

USGCRP WEB SITE



To meet the need for accurate and useful information on global change, the USGCRP maintains a Web site that helps connect scientists, government officials, and the private sector to information they are seeking.

Regular updates to the site's "What's New" page provide many links to new material on the USGCRP site and also from a wide range of other sources on the Web. Links are selected from hundreds of monitored sites – including those maintained by the government agencies that participate in the USGCRP. Site visitors can link to material ranging from the National Assessment of the Potential Consequences of Climate Variability and Change to short press releases announcing recent scientific advances, and audio segments.

For those seeking background information on the USGCRP itself, the site provides concise online documents. Users who wish to focus on any of the USGCRP agencies will find many postings conveniently organized by agency. Visitors looking for information by topic will find many links organized by research program element, ranging from Understanding the Climate System to Carbon Cycle Science to the Human Dimensions of Global Change. The site also contains links specifically collected and organized for teachers in elementary and secondary schools.

Other useful links on the site provide access to key Web sites and other current and archived material, including:

- Editions of *Our Changing Planet*, the USGCRP annual report
- The USGCRP Global Change Data and Information System
- USGCRP-related international scientific research programs
- The Intergovernmental Panel on Climate Change
- The Global Change Research Information Office
- Lists of upcoming events
- Research opportunities, including calls for proposals
- Archived material dating back to 1990, including background papers for USGCRP-sponsored events.

Each page on the site contains an e-mail link to the USGCRP Office, for additional inquiries.

GCRIO was established pursuant to the Global Change Research Act of 1990. The GCRIO Web site at <http://www.gcrio.org/> also serves as a gateway to a wide range of global change information for the general public in the United States and internationally.

APPENDIX A: THE USGCRP BUDGET AND PROGRAM BY AGENCY

The first table in this Appendix presents the FY 2001-FY 2002 USGCRP budget by Research Program Element, showing each department or agency's budgetary contribution to each element. The budget pages for individual participating agencies that follow include a listing of programs designated for inclusion in the USGCRP, as well as a general description of each agency's "Areas of Global Change Research." For each agency, a "FY 2002 Program Highlights" section outlines briefly some of the key USGCRP-related activities proposed for the coming year. In addition, the agencies conduct a broad range of "Related Research," as indicated, funding for which is not included as part of the USGCRP budget because the research is conducted primarily for other purposes.

The resources allocated to specific programs within agencies as reflected in these tables for FY 2001 appropriated funds and the FY 2002 budget request are estimates only, and are subject to adjustments based on decisions on scientific and programmatic priorities among USGCRP agencies and their advisory bodies and on the input of the national and international scientific communities.

Each agency budget also includes a "Mapping of Budget Request to Appropriations Legislation." The entry for each agency points to the location (or locations) in the various Appropriations bills (and, in some cases, Appropriations Committee reports) of funding for USGCRP activities. Note that it is common for global change research to be funded within Appropriations accounts that also include funding for other activities, so that Appropriations bills and committee reports do not necessarily designate funding specifically for global change research. Thus, the actual funding level for global change research activities must be determined, in part, by decisions within agencies about how to allocate appropriated funds. It should also be noted that global change research activities are funded by seven separate Appropriations bills. Thus, the relationship between the USGCRP budget crosscut and the Appropriations process is complex.

Table 9 U.S. Global Change Research Program

FY 2001 – FY 2002 Budget by Research Program Element by Agency
(Discretionary budget authority in \$millions)

	NOAA Science	NOAA Obs	DOE	DOI	EPA	NIH	NASA Science	NASA Obs	NSF	SI	USDA	Total
Climate Variability and Change												
FY01	44.6	9.0	70.3	6.0	0.0	0.0	61.9	238.8	100.4	2.0	0.0	533.0
FY02	44.8	16.3	70.8	4.5	0.0	0.0	61.9	193.7	92.4	2.0	0.0	486.4
Atmospheric Composition												
FY01	7.8	1.0	12.6	0.0	0.0	0.0	55.9	233.1	16.8	0.3	18.1	345.6
FY02	7.8	1.0	12.6	0.0	0.0	0.0	54.1	199.1	16.9	0.3	18.0	309.8
Global Water Cycle												
FY01	5.7	0.0	0.0	0.0	0.0	0.0	56.3	237.5	10.3	0.0	2.8	312.6
FY02	5.7	0.0	0.0	0.0	0.0	0.0	56.6	231.6	12.7	0.0	2.8	309.4
Global Carbon Cycle												
FY01	4.8	1.0	12.7	4.0	0.0	0.0	46.7	113.9	16.0	0.3	14.8	214.2
FY02	4.8	4.2	13.7	3.0	0.0	0.0	47.2	111.6	21.5	0.3	14.8	221.1
Changes in Ecosystems												
FY01	0.0	0.0	12.4	17.0	3.0	0.0	32.8	85.0	30.1	3.8	20.8	204.9
FY02	0.0	0.0	12.4	14.5	2.0	0.0	33.2	82.6	30.1	3.8	20.6	199.2
Human Dimensions of Global Change												
FY01	5.6	0.0	8.0	0.0	20.0	51.6	0.0	0.0	13.7	0.6	0.0	99.5
FY02	5.6	2.5	8.0	0.0	20.0	57.0	0.0	0.0	13.7	0.6	0.0	107.4
USGCRP Total												
FY01	68.5	11.0	119.1*	27.0	23.0	51.6	253.6	908.3	187.3	7.0	56.5	1713
FY02	68.7	24.0	120.6*	22.0	22.0	57.0	252.9	818.6	187.3	7.0	56.2	1637

*DOE totals include \$3.1 million for Small Business Innovative Research/Technology Transfer (SBIR/STTR)



Department of Agriculture

USDA	Program Title	FY00	FY01	FY02 Request
ARS	Agriculture and Rangeland Global Change	13.0	12.6	12.4
ARS	Methyl Bromide Research	14.9	16.7	16.6
CSREES	Improved Response Models	7.7	6.9	6.9
CSREES	UV-B Monitoring Network	1.0	1.4	1.4
ERS	Economics of Global Change and Agriculture	0.8	0.8	0.8
FS	Forest Global Change Research	16.9	16.9	16.9
NRCS	Soil Carbon Studies, Soil Surveys and Inventories	1.2	1.2	1.2
USDA Total		55.5	56.5	
President's Request				56.2

- ARS: Agricultural Research Service
- CSREES: Cooperative State Research, Education, and Extension Service
- ERS: Economic Research Service
- NRCS: Natural Resources Conservation Service
- FS: Forest Service

Areas of Global Change Research. USDA-sponsored research focuses on understanding terrestrial systems and the effects of global change (including water balance, atmospheric deposition, vegetative quality, and UV-B radiation) on food, fiber, and forestry production in agricultural, forest, and range ecosystems, examining the role of managed and unmanaged terrestrial systems in the global carbon cycle, and assessing how agricultural and forestry activities can contribute to a reduction in greenhouse gas concentrations.

FY 2002 Program Highlights. As part of the collaborative interagency Carbon Cycle Science Program, in FY 2002 USDA will conduct research on how land management practices affect the net carbon balance and develop methods to assist farmers, ranchers, and forest landowners in increasing carbon sequestration and better managing other greenhouse gas emissions. USDA will continue to quantify carbon sources and sinks from land management activities, including fluxes for all U.S. forest and agricultural lands and other land uses. The implications of changes in water quality and availability on agricultural and forest land productivity will be assessed. USDA research will examine the economic implications of alternative greenhouse gas offset strategies. In addition, USDA will continue to assess how resilient managed agricultural, rangeland, and forest ecosystems are to climate change and what adaptation strategies will be needed to adjust to a changing climate.

