

APPENDIX: THE FY 1999-2001 USGCRP BUDGET BY AGENCY AND PROGRAM

The first table in this Appendix presents the FY 2000-FY2001 USGCRP budget by Program Element, showing each agency's budgetary contribution to each element. The budget pages for individual participating departments and 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 2001 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 FY2000 appropriated funds and the FY 2001 budget request are estimates only, and are subject to change 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 department or 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 and the Appropriations process is complex and not easily summarized.

U.S. Global Change Research Program

FY 2000 – FY 2001 Budget by Program Element by Agency
(Discretionary budget authority in \$millions)

AGENCY	DOC/NOAA Science	Obs.	DOE	DOI/ USGS	EPA	HHS/ NIH	NASA Obs.	NASA Science	NSF	SI	USDA	Total
Program Element												
Understanding the Climate System												
FY00	41.1	0.0	63.2	0.0	0.0	0.0	251.4	58.8	83.7	0.4	0.0	498.6
FY01	41.1	19.8	69.5	0.0	0.0	0.0	208.8	62.3	83.5	0.4	0.0	485.4
Understanding the Composition and Chemistry of the Atmosphere												
FY00	8.8	0.0	14.6	0.0	0.0	0.0	273.7	56.4	18.7	0.3	15.4	387.9
FY01	8.8	1.0	12.6	0.0	0.0	0.0	252.7	53.7	18.7	0.3	17.6	365.4
Global Water Cycle												
FY00	5.0	0.0	4.0	0.0	0.0	0.0	205.4	49.4	9.7	0.0	0.3	273.8
FY01	5.0	1.9	3.0	0.0	0.0	0.0	228.7	59.5	9.7	0.0	0.3	308.1
Global Carbon Cycle												
FY00	4.6	0.0	13.3	3.3	0.0	0.0	113.6	40.6	13.1	0.3	15.4	204.2
FY01	4.6	5.3	15.6	3.5	0.0	0.0	104.6	45.0	13.1	0.3	37.2	229.2
Understanding Changes in Ecosystems												
FY00	0.0	0.0	10.8	13.4	3.0	0.0	93.0	30.6	29.0	3.8	22.0	205.6
FY01	0.0	0.0	10.8	13.9	3.0	0.0	101.9	32.0	29.0	3.8	29.2	223.6
Understanding the Human Dimensions of Global Change												
FY00	5.2	0.0	8.2	0.0	17.6	46.0	0.0	0.0	14.0	0.6	0.0	91.6
FY01	5.2	0.0	7.8	0.0	19.7	48.0	0.0	0.0	14.0	0.6	0.0	95.3
Paleoclimate: The History of the Earth System												
FY00	2.3	0.0	0.0	6.4	0.0	0.0	0.0	0.0	19.3	1.6	0.0	29.6
FY01	2.3	0.0	0.0	4.0	0.0	0.0	0.0	0.0	19.5	1.6	0.0	27.4
Agency Totals												
FY00	67.0	0.0	114.1*	23.0*	20.6	46.0	937.1	235.8	187.5	7.0	53.1	1,691.4*
FY01	67.0	28.0	119.3*	21.4*	22.7	48.0	896.7	252.5	187.5	7.0	84.6	1,734.7*

* Excludes \$4.0 million for DOI/USGS data management and \$3.1 million for the DOE SBIR/STTR program in FY 2000 and FY 2001.



Department of Agriculture

USDA	Program Title	FY99	FY00 Estimate	FY01 Request
ARS	Agriculture and Rangeland Global Change	11.4	11.4	14.4
ARS	Methyl Bromide Research	14.4	14.4	16.0
ARS	Carbon Cycle Research	0.0	0.9	5.0
CSREES	Improved Response Models	6.4	6.4	11.9
CSREES	UV-B Monitoring Network	1.0	1.0	1.6
ERS	Economic Incentive Carbon Sequestration	0.0	0.0	0.7
ERS	Economics of Global Change and Agriculture	0.8	0.8	0.8
FS	Forest Global Change Research	16.9	16.9	16.9
FS	Carbon Cycle Science	0.0	0.0	3.0
NRCS	Soil Carbon Studies	1.2	1.2	1.5
NRCS	Soil Surveys and Inventories	0.0	0.0	12.0
ARS	Regional, Sectoral, and National Assessments	0.0	0.0	0.8
USDA Total		52.1	53.0	
President's Request				84.6

- ARS Agricultural Research Service
- CSREES Cooperative State Research, Education, and Extension Service
- ERS Economic Research Service
- FS Forest Service
- NRCS Natural Resources Conservation 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 and examines how agricultural and forestry activities can contribute to a reduction in greenhouse gases.

FY 2001 Program Highlights. In FY 2001, USDA will increase its carbon cycle research program. As part of the interagency Carbon Cycle Science Program, USDA will collaborate with other Federal agencies to conduct research to better understand how agricultural practices affect the net carbon balance and develop methods which will assist farmers, ranchers, and forest landowners to increase carbon sequestration. Special emphasis will be given to measurement of the effects of management and conservation practices on carbon storage in cropland and grazing lands. Basic research will define the mechanisms by which soil carbon is lost to the atmosphere or transferred to stable carbon pools. USDA will also identify and quantify carbon sources, sinks and fluxes for all U.S. forest land, including marginal agricultural land and other potential conversion land-use types.

