Fiscal Year 2004 Climate Change Research Initiative

Background

On June 11, 2001, the President announced that his administration would "establish the U.S. Climate Change Research Initiative (CCRI) to study areas of uncertainty [about global climate change] and identify priority areas where investments can make a difference." The President directed the Secretary of Commerce to work with other agencies to "set priorities for additional investments in climate change research, review such investments, and to improve coordination amongst federal agencies." The President's FY 2003 budget request included $40.0M for the CCRI.

The CCRI represents a focusing of resources and enhanced interagency coordination of ongoing and planned research on those elements of the U.S. Global Change Research Program (USGCRP) that can best support improved public discussion and decision making in the near term. A particular goal of the CCRI is to measurably improve the integration of scientific knowledge, including measures of uncertainty, into effective decision support systems and resources. The CCRI programs will incorporate performance metrics that call for deliverable products useful to policymakers in a short time frame (2-4 years). To meet its goals, the CCRI aims to (1) enhance ongoing USGCRP elements where additional effort would rapidly lead to critical decision support information; (2) enhance and integrate observation, monitoring, and data management systems to support climate process and trend analyses; and (3) provide structured information that can inform policy and decision making, including the use of best available models to address important uncertainties about climate change and development of the range of plausible scenarios for drivers of climate change.

To be included in the CCRI, a program must both (1) produce significant decision or policy relevant deliverables within the next 2-4 years; and (2) contribute substantively to one or more of the following activities:

1. Address key and emerging climate change science areas that offer the prospect of significant improvement in understanding of climate change phenomena where additional resources would accelerate development of decision support information.
2. Optimize observations, monitoring, and data management systems of "climate quality data" for trend analysis, process evaluation, and model development and calibration for both climate and ecosystems.
3. Develop decision support resources including (a) scenario development and comparisons; (b) quantification of the sensitivity and uncertainty of the climate system to natural and anthropogenic forcings through the implementation and application of models; and (c) structured information to inform national, regional, and local discussions about possible global change causes, impacts, and mitigation and adaptation strategies.

Existing programs within the base USGCRP that are to be included in (transferred to) the CCRI must accelerate or refocus activities to deliver additional inputs to decision support systems.

For FY 2004, CCRI activities will be distributed among all three research areas: (1) key and emerging climate change science areas from ongoing USGCRP elements; (2) climate quality observations, monitoring, and data management; and (3) decision support resources.

Key and Emerging Climate Change Science Areas from Ongoing USGCRP Elements ($34.9M)

Research Needs

CCRI research will leverage existing USGCRP research to address major gaps in understanding climate change. Three areas are highlighted for FY 2004: aerosols, carbon cycle, and polar feedbacks. Uncertainty about effects of aerosols on climate are large, with both warming and cooling effects possible, depending on the nature of the aerosol. Research on the carbon cycle will focus on understanding controls on carbon uptake and storage in North American terrestrial and coastal systems. These systems may balance a significance fraction of U.S. carbon emissions. Polar systems may be especially sensitive to climate change and might provide early warnings of climate change as well as interact with climate variability and change through several important feedback processes.

CCRI will address these research needs through activities coordinated across the Department of Commerce/National Oceanic and Atmospheric Administration (DOC/NOAA), the Department of Energy (DOE), the National Aeronautics and Space Administration (NASA), and the National Science Foundation (NSF).

FY 2004 Milestones

<u>Aerosols</u>

- Major diagnostic field study above the northeast United States and western North Atlantic. (DOC/NOAA)
- Instrumentation for measurement of black carbon and related aerosols. (DOC/NOAA)
- Measurements of aerosols precursors. (DOC/NOAA)
- Sampling of black carbon aerosols over the United States. (DOC/NOAA)
- Global climatologies of tropospheric aerosols making use of multi-angle and multi-wavelength observations. (NASA)
- Improved global aerosol models evaluated by comparison with satellite data climatologies. (NASA)

<u>Carbon Cycle</u>

- Complete 29 of the 36 stations in the CO_2 observing system for the United States. (DOC/NOAA)
- An 80% reduction of uncertainty in net U.S. carbon balance. (DOC/NOAA)
- Initiation of activities leading to a capability to produce regional carbon maps from data assimilation models. (DOC/NOAA)

- Intercomparison of estimates of the net annual exchange of CO_2 between terrestrial ecosystems and the atmosphere for a region of the United States with independent estimates using atmospheric sampling and inverse modeling. (DOE and partnering agencies)
- Global climatologies of tropospheric methane column amount from satellite data. (NASA)
- Enhanced understanding of the sensitivity of carbon cycle processes to changing environmental parameters. (NSF)

Polar Feedbacks

- Inventory of polar variability in climate models and model characteristics that contribute to that variability. (NASA)
- First order estimates of Greenland and Antarctic contributions to sea level rise from ICESat and revised analysis of glacier contributions. (NASA)

Climate Quality Observations, Monitoring, and Data Management ($70.4M)

Needs and Goals

The CCRI will build climate observing systems and will help improve climate observations in developing countries. A climate observing system must go beyond data collection to include the processing and support systems that lead to reliable and useful products. To be most effective, it must target areas such as climate and weather forecasting, human health, and ecological monitoring to support decision and policy makers. The specific emphases on observing and information systems within CCRI will be to: (a) document historical records; (b) improve observations for model development and applications; (c) enhance biological and ecological observing systems; and (d) improve data archiving and information system architectures. These activities will involve substantial collaboration with the international climate science community and with several ongoing international monitoring development programs.

The climate science community has developed an extensive set of requirements to meet the needs for climate quality observations. For some variables, new observational techniques will have to be developed and employed. In other cases, additional effort is required to produce climate quality data records from existing operational data. A newly focused and coordinated national effort is needed to develop and to sustain the essential components of a comprehensive global observing system involving atmospheric, oceanic, and terrestrial elements, embracing physical, chemical, and biological parameters.