ARS will focus on four broad research areas: 1) studies of the carbon cycle and

carbon storage, emphasizing identification and quantification of the current and potential roles of agriculture in the global carbon cycle with sufficient accuracy to inform policy and aid producers in making decisions that are both economically and environmentally sound; 2) managing non-carbon dioxide trace gases, such as methane and nitrous oxide, which are produced by certain processes in some crop and animal production systems; 3) determining the impacts of increased atmospheric carbon dioxide, rising temperatures, and altered water availability on crops and their interactions with other biological components of agricultural ecosystems; and 4) characterizing and measuring changes in weather and the water cycles at local and regional scales, and determining how to manage agricultural production systems facing such changes.

CSREES will continue to support the USDA UV-B Monitoring Network. Information from this research network is combined with satellite-based measurements to provide an accurate climatological UV-B irradiance database. This database documents long-term trends and supports research and assessment of the potential for damage to ecosystems. Global change research in CSREES's National Research Initiative (NRI) Competitive Grants Program and formula-funded programs aims to increase understanding of the possible impacts of global environmental change on the sustainability of agriculture and forestry.

ERS will continue to focus on two broad research areas: 1) the long-run impacts of the accumulation of greenhouse gases on agriculture, including effects resulting from changes in temperature and precipitation, and from carbon dioxide fertilization; and 2) the economic implications of alternative net greenhouse gas emission reduction and carbon sequestration options for U.S. agriculture.

FS global change research program has established a national plan of forest sustainability to continue providing water, recreation, timber, wildlife, and clean air in a changing environment. Focus for FY 2002 will be to: 1) improve understanding of changes in forest carbon storage resulting from management, 2) improve strategies for sustaining forest health under multiple environmental stresses; and 3) develop projections of future forest water quality and yield in light of potential changes in climate.

NRCS will continue to collect data necessary to estimate soil carbon inventories, develop new technologies and methods to cost-effectively measure soil carbon, and work with collaborators to assess the impacts of policies and programs on soil carbon stocks.

Related Research. In addition to focused USGCRP research, the USDA sponsors research contributing to the assessment of global change effects on the agricultural food and fiber production systems and the forest and grassland ecosystems of the United States and worldwide. Programs include long-term studies addressing the structure, function, and management of forest and grassland ecosystems; research in applied sciences, including soils, climate, food and fiber crops, pest management, forest fish and wildlife, and social sciences; implementation of ecosystem management on the national forests and grasslands; and human interaction with natural resources.

CSREES will support global change research by funding a new consortium of ten Land Grant University partners to study the mitigation of greenhouse gases through agricultural production practices. The overall goal of the consortium is to provide the tools and information needed to implement soil carbon sequestration programs success-

fully so that the accumulation of greenhouse gases in the atmosphere can be lowered, while providing income and incentives to farmers, as well as improving the soil.

Mapping of Budget Request to Appropriations Legislation. In the Agriculture, Rural Development, Food and Drug Administration, and Related Agencies Appropriations Bill, USGCRP activities are funded under Title I-Agricultural Programs, within the ARS, CSREES Research and Education Activities, and ERS; and under Title II-Conservation Programs, within the NRCS Conservation Operations account. In the Interior and Related Agencies Appropriations Bill, USDA USGCRP activities are funded in the USDA FS section under Title II-Related Agencies, within the FS Forest Research account.



Department of Commerce / National Oceanic and Atmospheric Administration

DOC	Program Title	FY00	FY01	FY02 Request
NOAA	Aerosols	1.1	1.1	1.1
NOAA	Applications of Regional Forecasts	3.6	3.7	3.7
NOAA	Atmospheric Chemistry	6.6	6.7	6.7
NOAA	Carbon Cycle Science	4.7	4.8	4.8
NOAA	Climate Change Data and Detection	4.4	6.7	6.8
NOAA	Climate Dynamics and Experimental Prediction	17.3	17.7	17.7
NOAA	Climate Variability and Predictability (CLIVAR)	19.3	20.2	20.3
NOAA	Global Energy and Water Cycle Experiment (GEWEX)	4.8	5.7	5.7
NOAA	Human Dimensions of Global Change Research	1.9	1.9	1.9
NOAA	Paleoclimatology*	2.2	0.0	0.0
NOAA	Health of the Atmosphere**	0.8	0.0	0.0
NOAA	Climate Observations and Services		11.0	24.0
DOC Total***		66.7	79.5	
President's Request				92.7

* The Paleoclimatology Program is included in the Climate Change Data and Detection Project beginning in FY01.

** Contribution to NOAA Health of the Atmosphere Program ends in FY00.

*** FY00 total reflects appropriation less rescission of \$400K.

NOAA National Oceanic and Atmospheric Administration

Areas of Global Change Research. NOAA's global change efforts are designed to provide a predictive understanding of the climate system and its modes of variability, and to advance the application of this information in climate-sensitive sectors through a suite of process research, observations and modeling, and application and assessment activities. Specifically, NOAA's research program includes ongoing efforts in operational in situ and satellite observations with an emphasis on oceanic and atmospheric dynamics, circulation, and chemistry; understanding and predicting ocean-land-atmosphere interactions, the global water cycle, and the role of global transfers of carbon dioxide among the atmosphere, ocean and terrestrial biosphere in climate change; improvements in climate modeling, prediction, and information management capabilities; the projection and assessment of variability across multiple timescales; the study of the relationship between the natural climate system and society and the development of methodologies for applying climate information to problems of social and economic consequences; and archiving, management, and dissemination of data and information useful for global change research.

FY 2002 Program Highlights: NOAA research will continue to advance understanding of the whole-system dynamics and modes of climate variability, and the application of information generated by this research to decisionmaking processes in climate-sensitive regions and sectors. For FY 2002, NOAA requests new resources for Climate Observations and Services. The new funding will support: 1) regional assessments, education, and outreach; 2) contributions to climate change assessments; 3) observational and modeling efforts to improve forecasting of weather-climate connections at subseasonal time scales; 4) atmospheric carbon sampling over North America and analysis studies; and 5) enhancements to the global ocean observing system for climate. FY 2002 program highlights in support of the USGCRP research elements include:

Atmospheric Composition:

- Characterizing the “ozone-friendliness” of substitutes for ozone-depleting gases, developing methods for the detection of the recovery of the ozone layer, and characterizing the regional variance of tropospheric ozone and its role in the heat budget.
- Quantifying the trends and sources/sinks of long-lived greenhouse gases, and characterizing the fundamental processes that control the shorter-lived radiative species.
- Advancing efforts to reduce uncertainties in the understanding of direct radiative forcing by tropospheric aerosols through an integrated program focused on targeted in situ measurements of aerosols integrated with model analyses.

Climate Variability and Change:

- Increasing understanding of the role in climate variability, and the predictability, of the El Niño-Southern Oscillation, the North Atlantic (or Arctic) Oscillation, Tropical Atlantic Variability, the Pacific Decadal Oscillation, and the Pan-American monsoons.
- Continuing the advancement of the sustained global ocean observing system to support Climate Variability and Predictability (CLIVAR) research, operational and experimental climate forecasting, and the major scientific assessments.
- Advancing the improvement of models and modeling systems for climate prediction at all timescales and the ability to provide regional-scale forecasts and predicted probabilities of extreme weather events.
- Advancing detailed studies of past climate variability on seasonal to centennial time scales using century to millennia-long paleoenvironmental proxy records in order to improve the current understanding of seasonal to decadal variability.
- Developing and applying advanced statistical techniques to detect climate change signals and attribute these to specific causes.

Global Carbon Cycle:

- Advancing efforts to produce more accurate projections of future atmospheric CO₂ concentrations by better parameterization of transfers of CO₂ between ocean, atmosphere, and terrestrial biosphere, and development of dynamic, coupled carbon cycle models.
- Initiating observations and modeling necessary to quantify the magnitude and variability of the Northern Hemisphere terrestrial sink, with an initial focus on large scale observations over the North American continent and adjacent ocean basins.

- Continuing to document the inventory of carbon in the ocean as it accumulates, and characterize how that inventory might be affected by changes in ocean circulation in the future.