ARS will continue to focus on four broad research areas: 1) experimental determinations of the direct effects of rising atmospheric CO₂ levels, increasing temperatures, and

their interaction with the physiology and performance of crop plants and with ecosystem processes that control productivity of grazing lands; 2) carbon and nitrogen cycling and fluxes between the terrestrial surface and the atmosphere, including sequestration of carbon in soils and vegetation; 3) changes in hydrological processes associated with climate change that may impact water quality, efficiency of use by crops, and availability for industry, urban use, and irrigated agriculture; and 4) the development of simulation models with required inputs for predicting responses of crops, watersheds, and managed ecosystems to global change.

CSREES will continue to support the USDAUV-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 CREES's National Research Initiative (NRI) Competitive Grants Program aims to increase understanding of the possible impacts of global environmental change on the sustainability of agriculture and forestry.

ERS will continue its analysis of the agricultural links to biodiversity, land-use change, and the ability to satisfy increased demands for agricultural goods and services while minimizing damage to the world's natural resources. Research will also assess the potential farm sector impacts of changing weather variability and farmer adaptation to changing environmental conditions.

FS global change research focuses on determining how atmospheric changes and potential climatic change may affect forest productivity, forest health, and species distributions. Ecosystem-scale experiments involving increased CO₂ and other environmental factors have begun at several sites representing major U.S. forest types. As the uncertainty in model predictions is reduced, analysts are describing likely socioeconomic effects of global change on forests in the various regions of the U.S. In FY 2001 the Forest Service will enhance its long term research on forest and grassland carbon cycles, with particular emphasis on the soil component. This enhanced carbon research effort will result in better information for use by forest resource managers to improve carbon cycle management on their lands.

NRCS will collect data necessary to build validated, verified baseline soil carbon inventories and assess policy driven impacts on soil carbon stocks at national, regional, and field-level scales. NRCS goals include establishing baseline soil carbon levels under various covers/management systems; developing a "use-dependent" soil carbon database integrated with national soils databases; collecting soil carbon data on a sample-based inventory frame for national and regional level inventory estimation; and testing the use of models and field collection of soil carbon data.

Related Research. In addition to focused USGCRPresearch, the USDA sponsors research contributing to the assessment of global change effects on the agricultural food and fiber production systems and the forest and forest ecosystems of the U.S. 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.

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 Agricultural Research Service (ARS), Cooperative State Research, Education, and Extension Service (CSREES) Research and Education Activities, and Economic Research Service (ERS) accounts; and under Title II-Conservation Programs, within the Natural Resources Conservation Service (NRCS) Conservation Operations account. In the Interior and Related Agencies Appropriations Bill, USDA USGCRP activities are funded in the USDA Forest Service (FS) section under Title II-Related Agencies, within the FS Forest Research account.



Department of Commerce / National Oceanic and Atmospheric Administration

DOC	Program Title	FY99	FY00	FY01 Request
NOAA	Aerosols Project	1.1	1.1	1.1
NOAA	Applications of Regional Forecasts	3.5	3.5	3.5
NOAA	Atmospheric Chemistry Project	6.6	6.6	6.6
NOAA	Carbon Cycle Science	3.9	4.9	4.9
NOAA	Climate Change Data and Detection	4.6	4.6	4.6
NOAA	Climate Dynamics and Experimental Prediction	16.5	18.2	18.5
NOAA	Climate Variability (CLIVAR)	17.0	18.0	18.0
NOAA	Human Dimensions of Global Change Research	1.7	1.7	1.7
NOAA	Global Energy and Water Cycle Experiment (GEWEX)	5.0	5.0	5.0
NOAA	Health of the Atmosphere*	0.8	0.8	0.8
NOAA	Paleoclimatology	2.3	2.3	2.3
NOAA	Climate Observations and Services**	0	0	28.0
DOC Total		63.0	66.7	
President's Request				95.0

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

** The NOAA USGCRP budget is now a combination of the Climate and Global Change Program and Climate Observations and Services; the requested FY01 increase is directed almost entirely toward Climate Observations and Services.

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 hydrological 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 2001 Program Highlights. In FY2001, NOAA will continue to advance understanding of: 1) whole-system dynamics and modes of climate variability, for example the El Niño-Southern Oscillation (ENSO) and the North Atlantic Oscillation (NAO); and 2) the application of information generated by this research to decision-making

processes in climate-sensitive regions and sectors, such as agriculture, water management, hydropower, human health, and transportation infrastructure. In addition, NOAA will launch a new Climate Observations and Services program that will emphasize the transition of research data, observing systems, and understanding from experiments to applications, and from basic science to practical products. In FY2001 NOAA will focus on climate monitoring capabilities and will: 1) begin deployment of a Climate Reference Network to monitor precisely fundamental variables such as temperature and precipitation across the U.S.; 2) implement critical upgrades and enhanced measurement programs at NOAA's atmospheric baseline observatories; 3) extend the global ocean observational networks to provide data critical for the modeling of seasonal climate variations such as El Niño and the modeling of long-term climate variations; and 4) improve climate data information access and products.

