data Integration & Validation	3.8	3.8	3.8
ES	Global Modeling and Analysis Program	6.2	6.2	6.2
ES	GLOBE	5.0	5.0	5.0
ES	Interdisciplinary Research and Analysis	20.4	29.2	35.4
ES	Land Cover and Use Change	6.3	6.3	6.3
ES	Land Surface Hydrology	5.1	5.1	5.1
ES	Mission Analysis Program	40.0	42.0	38.8
ES	Natural Hazards Program	4.3	4.3	4.3
ES	Ocean Color Data Purchase/Sea WIFS	2.5	2.5	2.5
ES	Pathfinder Science Studies	3.4	3.5	3.5
ES	Physical Oceanography & Ocean Modeling	7.5	7.5	7.5
ES	Polar Programs	6.5	5.5	5.5
ES	Radiation Science Program	9.7	7.7	7.7
ES	Stratospheric Chemistry	17.2	17.2	17.2
ES	Tropical Rainfall Measurement Science	0.4	0.0	0.0
ES	Tropospheric Chemistry	8.8	9.8	10.8
ES	UAV Science	1.9	2.0	5.0
*Includes Congressional Add-on				
	NASA Global Change Science Program	284.6	275.1	318.5

Subcommittee on Global Change Research
Budget by Agency
Total Dollars in Millions

ES	Advanced Geostationary Studies	3.0	0.0	0.0
ES	Commerical Remote Sensing	21.5	24.8	25.9
ES	Earth Systems Science Pathfinder	22.8	70.0	85.4
ES	EOS Data and Information Systems (EOSDIS)	210.1	256.6	247.9
ES	EOS Flight Development	583.5	505.0	522.2
ES	EOS Special Spacecraft	96.7	152.1	178.8
ES	HPCC Earth Remote Sensing	18.3	14.5	21.9
ES	Information Systems	4.3	6.1	6.4
ES	LANDSAT	74.3	2.0	1.5
ES	Launch Services	39.4	0.0	0.0
ES	Lewis & Clark Land Imaging Spacecraft	1.4	5.0	0.0
ES	Light SAR	0.0	5.0	20.0
ES	Mission Operations	47.0	49.9	55.6
ES	Payloads and Instrument Development	3.5	1.0	3.0
ES	Total Ozone Mapping (TOMS)	6.0	4.9	4.9
ES	Tropical Rainfall Measurement TRMM	0.9	0.0	0.0
	NASA Global Change Hardware Development	1132.7	1096.9	1173.5
	NASA Total	1417.3		
	President's Request	1417.3	1372.0	1492.0

Subcommittee on Global Change Research
Budget by Agency
Total Dollars in Millions

NSF	Program Title	FY98	FY99 Request	FY00
	Antarctic Ecosystems	1.0	1.0	
	Arctic System Science (ARCSS)	15.2	16.0	
	Climate Modeling, Analysis & Prediction (CMAP)	12.0	13.4	
	Climate Variability and Predictability (CLIVAR)	11.0	13.2	
	Coastal Long-Term Ecological Research (LTER/LMER)	2.2	2.4	
	Earth System History	11.2	14.1	
	Ecol Diversity	5.0	6.7	
	Ecological Rates of Change (EROC)	3.2	3.2	
	Geodata	1.8	2.2	
	Global Ocean Ecosystems Dynamics (GLOBEC)	10.0	12.3	
	Global Tropospheric Chemistry Program (GTCP)	12.8	14.3	
	Greenhouse Gas Dynamics (GGD)	0.2	0.2	
	Human Dimensions of Global Change	12.1	14.3	
	Joint Global Ocean Flux Study	17.2	15.6	
	Methods and Models for Integrated Assessment	3.4	3.4	
	Ocean Observation, Data Assimilation, and Modeling (OOD,	-	4.6	
	Polar Ozone Depletion/UV Radiation Effects	4.2	4.2	
	Regional Research Institutes	3.2	3.4	
	Ridge Interdisciplinary Global Experiments (RIDGE)	3.3	3.3	
	Sea Level Changes	5.8	5.9	
	Solar Influences	6.8	7.7	
	Water & Energy: Atmospheric, Vegetative & Earth Interactio	8.8	10.2	
	World Ocean Circulation Experiment (WOCE)	16.8	15.8	
	NSF Total	167.2		
	President's Request	170.0	187.4	