Global Water Cycle:

- Investigating the role of land surfaces on the predictability of warm season precipitation over North America, with emphasis on seasonal and interannual variability.
- Completing studies in the Missouri River Basin showing how the land surface effects on the atmosphere are modulated by large-scale atmospheric circulation.
- Completing the characterization of regional water and energy budgets over the Mississippi River Basin.
- Implementing observational activities and data assimilation products needed to support the GEWEX Coordinated Enhanced Observing Period, and developing the data sets and parameterizations necessary to extend the Land Data Assimilation System (LDAS) developed for the United States to the entire globe.

Human Dimensions of Global Change:

- Advancing understanding of societal vulnerability and current coping mechanisms related to climate variability on seasonal up to decadal time scales (including climate extremes and surprises), and the potential use of climate information for economic, management, and policy planning purposes.
- Advancing efforts to foster the application of forecast information in climate-sensitive regions and sectors such as agriculture, water resources, energy, marketing, human health, and transportation infrastructure.

Related Research. In addition to focused USGCRP research, related activities include advance short-term weather forecasting and warning services; marine ecosystem research; prediction and observation systems in support of weather and seasonal to interannual climate forecasts; and facilitating the dissemination of global change information.

Mapping of Budget Request to Appropriations Legislation: In the Departments of Commerce, Justice, and State, the Judiciary, and Related Agencies Appropriations Bill, NOAA activities are funded under Title II—Department of Commerce and Related Agencies, within the NOAA Operations, Research, and Facilities account. In Appropriations Committee reports, funding for NOAA’s USGCRP activities is the Climate and Global Change line-item within Oceanic and Atmospheric Research.



Department of Defense

Areas of Global Change Research. The Department of Defense does not support dedicated Global Change Research, but continues a history of participation in the USGCRP through sponsored research that concurrently satisfies National Security requirements and stated Goals of the USGCRP. A non-inclusive summary of unique Defense research and infrastructure associated with the USGCRP is described below. Because these efforts are not part of the OMB Global Change Research Program construct, a budget table is not included. All data and research results are routinely made available to the civil science community.

FY 2002 Program Highlights. This summary of contributing Defense research and infrastructure is framed in terms of the USGCRP Program Elements.

Atmospheric Composition. The Naval Research Laboratory's Special Sensor Ultraviolet Limb Imager, scheduled for launch late 2001, will provide long-term baseline data for investigations of global change in the upper atmosphere. Analysis and prediction of world-wide aerosol concentrations, including desert dust, biomass smoke, marine and anthropogenic aerosols, and a radiative transfer algorithm yielding atmospheric transmission coefficients is generated by the Navy Aerosol Analysis and Prediction System [NAAPS].

Climate Variability and Change. Several DoD funded projects under the aegis of the National Oceanographic Partnership Program [NOPP] contribute directly to USGCRP goals. The Ocean Acoustic Observatory Federation involves government and private research organizations to exploit data from active and retired Navy Sound Surveillance System [SOSUS] stations for ocean acoustic tomography and thermometry measurements in the Eastern Pacific. This effort capitalizes on previous work done under the Acoustic Thermometry of Ocean Climate [ATOC] project. Another NOPP research effort, Estimating the Circulation and Climate of the Ocean [ECCO] is underway now to describe ocean transport and transport fluctuations of heat, volume, and freshwater and their relationship to air-sea fluxes. The DoD High Performance Computing [HPC] Challenge is sponsoring two relevant projects: a high resolution coupled atmosphere-ocean-ice model, the Coupled Environmental Model Prediction [CEMP] system, and a 1/32-degree global ocean nowcast/forecast model.

The Distributed Ocean Data System [DODS] is another NOPP-sponsored effort to facilitate data access by providing a transparent interface to recognize and process data in various formats. The DODS plug-and-play feature simplifies access via the internet. DODS software is free; details are available at <http://www.unidata.ucar.edu/packages/dods/>.

Navy continues to support the International Arctic Buoy Programme [IAGP]. These data are available at <http://iabp.apl.washington.edu>. Data and model output fields are available from the GODAE World Wide Web server at <http://www.usgodae.fnmoc.navy.mil>. The Defense Modeling and Simulation Office [DMSO] World Wide Web site <http://mel.dmsomil> provides access to a variety of environmental and geospatial data and

models. The multiagency MEDEA group will continue to bridge the national security and civil community for access to classified environmental data.

Global Water Cycle. Three space-based remote-sensing projects are on track to provide high resolution atmospheric and oceanographic data to the military and civil communities. First, WindSat is scheduled for launch late in 2001 with a polarimetric microwave radiometer sensor to measure vector winds over the ocean. Planning for the Naval EarthMap Observer [NEMO] mission is underway to provide hyperspectral data to characterize the global littoral. And Navy and NASA are jointly developing a mission to demonstrate geosynchronous imaging spectrometer technology. This project will launch in 2004 and carry the Navy Indian Ocean Meteorology and Oceanographic Imager [IOMI] and NASA's Geosynchronous Imaging Fourier Transform Spectrometer [GIFTS] sensor packages.

Terrestrial and Marine Ecosystems. Several research efforts coordinated under the NOPP umbrella comprise the Ocean Biological Information System [OBIS]. The OBIS is a public-private partnership and a new component of the UN Global Biodiversity Information Facility [GBIF]. Navy is directly investing in the development of new, in-water instruments capable of measuring biological and chemical properties of the sea associated with the fine structure of biological and chemical dynamics via the Thin Layers (Critical Scales) Program. The Strategic Environmental Research and Development Program [SERDP] is supporting related research to develop long-lived miniaturized sensors to measure terrestrial and marine ecosystem parameters.

Related Research and Infrastructure. Other DOD-sponsored research and supporting infrastructure, not described above, also contribute to observing, understanding and predicting environmental processes related to global change. Associated research programs include theoretical studies and observations of solar phenomena, monitoring and modeling of unique features in the middle and upper atmosphere, terrestrial and marine environmental quality research, and energy conservation measures.

DOD's continued investment in environmental infrastructure such as the Oceanographic Research Vessel Fleet, the Cold Regions Research and Engineering Laboratory, and the various services' operational oceanographic and meteorological computational centers will continue to provide data and services useful to the USGCRP.

Mapping of Budget Request to Appropriations Legislation. In the Department of Defense Appropriations Bill, research associated with the USGCRP is funded under Title IV – Research, Development, Test and Evaluation. In Appropriations Committee reports, nearly all funding is included within the budget for Defense Research Sciences.



Department of Energy

DOE	Program Title	FY00	FY01	FY02 Request
BER	Climate & Hydrology	67	70	71
BER	Atmospheric Chemistry & Carbon Cycle	26	26	27
BER	Ecological Processes	12	12	12
BER	Human Interactions	8	8	8
BER	Small Business Innovative Research/ Technology Transfer (SBIR/STTR)	0	3	3
DOE Total		113	119	121
President's Request				121

BER Biological and Environmental Research Program

Areas of Global Change Research. Research supported by DOE's Office of Biological and Environmental Research (BER) addresses the effects of energy production and use on the global Earth system, primarily through studies of climate response. It includes research in climate modeling, atmospheric chemistry and transport, atmospheric properties and processes affecting the Earth's radiation balance, and sources and sinks of energy-related greenhouse gases (primarily CO₂). It also includes research on the consequences of atmospheric and climatic changes on ecological systems and resources, critical data needs for the detection and attribution of climate change, and tools and methods needed to conduct scientific assessments of climate change, and education and training of scientists and researchers in global change.

FY 2002 Program Highlights. DOE supports global change research at its National Laboratories and other public and private research institutions, including universities. In FY 2002, DOE, along with the other USGCRP agencies, will continue to integrate the frontiers of climate and computational science to accelerate progress in climate simulation model development, testing, and application. In support of the USGCRP, highlights of the BER global change program include activities in the following four key areas:

Climate and Hydrology. DOE will continue the development of advanced diagnostics and an on-line diagnostic library to evaluate the ability of climate models to simulate and predict climate variability and change. To better connect observational and modeling research programs, DOE will implement a parameterization testbed that will facilitate the development and implementation of improved physics modules into climate models. Additionally, extensive effort will be directed toward advancing the computational, numerical, and software engineering aspect of climate models as part of the

Scientific Discovery through Advanced Computing Program in DOE's Office of Science.