The CCRI will address these needs and goals through activities coordinated across DOC/NOAA, DOE, NASA, the Agency for International Development (USAID), and the Department of Agriculture (USDA).

FY 2004 Milestones

Observations and Monitoring

- Completion of 48% of the climate component of the ocean observation network. (DOC/NOAA)
- Climate accuracy of global sea surface temperature. (DOC/NOAA)
- Improved seasonal forecasts from global tropical measurements. (DOC/NOAA)
- Ability to monitor sea level change and calibrate satellite altimetry. (DOC/NOAA)
- Deploy four ocean reference stations and deliver routine analyses of ocean-atmosphere heat flux at these stations. (DOC/NOAA)
- Autonomous CO_2 sampling capability provided to ships of opportunity. (DOC/NOAA)
- Program to survey global ocean CO_2 storage and change implemented. (NSF & DOC/NOAA)
- Dedicated ship support for carbon work and deployment of moored and drifting buoys. (DOC/NOAA)
- Key locations instrumented for abrupt climate change detection. (DOC/NOAA)
- Upgrade 5-10 GCOS Upper Air Network (GUAN) stations. (DOC/NOAA)
- Upgrade up to 50 GCOS Surface Network (GSN) stations. (DOC/NOAA)
- Upgrade 2-3 GCOS Global Atmosphere Watch (GAW) stations. (DOC/NOAA)
- Deployment of mobile Atmospheric Radiation Measurement (ARM) program facility. (DOE)
- Program plan for obtaining early copy of NPOESS instrument. (NASA)
- Identification of flight opportunity for NPOESS APS instrument. (NASA)
- Selection and award of development assistance projects for climate monitoring in developing nations. (USAID)
- New technologies and sampling strategies to test for rapid and economical field-level measurement of carbon. (USDA)

Data Management

- Criteria for data products from the ARM program for evaluating precipitation processes. (DOE)
- Preliminary report of the ability of NPOESS Preparatory Project (NPP) sensors, algorithms, and spacecraft to provide "climate-quality" data and of any steps that need to be taken to assure the usefulness of NPP data for climate studies. (NASA)
- Initial results from each of the "solution" projects funded under the REASoN program. (NASA)
- Initiation of algorithm development for use in unique environment of planned mission of NPOESS APS instrument. (NASA)
- Improved estimates of burned area and carbon emissions from fire in the United States. (USDA)
- Improved U.S. aboveground biomass carbon storage estimates. (USDA)
- Improved U.S. soil carbon storage estimates. (USDA)
- Initial versions of models to estimate carbon stocks and sequestration rates at different scales (field, farm, region) and under different conditions. (USDA)

Decision Support Resources ($79.2M)

Needs and Goals

The CCRI will provide structured information to inform national, regional, and local discussions about possible global change causes, impacts, and mitigation and adaptation strategies. It will synthesize results of research activities focused on climate change to present information needed by decision makers. Federal decision makers address such issues as setting national energy policy and negotiating international agreements. Local and regional decision makers must consider possible climate change when planning physical infrastructures and managing natural resources. The CCRI science and decision support resources will be designed to provide input to a number of these decision makers.

In FY 2004, CCRI activities directed at decision support resources will involve work in three areas: (1) applied climate modeling to reduce uncertainty about climate change; (2) support for national scope analyses; and (3) support for resource management analyses.

The CCRI will address these needs and goals through activities coordinated across DOC/NOAA, DOE, the Department of State (DOS), the Department of Transportation (DOT), NASA, NSF, and USDA.

FY 2004 Milestones

<u>Applied Climate Modeling</u>

- Computational support for a dedicated scenarios capability for the United States. (DOC/NOAA)
- Exploration of impacts for various strategies of energy, technological, demographic, and land use changes. (DOC/NOAA)
- Exploration of high-resolution models (higher than for Intergovernmental Panel on Climate Change-IPCC studies) to resolve regionality of impacts. (DOC/NOAA)
- Basic GFDL computational capability enhanced by 30%. (DOC/NOAA)
- New climate simulations based on forcing scenarios that have already been specified, such as CO_2 stabilization scenarios and some emission scenarios requested for the IPCC fourth assessment. (DOE)
- Documented source code of the Earth System Modeling Framework (ESMF). (NASA)
- ESMF-enabled NCAR, NOAA/GFDL, NOAA/NCEP, DOE/LANL, MIT, NASA/GSFC/DAO, NASA/GSFC/NSIPP coupled climate models and data assimilation system. (NASA)
- Demonstration of interoperability between major coupled climate model components. (NASA)
- More detailed simulations of regional climate from improvements in geography and topography available from the new CCSM-2 (twice the horizontal resolution of the CCSM-1). (NSF)
- Evaluations of contributions from changes in natural and human forcing (e.g., greenhouse-gas concentrations, solar irradiance, volcanic aerosols, and land use) to

the climate variability of the past 300-400 years. These will provide an enhanced understanding of the mechanisms for the warmth of the 20th century compared to earlier centuries, and provide a more complete context for analyzing and interpreting projections of future climate change resulting from human activities. (NSF)

