

**Subactivity: Climate Research**  
**Line Item: Laboratories & Cooperative Institutes**

**GOAL STATEMENT:**

The goal of the Climate Laboratories and Cooperative Institutes is to develop a more comprehensive understanding of atmospheric and oceanic processes that drive and respond to changes in climate over a variety of spatial and temporal scales through sustained monitoring and research. This research will lead to better understanding and prediction of climate variability and change and help the Nation respond to the risks and opportunities associated with global climate change.

**BASE DESCRIPTION:**

The OAR Laboratories and Cooperative Institutes are an integral part of the interagency Climate Change Science Program, which links the U.S. Global Change Research Program (USGCRP) and the Administration's Climate Change Research Initiative (CCRI). OAR Laboratories and Cooperative Institutes conduct a wide range of research into complex climate systems and how they work. The research aims to improve NOAA's ability to assess climate variability on seasonal to interannual timescales, as well as interdecadal to centennial timescales and beyond. NOAA researchers strive for consistent and uninterrupted monitoring of the Earth's atmosphere and ocean that can give us clues about long-term changes in the global climate. The data collected worldwide by NOAA researchers aids our understanding of, and ability to forecast changes in, complex climatic systems. Using sophisticated computer systems, NOAA researchers work on the numerical modeling of climate systems, which improves the accuracy of climate forecasts. NOAA's strategy is to: (1) acquire the essential data; (2) develop diagnostic and predictive models related to changes in the equatorial oceans; and (3) establish the relationship of those changes to widespread climate variations through data analysis and modeling.

These base activities support the objective, "Advance understanding and predict changes in the Earth's environment to meet America's economic, social, and environmental needs" under the Department of Commerce Strategic Goal of "Observe, protect, and manage the Earth's resources to promote environmental needs."

**PROPOSED LEGISLATION:**

**None.**

**SUMMARIZED FINANCIAL DATA**

(Dollars in thousands)

Subactivity: Climate Research	FY 2005 ACTUALS	FY 2006 CURRENTLY AVAILABLE	FY 2007 BASE PROGRAM	FY 2007 ESTIMATE	INCREASE / DECREASE
Line Item: Laboratories & Cooperative Institutes					
Laboratories & Cooperative Institutes (C)	65,148	45,843	43,823	44,968	1,145
Laboratories & Cooperative Institutes (MS)	1,774	1,775	1,803	1,848	45
Laboratories & Cooperative Institutes (WW)	1,413	1,415	1,436	1,471	35
<b>TOTAL</b>	<b>68,335</b>	<b>49,033</b>	<b>47,062</b>	<b>48,287</b>	<b>1,225</b>
FTE	211	248	248	248	-

Note: The dollars in this table represent budget authority.

**PROGRAM CHANGES FOR FY 2007:**

**Laboratories & Cooperative Institutes (+0 FTE and \$1,225,000):** NOAA requests an increase of 0 FTE and \$1,225,000 to continue its current research operations and activities.

**TERMINATIONS FOR 2007:** The following programs, or portions thereof, are terminated in FY 2007: Climate Research Laboratories and Cooperative Institutes, (\$3,001,000)

**Subactivity: Climate Research**  
**Line Item: Competitive Research Program**

**GOAL STATEMENT:**

NOAA's Competitive Climate Research Program sponsors focused scientific research, within eleven elements, aimed at understanding how society can best adapt and respond to climate variability and change. Researchers coordinate activities that jointly contribute to improved predictions and assessments of climate variability over a continuum of timescales ranging from seasonal to decadal and beyond.

**BASE DESCRIPTION:**

NOAA's Competitive Climate Research Program is an integral part of the interagency U.S. Climate Change Science Program (CCSP), which incorporates the U.S. Global Change Research Program (USGCRP) and the Administration's Climate Change Research Initiative (CCRI). The program addresses an important aspect of global change - understanding the global climate system - and advances research and assessment activities designed to address the interface between scientific information and society's various decision-making needs. Current research activities are organized across the following elements within two main components, Research and Major Observing Systems:

**A. Research Programs**

The **Atmospheric Composition and Climate Program (ACCP)** pursues two overall research objectives: (1) to improve the predictive understanding of the radiative forcing of the climate system by aerosols (airborne fine particles) and by chemically-active greenhouse gases, such as tropospheric ozone, and (2) to better characterize the recovery of the stratospheric ozone layer and its role in climate change. The integrated research activities that address these objectives involve instrument development, global observations, laboratory studies, and theoretical modeling by NOAA and extramural partners. Another significant component of the ACCP is the extramural component of the CCRI ***Aerosol-Climate Interactions***. Details of this research are described below.

The **Climate Change Data and Detection (CCDD)** program element ensures that the data needed to understand the climate system is available for analysis. The data and resultant products extend the existing long-term climate record and serve as essential input for predictive models. In addition, CCDD provides support for documenting variations in climate on time scales ranging from seasonal to decadal and beyond. Support is also provided for the analysis of observed climate variations and identifying causes that are consistent with Earth's long-term climate history.

The **Climate Dynamics and Experimental Prediction (CDEP)** program element supports NOAA's efforts towards improved global climate predictions on seasonal to interannual timescales through the Applied Research Centers (ARCs), which help develop and support climate services through a program of applied research, development, and experimental applications. The end-result is a coordinated suite of critical contributions to the predictions and assessments of climate variability and regional assessments and applications produced by NOAA's Climate Prediction Center (CPC) and the International Research Institute for Climate Prediction (IRI).

CDEP also supports the development of new climate reanalysis data sets and the capability to deliver explanations of the causes for observed climate variability and change in coordination with Weather-Climate Research described under the Labs & Cooperative Institute line item, above. This effort represents a key NOAA contribution to the CCSP goal of improving knowledge of the Earth's past and present climate and environment, including its natural variability, and improves understanding of the causes of observed variability and change.

The ultimate goal of the **NOAA Climate Variability and Predictability (CVP)** program element is to develop skillful predictions of climate variability and change on seasonal to multi-decadal time scales and regional spatial scales for optimal use in resource planning and policy decision making. The scientific objective of the NOAA CVP program is to understand the mechanisms of major climate variability and change on seasonal to decadal and longer time scales, including the thresholds and non-linearities of abrupt climate change, and to develop the predictive capability for these climate processes. An initial focus of the leading large-scale phenomena includes the El Nino-Southern Oscillation (ENSO), the Pacific Decadal Oscillation (PDO), Tropical Atlantic Variability (TAV), Arctic Oscillation/North Atlantic Oscillation (AO/NAO), the Meridional Overturning Circulation (MOC) and the American Monsoon systems. CVP research approaches include development of observational, theoretical, and computational means to understand and predict climate variability and change and making enhanced predictions, where feasible.