Using data collected at the Atmospheric Radiation Measurement (ARM) Cloud and Radiation Testbed sites, DOE's ARM Program will continue measurement and modeling efforts to improve the radiative flux calculations and associated heating rates in climate models.

DOE will conduct an experiment in the Walnut River watershed to advance land-surface hydrology and climate models at regional (large watershed) scales. The focus will be on developing and demonstrating improved methods to evaluate components of the water budget. Winter and summer storm events will be studied in conjunction with ongoing water and carbon flux and meteorological measurements, and a prototype water isotope measurement and modeling effort will be implemented. DOE will also develop capability in Single Column Model and test General Circulation Models to assess their ability to account for cloud water distribution determined from ARM site observational data streams. This effort will lead directly to improved cloud parameterization schemes in climate models and to supporting precipitation prediction efforts being evolved under the USGCRP.

Atmospheric Chemistry and Carbon Cycle. DOE will continue the support of field, laboratory, and modeling studies to improve our understanding of the atmospheric processes associated with transport, transformation, and dispersion of energy-related emissions and their effects on air quality and climate, including studies of oxidants, aerosols, and the heterogeneous chemistry of these materials. It will also include studies of the dispersion of energy-related materials through the lower troposphere to help understand the fundamental processes that control vertical transport for stable and transition boundary layers and how pollutants move through these layers in the lower atmosphere.

Research in both terrestrial and marine environments will be continued to improve understanding of the global carbon cycle. DOE will continue field CO₂ enrichment experiments (FACE), observations of net CO₂ exchange between the atmosphere and biosphere (AmeriFlux), and dynamic modeling of the carbon cycle and its relationship to climate influences. This research will focus on biophysical controls, biogeochemical mechanisms and climate-related feedbacks of terrestrial carbon cycling. Data from experiments and tested carbon cycle models will be used for predictions of future atmospheric CO₂ change and for estimating quantity and longevity of carbon sequestration by terrestrial ecosystems. Support for experiments and AmeriFlux measurements continues to be a high priority. DOE also will continue to fund the development and application of new molecular biological probes to carbon and nitrogen cycles in nearshore marine environments. A field experiment combining a range of new probes with biogeochemical rate measurements and satellite imagery will be planned for a well-characterized nearshore site.

Ecological Processes. A continuing weak link in understanding effects of environmental change on ecosystem structure and functioning is a lack of ecosystem-scale experiments available to both parameterize and test ecosystem models. The DOE global change program will continue to support large-scale and long-term experimental field manipulations of environmental factors in several terrestrial ecosystems throughout the United States. Key studies include: (a) the Throughfall Displacement Experiment

(TDE), started in 1993 in a deciduous forest in eastern Tennessee; and (b) several Free-Air CO₂ Enrichment (FACE) experiments initiated since 1995. The TDE will be continued to document further the effects of chronic changes in precipitation on forest processes and structure, and will be used to test several ecosystem models in the coming year. DOE-supported FACE experiments include those in both deciduous and evergreen forest plantations, a desert ecosystem, and artificial plant communities constructed to test hypotheses about the role of biodiversity in regulating plant-community responses to elevated CO₂. The combination of elevated CO₂ with elevated O₃ is being studied in one FACE experiment (initiated in 1998), providing unique data on forest responses to multiple changes in the troposphere. These large-scale experiments (TDE and FACE) are needed to develop confidence in—and improve scientific understanding represented by—ecological models, which form the basis of most assessments of ecological responses to environmental change. Thus, DOE will support model development and evaluation parallel to the experimental programs, and will also support laboratory research needed to explain results in the ecosystem-scale field experiments.

Human Dimensions. The DOE human dimensions program will continue its support of fundamental research to develop and improve data, models, and methods that can be used by others to analyze and assess the implications of various policy options and questions relevant to climate change. The FY 2002 focus areas will include: developing data and methods for use in assessing the benefits and costs of enhancing terrestrial carbon sinks, estimating the costs of non-CO₂ greenhouse gas mitigation, and assessing the influence of invention and diffusion of new technologies on greenhouse gas emissions. DOE also will continue support of the Carbon Dioxide Information and Analysis Center (CDIAC), to enable it to respond to data and information requests from users from all over the world who are concerned with the greenhouse effect and global climate change. The CDIAC will pay special attention in FY 2002 to data needs associated with carbon flux, regional air pollution, and ocean data.

Related Research: DOE plays a major role in carbon sequestration research to slow the increase in atmospheric concentrations of energy-related greenhouse gases, especially carbon dioxide, and their emissions to the atmosphere. The research builds on but is not part of the USGCRP. It focuses on developing the understanding needed both to enhance the net carbon sequestration of excess CO₂ from the atmosphere in terrestrial and ocean systems and to assess the potential environmental consequences and ancillary benefits. DOE (in collaboration with NSF) will support an iron-fertilization experiment in the Southern Ocean, the largest high nutrient-low chlorophyll region in the world's oceans, focusing on quantifying the amount of carbon that is exported to the deep ocean—a prerequisite for carbon sequestration.

Mapping of Budget Request to Appropriations Legislation: In the Energy and Water Development Appropriations Bill, DOE USGCRP activities are funded under Title III, Department of Energy, within the Energy Supply, Research, and Development Activities account. In Appropriations Committee reports, funding for DOE's USGCRP programs is included within the Biological and Environmental Research account.



Department of Health and Human Services / National Institutes of Health

HHS/NIH	Program Title	FY00 Actual	FY01 Estimate	FY02 Request
NIEHS	Human Health Effects of Exposure to UV Radiation and CFC Replacement Chemicals	5.2	5.7	6.2
NEI	Health Effects of UV Radiation	14.0	15.8	17.7
NCI	Health Effects of UV Radiation	28.2	29.8	32.8
NIAMS	Health Effects of UV Radiation	0.3	0.3	0.3
HHS/NIH Total		47.7	51.6	
President's Request				57.0

- NIEHS National Institute of Environmental Health Sciences
- NEI National Eye Institute
- NCI National Cancer Institute
- NIAMS National Institute of Arthritis and Musculoskeletal and Skin Diseases

Areas of Global Change Research. Three NIH institutes support research on the health effects of UV and near-UV radiation. Their principal objectives include an increased understanding of the effects of UV and near-UV radiation exposure on target organs (e.g., eyes, skin, immune system) and of the molecular changes that lead to these effects, and the development of strategies to prevent the initiation or promotion of disease before it is clinically defined. In addition, NIEHS supports research on the health effects of CFC replacement chemicals, including studies on the metabolism and toxicity of HCFCs and halogenated hydrocarbons.

FY 2002 Program Highlights. The NIEHS program supports grants and intramural projects that investigate the effects of UV exposure on the immune system, aging process, sensitive tissues such as the retina and skin, and methods to reduce these harmful effects. Other projects involve the comparison of mutagenic potential in bacteria of UV and near-UV radiation at levels found in natural sunlight and at levels anticipated with a 15 percent depletion of stratospheric ozone. Several projects supported by NIEHS are investigating molecular changes in DNA that lead to aberrations and mutations in human tissue, rodents, fruit flies, and bacteria, and the variety of ways these organisms repair damage to DNA resulting from UV exposure.

The NEI supports studies on the impacts of UV radiation on the eye (retinal damage as well as corneal capacity). A major initiative is underway to determine how and why eye cataract develops and to search for ways to prevent or slow the progression of cataract, an age-related eye disease that affects 17-20 million people globally. This project is investigating the role of UVB radiation, which has been implicated as a specific risk factor in cataract development. Another important area of research is the under-

standing of certain detoxification systems in the eye and how they combat damage from UVB radiation. The goal of this effort is to identify drugs that might have therapeutic or preventative applications.