Support for National Scope Analyses

- Development of a minimum of four emissions scenarios to provide alternatives to the "SRES" scenarios that were published by the IPCC for use in the Energy modeling Forum (EMF) by members of the integrated assessment modeling community. (DOE)
- Development of IPCC assessments serving as decision-making resources for CCRI themes. (DOS)
- Syntheses of risk assessment data specific to transportation infrastructure and operations including prioritization of data and analysis gaps for future research. (DOT)
- Initial analysis of existing transportation planning tools and their ability to incorporate climate change data, uncertainty, and risk analysis. (DOT)
- Development and testing of internet-based systems that transportation entities can use to calculate voluntary GHG reductions and register them under EPAct 1605(b). (DOT)
- Consumer-based demand reduction and mode selection model and studies that will aid in developing consumption reduction strategies to support transportation planners. (DOT)
- Selection of mode and site and initiation of the testing of new technologies to supplant current idling practices, focused on using electricity or fuel cells. (DOT)
- Initial analysis of existing transportation planning tools and their ability to incorporate climate change data, uncertainty, and risk analysis; identification of additional resources required to supplement existing resources and processes. (DOT)
- Model specification/design and support data compilation for an integrated national-scale model of freight transportation for stand-alone use and possible integration into the DOE NEMS and other economy-wide energy models. (DOT)
- Analysis of status of addressing uncertainties in aviation's impact on the atmosphere identified by the IPCC, including identifying in situ measurements and measurement technologies required in collaboration with science agencies (e.g., NASA). (DOT)
- Risk assessment of potential impact of aviation particulate emissions on climate change. (DOT)
- Completion of the first phase of a study on differential rates of energy use and emissions during trip phases. (DOT)
- Initial concepts for decision support resources for policy makers that inform implementation of sound farm policies and programs to store carbon while sustaining agricultural productivity and environmental quality. (USDA)
- Preliminary data describing how land management practices in different environments, including soil types and vegetation cover types, alter carbon sequestration throughout the high proportion of U.S. land that is under agricultural management. (USDA)

Support for Resource Management Analyses

- Report on results to incorporate information about regional historic climate variability, seasonal teleconnections, and socioeconomic trends in the Southwestern United States into existing operational decision frameworks to reduce ground water overdrafts. (DOC/NOAA)
- Hydrology model(s) that incorporate climatic information, alternative water sources, municipal and agricultural demands, and institutional constraints to identify the impact of alternative water policies on water availability, quality, and price. (DOC/NOAA)
- Transfer the first generation of climate-based stochastic reservoir management methodologies to reservoir managers to improve hydropower management and species and habitat protection. (DOC/NOAA)
- Technical support for DOS drought response programs, including development of monitoring and assessment methodologies. (DOC/NOAA)
- Two regional analyses of implications of climate change scenarios. Targeted regions will be selected in consultation with partners and stakeholders. (DOT)
- Roadmaps for each of the applications (agricultural competitiveness, carbon management, energy forecasting, water and air quality management, disaster management, invasive species management, coastal management, community growth, and public health) indicating projected enhancements to respective decision support systems, as enabled by observations from NASA mission and predictions from NASA sponsored science. (NASA)
- Technical reports documenting the project designs for benchmarking the improvements in decision support enabled by the assimilation of observations and predictions resulting from NASA research. The reports will include a description of the traditional approach for providing measurements and/or predictions, the engineering approach and processes for assimilating the observations and predictions into the decision support system, and the approach for measuring the performance of the system using Earth science results. Lessons learned in the process of conducting the project will be documented and included in the reports. (NASA)
- Prototype system configurations for the public health and the air quality decision support systems demonstrating the assimilation of Earth system science observations and predictions. (NASA)
- Establish centers that will work with decision makers, stakeholders, and others to disseminate research results through trade journals and other media that make their findings more readily available. (NSF)
- Initiate the process of working with decision makers. Goal is to beta-test and disseminate new resources. (NSF)
- Consistent accounting rules and guidelines for forest-based carbon sequestration projects. (USDA)
- Development and demonstration of capabilities and limitations of resource management applications in offsetting greenhouse gas emissions for use by resource managers. (USDA)
- Prototype decision support resources for use by land managers. (USDA)
- Grazing and feed management practices for field testing that reduce methane emissions from cattle and other ruminants. (USDA)

- Practices for field evaluation in crop and grazing systems to reduce nitrous oxide emissions. (USDA)
- Assessment of the mechanisms underlying responses and factors that can be managed to sustain food production and enhance marketability under changing carbon dioxide concentrations. (USDA)
- Progress toward decision support tools for climate and weather projects at timescales needed to improve agricultural decisions. (USDA)
- Analysis of seasonal precipitation forecasts with the framework of agricultural applications. (USDA)
- Improved estimates of greenhouse gas fluxes from agriculture and conservation activities. (USDA)

FY 2004 Budget Request by Agency ($millions)

Agency	Key and Emerging Climate Change Science Areas from Ongoing USGCRP Elements	Climate Quality Observations, Monitoring, and Data Management	Decision Support Resources	Total
DOC/NOAA	10.0	21.0	10.6	41.6
DOE	2.9	4.1	18.3	25.3
DOS	-	-	1.0	1.0
DOT	-	-	4.0	4.0
NASA	12.0	35.0	22.0	69.0
NSF	10.0	-	15.0	25.0
USAID	-	6.0	-	6.0
USDA	-	4.3	8.3	12.6
TOTAL	**34.9**	**70.4**	**79.2**	**184.5**

Performance Metrics

The Climate Change Science Program Office (CCSPO) will work with participating agencies to track progress toward CCRI milestones and deliverables. The CCSPO will prepare periodic reports that provide a crosscut summary of accomplishments related to the CCRI. Individual agencies will continue to document their own performance as required by the Administration and Congress.

Appendices

Appendix A provides agency program descriptions and milestones for the FY 2004 CCRI.