The **Climate Prediction Program for the Americas (CPPA)** element seeks to improve operational intra-seasonal to interannual climate and hydrologic forecasting. CPPA seeks to i) improve the understanding and model simulation of ocean, atmosphere and land-surface processes through observations, data analysis, and modeling studies; ii) determine the predictability of climate variations on intra-seasonal to interannual time scale, including predictability of the continental-scale monsoon systems across the Americas; iii) advance NOAA's operational climate forecasts, monitoring, and analysis systems; and iv) develop climate-based hydrologic forecasting capabilities and decision support tools for water resource applications.

The **Global Carbon Cycle (GCC)** program element seeks to improve our ability to predict the sources and sinks of anthropogenic CO<sub>2</sub> and future atmospheric CO<sub>2</sub> concentrations using a combination of atmospheric and oceanic global observations, process-oriented field studies, analysis, and modeling. The GCC program is a part of the interagency Carbon Cycle Science initiative of the Climate Change Science Program. GCC research addresses priorities identified in the U.S. Carbon Cycle Science Plan (1999), the North American Carbon Plan (2002), and the Ocean Carbon and Climate Change Plan (2004). The goal of GCC research is to aid in the achievement of NOAA's climate forecasting goals, including the advancement of our understanding of the global carbon cycle and its role in regulating climate.

**NOAA's Climate Transition Program (NCTP)** is a proposal-driven program that supports the transition of well-developed research and prototype decision products, processes and policy tools that will expand regional decision makers' (e.g., private sector, agriculture, state, and local government) use of climate information in their operational settings. These transition products and tools are the result of the research community, through programs such as SARP and RISA, investigating the climate information needs of decision makers and responding with user-relevant, place based applications. The program requires structured partnerships between operational staff, decision makers, and prototype developers; the program also requires an extension component to ensure effective use of the application by decision makers.

Specifically, this program responds to user/decision maker requirements, provides a mechanism for embedding research in a sustainable mode into operations; develops a deliberate bridge for research to applications; increases scientific and operational capacity; supports interactive learning; results in products that have value to regional/local climate-sensitive decision-making processes; adapts as the demand for climate services increases; and produces products that with modification, could be applied to other research sectors.

The **Regional Integrated Sciences and Assessments (RISA)** program supports integrated, place-based research across a range of social, natural, and physical science disciplines to expand decision-makers' (e.g., private sector, agriculture, state, and local government) options in the face of climate change and variability at the regional level. It does this in a manner that is cognizant of the context decision-makers function within and the constraints they face in managing their climate sensitive resources. RISA possesses three distinct qualities: (1) fostering interdisciplinary research and assessment synthesis; (2) improving our understanding of and bridging the gap among climatic, environmental and societal interactions on various temporal and spatial scales; and (3) contributing to regional decision support and climate information service. A successful RISA program requires innovative and embedded long-term partnerships among a spectrum of interested parties including Federal, State, Native, regional, local and private entities. The program relies heavily on consolidating the results and data from ongoing NOAA-OGP disciplinary program elements, already funded in a region, into an integrated framework.

The **Sector Applications Research Program (SARP)** replaces and refocuses activities formerly supported by Health and Human Dimensions and Environment, Science, and Development. The Sector Applications Research Program's (SARP) main goals are to provide new knowledge important to the identification and reduction of vulnerability to climate variability and change through: improved knowledge of the impacts of climate on society specifically in economically, ecologically, and socially important sectors (e.g., coastal, water resources agriculture, health, etc.); enhanced use of forecast information; increased understanding by scientists and policy makers of the needs of stakeholders currently working with the impacts of a changing climate; and a better understanding of society's ability to plan for and adapt to future uncertainties. SARP is built upon the evolution and successes of NOAA's Human Dimensions of Global Change; Environment, Science and Development; and Climate Variability and Human Health Programs. SARP is an interdisciplinary program, which promote social science methodologies and scientific findings required to build a knowledge base that addresses climate impact and adaptation uncertainties for stakeholders within sectors most at-risk. Specifically, SARP: (1) funds research projects that provide a better understanding of the impact of climate variability on specific sectors recognizing the role of complex societal and environmental interactions; (2) creates stronger sector communities by operating as a focal point for researchers, policy makers and decision makers to aggregate, evaluate and set evolving requirements for new knowledge critical to decision making; and (3) translates the results of the research and interactions regarding decision making needs and capacities to relevant programs within the NOAA Climate Office such as RISA, NCTP and CPPA and to other programs within the Agency that would benefit from this research such as Sea Grant and the National Weather Service.

The role of the **Arctic Research Program (ARP)** is to improve forecasts of temperature, precipitation, and storms across Alaska and the mainland U.S., and support improvements in forecasting and planning for energy needs, growing seasons, hazardous storms and water resources, as well as provide for better management of Alaskan and Arctic resources.

This will be accomplished by: 1) creating an effective climate observing system focused on the U.S. region of the Arctic to allow for regional-scale climate change detection and developing models capable of predicting Arctic climate change; 2) creating and analyzing Arctic physical and biological data sets designed to detect climate change, validating satellite observations, improving and initializing models, and support decision-making; and 3) through partnerships, developing Arctic-wide observing and modeling capability to detect and assess Arctic-wide change and impact, and determining how Arctic processes affect North American and global climate systems. The achievement of these tasks will help to assess climate change in the Arctic; the most well known of which is general warming illustrated by the loss of sea ice and glacier mass, thawing of permafrost, and other temperature-related phenomena. These changes affect every part of the Arctic environment and have significant impacts on society.

**Weather-Climate Research** activities (previously funded under CO&S as Weather-Climate Connection and Climate Data & Information sub-activities). During El Niño, shifts in the Pacific storm track affect the paths of storms approaching the U.S. west coast, and influence weather across the entire country. This activity seeks to understand the relationship between sub-seasonal tropical variability and changes in the frequency, location and intensity of extreme weather events over the U.S. Observational and modeling efforts document the pattern of variations in tropical rainfall on weekly to monthly time scales as well as air-sea interactions in both tropical systems and in mid-latitude oceanic and land-falling storms. An improved historical reanalysis dataset will substantially reduce uncertainty in historical climate variations and improve the analysis and detection of interannual-to-decadal variability and trends in weather and climate in the 20th century. OAR climate attribution research will enable NOAA to better interpret causes of observed climate variability, which is crucial for meeting the climate information needs of policy-makers on regional climate issues, including major droughts, floods, prolonged warm or cold conditions, climate trends and extremes, and multi-decadal variability. Weather-Climate Research activities culminate in transferring research and observational advances into operational practices at NWS/NCEP Climate Prediction Center.