FY 2001 program highlights include the following:

- Improving regional-scale modeling and the prediction of seasonal to interannual variability over North America.
- Increasing understanding of the role of the Atlantic Ocean in climate changes, with an initial focus on the relationship between tropical Atlantic variability and the North Atlantic Oscillation.
- Continuing the advancement of a sustained Atlantic observing system to support CLIVAR research.
- Advancing the improvement of models and modeling systems for seasonal to interannual climate prediction and the ability to provide regional-scale forecasts and predicted probabilities of extreme events.
- Developing a comprehensive understanding of the effects of land-surface forcing on climate during the full annual cycle and the effects of orography on precipitation and water supply in the Missouri River Basin.
- Advancing detailed studies of past climate variability on seasonal to centennial timescales using century to millennia-long paleoenvironmental proxy records in order to improve the current understanding of seasonal to interannual variability.
- Developing and applying advanced statistical techniques to detect climate change signals and attribute these to specific causes.
- Increasing our understanding of the global transfers of CO₂ between the atmosphere, ocean, and terrestrial biosphere, thereby helping to constrain predictions of the uptake of anthropogenically-released CO₂ within these reservoirs, with an initial focus on the sinks of carbon in the North American continental region.
- 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.
- 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.
- Advancing our understanding of societal vulnerability and current coping mechanisms related to climate variability on seasonal up to decadal timescales (including climate extremes and surprises), and the potential use of climate information for planning purposes.

- Advancing existing efforts to foster the application of forecast information in climate-sensitive regions and sectors such as agriculture, water management, energy, 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 formal USGCRP budget crosscut, a budget table is not included.

FY 2001 Highlights. This summary of Defense research and infrastructure describes DoD contributions to the USGCRP in the following three areas:

1) Observations. Ocean Acoustic Observatories, now in place and programmed, employ acoustic thermometry techniques to generate ocean temperature profiles along basin-scale source-receiver transects.

The North Pacific Acoustic Laboratory project capitalizes on networks previously installed by the Acoustic Thermometry of Ocean Climate (ATOC) project and extant Navy SOSUS arrays. Estimates of basin-scale sound speed (temperature) combined with altimetric and other data types clearly demonstrate the potential to improve understanding of gyre-scale ocean variability on seasonal and longer time scales.

The Arctic Climate Observations using Underwater Sound (ACOUS) project is a similar ocean thermometry project operating in the Arctic Ocean. This unique Navy program is included in the framework of the U.S.- Russia Joint Commission on Economic and Technical Cooperation (nee Gore-Primakov Commission).

Under the aegis of the multi-agency National Oceanographic Partnership Program (NOPP), a Pilot Project to assess the value, cost, and options to provide access to declassified Navy SOSUS data for civil research and education activities is planned for FY 2000-2002.

A unique program to use systems analyses techniques to develop optimal observing strategies is planned. This approach will use in-situ and remotely sensed data as well as synthetic data bases to construct optimal data collection schemes and data fields for operational and research models.

Navy continues to support the International Arctic Buoy Programme (IABP). The data and other products of the IABP are available on the World Wide Web at <http://iabp.apl.washington.edu>.

The Memorandum of Agreement between Navy and NSF was revised to continue Arctic research opportunities using available nuclear submarine platforms on a not-to-interfere basis.

A long term U.S. Research Vessel Fleet Plan is currently under development by the Office of Naval Research, NSF, and NOAA.

2) Data Assimilation. Several research efforts are underway to develop optimal, yet computationally efficient, methods to directly assimilate in-situ, remotely sensed, and

synthetic observations/data into operational and research models. Initial efforts with satellite altimetry have been successful. Another effort is developing a relocatable, three-dimensional, multi-variate data assimilation scheme for ocean and atmosphere models. Extending this latter approach to fine-scale, multi-layer, ocean-atmosphere-coupled models is planned.

New computer code to process daily solar magnetic field data was transitioned to the Kitts Peak, Arizona, National Solar Observatory and installed as a regular operating procedure. During the current solar maximum, this data assimilation scheme will allow a superior description/prediction of space weather systems.

The Navy Fleet Numerical Meteorology and Oceanography Center is operating the GODAE World Wide Web server in return for near real time ocean drifter buoy data. This is a win-win event for the research and operational communities.

3) Modeling. The Navy's Polar Ice Prediction System (PIPS) continues to be improved. A fully operational 9-kilometer resolution coupled model employing multi-level thermodynamics over an expanded domain should be operational in 2001. This National model is expected to provide high-resolution operational forecasts of sea-ice extent and internal Arctic ice pack features, and generate realistic model initialization and boundary conditions for climate modeling. Results from the recently completed multi-agency Surface Heat Budget of the Arctic (SHEBA) project were incorporated in the PIPS model upgrade as well as other ocean and atmosphere modeling research.

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 multi-agency MEDEA group will continue to bridge the national security and civil community for access to classified environmental data.