The NCI is supporting a wide range of studies to characterize the etiology, biology, immunology, and pathology of a variety of changes in the skin (morphological effects that might precede skin cancer), including photoaging, non-melanoma skin cancers, and melanoma caused by exposure to UV radiation. Other research is exploring UV-induced immunosuppression, which is critical to the development of UV-induced skin tumors, and the cellular and molecular basis for the genetic predisposition to UVB-induced skin cancer in people with Basal Cell Nevus Syndrome.

The NIAMS supports basic and clinical research on the effect of UVA and UVB radiation on skin.

Related Research. In addition to research areas that are designated as part of the USGCRP budget, NIEHS conducts research related to other impacts of global change on human health, including the effects of environmental and occupational exposures to air pollution, agricultural chemicals, and materials used in technologies to mitigate or adapt to climate change. Exposures of special concern include those that contribute to the greatly increased incidence of childhood asthma and that disrupt the normal functioning of the endocrine system. Renewed concern about emerging and reemerging infectious diseases has prompted increased attention to a variety of diseases whose incidence would be affected by environmental change. Other HHS agencies provide significant resources for research on the prevention of and treatment for water-, food- and vector-borne diseases, such as cholera, salmonella, encephalitis, malaria, dengue, and Lyme disease.

Mapping of Budget Request to Appropriations Legislation. In the Departments of Labor, Health and Human Services, and Education and Related Agencies Appropriations Bill, USGCRP activities are funded under the NIH section of Title II—Department of Health and Human Services.



Department of the Interior / U.S. Geological Survey

DOI Request	Program Title	FY00	FY01	FY02
USGS	Global Change Research	26.7	27.0	22.0
DOI/USGS Total President's Request		26.7	27.0	22.0

USGS U.S. Geological Survey

Areas of Global Change Research. Research at the Department of the Interior's U.S. Geological Survey (USGS) contributes directly to the USGCRP's intellectual framework of a whole-system understanding of global change (i.e., the interrelationships among climate, ecological systems, and human behavior). The USGS examines terrestrial and marine processes and the natural history of global change, including the interactions between climate and the hydrologic system. Studies seek to understand the character of past and present environments and the geological, biological, hydrological, and geochemical processes involved in environmental change.

The USGS supports a broad area of global change research, with a focus on understanding the sensitivity of natural systems and impacts of climate change and variability, surficial processes, and other global change phenomena on the Nation's lands and environments at the regional scale. Specific goals of the program are: to improve the utility of global change research results to land management agencies; to emphasize monitoring the landscape and developing technical approaches to identifying and analyzing changes that will take advantage of a burgeoning archive of remotely sensed and in situ data; and to emphasize the response of biogeographic regions and features, particularly montane, coastal, and inland wetland ecosystems.

FY 2002 Program Highlights.

Climate Variability and Change. USGS climate history research focuses on understanding the rates and magnitudes of decadal to millennial-scale natural changes in climate and determining how those changes have affected the environment. Emphasis is on the Holocene (last 10,000 years). Historical perspectives of past changes in landscapes and ecosystems and their relation to human activities are developed. Reconstruction of land-use histories, records of fire frequency, changing climate, and shifts in plant communities give a unique perspective on current environmental trends and help to distinguish the human imprint on ecosystems and landscapes. Research in hydroclimatology monitors trends in the accumulation and dissipation of snow and ice stored in selected U.S. benchmark glaciers; investigates the relations between climatic conditions and regional hydrologic variability, including long-term patterns and trends in hydrologic extremes; and develops improved procedures for simulating hydrologic processes and conditions in global climate models.

The Global Carbon Cycle. USGS conducts a broad range of carbon cycle research focused on North America, principally in four topical areas: biogeochemical cycling in lakes,

streams and wetlands; carbon cycling and sequestration in soils and sediments; land cover trends; and climate-vegetation change history and modeling, all with a focus on DOI lands. Biogeochemical cycling research is developing an understanding of the interactive influence of climate and ecosystems on carbon cycling by understanding the exchanges of water, energy, and nutrients between the atmosphere and land surface. The processes that control the cycling and fate of carbon and other nutrients in soils, rivers, lakes, reservoirs, and estuarine systems are critical to understanding carbon fluxes. Understanding of the role of land-use change and associated erosion and sedimentation processes on carbon storage in soil and sediments is key to determining human influences on carbon cycling. Research in Alaska is developing an understanding of boreal soil carbon dynamics and the historic and modern interactions among climate, surface temperature and moisture, fire, and carbon sequestration. Land cover trends research is developing an understanding of rates, patterns, and impacts of landscape changes in North America and their consequences for carbon stocks. Vegetation change research is developing a detailed history of vegetation change and models of possible future changes in North America to better understand future carbon stocks.

Changes in Ecosystems. USGS ecosystems research focuses on impacts on terrestrial and coastal ecosystems and fish and wildlife by determining the exposure, sensitivity, and adaptive capacity of natural systems and ecological processes to multiple environmental factors, including climate and other natural and anthropogenic influences at the local, landscape, regional, and continental scale. Research provides the scientific knowledge and technologies for conservation, rehabilitation, and management of ecosystems needed by public land management agencies. Land surface characterization includes research and development of techniques to monitor, analyze, describe, and predict land use, land cover, and other surface characteristics data. These data sets are used to characterize and map the Earth's surface, model land surface processes, detect changes over time, project the response of the land surface to changes in climate and other environmental influences, and investigate the impact of land-cover changes on the environment. Research to understand the causes and consequences of land-cover change is also conducted, in part, to improve model development and application.

Satellite Data Management and Dissemination. The USGS also operates and continually enhances the capabilities of the EROS Data Center to serve as the National Satellite Land Remote Sensing Data Archive, by maintaining existing datasets, adding new ones, and converting older data sets from deteriorating media to modern, stable media. This archive supports all research components that investigate the land surface and the ecosystems it supports.

Related Research. DOI also sponsors contributing research programs addressing the collection, maintenance, analysis, and interpretation of short- and long-term land, water, biological, and other geological and biological processes and resources through dispersed observing networks; research in land use and land cover, including creation of maps and digital data products; and inventorying and monitoring of biological habitats, resources, and diversity.

Mapping of Budget Request to Appropriations Legislation. In the Interior and Related Agencies Appropriations Bill, DOI USGCRP activities are funded under Title I-Department of the Interior. Funding for U.S. Geological Survey USGCRP programs is included within the USGS Survey, Investigations, and Research account.



Environmental Protection Agency

EPA	Program Title	FY00	FY01	FY02 Request
ORD	Assessment of Consequences of Climate Variability and Change	18.0	20.0	20.0
ORD	Changes in Ecosystems	3.0	3.0	2.0
EPA Total		21.0	23.0	
President's Request				22.0

ORD Office of Research and Development

Areas of Global Change Research. EPA's Global Change Research Program is an assessment-oriented program with primary emphasis on understanding the potential consequences of climate variability and change on human health, ecosystems, and socioeconomic systems in the United States. This entails: (1) improving the scientific basis for evaluating effects of global change in the context of other stressors and human dimensions (as humans are catalysts of and respond to global change); (2) conducting assessments of the risks and opportunities presented by global change; and (3) assessing adaptation options to improve society's ability to respond effectively to the risks and opportunities presented by global change as they emerge.

FY 2002 Program Highlights. The program has made a major commitment to the National Assessment activities organized through the USGCRP. The Global Change Research Act of 1990 mandates that the USGCRP conduct periodic assessments of the potential consequences of global change, to be conducted not less than every four years. As part of the first U.S. National Assessment of the Potential Consequences of Climate Variability and Change, EPA helped to successfully produce the Mid-Atlantic and Great Lakes Regional Assessments and Human Health Assessment. The Gulf Coast Regional Assessment is ongoing. All of the EPA-sponsored assessments fed into the Overview and Foundation documents for the first U.S. National Assessment. EPA will continue to make significant contributions to the ongoing U.S. National Assessment process. EPA will continue to sponsor these regional and sectoral assessments through cooperative agreements with universities. The EPA-sponsored assessments will continue to be conducted through public-private partnerships that actively engage researchers from the academic community, decisionmakers, resource managers, and other affected stakeholders in the assessment process.