**Climate Modeling Center** activities (formerly funded under CCRI). Climate models are essential tools for synthesizing observations and theory to investigate how the system works and how it is affected by human activities. The continued development and refinement of computational models capable of simulating past and future conditions of the Earth system are crucial for developing capabilities to provide more accurate projections of future change. The Climate Modeling Center will enable the Geophysical Fluid Dynamics Laboratory to take the national lead in the systematic production of model-based products developed in consultation with stakeholders to document, understand, and assess the impacts of climate variability and change on the U.S. that can be used for policy and business decisions.

**Aerosol-Climate Interactions, Clouds & Climate Change** research (formerly funded under CCRI). Aerosols and tropospheric ozone play unique, but poorly quantified, roles in the atmospheric radiation budget. This research focuses on attaining a better understanding of the absorption and scattering of radiation by aerosols (fine airborne particles) and the associated heating and cooling roles in the climate system. Goals are to: (1) establish new and augment existing in-situ monitoring sites, in and down wind of major population areas (e.g., Asia, Eastern North America, and South America) to determine temporal and spatial distributions, trends, and aerosol chemical and radiative properties and (2) develop integrated models used to study regional patterns, evaluate our understanding of source and sink processes, and project future distributions.

In collaboration with NPOESS, the program will evaluate and advance the development of algorithms and establish the appropriate in-situ measurements for the calibration and validation of the NPOESS data. In addition, this research will address the development of better decision-support tools which will improve the linkage between sources of emissions of compounds that directly or indirectly contribute to climate-relevant aerosols, which impact climate radiative forcing.

## **B. Observing Systems**

The **Office of Climate Observation (OCO)** is establishing and maintaining the sustained global ocean observing system necessary for climate research and prediction as well as the long-term monitoring system necessary for climate change detection and attribution. NOAA's ocean climate contributions provide the major U.S. contribution to the Global Component of the U.S. Integrated Ocean Observing System. All of NOAA's contributions to the global ocean observing system are managed internationally in cooperation with the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (WMO: World Meteorological Organization. IOC: Intergovernmental Oceanographic Commission of the United Nations Educational, Science, and Cultural Organization). This international observation network is based on a set of core observations (e.g., temperature, surface wind stress, salinity, sea level, CO<sub>2</sub>), consisting of both in situ and remotely sensed measurements that have been identified in national and international reports as needed to satisfy research and operational climate requirements. Initial investments in the ocean observing system include:

- ***Argo Floats:*** These floats, together with satellites, will initiate the oceanic equivalent of today's operational observing system for the global atmosphere. This is an international effort with 14 nations plus the European Union currently providing floats.
- ***Surface Drifting Buoys:*** Sea surface temperature is the single most important ocean parameter for the global heat, water, and carbon cycles. A global array of 1,250 surface drifting buoys is maintained by NOAA and 14 international partners to calibrate satellite observations and reduce errors in global measurement of this critical ocean climate parameter. The drifters also measure surface currents globally and provide critical sea surface data under hurricanes to help improve hurricane landfall projections.
- ***Tide Gauge Stations:*** Sea level rise is one of the most immediate impacts of climate change. NOAA in cooperation with 64 nations is implementing the Global Climate Observing System (GCOS) sea level reference network of 170 tide gauge stations. The stations report in near-real-time and are also used for the tsunami warning system and other marine services.
- ***Tropical Moored Buoys:*** The Earth's tropics are the ocean's major capacity for heat exchange with the atmosphere. The Pacific El Niño influences global climate and weather. Together with international partners, NOAA is working to instrument all three tropical oceans – the Pacific, Atlantic, and Indian Ocean.

- ***Ocean Reference Stations:*** NOAA, in cooperation with the National Science Foundation and international partners, is implementing a sparse global network of ocean reference station moorings, expanding from the present three pilot stations to a permanent network of 16 by 2010. These have been a cornerstone of decadal-to-centennial documentation of changes in ocean properties designed to improve seasonal-to-interannual forecasting by providing calibration/validation data for remote sensing of surface flux fields. This network also monitors ocean transports to identify changes in circulation that could provide possible indications of abrupt climate change.
- ***Ships of Opportunity (SOOP):*** The global atmospheric and oceanic data from ships of opportunity have been the foundation for understanding long-term changes in marine climate and are essential input to climate and weather forecast models.
- ***Ocean Carbon:*** Projecting decadal to centennial global climate change is closely linked to assumptions about feedback effects between the ocean and atmosphere related to sequestering of carbon in the ocean and additional input of carbon dioxide into the atmosphere. The SOOP fleet and NOAA in cooperation with the National Science Foundation and international partners are implementing an ongoing ocean carbon inventory surveying the globe once every ten years which will be supplemented by autonomous carbon dioxide sampling instruments added to the moored arrays .
- ***Arctic Ocean Fluxes:*** Over the past 20 or more years, significant changes have been noted in the Arctic, such as thawing of permafrost, earlier break-up of ice on rivers, and thinning of the ice cover on the Arctic Ocean. NOAA is joining with other Federal agencies and international collaborators to begin a long-term effort to quantify the flux of fresh water from the Arctic to the North Atlantic. The initial steps will be made through deployment of moorings at critical locations in the Arctic.
- ***Dedicated Ships:*** Ocean research vessels from NOAA and university partners are essential elements of the support infrastructure necessary to sustain the ocean observing system. The dedicated ships provide: 1) the highest quality reference data sets, 2) the platforms for the ocean carbon surveys, and 3) platforms for deployment of the moored and drifting buoys and the Argo floats.
- ***Data Management, Data Assimilation and Analysis:*** A robust and scalable Data Management and Communications (DMAC) infrastructure is essential to the vision of a sustained ocean observing system. Standards and protocols are essential to enable interoperability across all global and coastal ocean observing systems. Data must be retained and made available for analyses and for assimilation into models to understand and forecast climate change, and for efficiently managing observing system operations and improvements. Thus, the advancement of assimilation techniques and the scientific analysis of ocean data are also important components of the observing system.