All data and research results are routinely made available to the civil science community.

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 1V – 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	FY 99	FY00	FY01 Request
BER	Climate & Hydrology	65.8	67.2	72.3
BER	Atmospheric Chemistry & Carbon Cycle	24.0	26.8	26.9
BER	Ecological Processes	13.7	11.9	12.0
BER	Human Interactions	8.1	8.2	8.2
BER	Small Business Innovative Research/ Technology Transfer (SBIR/STTR)	—	3.1	3.1
DOE Total President's Request		111.6*	117.2	122.5

* Excludes \$2.8M which was transferred to the SBIR program and \$0.2M which was transferred to the STTR program in FY1999.

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 2001 Program Highlights: The DOE Biological and Environmental Research program utilizes the unique, multidisciplinary facilities and capabilities of the DOE National Laboratories. BER supports global change research at these and other public and private research institutions, including universities. In FY2001, 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 includes activities in the following four key areas:

- **Climate and Hydrology:** DOE will continue observational and analytical research to acquire and interpret the data needed to describe the radiation balance from the surface of the Earth to the top of the atmosphere, to determine the atmospheric characteristics responsible for this balance, to improve the parameterization of the formation and evolution of clouds in climate models, and to see this understanding reflect-

ed in the improvement of climate models. This includes maintaining and operating Cloud and Radiation Testbed facilities in the central Great Plains, the north slope of Alaska, and in the Western Tropical Pacific. Additional new resources are requested by DOE in FY2001 for climate modeling to substantially reduce the uncertainties in decade-to-century model-based projections of climate change and to increase the availability and utility of climate change simulations to the broader climate research and assessment communities.

- **Atmospheric Chemistry and Carbon Cycle:** DOE will continue field research and modeling activities to understand and document the net exchange of carbon dioxide between major terrestrial ecosystems and the atmosphere, to identify the biophysical processes controlling the net exchange, and to develop and test carbon cycle models for use in simulating the exchange of carbon between terrestrial ecosystems and the atmosphere. Support for an expanded AmeriFlux network of CO₂ flux measurement sites and for process studies at these sites will be a priority. In the Atmospheric Science area, research will focus on acquiring the data to understand the atmospheric processes that control the transport, transformation, and fate of energy-related chemicals and particulate matter. Field and laboratory studies will be supported in both atmospheric chemistry and environmental meteorology to acquire the data needed to develop and test models used to simulate and predict the transport, transformation, and fate of energy-related emissions in the atmosphere.
- **Ecological Processes:** In FY2001, the DOE global change program will continue to support long-term experimental studies using, for example, the Free-Air CO₂ Enrichment (FACE) facilities to document the response of intact terrestrial ecosystems to alterations in climate and atmospheric composition, especially increasing concentrations of CO₂.
- **Human Dimensions:** The focus of research by DOE in this area in FY2001 will be on developing and improving methods and tools for use in conducting integrated analyses of the climate change system from emissions of aerosols and greenhouse gases to the consequences of these emissions on climate and the resulting effects of human-induced climate change on economic and social systems. The research is intended to fill critical gaps in current integrated assessment modeling, including modeling of technology innovation and diffusion for the prediction of greenhouse emissions over long time scales. It also includes research to develop metrics and measures of economic costs of climate change for the purpose of comparing alternative policies or options for coping with or mitigating climate change. Finally, research will be supported on autonomous adaptation, i.e., that which may occur naturally in, for example, unmanaged ecosystems, or adaptation taken by individuals in response to actual or perceived climate change and to understand individual adaptation alternatives.

Related Research: DOE plays a major role in the President's Climate Change Action Plan to reduce greenhouse gas emissions through changes in energy supply and improvements in energy efficiency and conservation. Although it builds on but is not

part of the USGCRP, research to understand how to enhance carbon sequestration in terrestrial and marine ecosystems and the potential environmental consequences of enhancing the sequestration in these systems are part of the Climate Change Technology Initiative.

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	FY99	FY00	FY01 Request
NIEHS	Human Health Effects of Exposure to UV Radiation and CFC Replacement Chemicals	5.0	5.4	5.6
NEI	Health Effects of UV Radiation	10.7	12.2	12.8
NCI	Health Effects of UV Radiation	24.3	27.8	29.5
NIAMS	Health Effects of UV Radiation	0.0	0.3	0.3
HHS/NIH Total President's Request		39.9	45.7	48.1

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

Areas of Global Change Research. Four 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 2001 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.

A major NEI 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 NEI research is the understanding 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, 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.

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, 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 for FY2001 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

DOI	Program Title	FY99	FY00	FY01 Request
USGS	Global Change Research	26.7	27.0	25.4
	DOI TOTAL President's Request	26.7	27.0	25.4

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.

FY 2001 Program Highlights. In FY 2001, the USGS will support ongoing efforts across 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. In direct support of USGCRP, the USGS includes activities in the following areas:

Biogeochemical Cycling - Research is developing an understanding of 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 issues related to erosion, sediment transport, biogeochemical budgets, snowpack chemistry, surface hydrology, and climate response.