Subcommittee on Global Change Research
Budget by Agency
Total Dollars in Millions

SI	Program Title	FY98	FY99 Request	FY00
	NMNH Long-Term Environmental Change	1.6	1.6	1.6
	SAO, I Monitoring Natural Environmental Change	1.2	1.2	1.2
	NZP, I Biological Responses	4.2	4.2	4.2
	SI Total	7.0		
	President's Request	7.0	7.0	7.0

*Automated Records Management System
Hex-Dump Conversion*

Subcommittee on Global Change Research
 Budget by Agency
 Total Dollars in Millions

USDA	Program Title	FY98	FY99	FY00
		Estimate	Request	
ARS	Agriculture and Rangeland Global Change	12.1	11.3	
ERS	Economics of Global Change and Agriculture	0.8	0.8	
FS	Forest Global Change	16.9	16.9	
CSREI	Improved Response Models	10.6	10.6	
ARS	Methyl Bromide Research	14.9	16.6	
NRCS	Soil Carbon Studies	1.2	1.2	
CSREI	UV-B Monitoring Network	1.0	1.6	
	USDA Total	57.5		
	President's Request	62.1	59.0	

RECORD TYPE: FEDERAL (TRP NOTES MAIL)

CREATOR: gdavis (gdavis@nesdis.noaa.gov@INET@LNGTWY [UNKNOWN])

CREATION DATE/TIME:14-SEP-1998 14:01:00.00

SUBJECT: Fwd: Addiional Questions from POPs

TO: Lisa A. Gaisford (Lisa A. Gaisford@eop [UNKNOWN])

READ:UNKNOWN

TEXT:

got 'em

>X-Sender: gdavis@nesdis.noaa.gov

>Date: Mon, 14 Sep 1998 14:02:54 -0400

>To: gdavis@nesdis.noaa.gov

>From: gary davis <gdavis@nesdis.noaa.gov>

>Subject: Fwd: Addiional Questions from POPs

>

>>From: Lisa_A._Gaisford@omb.eop.gov

>>X-Lotus-Fromdomain: EOP

>>To: gwithhee@nesdis.noaa.gov, gwithhee@nesdis.noaa.gov,

Gary.Davis@noaa.gov,

>> Doug.Namian@noaa.gov, Margaret.Eckard@noaa.gov,

>Steve.Kirkner@noaa.gov,

>> Wilfred.E.Mazur@noaa.gov

>>Cc: cmurray@doc.gov

>>Date: Mon, 14 Sep 1998 13:29:55 -0400

>>Subject: Addiional Questions from POPs

>>

>>After quickly reviewing the POPS, here are the additional questions that

I

>>have.

>>

>>Also, does NOAA/IPO receive anything comparable from the USAF for NPOESS
as

>>NESDIS receives from NASA for POPs?

>>

>>Please send me a clearance list by COB Wednesday for our Friday meeting.

>>Thanks

>>

>>POES:

>>

>>On p.2 of cover letter, NASA states that FY 2000 requirements for POES
have

>>increased by \$14.9M of which \$9.6M is for scope changes. What is driving
>>these scope changes and when was the decision made to go forward on
them?

>>

>>On p.1 of cover letter, NASA states that FY 1998 forward funding was
>>reduced to 30 days because NOAA chose to withhold \$5M. NOAA reallocated
>>funds in both the POES and GOES programs for many things including
>>"management contingency". NOAA management have stated their preference
for

>>consistent 60 day forward funding. Please explain the lower priority
>>placed on the 60 days relative to other needs in NESDIS? Will forward
>>funding continue to be used as a flexible tool to create surplus funds
for

>>reallocation?