Appendix A

Fiscal Year 2004 Climate Change Research Initiative
Program Descriptions and FY 2004 Milestones

Key and Emerging Climate Change Science Areas From Ongoing USGCRP Elements

FY 2004 Budget Request by Agency ($millions)

Agency	FY 2004 Request
DOC/NOAA	10.0
DOE	2.9
NASA	12.0
NSF	10.0
TOTAL	**34.9**

DOC/NOAA

Through its new Aerosols Program, NOAA will contribute to the interagency National Aerosol-Climate Interactions Program (jointly with DOE, NASA, and NSF) currently under development to advance the understanding of the distribution of all major types of aerosols and their variability through time, the different contributions of aerosols from human activities, and the processes by which the different contributions are linked to global distributions of aerosols. NOAA will establish new, and augment existing, field monitoring sites (including aircraft sampling) within and downwind of major population areas to determine temporal and spatial distributions, trends, and chemical and radiative properties of aerosols. ($3.0M)

FY 2004 Milestones

- Major diagnostic field study above the northeast United States and western North Atlantic.
- Instrumentation for measurement of black carbon and related aerosols.
- Measurements of aerosols precursors.
- Sampling of black carbon aerosols over the United States.

Through its Carbon Monitoring Program, NOAA will augment carbon-monitoring capabilities in North America as well as observations of globally relevant parameters in key under-sampled oceanic and continental regions around the globe. Sites will be selected to reduce high uncertainty in current North American carbon flux (balance) estimates. The fully realized carbon-monitoring capabilities will determine the size and variability of carbon sources and sinks, leading to North American carbon maps. ($7.0M)

FY 2004 Milestones

- Complete 29 of the 36 stations in the CO_2 observing system for the United States. An 80% reduction of uncertainty in net U.S. carbon balance.

- Initiation of activities leading to a capability to produce regional carbon maps from data assimilation models.

DOE

DOE's AmeriFlux network measures net CO_2 exchange (Net Ecosystem Exchange - NEE) between the atmosphere and terrestrial ecosystems. The research determines how much carbon is gained or lost by the system on an annual basis. Investment in carbon measurement systems at AmeriFlux sites assures comparability of data across sites, provides high-accuracy standards for estimating absolute atmospheric CO_2 concentration across the USA, and makes systematic data available to the carbon cycle science community for companion research on the "North American carbon sink" issue and for regional-scale analyses of terrestrial carbon sequestration. Beginning in FY 2004, the AmeriFlux Program will join with the North American Carbon Program (NACP), and the NEE measurements will be coupled with related atmospheric measurements and modeling in the comprehensive investigation of the North American carbon sink. The work makes contributions to climate-quality observation and monitoring networks, and provides data needed for decision support. ($2.9M)

FY 2004 Milestone

- Intercomparison of estimates of the net annual exchange of CO_2 between terrestrial ecosystems and the atmosphere for a region of the United States with independent estimates using atmospheric sampling and inverse modeling.

NASA

NASA's new Non-CO_2 Greenhouse Forcing Program supports research to improve understanding of processes by which trace constituents are transformed and transported in the atmosphere. Studies of how atmospheric chemistry, composition, and climate are linked are emphasized, including those processes that control the abundance of constituents that affect the Earth's radiation budget, such as tropospheric methane, ozone, and aerosols. The Program supports observations by obtaining global distribution and variability from satellite observations of a limited number of atmospheric parameters over long periods of time (including climatically relevant parameters such as ozone and aerosols) and more comprehensive suites of observations over briefer time periods. Data recently obtained and to become available for the first time from satellites on methane, tropospheric ozone, and tropospheric aerosols will be analyzed and interpreted in the context of global models and assimilation systems. The Program will provide decision support through information on emissions and atmospheric formation of non-CO_2 climate forcing agents. The results will support development of alternative scenarios for reductions in greenhouse forcing whose environmental impact can then be assessed by climate models. ($7.0M)

FY 2004 Milestones

- Global climatologies of tropospheric aerosols making use of multi-angle and multi-wavelength observations.

- Improved global aerosol models evaluated by comparison with satellite data climatologies.
- Global climatologies of tropospheric methane column amount from satellite data.

NASA's new Polar Feedbacks Program will support research to improve understanding of processes that determine the behavior of the slower elements of the physical climate system, especially the oceanic and cryospheric portions. Particular foci include the processes by which the ice-covered regions of the high latitude Earth behave and by which the distribution of sea ice varies and the way in which knowledge of ocean circulation can be enhanced through use of global observations of ocean state and forcing parameters. The development and testing of new capabilities for measuring climatic properties, such as ocean surface salinity, mixed layer depth, and ice sheet thickness will also be carried out. The program will support the obtaining of systematic data sets for a limited number of earth system parameters such ice thickness, extent, and concentration, in the case of sea ice, and mass balance and surface temperatures in the case of land ice and snow cover. It will shortly enable the initiation of regular observations of ice sheet thickness. Data assimilation systems using satellite data that provide for accurate geophysically consistent data sets will also be carried out through this program. The program will also support decision support through cryospheric observations and associated models that support initialization and verification of climate models, and the reduction in uncertainty of model output. Strategically, the models will also support real-time decision making by the US Navy and commercial maritime interests in high-latitude regions. ($5.0M)

FY 2004 Milestones

- Inventory of polar variability in climate models and model characteristics that contribute to that variability.
- First order estimates of Greenland and Antarctic contributions to sea level rise from ICESat and revised analysis of glacier contributions.

NSF

NSF's Carbon Fluxes and Cycle Program is an element of the existing CCRI. NSF will, with NOAA, deliver improved understanding of the carbon cycle and the effect on climate through diagnostic analyses and modeling. ($10.0M)

FY 2004 Milestone

- Enhanced understanding of the sensitivity of carbon cycle processes to changing environmental parameters.