Base activities support the objective, “Advance understanding and predict changes in the Earth’s environment to meet America’s economic, social, and environmental needs” under the Department of Commerce Strategic Goal of “Observe, protect, and manage the Earth’s resources to promote environmental needs.”

Under the new FY2007 OAR budget structure, the Competitive Research line item now includes those former Climate Observations & Services (CO&S) and Climate Change Research Initiative (CCRI) programs, including:

**Baseline Observatories** (previously funded under CO&S). These funds are used to maintain and expand operations at NOAA's manned Global Atmospheric Baseline Observatories, which measure up to 250 different atmospheric parameters relevant to the study of climate change and ozone depletion at: Barrow, Alaska; Mauna Loa, Hawaii (since 1957); Cape Matatula, American Samoa; and South Pole, Antarctica (also since 1957), and for operations at NOAA's Baseline Air Quality station at Trinidad Head, California. These observations are critical to the collection and continuity of the world's longest atmospheric data time series, supplying information on: 1) the state and recovery of the ozone layer, 2) global carbon dioxide and other trace gases impacting the global climate, and 3) the quality of the air entering the west coast of the U.S. These data are used for assessments of atmospheric change that are valuable for environmental policy.

**Carbon Cycle Atmospheric Observing System** and other carbon cycle/carbon monitoring activities (previously funded under both CO&S and CCRI). The U.S. scientific community coordinates its carbon cycle activities through an integrated interagency effort that aims to quantify, understand, and project the evolution of global carbon sources and sinks in order to better predict future climate. As part of this multi-agency effort, NOAA has begun a network of airborne and tall-tower based sampling sites over North America. This sampling program will complement local-scale process research managed by other agencies and provide an estimate of the magnitude of regional terrestrial sinks on a continental scale. This monitoring program will provide decision-makers, resource managers, and the American public with solid, quantitative information on the role of the U.S. as both a source and a sink for carbon. The information gathered will be useful for international negotiations and identifying regions where mitigation activities are most needed or would have the most impact. Similarly, projections of climate change and the scenarios used to inform assessments will be improved; and additional insight into the societal risks of climate change and human efforts to mitigate climate change will be derived. Recent advancements in the program include expansion of a pilot program using small aircraft and tall towers to profile carbon gases. With input from other agencies, this program forms the foundation for routine spatial carbon "maps" and periodic "State of the Carbon Cycle" reports that will keep scientists and policy-makers abreast of progress in understanding the North American carbon cycle.

**PROPOSED LEGISLATION:**

**None.**

**SUMMARIZED FINANCIAL DATA**

(Dollars in thousands)

Subactivity: Climate Research	FY 2005 ACTUALS	FY 2006 CURRENTLY AVAILABLE	FY 2007 BASE PROGRAM	FY 2007 ESTIMATE	INCREASE / DECREASE
Line Item: Competitive Research Program					
Competitive Research Program	99,349	110,587	113,660	125,712	12,052
<b>TOTAL</b>	99,349	110,587	113,660	125,712	12,052
FTE	-	99	102	102	-

Note: The dollars in this table represent budget authority.

**PROGRAM CHANGES FOR FY 2007:**

NOAA requests 0 FTE and \$12,052,000 to further NOAA's national and international commitments to the U.S. Climate Change Science Program, the National Integrated Drought Information System, and the U.S. Integrated Ocean Observing System.

**Integrated Ocean Observing System for Climate (IOOS): Global Ocean Observing System for Climate (+0 FTE and +\$6,052,000):**

NOAA requests an increase of 0 FTE and \$6,052,000 to continue building the global component of the U.S. IOOS, which is the major U.S. contribution to the Global Ocean Observing System (GOOS) and the Global Earth Observation System of Systems (GEOSS); NOAA's Climate Program is the principal U.S. contributor to the global baseline ocean observing system. In 2007, NOAA, in cooperation with national and international partners, will make incremental advancements across all ocean observing networks with emphasis on these priority areas: (1) ocean circulation to monitor for possible indications of abrupt climate change, and for monitoring the climate's influence on marine ecosystems; (2) ocean storage of carbon in support of National policy decisions; and (3) oceanic contributions to the global water cycle especially in support of drought early warning and diagnostics. This request responds to the long-term observational requirements of the operational forecast centers, international research programs, and major scientific assessments. This investment is one of the high priority investments required for NOAA's implementation of IOOS as the ocean component of GEOSS in response to the U.S. Ocean Action Plan. Combined with other like-identified IOOS investments across NOAA, it is part of NOAA's strategy to provide initial benefits of an integrated ocean observing system.

**Statement of Need**

The United Nations Framework Convention on Climate Change (UNFCCC) has called upon the nations of the world for urgent action to complete global coverage by the ocean observation networks. Without urgent action to address this need, the parties will lack the information necessary to effectively plan for and manage their response to Earth's changing climate.

The system put in place for climate will also support global weather prediction, global and coastal ocean prediction, comprehensive marine hazard forecast and warning systems (e.g. tsunami), marine environmental monitoring, transportation, naval applications, homeland security, and many other non-climate users. This increase is part of NOAA's multi-year phased program plan to build the required global system as described in the Office of Climate Observation write-up, above. This increase will advance the ocean system to 61 percent complete.

**Proposed Actions:** Incremental advancements across all networks will be undertaken in FY 2007 in direct response to the U.S. Climate Change Science Program and the Integrated Ocean Observing System Development Plan. Priorities for system advancement:

- Reduce the uncertainty in estimates of changes in the carbon inventory in the global ocean. The exchange of carbon dioxide between the atmosphere and ocean is a major factor in the global carbon cycle. The immediate plan will be to add autonomous carbon dioxide sampling instrumentation to the moored arrays and ships of opportunity to analyze seasonal variability and long-term trends in carbon exchange between the ocean and atmosphere.
- Resolve the uncertainties in sea level change and sea surface temperature. Sea level change has the most direct societal impact and sea surface temperature is the single most important variable in the heat, carbon, and water cycles. The immediate plan will be to complete the global subset of tide gauge stations for altimeter calibration and long-term trends identified as the ocean climate reference network. The real time reporting capability being implemented at these stations makes them equally important as a contribution to the international tsunami warning system.
- Document the ocean's heat storage and transport to identify where anomalies enter the ocean, how they move and are transformed, and where they re-emerge to interact with the atmosphere. The immediate plan will be to advance the implementation of a global network of ocean reference stations to provide validation points for climate forecast and projection models, monitor key locations in the ocean for signs of possible abrupt climate change, and enhance data collection from ships of opportunity, completing a subset of high accuracy lines to be frequently repeated and sampled at high resolution for systematic upper ocean and atmospheric measurements. Additionally, the 2005 hurricane season tragically demonstrated the need for better understanding and forecasting of hurricane development; NOAA will equip a subset of special hurricane drifters (drifting data buoys) with upper ocean temperature chains to be air-deployed directly in the path of approaching hurricanes to measure the ocean's heat energy potential.
- Document changes in the ocean's contributions to the global water cycle. With increasing world population and the changing climate, global distribution of fresh water is rapidly become one of the most important natural resource concerns. Our understanding of the water cycle is limited by our knowledge of oceanic evaporation and precipitation over the ocean – 70% of the earth's surface. The immediate plan will be to instrument the global arrays of moored and surface drifting buoys and ships of opportunity for measurement of sea surface salinity which is a direct indicator of the ocean's evaporation and precipitation.
- Augment current activities to establish a national, sustainable Data Management and Communications (DMAC) standards infrastructure including ongoing standards development that will lead to interoperable data access and dissemination across observing systems. The immediate plan will be to establish a long-term data and product server to continue the server function that was established as an element of the Global Ocean Data Assimilation Experiment (GODAE). The GODAE experiment ends in 2007. The server capability must be continued in support of sustained earth observation.

Note: The President's budget transfers \$3,000,000 from NWS base to OAR base in 2007 for advancement of the tropical moored buoy network – TAO/PIRATA enhancements and the Indian Ocean expansion. Funding for TAO/PIRATA ongoing operations remain in NWS base. However, this \$3,000,000 for expansion of the observing system is subtracted from NWS and added to OAR for management by OCO in advancing the science-guided development of the Global Component of the Integrated Ocean Observing System. This is not a net increase to the observing system, but is a transfer of funding from one line to another.

## **Benefits**

NOAA's Climate Goal seeks "a predictive understanding of the global climate system on time scales of weeks to decades with quantified uncertainties sufficient for making informed and reasoned decisions." The only way to quantify the uncertainties in the climate system is through accurate Earth observation, including rigorous data stewardship. The ocean occupies over 70 percent of the Earth's surface—achieving global coverage by the ocean systems, and rigorously assessing system performance are essential to understanding and predicting the Earth's climate variability and change. Over the past decade, the investments made by NOAA and our national and international partners (e.g., Global Climate Observing System, Data Buoy Cooperation Panel, JCOMM) have provided unprecedented global views of the Earth as a set of complex, interacting systems. Advancing the ocean systems toward global coverage will allow NOAA to:

- Monitor and analyze long-term ocean variability, providing information needed for society to anticipate and adapt to changes in the Earth's climate system;
- Assess oceanic carbon inventories to assist decision makers in establishing long-range policy for adapting to climate change;
- Monitor and forecast sea level change for essential engineering and land use decisions in coastal regions; and
- Improve initial conditions (i.e. the present state of the ocean) in climate models for enhanced seasonal forecasting and better immediate-term economic and management decision making.

This program change implements the first steps towards realizing global coverage by the surface and subsurface ocean observing systems and its successful completion will directly enhance the development of internally consistent climate data sets, help make improved use of existing observation efforts by many users, and reduce overall costs of maintaining separate and sometimes incompatible data management infrastructures. Through this integrating approach, future NOAA investments will not only improve tools and capabilities, but will also enhance the services provided to NOAA's diverse national and international user communities.

## **Performance Goals and Measurement Data**

This request directly helps to meet NOAA's strategic performance objective to describe and understand the state of the climate through integrated observations, analysis and data stewardship under the NOAA mission goal "Understand Climate Variability and Change to Enhance Society's Ability to Plan and respond" under the Department of Commerce strategic goal of "Observe, protect, and manage the Earth's resources to promote environmental

stewardship.” The request also addresses the Climate Change Science Program’s goal to expand observations, monitoring, and data/information system capabilities and increase confidence in our understanding of how and why climate is changing. Specifically, this increase supports the following performance measures:

<b>Performance Goal: Climate</b>	<b>FY 2005</b>	<b>FY 2006</b>	<b>FY 2007</b>	<b>FY 2008</b>	<b>FY 2009</b>	<b>FY 2010</b>	<b>FY 2011</b>
<b>Performance Measure:</b> Increased percentage of global in situ ocean observing system implementation							
Without Increase	55%	55%	55%	55%	55%	55%	55%
With Increase	55%	55%	61%	63%	66%	71%	76%
<b>Performance Measure:</b> Percent of NOAA Observing Systems as identified in NOAA’s Observing System Architecture (NOSA) meeting IOOS DMAC interoperability standards for metadata, data discovery, and retrieval							
Without increase	5	10	15	20	25	30	40
With increase	5	10	15	25	40	60	90%
<b>Performance Measure (GPRA):</b> Reduce the Error in Global Measurement of Sea Surface Temperature (degrees C)							
Without increase	0.6°C	0.5°C	0.5°C	0.5°C	0.5°C	0.5°C	0.5°C
With increase	0.6°C	0.5°C	0.4°C	0.3°C	0.2°C	0.2°C	0.2°C

Note: Draft IOOS DMAC Standards published in May 2004.

**National Integrated Drought Information System and Regional Decision Support Partnerships: Coping with Drought (+0 FTE and \$4,000,000):**

NOAA requests an increase of 0 FTE and \$4,000,000 to develop a focused decision-support research effort to aid risk management in the context of severe, sustained drought, and broader water resources management issues. Water resources management is the pathway through which climate affects ecosystems management, including coastal challenges, public health concerns and agricultural productivity. In FY 2007, NOAA will sponsor integrated, problem-focused research and research-to-operations transition projects addressing the effects of drought on society and economically productive sectors of the US economy and the expressed needs of regional decision makers as they confront the challenges of drought planning, mitigation and efforts to incorporate climate variability over years to decades into their planning processes. A deeper understanding of the specific information needs of local and regional decision makers, as well as an appreciation for addressing outcomes in terms of the overall well-being of affected communities, are much needed contributions to a national climate service. Structured feedback from this research, as well as a defined mechanism for incorporating research into operational climate services, are expected to result in more widespread use of climate information and will be critical to building an end to end climate service.