>>

>>GOES:

>>Why have GOES I-M spacecraft requirements increased by \$14M over 00-01?

>>

>>Why was NOAA's guidance to NASA \$31M for FY 2000 spacecraft funding when

>>the DOC passback provided \$20M for this year?

>>

>>POP 98-02 shows that the third and fourth SXI options "will not be

>>exercised due to lack of funding". When was this decision made? Whose

>>lack of funding, USAF or NOAA, is driving the reduction? It appears as

if

>>NOAA is funding two SXIs and USAF is now funding none.

>>

>>The SAO GOES crosswalk attributes \$189M in additional funding for FY

00-CTC

>>to Dr. Baker's 5/1/98 decision to accelerate an advanced imager and

sounder

>>from GOES R to GOES P. How are these instruments different from the

>>current instruments? What operational improvements can be expected?

>>Please provide a break-out of these costs for recurring vs. non-recurring

>>requirements. It appears that four units of the existing imager and

>>sounder are being funded in the ITT contract -- does this mean that five

>>sets of instruments are being procured for GOES N-Q? Would the current

>>Hughes spacecraft design for GOES N and O accommodate the technical

>>requirements of these advanced instruments or would modifications be

>>required? If it appears that modifications are required is this

indicative

>>of NOAA not planning to exercise the Hughes contract options?

>>

>

>===== ATTACHMENT 1 =====
ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:

RFC-822-headers:

Received: from conversion.pmdf.eop.gov by PMDF.EOP.GOV (PMDF V5.1-9 #29131)
id <01J1SS90YQ4G007RTI@PMDF.EOP.GOV> for GAISFORD_L@a1.eop.gov; Mon,
14 Sep 1998 14:04:14 EDT

Received: from Storm.EOP.GOV by PMDF.EOP.GOV (PMDF V5.1-9 #29131)
with ESMTTP id <01J1SS8YQM8W006U91@PMDF.EOP.GOV> for GAISFORD_L@a1.eop.gov;

Mon, 14 Sep 1998 14:04:11 -0400 (EDT)
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by STORM.EOP.GOV (PMDF V5.1-12 #29131)
with ESMTTP id <01J1SS8MQI1U0017PM@STORM.EOP.GOV> for GAISFORD_L@a1.eop.gov;
Mon, 14 Sep 1998 14:03:55 -0400 (EDT)
Received: from gdavis.nesdis.noaa.gov (gdavis.nesdis.noaa.gov [140.90.233.163])

by nes1.nesdis.noaa.gov (8.8.5/8.8.5) with SMTP id OAA13015 for
<GAISFORD_L@a1.eop.gov>; Mon, 14 Sep 1998 14:03:53 -0400 (EDT)
X-Sender: gdavis@nesdis.noaa.gov
X-Mailer: Windows Eudora Pro Version 3.0.1 (32)
===== END ATTACHMENT 1 =====

Withdrawal/Redaction Marker

Clinton Library

DOCUMENT NO. AND TYPE	SUBJECT/TITLE	DATE	RESTRICTION
001. email	Charlie Murray to Lisa Gaisford [partial] (1 page)	9/15/1998	P6/b(6)

COLLECTION:

Clinton Presidential Records
Automated Records Management System
Default ([National Polar-Orbiting Environmental Satellite System, NPOESS])
OA/Box Number: 1100000

FOLDER TITLE:

[10/27/1997 - 10/13/1998]

2008-0829-F

wr637

RESTRICTION CODES

Presidential Records Act - [44 U.S.C. 2204(a)]

- P1 National Security Classified Information [(a)(1) of the PRA]
- P2 Relating to the appointment to Federal office [(a)(2) of the PRA]
- P3 Release would violate a Federal statute [(a)(3) of the PRA]
- P4 Release would disclose trade secrets or confidential commercial or financial information [(a)(4) of the PRA]
- P5 Release would disclose confidential advice between the President and his advisors, or between such advisors [(a)(5) of the PRA]
- P6 Release would constitute a clearly unwarranted invasion of personal privacy [(a)(6) of the PRA]

C. Closed in accordance with restrictions contained in donor's deed of gift.

PRM. Personal record misfile defined in accordance with 44 U.S.C. 2201(3).