Climate Quality Observations, Monitoring, And Data Management

FY 2004 Budget Request by Agency ($millions)

Agency	FY 2004 Request
DOC/NOAA	21.0
DOE	4.1
NASA	35.0
USAID	6.0
USDA	4.3
TOTAL	**70.4**

DOC/NOAA

NOAA will implement a new observing system that can accurately document climate-scale changes in ocean heat, carbon, and sea level change. Some effective subsystems have recently been developed to monitor some aspects of the ocean, but major issues remain in better determining fields of sea surface temperature and surface fluxes. There is also a crucial need to systematically provide continuous, three-dimensional fields of variables for the ocean: heat content, salinity, and currents. The Global Ocean Observing System will provide the United States and its international partners critical information on the role of the ocean in climate and the rate of climate change through changes in heat storage. The ocean data will be used to develop, test, and initialize comprehensive climate models. ($17.0M)

FY 2004 Milestones

- Completion of 48% of the climate component of the ocean observation network.
- Climate accuracy of global sea surface temperature.
- Improved seasonal forecasts from global tropical measurements.
- Ability to monitor sea level change and calibrate satellite altimetry.
- Deploy four ocean reference stations and deliver routine analyses of ocean-atmosphere heat flux at these stations. Autonomous CO_2 sampling capability provided to ships of opportunity.
- Program to survey global ocean CO_2 storage and change implemented. (with NSF)
- Dedicated ship support for carbon work and deployment of moored and drifting buoys.
- Key locations instrumented for abrupt climate change detection.

NOAA will provide assistance for the development and implementation of climate observing systems in developing nations through its Global Climate Observing System (GCOS) program (initiated in FY 2003). The products will be integrated into a larger international climate observing, monitoring, and data management network. ($4.0M)

FY 2004 Milestones

- Upgrade 5-10 GCOS Upper Air Network (GUAN) stations.
- Upgrade up to 50 GCOS Surface Network (GSN) stations.
- Upgrade 2-3 GCOS Global Atmosphere Watch (GAW) stations.

DOE

As a contribution to CCRI, DOE's Atmospheric Radiation Measurement (ARM) Program will deploy a mobile climate observatory to provide new atmospheric measurements needed to fill data gaps and will develop the corresponding data products needed for evaluating and modeling the effects of atmospheric processes and properties on the radiation balance and for developing and evaluating the models. A mobile Cloud and Radiation Testbed (CART) facility will be deployed in selected data poor regions (e.g., tropics) and regions that represent locations of opportunity for measuring the effects of atmospheric conditions on the radiation balance that are currently poorly understood (e.g., direct and indirect effects of aerosols). The mobile site will be instrumented for cloud and radiation measurements. The primary siting criterion is to provide those measurements needed to address specific modeling needs that presently cannot be addressed by the permanent ARM sites, but efforts will be made to coordinate operations with other programs sponsored by DOE, other U.S. agencies, and international partners such as Australia, Japan, China, and European countries. Data products will be developed through collaborations with model developers and parameterization specialists. ($4.1M)

FY 2004 Milestones

- Deployment of mobile Atmospheric Radiation Measurement (ARM) program facility.
- Criteria for data products from the ARM program for evaluating precipitation processes.

NASA

NASA's NPOESS Preparatory Project (NPP), to be launched early 2006, will provide continuity for a number of critical environmental parameters using instruments provided by NPOESS. These are new instruments, with algorithms being provided by the instrument vendors to meet the requirements established by the NPOESS Integrated Project Office and the relevant agencies (NASA, NOAA, DOD). For climate research, however, it is important that consistency between the new instruments and algorithms and those from predecessor instruments (including the imagers and sounders on NASA's Earth Observing System spacecraft) be documented. This is particularly true for issues such as calibration and validation. NASA is committed to work to assure that the observations made by NPP for those variables whose long-term evolution is of interest will be suitable for use in climate change studies. ($3.0M)

FY 2004 Milestone

- Preliminary report of the ability of NPOESS Preparatory Project (NPP) sensors, algorithms, and spacecraft to provide "climate-quality" data and of any steps that need to be taken to assure the usefulness of NPP data for climate studies.

NASA's Research, Education, and Applications Solutions Network (REASoN) program is structured to fund competitively selected solutions to benchmark the assimilation of NASA measurements and predictions resulting from Earth science research. It will develop advanced data systems technologies integrated with "solutions" that meet user needs.

Solicitation for this program will be distributed by October 2002. Priorities for desired data sets include those that will support science associated with in-guide augmentation requests (polar climate feedbacks, non-CO_2 forcing) Projects are expected to begin early 2003. ($7.0M)

FY 2004 Milestone

- Initial results from each of the "solution" projects funded under the REASoN program. The projects will be focused on research, education, and applications of Earth science and remote sensing technologies as integrated into decision support resources.

NASA will accelerate the flight of the NPOESS Aerosol Polarimetry Sensor (APS) Instrument so that observations of aerosol properties that it will provide could become available appreciably sooner than would be likely given the current NPOESS schedule. Polarimetric observations of atmospheric aerosols provide a unique method to determine the physical and optical properties of aerosols and thus improve our ability to understand their impact on the Earth's climate. There is currently no dedicated space-based instrument providing such observations. A polarimeter is to fly on NPOESS in the 2009-2011 time frame, but the flight can be accelerated. This would not only allow for earlier data availability, but would enable early testing of algorithms that would facilitate the improvement of space-based polarimetric observations and thus the representation of aerosol forcing in climate models. ($25.0M)

FY 2004 Milestones

- Program plan for obtaining early copy of NPOESS instrument.
- Identification of flight opportunity for NPOESS APS instrument.
- Initiation of algorithm development for use in unique environment of planned mission of NPOESS APS instrument.

USAID

USAID's FEWS NET analyzes remote sensing data and ground-based meteorological, crop, and range-land observations to track progress of rainy seasons in semi-arid regions of Africa to identify early indications of potential famine. ($6.0M)

FY2004 Milestone

- Provide decision-makers with the information to effectively respond to drought and food insecurity.