This investment will be implemented through the RISA Program, SARP, and the NOAA Climate Transition Program, drawing heavily on collaborations from other parts of NOAA, such as NWS and NESDIS. Specifically, the initiative will: (1) provide the resources for a RISA Drought Initiative to build upon and highlight the experience gained throughout the RISA network of researcher-practitioner collaborations over the last 5+ years of the severe, sustained drought in the western US; (2) identify, via a sector-based impacts research effort, the economic and social effects of drought (across and outside the US) through methods compatible with the short and long-term data and information needs of policy and decision makers; and (3) meet user requirements for the development of end-stage climate information tailored for specific decision needs associated with operational activities. NOAA's emerging climate services will ultimately be better documented, tested, evaluated, and improved. This request will provide resources to respond to the challenges of such practical issues as the re-licensing of dams, reservoir management challenges, ecosystem restoration initiatives, and a host of other complex and competing water-resource allocation issues.

### **Statement of Need**

Due to population growth, drought will become an increasingly important issue as water demand increases. Important components of addressing this issue in the context of climate services is to: (1) develop a framework for organizing scientific content that meets technical and scientific standards and (2) ensure clear communication of new products and information to the public. This investment represents a strong effort on the part of NOAA to respond in an organized, visible fashion to drought problems. The experience of the drought in the West and studies of the origins, patterns, and projections of drought in the context of climate variability and change, offer a unique opportunity for NOAA's emerging climate services to channel innovative scientific research developed through climate process studies via a decision support research framework and a clear methodology for transition to operations of these research-based, user-driven tools. Such a framework will be essential to the formidable task of building capacity for drought preparedness, as well as fulfilling goals within the NOAA Strategic Plan and the Administration's Climate Change Science Program (CCSP) strategic plan by identifying the need for relevant climate information and sustained services; research efforts will also directly address the recommendations made by the National Research Council (NRC)'s Board on Atmospheric Sciences and Climate's (BASC) 2001 study, *A Climate Services Vision: First Steps Toward the Future*, which calls for building a robust U.S. climate service.

NOAA's increasing interest in supporting decisions sensitive to climate, the continuing drought conditions in the Western United States, the interest of U.S. Congress in drought issues (e.g., discussions regarding the National Drought Preparedness Act), the national interest in NIDIS, and the progress of several NOAA Climate Program research, transition, and delivery efforts all point to an opportune time for NOAA to work to synthesize diverse efforts in understanding decision-making and drought across timescales of concern to water allocation. The approach used in this prototype activity will be transferable to other sectors (e.g. coastal management, energy management).

## Proposed Actions

### A. RISA Initiative (\$1,800,000)

- **Enhanced RISA research capacity (\$800,000):** The success of the existing RISA teams has resulted in a research demand in other regions of the U.S. (e.g. Southern Great Plains, Great Lakes, Mid-Atlantic). For example, a scoping meeting clearly showed the value of establishing a RISA in the Southern Great Plains; particularly for managing water resources in rapidly depleted aquifers with potentially devastating affects to agriculture (RISA:Enhancing Decision-Making Through Integrated Climate Research, Southern Great Plains, 2004). The bulk of this program change request would be used to award one new competitive RISA award. RISA's sustained interaction with stakeholder communities needs to be evaluated on an ongoing basis. A portion of the request would be made available to fund a limited number of evaluation studies to document and/or quantify the results of the RISA process in terms of influencing decisions and the resulting social and economic consequences.
- **Targeted Cooperative Funding (\$1,000,000):** Climate sensitive issues such as drought will require coordinated research across multiple regions of the U.S as well as coordinated activities across federal and state agencies. A climate service, as it develops, will require a research network that can address issues of concern within a region but also speak to issues at the multi-region, national and international levels. Building on research and tools developed within individual regions (e.g., downscaling climate information for watershed planning, ecosystem restoration, crop modeling or coastal planning), climate information would have a much greater impact on these management issues across the U.S. if two or more RISA teams worked together to advance the methodology and insights from research and tool development for transferability across geographic regions. This request will enable RISA teams across the US to focus and enhance their research and stakeholder interaction in support of local and regional entities preparing for and addressing the impacts of drought. Specifically, funding will support: 1) research and product development that integrate a range of climate information (e.g. paleoclimate records, decadal trends, current observations), models (e.g. climate, hydrology, ecology), forecasts (e.g., 3-month climate outlooks), and projections on seasonal through decadal timescales into management and planning models for water supply, farming, ranching, forests and ecosystems restoration, with the goal of aiding decision makers in their ability to cope with drought; 2) inter-RISA capacity to advance methodology and insights from research and tool development for transferability across geographic regions. Products and innovations from this integrated research will also be used as input to state and regional drought planning, and would have the potential for transition into operational entities (both within and outside of NOAA) through the NOAA Climate Transition Program (NCTP).

### B. Drought Impact Initiative (\$1,200,000) will support:

- **Drought Impacts Research (\$950,000).** This effort will fund new research into the socioeconomic impacts of drought and its cycles, and current and potential coping mechanisms for reduction of vulnerability to drought. It has been widely recognized that an essential element in moving from ad-hoc response to drought preparedness and mitigation is more sophisticated drought impacts information. These resources would be directed to such areas as: economic analyses of the cost of drought (including the effects of collective mitigation efforts); studies of institutional constraints and innovations in the area of drought preparedness; and specific data and information needs related to reducing vulnerability to drought impacts. Improved understanding of the impacts of drought and the pathways of impacts would result in recommendations for improved monitoring,

reporting, and assessing the cost of drought, all of which will help to improve mitigation strategies. New drought impact insights and information are distinctly called for in NIDIS as part of an overall strategy for moving to improved preparedness: a National Drought Impacts Reporting Strategy. Furthermore, impacts methodologies and findings will provide a critical contribution to efforts across NOAA's climate services elements – from NCEP to CDC and NWS field offices – to improve the development of a range of web-based visualization and information products intended to provide accessible information on drought indices.

2. **A Prototype for Directed Drought Regional Decision Support (\$250,000).** This effort will assemble the collective work of researchers funded competitively through NOAA and other agencies to provide a comprehensive examination of drought decision support and water management in a river basin. In the case of the Colorado River Basin, modern-day water management decisions are based upon the Colorado River Basin Compact, which was signed by seven Colorado River Basin states over 80 years ago. The Compact is based on water flow values that are not representative in today's drought conditions and does not include provisions to deal with shortages due to drought. Given increases in population growth in such states as Utah, Colorado, and Arizona as well as increased water needs by the energy and agricultural sectors, many states are currently investigating ways that the Compact might be modified. These states are also concerned about drought conditions today, the continuing impacts of climate variability, and the implications of water usage in the future. With this funding request, NOAA will convene a committee of regional experts (including a range of key partners) to produce a study of an individual river basin(s) contributing to the broader efforts to improve Basin management. At the end of this prototype activity, which should take approximately 18 months, the committee will provide an inventory of relevant research performed within and outside of the region, a synthesis of the present use of climate information, an accounting of gaps in information and approach, and a formal report detailing recommendations for future opportunities and activities.