RR. Document will be reviewed upon request.

Freedom of Information Act - [5 U.S.C. 552(b)]

- b(1) National security classified information [(b)(1) of the FOIA]
- b(2) Release would disclose internal personnel rules and practices of an agency [(b)(2) of the FOIA]
- b(3) Release would violate a Federal statute [(b)(3) of the FOIA]
- b(4) Release would disclose trade secrets or confidential or financial information [(b)(4) of the FOIA]
- b(6) Release would constitute a clearly unwarranted invasion of personal privacy [(b)(6) of the FOIA]
- b(7) Release would disclose information compiled for law enforcement purposes [(b)(7) of the FOIA]
- b(8) Release would disclose information concerning the regulation of financial institutions [(b)(8) of the FOIA]
- b(9) Release would disclose geological or geophysical information concerning wells [(b)(9) of the FOIA]

RECORD TYPE: FEDERAL (TRP NOTES MAIL)

CREATOR: Charlie Murray (Charlie Murray@4-BEP@5-OSEC PBE@3-GOV+COMM.BAN@2-ATTMAIL@1-US@MRX@LNGTWY [UNKNOWN])

CREATION DATE/TIME:15-SEP-1998 11:06:00.00

SUBJECT: fwd: POES, GOES & NPOESS Briefings to OMB

TO: Lisa A. Gaisford (Lisa A. Gaisford@eop [UNKNOWN])

READ:UNKNOWN

TEXT:

me too! (b)(6)

Original Text

From: Kathy Adams@Budget@OFA, on 9/14/98 11:07 AM:

To: Barry S. Meyer@Budget@OFA, Charlie Murray@BEP@OSEC PBE

Cc: Paul F. Roberts@Dir@OFA

Both Barry Meyer and I will be attending the POES, GOES, and NPOESS briefings at OMB.

Below is the required information to gain entry into OMB:

Barry Meyer, DOB: (b)(6) SSN: (b)(6)

Kathy Adams, DOB: (b)(6) SSN: (b)(6)

POES & GOES

Friday, September 18, 1998

1:00 - 4:00 pm

NEOB

NPOESS

Wednesday, September 23, 1998 (Tentative)

3:00-5:00

White House Conference Center, Eisenhower room

I'm not sure if Paul Roberts will be attending I have left a message with his secretary. If Paul does attend his information will be forwarded directly to you by his secretary.

RECORD TYPE: FEDERAL (TRP NOTES MAIL)

CREATOR: Charlie Murray (Charlie Murray@4=BEP@5=OSEC PBE@3=GOV+COMM.BAN@2=ATTMAIL@1=US@MRX@LNGTWY [UNKNOWN])

CREATION DATE/TIME:22-SEP-1998 12:36:00.00

SUBJECT: NPOESS Hearing at OMB

TO: Lisa A. Gaisford (Lisa A. Gaisford@eop [UNKNOWN])
READ:UNKNOWN

TEXT:
Greg,

Forgot to ask you about the briefing package for the meeting tomorrow. I would like to get a copy (draft if necessary) today so I can clear it by tomorrow morning. Could you let me know if this is going to be a problem?

THANKS!