USDA

USDA's Forest Service Inventories of Carbon Biomass Program will reduce uncertainties in national land-based carbon monitoring, improve the timeliness of reporting, facilitate integration of monitoring across agencies and land ownerships, and strengthen the scientific foundation for the Administration to include carbon sequestration in national accounting programs and international negotiations on emissions. Improved estimates of

burned areas and carbon emissions from wildland fires in the US for federal, state, and private lands will be available. These will be based on combining remote sensing data from Terra and Aqua satellites with vegetation and fuels data, ground and aerial surveys of burned areas, and experimentally derived emission factors. Spatial databases will enable data to be broken down by vegetation or fuel types, ownerships, ecoregions, and geographic regions (e.g. states). Improved aboveground biomass carbon estimates, including estimates of coarse woody debris, will be based on a comprehensive compilation of thousands of biomass equations for the U.S. Statistical models will be used for aggregating the equations and applying them to forest inventory data. The uncertainty of estimates will be quantified. Improved statistical techniques and linking of multiple data sources will facilitate estimation of annual changes in biomass stocks and improved attribution of the causes of annual changes in biomass stocks. The spatial resolution of biomass estimates will be increased through an advanced data retrieval and estimation system. Improved soil carbon storage estimates will be made by integrating forest inventory data with soil maps and databases using Geographical Information System (GIS) technology. Estimates will be more consistent with those developed for non-forest lands, which will facilitate better estimates of the effects of land use change on soil carbon. Estimates of soil carbon storage will also be improved by better separation of estimates of soil and litter carbon pools, which are often confused in reported literature. ($3.8M)

FY 2004 Milestones

- Improved estimates of burned area and carbon emissions from fire in the United States.
- Improved U.S. aboveground biomass carbon storage estimates.
- Improved U.S. soil carbon storage estimates.

USDA's Agricultural Research Service (ARS) Measurement Verification and Modeling of Carbon Storage Program will develop inventory methods and models for estimating current carbon stocks and potential changes in carbon stored in U.S. croplands and rangelands under different global change and management scenarios. This research will include efforts to develop new methods for rapid and accurate measurement of carbon in soil and greenhouse gases in the atmosphere associated with agricultural systems. ($0.5M)

FY 2004 Milestones

- New technologies and sampling strategies to test for rapid and economical field-level measurement of carbon.
- Initial versions of models to estimate carbon stocks and sequestration rates at different scales (field, farm, region) and under different conditions.

Decision Support Resources

FY 2004 Budget Request by Agency ($millions)

Agency	FY 2004 Request
DOC/NOAA	10.6
DOE	18.3
DOS	1.0
DOT	4.0
NASA	22.0
NSF	15.0
USDA	8.3
TOTAL	**79.2**

DOC/NOAA

NOAA will establish a climate modeling center within the Geophysical Fluid Dynamics Laboratory (GFDL) at Princeton, New Jersey, which will focus on model product generation for research, analysis and policy applications as its principal activity. GFDL has played a central role in climate research, pioneering stratospheric modeling, seasonal forecasting, ocean modeling and data assimilation. This core capability will be enhanced to enable product generation and policy related research. ($8.5M)

FY 2004 Milestones

- Computational support for a dedicated scenarios capability for the United States.
- Exploration of impacts for various strategies of energy, technological, demographic, and land use changes.
- Exploration of high-resolution models (higher than for IPCC studies) to resolve regionality of impacts.
- Basic GFDL computational capability enhanced by 30%.

Working with NSF, NOAA will augment its Regional Integrated Sciences and Assessments (RISA) research capability in assessing climate change impacts vulnerability by utilizing the research on "decision making in the face of uncertainties" in the framework of the RISA program. The RISA program links analysis of regional climate with study of social and economic processes in sectors influenced by climate variability. Under the CCRI, the RISA Program will have additional capacity to sponsor regionally specific research to identify and expand options for adaptation to complex, multi-factor impacts associated with climate change. Research will focus initially on two critical issues: (1) Water supply to large, growing urban areas, and (2) Integrated studies of climate, ecosystem, human interactions that influence management of: agriculture, forestry and fire regimes, and public health threats. RISA teams are located in the Pacific Northwest, Southwest, California, the Intermountain West, and Southeast. ($1.0M)

FY 2004 Milestones

- Report on results to incorporate information about regional historic climate variability, seasonal teleconnections, and socioeconomic trends in the Southwestern

United States into existing operational decision frameworks to reduce ground water overdrafts.

- Hydrology model(s) that incorporate climatic information, alternative water sources, municipal and agricultural demands, and institutional constraints to identify the impact of alternative water policies on water availability, quality, and price.
- Transfer the first generation of climate-based stochastic reservoir management methodologies to reservoir managers to improve hydropower management and species and habitat protection.
- Technical support for the Department of State drought response programs, including development of monitoring and assessment methodologies.

As lead agency for the interagency Climate Change Science Program, DOC will establish a Program Office to support the Nation's interagency climate and global change programs. The Office will enable coordinated programmatic decisions and will support direct application of science products such as climate scenarios and carbon source/sink distributions to such questions as alternative energy strategies, climate change adaptation, and ranges of emissions scenarios. ($1.1M)

DOE

As a contribution to CCRI, DOE's Climate Change Prediction Program will develop, improve, evaluate, and apply coupled atmosphere-ocean General Circulation Models (GCMs) to simulate climate and project climate changes in response to various forcing scenarios. The program will provide climate simulations for the range of specified policy-relevant climate forcing scenarios. ($15.3M)

FY 2004 Milestone

- New climate simulations based on forcing scenarios that have already been specified, such as CO_2 stabilization scenarios and some emission scenarios requested for the IPCC fourth assessment.