EPA's intramural assessment program has four areas of emphasis: (1) human health; (2) air quality; (3) water quality; and (4) ecosystem health. These four focus areas are consistent with EPA's mission and the strengths of EPA's research program:

Human Health. Since health is affected by a variety of social, economic, political,

environmental, and technological factors, assessing the health impacts of global change is a complex challenge. As a result, health assessments in EPA's Global Program go beyond basic epidemiological research to develop integrated health assessment frameworks that consider the effects of multiple stresses, their interactions, and human adaptive responses. Along with health sector assessments conducted in conjunction with the USGCRP National Assessment process, there are research and assessment activities focused on the consequences of global change on weather-related morbidity and vector- and water-borne diseases. In addition, the results from the Global Program's air quality assessments will be used to evaluate health consequences.

Ecosystems. The EPA's mission is not only to protect human health but also to safeguard the natural environment. EPA has pledged to provide environmental protection that "contributes to making communities and ecosystems diverse, sustainable, and economically productive." Consistent with this goal, EPA's Global Program has planned three research and assessment activities that evaluate the effects of global change on 1) aquatic ecosystems (which may include lakes, rivers, and streams; wetlands; and estuaries and coastal ecosystems); 2) invasive non-indigenous species; and 3) ecosystem services. EPA's assessments of the effects of global change on aquatic ecosystems will use as input the research being done by other USGCRP agencies on marine and terrestrial ecosystems. Thus, EPA's ability to complete its assessments successfully depends crucially upon the ability of other USGCRP agencies to complete their related research and assessment activities.

Air Quality. Few studies have investigated the effect of global change on air quality. Given EPA's legal mandates with respect to air pollution and substantial capability and expertise in modeling air quality and evaluating integrated response actions, examining the effects of global change on air quality is a logical focus of the Global Program. Assessments are planned that will examine the potential consequences of global change on tropospheric ozone and particulate matter. The air quality assessments will provide input to related human health assessments.

Water Quality. Water quality is affected by changes in runoff following changes in precipitation and evapotranspiration and/or changes in land use. The program plans assessments of the possible impacts of global change (climate and land-use change) on water quality. The water quality assessments will either contribute to or benefit from Human Health and Ecosystems assessments.

Intramural and extramural research contribute to assessments. To capitalize on expertise in the academic community, a significant portion of the program's resources are dedicated to extramural research grants administered through the STAR (Science to Achieve Results) grants program. The STAR program focuses on two principal areas related to global change research—science to support assessments of consequences of global change and human dimensions research. EPA will continue to coordinate closely with other USGCRP agencies that support human dimensions research to identify the specific topics that should be emphasized within the STAR program.

Related Research. In addition to the focused USGCRP activities, EPA conducts research that contributes to the characterization and understanding of risks to ecosystems and to human health. The ecosystem-based research is designed to understand and predict ecosystem exposure, responses, and vulnerabilities to high-risk chemicals and non-chemical stressors (e.g., invasive species, genetically altered organisms) at multiple

scales of biological organization and geographic scales. The research in human health is oriented toward assessing the cumulative health risks to humans (e.g., cancer, reproductive, cardiovascular), including high-risk subpopulations (e.g., children), from chemical stressors emanating from multiple sources. Both of these major research areas will be impacted by and are inextricably interrelated with climate change.

Mapping of Budget Request to Appropriations Legislation. In the Departments of Veterans Affairs and Housing and Urban Development, and Independent Agencies Appropriations Bill, EPA USGCRP activities are funded under the EPA section of Title III – Independent Agencies, within the Science and Technology account. Appropriations Committee report language may specify more directly the funding for global change research.



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NASA	Program Title	FY 2000 Enacted	FY 2001 Planned	FY 2002 Request
	Ecological Processes (Terrestrial Ecology)	16.9	16.9	16.9
	Land Cover and Use Change (Ecology and Atmospheric Chemistry)	6.3	6.2	6.3
	Stratospheric Chemistry	18.3	16.9	16.7
	Atmospheric Chemical Modeling	7.1	7.2	7
	Tropospheric Chemistry	8.7	9.4	9
	Radiation Science Program	9.6	10.9	7.9
	Land Surface Hydrology/Water cycle (Water Cycle Processes)	6.3	6.3	6.3
	Atmospheric Dynamics & Remote Sensing	4.9	5.8	5.1
	Physical Oceanography & Ocean Modeling	8.1	8.6	8.5
	Biological Oceanography (Ocean Biogeochemistry)	4.7	4.7	4.7
	Polar Programs	6.3	6.6	5.5
	Global Modeling and Analysis Program (Global Atmos Model & Analysis)	7.2	7.6	7.3
	Global Data Integration & Validation (Global Change Data Analysis)	4	4.1	3.7
	Interdisciplinary Research and Analysis	15.6	18.1	25
	Global Water Cycle	0	5	8
	Global Carbon Cycle	0	5	5
	Global Ocean Research (includes NOPP)	1	3	4
	Aircraft Emissions	0	4	4
	EOS Science	55	48.4	54.3
	GLOBE	5	5	5
	Mission Analysis Program	40.8	47.2	40.6
	Ocean Color Data Purchase/Sea WIFS	2.5	2.7	2.2
	Pathfinder Science Studies	3.7	4.2	0.0
NASA	Global Change Science Program	231.8	253.6	252.9
	Earth System Science Pathfinder	90	111.5	84
	EOS Data and Information Systems (EOS DIS)	278.9	281.4	252.7
	EOS Flight Development (less Tech Inf.)	348.9	335.2	357.9
	EOS Special Spacecraft	121.1	111.2	56.4
	Information Systems	7.6	9.7	13.6
	LANDSAT		10.3	1.4
	1.7			
	Mission Operations	47.6	57.8	52.3
	Total Ozone Mapping Spectrometer (TOMS)	24.5	0.1	0.0
NASA	Global Change Hardware Development	928.9	908.3	818.6
NASA Total	President's Request	1160.7	1161.9	1071.5

Areas of Global Change Research. The mission of NASA's Earth Science Enterprise (ESE) is to develop a scientific understanding of the Earth system and its response to natural and human-induced changes to enable improved prediction of climate, weather, and natural hazards for present and future generations. NASA provides the research and technology employed by NOAA and others who provide these predictive services to the Nation. NASA has mapped out a new Research Strategy for the next decade to address the questions:

How is the Earth changing, and what are the consequences for life on Earth?

- How is the global Earth system changing?
- What are the primary causes of change in the Earth system?
- How does the Earth system respond to natural and human-induced changes?
- What are the consequences of change in the Earth system for human civilization?
- How well can we predict future changes in the Earth system?

The five component questions follow a logical scientific progression of variability, forcings, responses, consequences, to prediction. Under each of the five are a set of detailed questions, 23 in all, that reflect thematic research areas that are well-aligned with the USGCRP program elements, as described below. While in the past, NASA's Earth science programs were observation-driven, the Research Strategy is question-driven, and NASA is rebalancing its investment portfolio across observations, research, analysis & modeling, applications demonstration, and advanced technology development in order to answer the selected science questions. NASA will address the USGCRP research program elements, such as Climate Variability and Change, the Global Water Cycle, and the Global Carbon Cycle, in terms of the above questions.