CM

RECORD TYPE: FEDERAL (TRP NOTES MAIL)

CREATOR: Charlie Murray (Charlie Murray@4=BEP@5=OSEC PBE@3=GOV+COMM.BAN@2=ATTMAIL@1=US@MRX@LNGTWY [UNKNOWN])

CREATION DATE/TIME:22-SEP-1998 12:40:00.00

SUBJECT: fwd: Address for NPOESS Hearing

TO: Lisa A. Gaisford (Lisa A. Gaisford@eop [UNKNOWN])
READ:UNKNOWN

TEXT:
fyi

Original Text

From: Charlie Murray@BEP@OSEC PBE, on 9/21/98 3:05 PM:

To: James Smith@MHub@NESDIS

Jim:

726 Jackson place - adjacent to Lafayette Park. When will I get a copy of
the briefing package to clear?

CM

RECORD TYPE: FEDERAL (TRP NOTES MAIL)

CREATOR: Charlie Murray (Charlie Murray@4=BEP@5=OSEC PBE@3=GOV+COMM.BAN@2=ATTMAIL@1=US@MRX@LNGTWY [UNKNOWN])

CREATION DATE/TIME:25-SEP-1998 12:28:00.00

SUBJECT: fwd:

TO: Lisa A. Gaisford (Lisa A. Gaisford@eop [UNKNOWN])
READ:UNKNOWN

TEXT:
fyi

Original Text

From: Karen A. Swanson-Woolf@LA@NOAA, on 9/25/98 12:12 PM:

To: Brian Wheeler@LA@NOAA, Scott B. Gudes@UnSec@NOAA, Susan B.

Fruchter@UnSec@NOAA

Cc: Charlie Murray@BEP@OSEC PBE, Doug Namian@MB@E, Paul F.

Roberts@Dir@OFA,

Robert Winokure@MHub@NESDIS

The Defense Appropriations Subcommittee completed its conference on Sept,

23. NPOESS remains at \$64,732 million.

RECORD TYPE: FEDERAL (TRP NOTES MAIL)

CREATOR: bakerc (bakerc@osd.pentagon.mil@INET@LNGTWY [UNKNOWN])

CREATION DATE/TIME:28-SEP-1998 08:30:00.00

SUBJECT: NPOESS

TO: SARAH A. LASKIN (SARAH A. LASKIN@EOP [UNKNOWN])

READ:UNKNOWN

TEXT:

I have heard that a lot of high level visits and phone calls between DoC and DoD are taking place as the result of the NPOESS hearing last week. They seem to be wanting to call an Ex Com ASAP to reverse the DoC budget changes. I am advising folks on this end that the Air Force's unilateral slip of the DMSP launches from a 50 percent need date to a 90 percent need date has as much an impact on NPOESS as does the DoC budget cut. Both Departments share the blame (sic). What we need to do now is to stop the Ex Com from stirring up the Deputy Secretaries and the OMB senior leadership before we have had a chance to analyze the facts of the case.

Charlie Baker (703) 697-1445

bakerc@osd.pentagon.mil

===== ATTACHMENT 1 =====
ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:

RFC-822-headers:

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id <01J2C0URNQSW00AKLM@PMDF.EOP.GOV> for Laskin_S@a1.eop.gov; Mon,
28 Sep 1998 08:35:53 EDT

Received: from Storm.EOP.GOV by PMDF.EOP.GOV (PMDF V5.1-9 #29131)
with ESMTP id <01J2C0UOWM4G00DEBS@PMDF.EOP.GOV> for Laskin_S@a1.eop.gov; Mon,

28 Sep 1998 08:35:49 -0400 (EDT)
Received: from dddc001.osd.mil ([134.152.184.11])
by STORM.EOP.GOV (PMDF V5.1-12 #29131)
with ESMTP id <01J2C0U0EPB200123D@STORM.EOP.GOV> for Laskin_S@a1.eop.gov; Mon,

28 Sep 1998 08:35:16 -0400 (EDT)
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id <TT9QG1KZ>; Mon, 28 Sep 1998 08:24:35 -0400
X-Mailer: Internet Mail Service (5.5.2232.9)

===== END ATTACHMENT 1 =====

RECORD TYPE: FEDERAL (TRP NOTES MAIL)