Carbon Cycle - Studies are developing a quantitative understanding of the role of land-use change and associated erosion and sedimentation processes on carbon storage and nutrient cycles within the Mississippi Basin. Rates of organic carbon accumulation, erosion, and burial are used to develop whole-basin models of these

dynamic relationships.

Climate History - 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.

Hydroclimatology - This research consists of monitoring trends in the accumulation and dissipation of snow and ice stored in selected U.S. benchmark glaciers.

Impacts on Terrestrial and Coastal Ecosystems, Coastal Wetlands, and Fish and Wildlife – This research determines the sensitivity and response of natural systems and ecological processes to multiple environmental factors, including existing climate and natural and anthropogenic impacts, at the local, landscape, regional, and continental level. It provides the scientific knowledge and technologies for conservation, rehabilitation, and management of sustainable ecosystems needed by land management agencies of the Federal and state governments.

Land Surface Characterization – This area includes research and development of techniques to monitor, analyze, describe, apply, and predict land use, land cover, and other surface characteristics data. Data sets are used to characterize and map the Earth’s surface, model land surface processes, detect changes over time, and forecast the response of the land surface to changes in climate, environment, land use, and land cover.

Satellite Data Management and Dissemination - The USGS continues to operate and enhance the capabilities of the EROS Data Center to serve as the National Satellite Land Remote Sensing Data Archive, by maintaining existing datasets, adding new data sets, and converting older data sets from deteriorating media to modern, stable media.

Terrestrial Earth Surface Processes - Research examines the impact of climatic variability and change on earth surface processes, including vegetation change, soil and sediment dynamics, and carbon sequestration. A detailed history of vegetation change in the western U.S. and southern Alaska is being constructed.

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	FY99	FY00 Enacted	FY01 Request
ORD	Assessment of Consequences of Climate Variability and Change	16.0	17.6	19.7
ORD	Biology and Biogeochemistry of Ecosystems	0.0	3.0	3.0
EPA Total President's Request		16.0	20.6	22.7

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 effectively respond to the risks and opportunities presented by global change as they emerge.

FY 2001 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 for the United States. (These periodic assessments are to be conducted not less than every four years.) As a member of the USGCRP, EPA's Global Program will continue to make significant contributions to the ongoing U.S. National Assessment Process. The EPA-sponsored assessments will continue to be conducted through public-private partnerships that actively engage researchers from the academic community, decision makers, 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.

The first of four focus areas is Human Health. Because 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 USGCRPNational 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. In FY 2001, the program's focus will be on the assessment of the effects of climate change on weather-related morbidity.

The second focus area is 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 is considering comprehensive ecosystem issues related to global change. Three research and assessment activities are planned 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. The assessment of aquatic ecosystems will contribute to water quality assessments of pollutants and pathogens and of biocriteria. The ecosystem services assessment will draw on work from the other ecosystem assessments. In FY2001, the program's focus will be on the assessment of the effects of global change on aquatic ecosystems.

The third focus area is 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. Each of these assessments is paired with a related human health assessment. In FY 2001, the program's focus will be on the assessment of the effects of global change on tropospheric ozone.

The fourth focus area is 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 two assessments of the possible impacts of global change (climate and land use change) on water quality. Both water quality assessments will either contribute to or benefit from human health and ecosystems assessments. In addition, results from the assessment of pollutants and microbial pathogens will be used in the assessment of biocriteria.

Intramural and extramural research contribute to all of EPA's assessments. In an attempt 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.

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 (e.g., invasive species, genetically altered organisms) stressors at multiple scales of biological organization and geographic scales. The research in human health is oriented towards assessing the cumulative health risks (e.g., cancer, reproductive, cardiovascular) to humans, 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 1999 Enacted	FY 2000 Planned	FY 2001 Request
Atmospheric Chemical Modeling	7.2	7.0	7.0
Atmospheric Dynamics & Remote Sensing	5.5	5.1	5.1
Biological Oceanography	4.4	4.7	4.7
Ecological Processes	16.9	16.9	16.9
EOS Science	46.4	55.0	52.2
Global Data Integration & Validation	3.4	3.7	3.7
Global Modeling and Analysis Program	7.7	7.3	7.3
GLOBE	5.0	5.0	5.0
Interdisciplinary Research and Analysis	15.7	16.4	20.7
Global Water Cycle	0.0	0.0	5.0
Global Carbon Cycle	0.0	0.0	5.0
Global Ocean Research (incl. NOPP)	0.0	1.0	3.0
Land Cover and Use Change	5.0	6.3	6.3
Land Surface Hydrology/water cycle	5.8	6.3	6.3
Mission Analysis Program	40.6	41.9	50.0
Ocean Color Data Purchase/Sea WIFS	2.5	2.6	2.7
Pathfinder Science Studies	3.5	3.5	0.0
Physical Oceanography & Ocean Modeling	8.5	8.5	8.5
Polar Programs	5.4	6.5	6.5
Radiation Science Program	7.7	9.9	10.9
Stratospheric Chemistry	17.4	19.2	16.7
Tropospheric Chemistry	9.0	9.0	9.0
NASA Global Change Science Program	217.5	235.8	252.4
Earth System Science Pathfinder	62.3	94.5	105.9
EOS Data and Information Systems (EOS DIS)	261.7	261.9	252.0
EOS Flight Development (less Tech Inf.)	410.5	370.8	397.9
EOS Special Spacecraft	116.0	120.4	86.7
Information Systems	6.1	7.6	9.7
LANDSAT	17.0	9.6	1.4
Launch Services	4.2	0.0	0.0
Mission Operations	49.6	47.6	42.7
Total Ozone Mapping Spectrometer (TOMS)	9.9	24.8	0.5
NASA Global Change Hardware Development	937.3	937.2	896.8
NASA USGCRP Budget	1,154.8	1,173.0	1,149.2