Recent Accomplishments: The past two years have been the most productive in the history of NASA's Earth Science Enterprise, as measured by its contribution of top science discoveries internationally. Major accomplishments include:

- Demonstrated ability for 2-day storm formation prediction with QuikSCAT;
- Observed influence of Arctic polar stratospheric clouds on ozone in SOLVE aircraft campaign;
- Tested a coupled ocean-atmosphere model using observations of the 1997-99 El Niño/La Niña, and began use in prediction experiments;
- Completed a model of Pacific Ocean circulation employing temperature, salinity and velocity data;
- Successfully launched Terra, ACRIMSAT, SRTM, NOAA-L, GOES-L, and EO-1;
- Conducted 3 major international scientific field campaigns (SOLVE, SAFARI, PACRIM)

FY 2002 Program Highlights. Through the end of FY 2002, ESE plans to launch QuikTOMS, Aqua, Jason-1, SAGE III (on Russia's Meteor-3M), GRACE, ICESat, SORCE and SeaWinds (on Japan's ADEOS-2). In addition, NASA will continue implementation of its Research Strategy, consonant with the USGCRP's Long-term Plan. The following describes expected progress by question.

How is the global Earth system changing?

- Combine analysis of global water vapor, precipitation, and wind data sets to decipher variations (and possible trends) in the cycling of water through the atmosphere and their relation to sea surface temperature changes.
- Establish a quantitative relationship between vegetative indices time series derived from the AVHRR and MODIS instruments to ensure long-term continuity and comparability of time series.

What are the primary causes of change in the Earth system?

- Provide the first comprehensive multi-instrument, multi-angle integrated data set for the study of sources and sinks and distribution of tropospheric aerosols over land.
- Characterize the role of land-cover changes associated with natural fires in determining the carbon balance of ecosystems in two major boreal forest areas.

How does the Earth system respond to natural and human-induced changes?

- Near decade-long sea surface topography time series will be assimilated into a high resolution Pacific Ocean model to elucidate the mechanisms of the Pacific Decadal Oscillation and its impact on seasonal to decadal climate variations.
- Map the surface velocities at their outlets of at least 10 major outlet glaciers draining West Antarctica and at least 10 draining East Antarctica.

What are the consequences of change in the Earth system for human civilization?

- Demonstrate impact of assimilation of TRMM rainfall data on forecasting track and intensity of tropical storms by showing improvement in near real-time hurricane and typhoon forecasts in a variety of cases and conditions.
- Increase the coverage of space-based maps of coral reef distribution by 25 percent beyond current estimates by using remote-sensing imagery.

How well can we predict future changes in the Earth system?

- Document in peer-reviewed literature the quantified impact of satellite altimeter observations on improving 12-month El Niño forecasts with a state-of-the-art coupled ocean-atmosphere model.

Scientific Research: The priorities embodied in NASA's ESE Research Strategy for 2000-2010 reflect the national priorities identified by the National Research Council in several recent reports, including Global Environmental Change: Research Pathways for the Next Decade and Atmospheric Science in the 21st Century. ESE manages its research along thematic areas that map readily to USGCRP research program elements as follows.

USGCRP Program Element

Climate Variability and Change
Atmospheric Composition
Global Water Cycle
Changes in Ecosystems / Global
Carbon Cycle

ESE Research Theme

Oceans and Ice in the Earth System
Atmospheric Chemistry, Aerosols, and Solar Radiation
Global Water and Energy Cycle
Biology and Biogeochemistry of Ecosystems and the
Global Carbon Cycle

NASA's Earth Science Enterprise has rebalanced its portfolio of investment among research, observing and information systems, and other areas to increase the percentage of investment in sponsored research from 17 percent in 1998 to a target of 25 percent. This change reflects two recent developments. First is the movement from a "data poor" to a "data rich" environment with the deployment of EOS. Second is a strategic shift from being principally a supplier of observations to an emphasis on answering the science questions posed in the Research Strategy.

Space and Suborbital Observations & Information: NASA remains the principal supplier of global to regional-scale observations for global change research, both through research satellites and the operational weather satellites built and launched by NASA for NOAA. Deployment of the Earth Observing System is well underway, with LANDSAT 7, QuikSCAT, Terra, and ACRIMsat already in orbit and providing science data. Terra, Aqua (late 2001/early 2002) and Aura (2003) are the larger, multi-instrument EOS missions, and are accompanied by a series of smaller missions such as ICESat (ice sheet topography), Jason (ocean topography), and SORCE (solar irradiance). Complementing EOS' long-term monitoring for the study of variability and trends are a series of small, focused Earth Explorer missions to study forcings and responses in the Earth system. These include the Earth System Science Pathfinder missions such as VCL (vegetation canopy), GRACE (Earth's geoid), PICASSO (3-D aerosol profiles) and Cloudsat (3-D cloud profiles). Satellite data are compared with data from a variety of aircraft and balloon-borne instruments for both remote sensing and in situ measurements. Major scientific field campaigns using these suborbital platforms study Arctic ozone depletion, regional and cross-regional aerosol transport, and hurricane formation. The EOS Data and Information System (EOSDIS) is 90 percent complete and is processing and distributing data products from the current EOS satellites. In FY 2000, EOSDIS provided more than 8 million data products in response to 1.5 million user requests. EOSDIS processes more data from Terra in a single day than the Hubble Space Telescope generates in a year. NASA has begun planning for the evolution of data and information system services to support Earth science over the next decade.

Related Research: Outside the scope of the USGCRP, NASA's Earth Science Enterprise also conducts research and observing missions to study the solid Earth and related natural hazards. ESE also manages an applications demonstration program in partnership with State and local governments, academia, and industry to test new uses of remote-sensing data to solve practical societal problems in food and fiber production, infrastructure planning, flood hazard assessment, and other areas.

Mapping of Budget Request to Appropriations Legislation. In the Departments of Veterans Affairs and Housing and Urban Development, and Independent Agencies Appropriations Bill, National Aeronautics and Space Administration USGCRP activities are funded under the NASA section of Title III-Independent Agencies, as part of the Science, Aeronautics, and Technology account. Within this account, Appropriations Committee reports specify funding for the Earth Science program.



National Science Foundation

Program Title	FY 2000 Actual	FY 2001 Plan	FY 2002 Request
Antarctic Ecosystems	1.00	1.00	1.00
Arctic System Science (ARCSS)	14.25	10.50	8.80
Carbon Cycling	5.20	9.49	16.41
Climate Modeling, Analysis & Prediction (CMAP)	13.43	14.13	14.22
Climate Variability and Predictability (CLIVAR)	15.87	20.52	21.57
Coastal Long-Term Ecological Research (LMER /cLTER)	3.15	3.15	3.15
Earth System History (ESH)	19.32	17.53	17.54
Ecological Diversity	6.65	6.65	6.65
Ecological Rates of Change (EROC)	3.15	3.15	3.15
GEODATA	2.78	2.96	3.97
Global Ocean Ecosystems Dynamics (GLOBEC)	14.90	16.13	16.18
Global Tropospheric Chemistry Program (GTCP)	14.33	15.11	15.22
Greenhouse Gas Dynamics (GGD)	0.20	0.20	0.20
Human Dimensions of Global Change (HDGC)	13.65	13.65	13.65
Joint Global Ocean Flux Study (JGOFS)	7.94	6.54	5.04
Methods and Models for Integrated Assessment (MMIA)	3.38	2.82	2.53
Ocean Observation, Data Assimilation, and Modeling (OODAM)	4.59	6.67	7.77
Polar Ozone Depletion/UV Radiation Effects	4.18	1.50	1.50
Regional Research Institutes	3.20	3.60	3.60
Ridge Interdisciplinary Global Experiments (RIDGE)	3.33	1.33	0.03
Sea-Level Changes	6.23	6.00	0.00
Solar Influences	7.37	7.74	7.78
Water Cycle		0.60	3.00
Water and Energy: Atmospheric, Vegetative, and Earth Interactions (WEAVE)	9.68	9.71	9.72
World Ocean Circulation Experiment (WOCE)	9.07	6.17	4.17
NSF Total	186.85	186.85	
President's Request			186.85

Areas of Global Change Research. NSF programs address global change issues through investments in challenging ideas, creative people, and effective tools. In particular, NSF global change research programs support research and related activities to advance the fundamental understanding of dynamic physical, biological, and human systems and the interactions among them. The programs encourage interdisciplinary activities with particular focus on Earth system processes and the consequences of change. NSF programs facilitate data acquisition and information management activi-

ties necessary for fundamental research on global change, and promote the enhancement of models designed to improve our understanding of Earth system processes and interactions and to develop advanced analytic methods to facilitate basic research. NSF also supports fundamental research on the general processes used by organizations to identify and evaluate policies for mitigation, adaptation, and other responses to the challenge of varying environmental conditions.