CREATOR: bakerc (bakerc@osd.pentagon.mil@INET@LNGTWY [UNKNOWN])

CREATION DATE/TIME:29-SEP-1998 08:35:00.00

SUBJECT: Re: NPOESS

TO: SARAH A. LASKIN (SARAH A. LASKIN@EOP [UNKNOWN])
READ:UNKNOWN

TEXT:

Lisa, the problem is also over here in Air Force and in the Office of the Assistant Secretary of Defense for C3I. They want to rock the boat with Dr. Baker. I am telling them not to rock the boat until after we have had a chance to look at the program because they could make the political appointees look stupid if they start holding Ex Com meetings and making phone calls to Deputy Secretaries if it turns out that the adjustments make sense in light of DMSP launch schedules and overall Commerce budget constraints. Perhaps you, Sarah, Shannon, Charlie, and I should get together for an hour later this week to compare notes, because there are still some factual discrepancies that need to be settled.

Charlie Baker

-----Original Message-----

From: Lisa_A._Gaisford@omb.eop.gov [mailto:Lisa_A._Gaisford@omb.eop.gov]

Sent: Monday, September 28, 1998 22:26

To: Baker, Charlie, , OUSDC

Cc: Shannon_Stuart@omb.eop.gov; cmurray@doc.gov

Subject: Re: NPOESS

Thank you for the information! I spoke to the Commerce CFO and asked him to help put a stop to this. I also had it out with both Winokur and

Withee. They claim to have had no knowledge of the Commerce cuts which is impossible since Charlie passed back detailed tables with the numbers.

They tried to explain the Excom as necessary to approve the new mods program. I told them that I was not inclined to fund the mods unless they could give us hard cost data.

I also told them that how pissed off I was that they were doing a repeat of last year. Commerce is so far over ceiling, hopefully the Department management will stick to their cuts!

Stay tuned.....

===== ATTACHMENT 1 =====
ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:

RFC-822-headers:

Received: from conversion.pmdf.eop.gov by PMDF.EOP.GOV (PMDF V5.1-9 #29131)
id <01J2DF9RS134008Y8L@PMDF.EOP.GOV> for Laskin_S@a1.eop.gov; Tue,
29 Sep 1998 08:39:38 EDT

Received: from Storm.EOP.GOV by PMDF.EOP.GOV (PMDF V5.1-9 #29131)
with ESMTP id <01J2DF9PPTEO00DS2N@PMDF.EOP.GOV> for Laskin_S@a1.eop.gov; Tue,

29 Sep 1998 08:39:35 -0400 (EDT)
Received: from dddc001.osd.mil ([134.152.184.11])
by STORM.EOP.GOV (PMDF V5.1-12 #29131)
with ESMTP id <01J2DF9O6S500017KY@STORM.EOP.GOV> for Laskin_S@a1.eop.gov; Tue,

29 Sep 1998 08:39:32 -0400 (EDT)
Received: by dddc001 with Internet Mail Service (5.5.2232.9)
id <T54SVZZV>; Tue, 29 Sep 1998 08:28:50 -0400
X-Mailer: Internet Mail Service (5.5.2232.9)

===== END ATTACHMENT 1 =====

RECORD TYPE: FEDERAL (TRP NOTES MAIL)

CREATOR: Charlie Murray (Charlie Murray@4=BEP@5=OSEC PBE@3=GOV+COMM.BAN@2=ATTMAIL@1=US@MRX@LNGTWY [UNKNOWN])

CREATION DATE/TIME:13-OCT-1998 12:55:00.00

SUBJECT: fwd: re: fwd: re: More Trouble on NPOESS

TO: Lisa A. Gaisford (Lisa A. Gaisford@eop [UNKNOWN])
READ:UNKNOWN

TEXT:
Lisa,

Are there any developments that I ought to know about before I write this one-pager? By the way, I'm in training today and tomorrow. Thanks!