Areas of Global Change Research. NASA research efforts in global change involve space-based studies of the Earth as an integrated system, including research and satellite programs studying atmospheric chemistry and ozone; ocean surface winds, tropical precipitation and the global hydrological cycle and climate variability cycle; and the global carbon cycle, ocean biological productivity and land surface vegetation and ecosystems.

The space-based activity complements ongoing ground-based research programs in the observation, understanding, and modeling of radiation, climate dynamics, and hydrology and water resources; ecosystem dynamics and biogeochemical cycles; atmospheric chemistry; and the processing, archiving, retrieval, dissemination, and use of global change data. The focus is Earth system science, which involves interdisciplinary research and coupled modeling. Development of algorithms for retrieval of the information content of space-based, remotely-sensed observations is carried out as part of the flight mission.

FY 2001 Program Highlights. The overall goal of NASA's Earth Science Enterprise (ESE) is to understand the Earth system and the effects of natural and human-induced changes on the global environment. To preserve and improve the Earth's environment for future generations, policies and decisions worldwide should have the strongest possible scientific basis. The vantage point of space provides information that is obtainable in no other way about the Earth's land, atmosphere, ice, oceans, and biota, as well as the impact of humans on the Earth system.

The science and observations of ESE are becoming increasingly important as nations work to meet the demand for economic progress by a growing global population. In addition, remote sensing has the potential to improve dramatically crop and forest yield predictions, seasonal and interannual climate forecasts, urban planning, mineral exploration, fisheries management, and many other activities of socioeconomic importance. In concert with the global change research community, the ESE is utilizing the vantage point of space to lead the development of knowledge required to support the complex national and international policy decisions that lie ahead.

This edition of *Our Changing Planet* continues to divide the ESE budget into two main components: (1) scientific research; and (2) the budget associated with satellite, aircraft, and balloon measurements, operations, and data processing and distribution (including mission costs such as launch, flight, instrument and technology development, fabrication assembly, integration, and testing, as well as mission operation support).

Scientific Research. The scientific research component of the ESE budget is supported by an integrated science plan that relates research plans to space observations, and fully integrates the Earth Observing System (EOS) and non-EOS science. EOS is a program of multiple spacecraft and interdisciplinary science investigations, designed to provide a 15-year data set of key parameters needed in order to understand global climate change. The major themes of NASA's ESE Science Research Plan are consistent with the newly refined USGCRP Program Elements for FY 2000-2001.

Against the backdrop of the overall ESE effort to better understand the state and health of the Earth's life-support systems, NASA's FY 2001 research will target specific research issues important to national and international environmental and economic security. Through increases in Interdisciplinary Research and Analysis funding and targeted augmentations in the Radiation Science component of the Research & Analysis Program, NASA will participate in the new interagency Global Water and Energy Cycle

Science Program. New research will focus on exploiting data from new satellites (i.e., EOS Terra, Landsat 7, VCL, EO-1) to document the role of land-cover change, ecosystem disturbances, and interannual variability in terrestrial and marine ecosystem productivity in regional and global carbon dynamics. Another important priority is to provide an accurate assessment of the extent and health of the world's forests, grasslands, and agricultural resources.

In a time of rapid, and often unrecorded, land-use change, observations from space are the only global source of objective information on the human use of land. A related priority is to improve understanding and prediction of seasonal to interannual climate variation. Reducing uncertainties in climate predictions out to a season or a year in advance can help dramatically improve the efficiency of water use for agriculture and hydropower, as well as improve contingency planning for energy demand and in other economic sectors.

There is increasing evidence that predictions of extreme weather events can be improved by understanding their links to interannual climate phenomena, such as the El Niño events. The ESE Science Plan also calls for special attention to measuring and modeling the relative influence of forcing factors in long-term climate change, including clouds, aerosols, and greenhouse gases, in order to improve the understanding and prediction of climate on time scales of decades to centuries. A continuing priority area for ESE is to understand the causes and consequences of changes in atmospheric ozone and the nature and timing of the expected recovery of stratospheric ozone in an atmosphere with increased abundances of greenhouse gases. Research to resolve questions related to stratospheric ozone depletion continues to make great progress, and increased emphasis is now being focused on the changing composition of the lower atmosphere, which is especially sensitive to the unprecedented growth of pollutant emissions in East Asia and other rapidly developing regions.