### **C. NOAA Climate Transition Program (\$1,000,000)**

In FY 2007, NCTP will begin to partner with other NOAA programs to provide improved climate services to the operational and policy communities. Drought is a topic of prime concern for several other programs in FY 2007, specifically, SARP, RISA, and the Office of Climate, Water and Weather Services within the NWS. For example, preliminary discussions have already been held with NOAA's Office of Hydrologic Development for a potential joint announcement. The possibility of partnerships with programs in other agencies will be explored for future activities. Additional funding would allow the research, education, and outreach efforts put forth by these programs to effectively be delivered and used by the operational community in subsequent years. The NCTP Program will request of all awardees an evaluation of the economic effect of new operational information in their given settings. Three simultaneous occurrences also make this year prime for NCTP expansion: (1) increased impetus of the NIDIS, which states that the development, integration and maintenance of "a suite of drought decision support and simulation tools is fundamental for the success of NIDIS"; (2) focused interest and activity in state drought task force planning and the need for additional tools to respond to triggers that set these plans into action; and (3) expanded capacity and interest of NWS state and local offices allowing more capability for making climate forecasts operational through NCTP activities.

## **Benefits**

The goal of this investment is to produce climate service products designed to be best used by local, state, and regional decision makers in sectors affected by drought. The initiative serves water resource managers, farmers, forest managers, public health officials, and state and federal agencies responsible for ecosystem restoration in their capacity to cope with drought including estimating the costs of droughts as well as the social and economic benefits of using climate impacts information. “Spending a little up front to plan for drought will save states and the federal government billions in the long run” (Rep. Alice Hastings, NIDIS Plan, 2004). The evolution of cross-region RISA activity, evaluation, and regional expansion proposed above, will help to frame the architecture of NOAA’s emerging Climate Services in a manner that links research findings and tools directly to providing relevant, timely, and useful climate information to meet the NOAA Climate Program’s goals for Regional Decision Support. An evaluation of the economic impact of new operational information and/or services will fulfill an increasing need for NOAA to better document the value of our investments. Finally, the expansion of NCTP will help to fill a critical gap in developing an end-to-end climate service.

## **Performance Goals and Measurement Data**

This increase will support the objective, “Advance understanding and predict changes in the Earth’s environment to meet America’s economic, social, and environmental needs” under the Department of Commerce strategic goal, “Observe, protect, and manage the Earth’s resources to promote environmental needs.” This investment supports the 100% requirements identified by the Regional Decision Support Program of the NOAA Climate Mission Goal.

<b>Performance Goal: Climate</b> <b>Performance Measure:</b> Improve ability of society to plan and respond to climate variability and change using NOAA climate products and information	<b>FY 2005</b>	<b>FY 2006</b>	<b>FY 2007</b>	<b>FY 2008</b>	<b>FY 2009</b>	<b>FY 2010</b>	<b>FY 2011</b>
Without Increase	28	32	32	32	34	35	35
With Increase	28	32	35	37	41	44	47

<b>Performance Goal: Climate</b> <b>Performance Measure:</b> Increased number of instances where climate information is integrated into prototype decision support tools or management systems	<b>FY 2005</b>	<b>FY 2006</b>	<b>FY 2007</b>	<b>FY 2008</b>	<b>FY 2009</b>	<b>FY 2010</b>	<b>FY 2011</b>
Without Increase	5	5	5	5	5	5	5
With Increase	5	5	5	7	9	11	11

<b>Performance Goal: Climate</b> <b>Performance Measure<sup>2</sup>:</b> Increased number of RISA teams to conduct region-specific integrated research in collaboration with stakeholders	<b>FY 2005</b>	<b>FY 2006</b>	<b>FY 2007</b>	<b>FY 2008</b>	<b>FY 2009</b>	<b>FY 2010</b>	<b>FY 2011</b>
Without Increase	8	9	9	9	9	9	9
With Increase	8	9	10	10	10	10	10

<sup>2</sup> Number indicates total number of RISA teams sponsored

<b>Performance Goal: Climate</b> <b>Performance Measure:</b> Increased transition of decision support research to operational settings	<b>FY 2005</b>	<b>FY 2006</b>	<b>FY 2007</b>	<b>FY 2008</b>	<b>FY 2009</b>	<b>FY 2010</b>	<b>FY 2011</b>
Without Increase	0	0	1	3	1	3	3
With Increase	0	0	1	3	4	7	10

**Explaining Climate Conditions to Improve Predictions (+0 FTE and \$2,000,000):** NOAA/OAR is requesting an increase of 0 FTE and \$2,000,000 to develop new climate reanalysis data sets and the capability to deliver explanations of the causes for observed climate variability and change. This effort represents a key NOAA contribution to the CCSP goal of improving knowledge of the Earth’s past and present climate and environment, including its natural variability, and improve understanding of the causes of observed variability and change. This work will enable NOAA, as the lead agency, to deliver a high priority interagency CCSP synthesis product in 2-4 years: “Reanalyses of historical climate data for key atmospheric features. Implications for attribution of causes of observed change.” This program component supports NOAA’s Mission Goal to “Understand climate variability and change to enhance society’s ability to plan and respond.”

This program is required to deliver the reference data set for verification and calibration of prediction components, which are crucial for meeting NOAA’s GPRA performance measure for U.S. Seasonal Temperature Forecast Skill. It also provides the mechanism for ingesting and assimilating all GEOSS data sources into an official historical reference system, which replaces a system using 15 year old technology.

**Background:** NOAA lacks adequate capacity to provide global climate analyses that are required to describe major features of 20<sup>th</sup> Century climate and the capacity to address the causes of observed regional climate variations that are crucial to informing policy decisions. The first-generation reanalyses, based on mid-1990’s models, lack adequate spatial resolution and contain known deficiencies which limit their usefulness for identifying climate trends and assessing causes of observed change. Advances in models, improved data assimilation methods, and new data sources make it desirable and feasible for NOAA to develop and continually update global reanalyses datasets. An assessment of the causes of observed changes will complement the data set development and enable NOAA to meet CCSP synthesis product requirements.