The DOE Integrated Assessment Program integrates simplified representations of the entire global climate system, emphasizing (a) greenhouse gas emissions and actions that would affect emissions and (b) the connections of those actions to consequences in various sectors, such as economic output, energy use, and agriculture. The integrated assessment models typically use scenarios as input, and the output can be used to evaluate "if-then" type analyses. The results of this research will provide a foundation for subsequent policy analysis or national-level decision-making. ($3.0M)

FY 2004 Milestone

- Development of a minimum of four emissions scenarios to provide alternatives to the "SRES" scenarios that were published by the IPCC for use in the Energy modeling Forum (EMF) by members of the integrated assessment modeling community.

DOS

The DOS FY 2004 voluntary contribution to the United Nations Framework Convention on Climate Change (UNFCCC) and the IPCC will support various IPCC projects to advance assessments of climate science, carbon sequestration, climate observations, and/or other priority initiatives of the CCRI as determined in consultation with IPCC members. ($1.0M)

FY 2004 Milestone

- Development of IPCC assessments serving as decision-making resources for CCRI themes.

DOT

The transportation sector accounts for about a third of CO_2 emissions and about one quarter of total greenhouse gas (GHG) emissions in the United States. The DOT is addressing the sector's contribution to GHG emissions through its Energy Efficiency and Climate Change Implications for Transportation research program. The program will focus on three areas in FY 2004: (1) Impact Of Climate Variability and Change On Transportation: This research will examine the effects climate variability and change may have on transportation infrastructure and services, and identify potential adaptation and mitigation strategies for use by transportation professionals. (2) Increasing energy efficiency and reducing GHGs: Research to reduce energy usage will cover both the potential for conservation through more efficient practices by transportation providers/users in existing transportation operations and technological applications. The research augments ongoing federal efforts through a focus on consumer acceptance and transportation-specific applications. (3) Modeling: This effort will focus on developing and improving analytical tools to support decision making about transportation energy use and emissions and through fiscal instruments and other market mechanisms, vehicle and fuel characteristics, and transportation system design and operation. Transportation elements of models developed by DOE for national decision making (e.g., NEMS) must be augmented to achieve a more realistic policy making aid. ($4.0M)

FY 2004 Milestones

- Two regional analyses of implications of climate change scenarios. Targeted regions will be selected in consultation with partners and stakeholders.
- Syntheses of risk assessment data specific to transportation infrastructure and operations including prioritization of data and analysis gaps for future research.
- Initial analysis of existing transportation planning resources and their ability to incorporate climate change data, uncertainty, and risk analysis.
- Development and testing of internet-based systems that transportation entities can use to calculate voluntary GHG reductions and register them under EPAct 1605(b).
- Consumer-based demand reduction and mode selection model and studies that will aid in developing consumption reduction strategies to support transportation planners.
- Selection of mode and site and initiation of the testing of new technologies to supplant current idling practices, focused on using electricity or fuel cells.

- Initial analysis of existing transportation planning resources and their ability to incorporate climate change data, uncertainty, and risk analysis; identification of additional resources required to supplement existing resources and processes.
- Model specification/design and support data compilation for an integrated national-scale model of freight transportation for stand-alone use and possible integration into the DOE NEMS and other economy-wide energy models.
- Analysis of status of addressing uncertainties in aviation's impact on the atmosphere identified by the IPCC, including identifying in situ measurements and measurement technologies required in collaboration with science agencies (e.g., NASA).
- Risk assessment of potential impact of aviation particulate emissions on climate change.
- Completion of the first phase of a study on differential rates of energy use and emissions during trip phases.

NASA

NASA's Earth System Modeling Framework (ESMF) multi-agency (NASA, NOAA, NSF, and DOE) collaboration is building a high-performance, flexible software infrastructure to increase ease of use, performance portability, interoperability, and reuse in climate, data assimilation, and other Earth science models (e.g., land surface hydrologic models). This is an enabling technology project aiming to create a common climate-modeling framework usable by university researchers as well as major research and operational centers such as NCAR and GFDL. ($4.0M)

FY 2004 Milestones

- Documented source code of the Earth System Modeling Framework (ESMF).
- ESMF-enabled NCAR, NOAA/GFDL, NOAA/NCEP, DOE/LANL, MIT, NASA/GSFC/DAO, NASA/GSFC/NSIPP coupled climate models and data assimilation system.
- Demonstration of interoperability between major coupled climate model components.

NASA's National Earth Science Applications program provides systems engineering support to benchmark the assimilation of Earth science measurements and predictions from science models resulting from NASA research to enable decision support systems developed by federal agencies to serve our Nation. Many of the applications will benefit from, and add benefit to, NASA research focus areas and CCRI related research. Applications relevant to CCRI include monitoring and management of terrestrial carbon, energy forecasting and management, water and air quality, disaster management, invasive species monitoring and management, coastal zone management, agricultural competitiveness, aviation safety, and public health. ($18.0M)

FY 2004 Milestones

- Roadmaps for each of the applications (agricultural competitiveness, carbon management, energy forecasting, water and air quality management, disaster

management, invasive species management, coastal management, community growth, and public health) indicating projected enhancements to respective decision support systems, as enabled by observations from NASA mission and predictions from NASA sponsored science.
- Technical reports documenting the project designs for benchmarking the improvements in decision support enabled by the assimilation of observations and predictions resulting from NASA research. The reports will include a description of the traditional approach for providing measurements and/or predictions, the engineering approach and processes for assimilating the observations and predictions into the decision support system, and the approach for measuring the performance of the system using Earth science results. Lessons learned in the process of conducting the project will be documented and included in the reports.
- Prototype system configurations for the public health and the air quality decision support systems demonstrating the assimilation of Earth system science observations and predictions.