Satellite, Aircraft, and Balloon Measurements, Operations, and Data Processing and Distribution. The Earth Observing System is a program of multiple spacecraft (the Terra, Aqua, and Aura series, Landsat-7, and others) and interdisciplinary science investigations to provide a 15-year data set of key parameters needed to gain a fuller understanding of global climate change.

Preceding EOS are a number of individual satellite and Shuttle-based missions which are helping to reveal the basic processes of: atmospheric chemistry (Upper Atmosphere Research Satellite-UARS/1991), ozone distribution and depletion (Total Ozone Mapping Spectrometer-TOMS/1978, 1991, 1996, and 2001), ocean topography and circulation (TOPEX/Poseidon/1992), ocean winds (NASAScatterometer-NSCAT/1996; QuikSCAT/1999), ocean color (Sea Wide-Field-of-View Sensor-SeaWiFS/1997), and global tropical precipitation (Tropical Rainfall Measuring Mission-TRMM/1997), among others. These provide the scientific and technological foundation on which EOS builds. TRMM was launched in November 1997 and is still operating. It will provide important data on precipitation in the tropics that will help better understand the global hydrological cycle.

The first EOS satellite launches began in 1999, with Landsat-7, QuikSCAT, ACRIMSAT and Terra. In February 2000, the Shuttle Radar Topography Mission successfully collected 30-m and 90-m horizontal resolution topographic data on the entire land surface of the Earth between 60°N and 56°S. In April 2000, science data from Terra began flowing to an enthusiastic science community. The balance of the calendar year 2000 should see the launches of QuikTOMS, SAGE III for atmospheric research, and Jason-1 for ocean altimetry. As ESE moves into 2001, data from Aqua will provide vastly improved measurements of atmospheric temperature and humidity, as well as complementing Terra's global biosphere and clouds and radiation measurements. 2001 will also see the launch of ICESat and SORCE.

In addition, NASA will launch the New Millennium Program Earth Observer-1 technology demonstration mission in 2000, designed to make future Landsat-type missions possible at vastly reduced size and cost. The New Millennium Program (NMP) provides for the infusion of innovative new technologies into ESE, with an initial focus on the EOS follow-on missions, and will emphasize fast-track development and low-cost demonstration missions. These technologies, which will lead to the development of smaller and lighter-weight instruments, will reduce annual program expenditures in the post-2002 time frame.

Complementing EOS will be a series of small, rapid-development Earth System Science Pathfinder (ESSP) missions to study emerging science questions and make innovative measurements in parallel with the systematic, long-term measurements begun with EOS. ESSP will feature low life-cycle costs, peer-reviewed science, and missions based on best science value. The first two ESSP missions — Vegetation Canopy Lidar (VCL) and Gravity Recovery and Climate Experiment (GRACE) — were selected and are scheduled for launch in 2000 and 2001, respectively.

ESE has adopted an evolutionary approach to fulfilling its mission and goals. Future missions needed to achieve continuity for systematic measurements, together with those in the exploratory mode of ESSP, will be implemented according to the "better/faster/cheaper" paradigm. ESE will use commercially available spacecraft in a "catalog" procurement mode to reduce the cost and development time required to prepare a mission for launch. Meanwhile, ESE will invest upfront in instrument technology development, and base its mission selection on both scientific need and technology readiness. ESE has developed a Research Strategy for the new decade. It will serve as the basis for prioritizing and selecting satellite missions for the 2003-2010 time frame. This document is currently being reviewed by the National Academy of Sciences. Science needs for the new decade are already sufficiently mature to have initiated formulation of two key missions in this timeframe. The NPOESS Preparatory Project will serve to extend essential measurements from Terra and Aqua as well as demonstrate new instruments for the converged weather satellite program. A Landsat continuity mission, which may take the form of a commercial and/or international collaboration, will extend the valuable 30m global land cover data set beyond the lifetime of Landsat 7. Both missions are envisioned to launch in 2005.

Related Research. All NASA global change research is included in the USGCRP program.

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

NSF Program Title	FY99	FY00	FY01 Request
Antarctic Ecosystems	1.0	1.0	1.0
Arctic System Science (ARCSS)	13.8	14.3	14.3
Carbon Cycling	2.8	5.2	8.1
Climate Modeling, Analysis & Prediction (CMAP)	13.0	13.4	13.4
Climate Variability and Predictability (CLIVAR)	13.6	15.9	18.8
Coastal Long-Term Ecological Research (cLTER/LMER)	3.2	3.2	3.2
Earth System History	18.1	19.3	19.5
Ecological Diversity	6.2	6.7	6.7
Ecological Rates of Change (EROC)	3.2	3.2	3.2
Geodata	2.7	2.8	2.8
Global Ocean Ecosystems Dynamics (GLOBEC)	13.3	14.9	14.9
Global Tropospheric Chemistry Program (GTCP)	13.9	14.3	14.3
Greenhouse Gas Dynamics (GGD)	0.2	0.2	0.2
Human Dimensions of Global Change	13.6	14.0	14.0
Joint Global Ocean Flux Study	10.2	7.9	5.0
Methods and Models for Integrated Assessment	3.4	3.4	3.4
Ocean Observation, Data Assimilation, and Modeling (OODAM)	4.1	4.6	4.6
Polar Ozone Depletion/UV Radiation Effects	4.2	4.2	4.2
Regional Research Institutes	3.2	3.2	3.2
Ridge Interdisciplinary Global Experiments (RIDGE)	3.3	3.3	3.3
Sea Level Changes	6.2	6.4	6.2
Solar Influences	7.2	7.4	7.4
Water & Energy: Atmospheric, Vegetative & Earth Interactions	9.6	9.7	9.7
World Ocean Circulation Experiment (WOCE)	11.8	9.1	6.2
NSF Total President's Request	181.7	187.5	187.5