FY 2002 Program Highlights. During FY2002, NSF will support research and related activities addressing all six of the USGCRP program elements and the interdisciplinary science aspects that link them. As in preceding years, NSF will continue to invest in collaborative international programs such as the World Climate Research Programme, the International Geosphere-Biosphere Programme, and the International Human Dimensions Programme.

A major focus on atmospheric composition and chemistry will continue through programs in tropospheric chemistry. Studies of atmospheric transport of aerosols will provide insights into how aerosols affect the radiative and cloud nucleating properties of the atmosphere, and ultimately the climate.

In concert with its agency partners, NSF will continue its emphasis on climate variability and change. This is a major activity for the Agency and consists of support for observational campaigns and numerous analytical and modeling activities, as well as paleoclimate studies. A number of ocean and atmospheric science projects will address topics identified in the CLIVAR implementation plans. Ocean science studies will address superannual changes in ocean structure, ocean circulation and ocean-atmosphere coupling to improve the present, relatively poor, understanding of the role of the ocean in climate, and should lead to the development of better climate models. In addition, improved coupled atmosphere/ocean models will incorporate parameterizations of land-surface processes and biogeochemistry. Continued support of the second generation community climate model will provide opportunities for U.S. climate scientists to understand better the climate and its variability.

NSF is increasing its support for studies of the carbon cycle. In FY 2002 NSF will take the first steps to implement a globally integrated carbon cycle research portfolio to encourage cooperative research among atmospheric, marine, geological, and ecological scientists to understand the key processes underlying carbon cycling. As an element of the effort, ocean sciences will support the JGOFS Synthesis and Modeling Project and SOFEX, a complex mesoscale fertilization experiment in the Southern Ocean, and continue several CO₂ observational time-series activities (Hawaii and Bermuda ocean stations, and atmospheric CO₂ and O₂ observational programs).

Water pervades nearly all environmental issues and clearly requires a comprehensive approach. NSF is one of the several agencies supporting global water cycle research and will focus on key aspects with its available resources. NSF programs will emphasize the development of hydrologic and atmospheric models to simulate the water cycle and to understand the processes that control it.

Several programs will address aspects of land-use and land-cover change as important aspects of global change. Ecological rates of change and related species diversity, Arctic systems and their temporal variability, water and energy influences on vegetative systems, and diverse human influences exemplify program components related to land

use and land cover.

Several NSF programs will focus on terrestrial and marine ecosystems through observational and laboratory studies. NSF will continue to support the collection of terrestrial and marine ecosystem data through its Long-Term Ecological Research programs. In addition, studies will continue in terrestrial ecosystem functions and landscape ecology. The Global Ocean Ecosystem Dynamics program will continue to study the impact of the global ocean environment on marine ecosystems. In FY 2002 experimental research will focus on the Northwest Atlantic, Northwest Pacific, and Southern Ocean.

Related Research. In addition to the research focused on global change, NSF will continue to support research on broader topics that are closely related to global change. These include, *inter alia*, studies of the atmosphere, ocean, land surface, ecosystems, and human dimensions that add substantively to the specific programs supporting USGCRP objectives. Thus, much NSF research support may be considered “contributing research.”

Mapping of Budget Request to Appropriations Legislation. In the Departments of Veterans Affairs and Housing and Urban Development, and Independent Agencies Appropriations Bill, NSF USGCRP activities are funded under the NSF section of Title III – Independent Agencies within the NSF Research and Related Expenses account.



Smithsonian Institution

SI	Program Title	FY00	FY01	FY02 Request
NMNH/STRI	Long-Term Environmental Change	1.6	1.6	1.6
SAO/NASM/SERC	Monitoring Natural Environmental Change	1.2	1.2	1.2
NZP/NMNH/SERC	Biological Responses	4.2	4.2	4.2
Smithsonian Total		7.0	7.0	
President's Request				7.0

- NASM National Air and Space Museum
- NMNH National Museum of Natural History
- NZP National Zoological Park
- SAO Smithsonian Astrophysical Observatory
- SERC Smithsonian Environmental Research Center
- STRI Smithsonian Tropical Research Institute

Areas of Global Change Research. Within the Smithsonian Institution, global change research is conducted at the Smithsonian Astrophysical Observatory, the National Air and Space Museum, the Smithsonian Environmental Research Center, National Museum of Natural History, Smithsonian Tropical Research Institute and National Zoological Park. Research is organized around themes of atmospheric processes, ecosystem dynamics, observing natural and anthropogenic environmental change on daily to decadal time scales, and defining longer-term climate proxies present in the historical artifacts and records of the museums as well as in the geologic record at field sites. The Smithsonian Institution program strives to improve knowledge of the natural processes involved in global climate change, provide a long-term repository of climate-relevant research materials for present and future studies, and to bring this knowledge to various audiences, ranging from scholarly to lay public. The unique contribution of the Smithsonian Institution is a long-term perspective, e.g., undertaking investigations that may require extended study before producing useful results and conducting observations on sufficiently long (e.g., decadal) timescales to resolve human-caused modification of natural variability.

FY 2002 Program Highlights.

Atmospheric Composition: Researchers at SAO will study stratospheric trace species that play an important role in ozone photochemical cycles using balloons, airplanes, and satellites. Solar activity and irradiance are being studied to understand better the climatic effects of solar variability. At SERC, measurements will be made of spectral UV-B in Maryland (>25-year record), Florida, Arizona, and other sites in the United States. These data will be disseminated electronically to meet the needs for assessing

the biological and chemical impact of varying UV exposure.

Climate Variability and Change: Ongoing global sea-level change is being estimated by SAO using space geodetic measurements. Research at NASM emphasizes the use of remote-sensing data to improve theories of drought, sand mobility, soil stability, and climate change in the eastern Sahara. Studies at NMNH and STRI focus on the paleoecology of climate change.

Changes in Ecosystems: Several SI programs will examine biological responses to global change. At SERC, research will be conducted on the responses of global ecosystems to increasing CO₂ (also a contribution to the **Global Carbon Cycle** program), exotic species introductions, and solar UV. At STRI, research will be conducted on the effects of climate change (including CO₂ increase) on tropical ecosystems. Biodiversity education and research will be performed at STRI, NMNH and NZP. Tropical biodiversity research programs monitor global change effects through repeated sampling of flora and fauna in tropical forests, and identifying the physical and biological processes of growth and decline of species. Other studies on ecosystem response to increasing habitat fragmentation will be conducted at NZP.

Human Dimensions of Global Change: The general public and research community will be informed of global change research conducted by the Smithsonian and other USGCRP agencies via exhibits, such as the planned “Forces of Change: Global Links” display at NMNH, educational programs, and a global change information Web page.

Related Research. Many global change research projects at the Smithsonian are supported by other private and public sources. These projects are nonetheless organized around the USGCRP program elements and thus amplify the scope and impact of research supported by direct Federal appropriation. Other contributing activities include research conducted by several units within the Smithsonian in a variety of habitats concerning natural and human-induced variations in species, populations-communities, and ecosystems. These studies help clarify the relative importance of global change effects as one of several agents of ecological change. Studies of environmental change over long time periods are aided by the Institution’s collections. Utilized by researchers around the world, these materials provide raw data for evaluating changes in the physical and biological environment that occurred before human influences.

Mapping of Budget Request to Appropriations Legislation. In the Interior and Related Agencies Appropriations Bill, Smithsonian Institution USGCRP activities are funded in the SI section of Title II—Related Agencies, within the Salaries and Expenses account. Appropriations Committee reports specify funding for a Sciences line item component of this account, which includes USGCRP programs.