CM

Original Text

From: Mark Brown@Directors@OSEC PBE, on 10/13/98 7:42 AM:

To: Charlie Murray@BEP@OSEC PBE

Please prepare this with a cover memo from Scott to the Secretary through Mallet. Soon. Thanks.

From: W. Scott Gould@Admin@OSEC, on 10/12/98 10:03 PM:

To: Mark Brown@Directors@OSEC PBE

Mark, would you and Charlie write the one-pager requested in the attached e-mail. Thanks for keeping me posted on this one.

From: Robert Mallett@Admin@OSEC, on 10/11/98 2:28 PM:

To: W. Scott Gould@Admin@OSEC

Thanks. Would you please get a one pager on this for the Secretray and me to use in our meeting with Jim baker next week. Thanks.

From: W. Scott Gould@Admin@OSEC, on 10/9/98 6:24 PM:

Here is another e-mail on background.

From: Charlie Murray@BEP@OSEC PBE, on 10/8/98 5:49 PM:

To: W. Scott Gould@Admin@OSEC

Cc: Mark Brown@Directors@OSEC PBE

Mark/Scott:

I agree with Lisa that it might be in our best interests to have Winokur support DOC's request to OMB even if it is matched by DOD in FY 2000 and out. OMB analysts/DOD Office of the Secretary/ and myself agree that the spacecraft and launching segments of the NPOESS program can slip one year.

This slippage (as reflected in our budget request to OMB) still allows NPOESS to continue instrument development on all fronts in FY 2000, which is the primary activity going on in this program in FY 2000.

DOD is projected to need the first NPOESS in February 2009 according to DOD

launch schedules. NOAA is currently showing a need date for the first NPOESS as July 2007, to back up N'. Although NOAA has not officially changed their schedule, they have four afternoon satellites (same orbit) set for launch from December 1999 - July 2007. Even if one fails on launch,

that's two satellites covering 7.5 years of on-orbit life (the third would cover from July 2007 on out, but would be available as EARLY as FY 2003 for launch). NOAA assumes a 4-year on-orbit life for each satellite. Once these satellites successfully reach orbit, however, their life usually exceeds 4 years, e.g., NOAA-12 (seven years), NOAA -14 (still operational, but planned for five years).

Bottom line is NOAA has been overly conservative in its POES launch planning, and slipping the NPOESS spacecraft and launching segments one year will do no harm to either program. As such, NOAA should support our budget as it is completely viable. The bigger worry is a large cut to FY 1999 in Conference.

Hope that helps!

CM

From: W. Scott Gould@Admin@OSEC, on 10/8/98 2:05 PM:

Thanks, Lisa. FYI, I heard that the European satellite launch was in jeopardy. Do you have any information on this?

Original Text

From: S=Lisa(u)A.(u)Gaisford/C=US/A=INTERNET/DDA=ID/Lisa(u)A.(u)Gaisf, on
10/8/98 11:11 AM:

This is a quick summary of the latest NPOESS issue.

Apparently, NOAA, recognizing that they are not going to get support from
DOC to restore the funding cuts included in the Secretary's budget is
actively lobbying DOD to push for restoration of the cuts.

NOAA has convinced General Clay, the head of USAF space command, that the
first NPOESS satellite needs to be available to back up the last NOAA
satellite. NOAA's arguments are overly conservative for the readiness date
of this satellite. They are planning to have it available four years in
advance of expected launch. Furthermore, the expected launch is based on
probability curves for having two NOAA satellites in orbit when NOAA's
actual requirements is one satellite in orbit, the second satellite is a
back-up. It is important to note that by this time, the Europeans will
have a satellite in orbit carrying our instruments which can serve as a
back-up.

Charlie is preparing additional details on this for you.

The head of NESDIS is scheduled to meet with Defense this Friday to discuss
having an Excom. I think that NOAA needs to be reigned in and coordinate
with the Department. It appears like they are advocating a position that
runs directly counter to the Department's budget. It may be time to
revisit NOAA's representation on the Excom and change it to you or Mallet.