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 socioeconomic 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 activities necessary for fundamental research on global change, 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 2001 Program Highlights. During FY2001, NSF will continue to support research and related activities across its broad range of environmental programs. New NSF-wide initiatives will emphasize environmental processes, information technology, and human resource issues. As in preceding years, NSF will continue to invest in major international collaborative field, modeling, and analysis programs. Major emphasis will focus on: 1) Arctic systems; 2) climate modeling and predictability; 3) global carbon and global water cycles; 4) atmospheric chemistry analysis; 5) global ocean ecosystems; 5) Earth system history; and 6) human dimensions of climate change. In addition, the Ocean Observations, Data Assimilation, and Modeling (OODAM) and Climate Variability and Predictability (CLIVAR) programs will be expanded in FY 2001.

The Arctic systems program will support the Surface Heat Budget of the Arctic (SHEBA) Ocean project to incorporate sea-ice albedo and cloud-radiation feedback data in models that predict the impact of global warming on the fate of sea ice, studies of the impact of global change on terrestrial ecosystems, incorporation of atmospheric chemistry into the snow and ice record, and the processes influencing the marine biogeochemistry at the shelf-basin interface. A new initiative will seek to establish a center for the study of the Human Dimensions of the Arctic System.

Emphasis will continue to be placed on climate modeling activity at various academic and research centers. The centerpiece will be the Community Climate System Model (CCSM), the only climate model available for community use. CCSM is being developed, tested, and applied cooperatively by scientists from the National Atmospheric Research Center, universities, and private and government laboratories. Notably, it is the first model to simulate several centuries of Earth's climate without the need for artificial "flux corrections." In FY 2001, a second generation CCSM will be available and will include improved atmospheric and ocean physics, land surface characterizations, sea-ice processes, and biogeochemistry.

While the World Ocean Circulation Experiment and the Joint Global Ocean Flux Study are entering their synthesis phase, other NSF programs will take on increased emphasis. Two particular examples are the global carbon cycle and the global water cycle. A plan for an integrated carbon cycle science will address terrestrial and oceanic reservoirs and consider biophysical and ecological feedback mechanisms. A global water cycle science plan is nearing completion. It will focus on understanding the causes of water cycle variability, both natural and human-induced; improving predictions and understanding the impacts and relationships to biogeochemical cycles.

The field portion of the Indian Ocean Experiment (INDOEX) has now concluded. It investigated the transport of pollutants and how they affect atmospheric composition and solar radiation processes. In the future, analysis and modeling work will continue to focus on particles and their influence on surface temperatures which have important consequences for the region's climate.

Related Research. In addition to the research focused on global change, NSF will continue to conduct research on topics which are closely related to global change including

laboratory and field studies of the atmosphere and ocean. These physical, chemical, geophysical, and biological investigations will provide additional understanding of Earth processes in support of the objectives of the USGCRP. In addition, many NSF-sponsored research projects consider interactions linking ecosystems and human activities with other factors including climate variability and change. Thus, much NSF research support may be considered “contributing research.” Examples include the Long-Term Ecological Research sites, which provide insights into ecosystem responses and simultaneously perspectives on ecological responses to other stresses beside climate change. NSF supports research projects examining economic, cultural, and behavioral responses to global environmental change. Finally, the need to understand the responses of society to risks has fostered research in risk assessment and management.

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	FY99	FY00	FY01 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 President's Request		7.0	7.0	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) time-scales to resolve human-caused modification of natural variability.

FY 2001 Program Highlights. Researchers at SAO will study stratospheric trace species that play an important role in ozone photochemical cycles using balloons, air-planes, and satellites. Solar activity and irradiance are being studied to better understand the climatic effects of solar variability. Ongoing global sea-level change is being estimated 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. At SERC, measurements will be made of spectral UV-B in Maryland (>25 y record), Florida, Arizona and other sites in the U.S. This data will be electronically disseminated to meet the needs for assessing the biological and chemical impact of varying UV exposure.

Several SI programs will examine biological responses to global change and increase public understanding of global change issues. At SERC, research will be conducted on the responses of global ecosystems to increasing CO₂, 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.

The general public and research community will be informed of global change research conducted by Smithsonian and other USGCRP agencies via exhibits, such as the “*Forces of Change*” exhibit at NMNH, educational programs, and a global change information web page.

Related Research. 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 staff and researchers from other institutions, 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.