NSF

NSF's Climate Variability and Change Program includes studies and modeling to extend and improve predictions of climate variability. It encompasses research to determine how and why climate changes, the effects of ocean circulation and periodic natural fluctuations (e.g., El Niño), and the influence of solar activity on climate variability and change. In FY 2004 NSF will focus the program for additional high performance climate modeling to accelerate and enhance development of assessment models through the CCSM (Community Climate Simulation Model). ($10.0M)

FY 2004 Milestones

- More detailed simulations of regional climate from improvements in geography and topography available from the new CCSM-2 (twice the horizontal resolution of the CCSM-1).
- Evaluations of contributions from changes in natural and human forcing (e.g., greenhouse-gas concentrations, solar irradiance, volcanic aerosols, and land use) to the climate variability of the past 300-400 years. These will provide an enhanced understanding of the mechanisms for the warmth of the 20th century compared to earlier centuries, and provide a more complete context for analyzing and interpreting projections of future climate change resulting from human activities.

NSF will provide continuing support for a set of centers focusing on Decision Making Under Uncertainty associated with climate change. These centers, which are expected to be established in FY 2004 following a special competition, will support research, education, and outreach that increase understanding of decision-making processes and of the information needed by decision makers. The centers also will develop resources to support decision makers and increase their ability to make sound decisions, and they will facilitate interaction among researchers and decision makers. ($5.0M)

FY 2004 Milestones

- Establish centers that will work with decision makers, stakeholders, and others to disseminate research results through trade journals and other media that make their findings more readily available.
- Initiate the process of working with decision makers. Goal is to beta-test and disseminate new resources.

USDA

The USDA Forest Service's Carbon Measurements/Forest Inventory and Analysis (FIA) Program will establish a common carbon monitoring and accounting framework for forested lands. Such protocols are needed to reduce risks and facilitate private investment in sequestration projects. Consistent accounting rules and guidelines for forest-based carbon sequestration projects will be developed. Carbon sequestration estimates will be provided for selected activities, based on a variety of sources of information including forest inventory data, forest management model simulations, and results of research projects. Technical guidelines will be documented for project-level carbon measurements. Software will be developed for calculating emissions and sequestration, and preparing forms for reporting activities for carbon credit. These accounting rules and guidelines will include broad participation by the scientific community, and public review. ($0.6M)

FY 2004 Milestone

- Consistent accounting rules and guidelines for forest-based carbon sequestration projects.

The USDA's Forest Service Pilot Projects in Sequestration Technologies Program will develop and demonstrate techniques to increase forest sequestration and decrease carbon emissions through forest management. A series of projects to develop and demonstrate forest management for carbon sequestration will be implemented through public-private partnerships. Projects may be designed to include environmental co-benefits such as improved soil quality and wildlife habitat, or decreased risk of wildfire emissions; to increase storage of carbon in products; or to substitute biomass carbon for fossil fuels and other non-renewable, carbon-intensive materials. Products include demonstration sites, improved resources for managers, improved estimates of impacts of management on carbon storage, research reports, and educational materials. ($1.2M)

FY 2004 Milestones

- Development and demonstration of capabilities and limitations of resource management applications in offsetting greenhouse gas emissions for use by resource managers.
- Prototype decision support resources for use by land managers.

USDA's ARS Strengthening Basic Climate Change Technology Research Program will conduct research to develop methods for managing agricultural production systems to reduce emissions of non-CO2 greenhouse gases. An integral part of this research will focus on improving ways to rapidly measure trace gases in the field. Production methods will be

developed for ruminant livestock and pastures that minimize emissions of methane. Strategies will be tested for managing plants and soils in crop and rangeland systems in ways that minimize emissions of nitrous oxide. ($1.0M)

FY 2004 Milestones

- Grazing and feed management practices for field testing that reduce methane emissions from cattle and other ruminants.
- Practices for field evaluation in crop and grazing systems to reduce nitrous oxide emissions.

USDA's ARS Land Use and Land Management Impacts on Carbon Sequestration Program will begin to develop a network of 30 coordinated sites on crop lands, pastures, and range lands throughout the United States and observe carbon fluxes in agricultural systems on a continental scale. These sites will utilize mircrometeorological techniques to determine the impact of agricultural and rangeland management practices on large-scale carbon fluxes. ($3.0M)

FY 2004 Milestones

- Initial concepts for decision support resources for policy makers that inform implementation of sound farm policies and programs to store carbon while sustaining agricultural productivity and environmental quality.
- Preliminary data describing how land management practices in different environments, including soil types and vegetation cover types, alter carbon sequestration throughout the high proportion of U.S. land that is under agricultural management.

USDA ARS carbon cycle program will conduct interdisciplinary research to reduce uncertainties associated with projecting future food supplies, food quality, and carbon sequestration and storage by agricultural systems exposed to multiple environmental changes, including changes in carbon dioxide concentrations. ($1.0M)

FY 2004 Milestone

- Assessment of the mechanisms underlying responses and factors that can be managed to sustain food production and enhance marketability under changing carbon dioxide concentrations.

USDA ARS regional and sectoral impacts of climate change will develop methods and tools to assess risks to crop and livestock production arising from weather variability, trends in climate, and atmospheric chemistry. ($1.0M)

FY 2004 Milestones

- Progress toward decision support tools for climate and weather projects at timescales needed to improve agricultural decisions.
- Analysis of seasonal precipitation forecasts with the framework of agricultural applications.

USDA Natural Resources Conservation Service (NRCS) pilot projects on inventories of carbon biomass will develop and test methods for quantifying changes in greenhouse gas emissions and carbon sequestration from agricultural and conservation practices. This work will improve the reporting of greenhouse gas fluxes from activities and projects. NRCS will also use this information to help incorporate greenhouse gas considerations in establishing conservation priorities. ($0.5M)

FY 2004 Milestone

- Improved estimates of greenhouse gas fluxes from agriculture and conservation activities.