**Proposed Actions:** Developing improved climate reanalyses and attribution capabilities requires strong links among NOAA’s observational, research, and operational prediction efforts. This program enhancement will establish the capacity to produce consistent and continually updated climate analysis data sets; to expand climate services through the delivery of regular and systematic explanations of the state of the climate system; and to advance understanding and predictions of climate extremes for proactive decision-making.

Activities at NESDIS’ National Climatic Data Center will provide new, quality-controlled data products that will serve as crucial observational input for an historical reanalysis. Observational data sets will be constructed with at least once-daily temporal resolution and will include land and marine surface pressure observations calibrated to account for time-varying measurement practices for the period 1893 to present. These data will be extracted from a variety of sources, including the Integrated Surface Hourly land station database, which will be expanded with newly digitized US observations, and newly available data from international partners. These data will be quality controlled and metadata will include estimated errors and corrections for time-varying observation practices.

NWS' National Centers for Environmental Prediction (NCEP) will implement an improved global climate reanalysis system that will be used to quality control upper air data from 1948 to present and bias correct input data to reduce spurious climate trends due to changes in observing systems. NCEP will also assess the effects of changes in the observations to determine the best reanalysis strategy; maintain, improve and implement the climate reanalysis. Finally, NCEP will provide real-time diagnostics to correct problems as they occur, and support the necessary computing infrastructure.

OAR reanalysis activities will extend the current reanalysis period (1948-present) to provide a model reanalysis data set that covers the entire 20th Century. This effort will build on reanalysis research indicating that large-scale aspects of climate variability and change can be developed from surface pressure observations using advanced ensemble data assimilation techniques. This historical reanalysis will vastly improve upon existing hand-drawn analyses. This dataset will substantially reduce uncertainty in historical climate variations and improve the analysis and detection of interannual-to-decadal variability and trends in weather and climate in the 20th Century. OAR climate attribution research will provide NOAA with a greatly improved capability to interpret causes of observed climate variability and, therefore, will be crucial to serve the climate information needs of policy-makers for explanations of current and evolving regional climate conditions. A major focus will be to develop capabilities to attribute causes of regional climate events, such as major droughts, floods, prolonged warm or cold conditions, climate trends and extremes, and multi-decadal variability.

Initial funding for the Explaining Climate Conditions to Improve Predictions Program is:

- \$300,000 to NESDIS/NCDC for three contractors to support production of new quality-controlled data products and long term archive and access to the climate reanalysis suite.
- \$700,000 for five NWS Environmental Modeling Center and Climate Prediction Center contractors to establish an infrastructure for the development, maintenance, and distribution of the climate reanalysis suite and develop climate attribution products at NCEP
- \$150,000 for NWS to augment the disk storage to allow for routine production of NWS and OAR reanalysis datasets on the NCEP backup computing facility.
- \$450,000 at OAR for four Climate Diagnostics Center affiliated Joint Institute investigators to develop climate attribution products and to construct an historical reanalysis extending from 1893-present.
- \$400,000 for OAR's Office of Global Programs to support extramural research on reanalysis and climate attribution.

**Benefits:**

- New quality controlled data products for use in the next generation reanalysis.
- Production and dissemination of improved climate reanalysis data products for accurately assessing climate variability, detecting climate change and regional trends in climate extremes.
- Fulfillment of NOAA's commitment to the CCSP goals, and specifically, to deliver the interagency CCSP priority synthesis and assessment products.

- New diagnostic and analysis tools to link the behavior of climate and forcing mechanisms in a physically consistent manner.
- Regular and systematic explanations of past, current, and evolving climate conditions, including the detection and explanation of regional trends and multi-year variability.
- Enhanced climate prediction capabilities that will enable regional and national decision makers and resource managers to better plan for impacts of climate extremes, variability, and change.

**Performance Goals and Measurement Data:**

This increase will support the objective, “Advance understanding and predict changes in the Earth’s environment to meet America’s economic, social, and environmental needs” under the Department of Commerce Strategic Goal of “Observe, protect, and manage the Earth’s resources to promote environmental needs.” Specifically, this increase supports the Climate Performance Goal. These activities provide the foundation for future climate research and are related to the work that will be necessary to achieve the following outcome: “A predictive understanding of the global climate system on time scales of weeks to decades with quantified uncertainties sufficient for making informed and reasoned decisions.” By conducting the data reanalysis, NOAA will be better positioned to be able to describe and explain climate variability and change.

<b>Performance Goal: Climate</b>	<b>FY 2005</b>	<b>FY 2006</b>	<b>FY 2007</b>	<b>FY 2008</b>	<b>FY 2009</b>	<b>FY 2010</b>	<b>FY 2011</b>
<b>Performance Measure:</b> Extend climate analyses and reanalyses to include earlier and later time periods (metric: number of years (extended back from present) included in the surface-observation based historical climate reanalysis)							
Without Increase	68	69	70	71	72	73	74
With Increase	68	69	81	93	105	117	130

**TERMINATIONS FOR 2007:** The following programs, or portions thereof, are terminated in FY 2007: Competitive Research Program (\$328,000).

**Subactivity: Climate Research**  
**Line Item: Climate Operations**

**GOAL STATEMENT:**

The goal of NOAA's Climate Operations is to provide accurate and timely climate information/forecasts to best serve the public and private sector which will be achieved via improved climate forecasts on timescales from subseasonal through interannual and beyond.

**BASE DESCRIPTION:**

Seasonal and interannual climate variability impact life and property on local, regional, and global scales. Since societal impacts from climate variability and change extend down to sub-seasonal time scales, connections between climate and extreme weather events must be identified. The establishment of climate/weather links will improve the forecast timing and location of extreme weather events thereby minimizing their impacts on the lives and property of U.S. inhabitants. Activities funded under Climate Operations include Operational Forecasts. This is a primary mission of NOAA to provide improved forecasts on subseasonal through interannual timescales and beyond. This will be achieved by improving model performance, developing new forecast designs, and upgrading existing datasets. The end-result will be the ability to produce and disseminate operational forecast products to private industry and the public resulting in the preservation of life and property.

Base activities support the objective, "Advance understanding and predict changes in the Earth's environment to meet America's economic, social, and environmental needs" under the Department of Commerce Strategic Goal of "observe, protect and manage the Earth's resources to promote environmental needs."

Under the new FY2007 OAR budget structure, the Climate Operations line item remains as defined in the FY 2006 budget, including operational climate activities funded under former CO&S lines: Regional Assessments Education and Outreach, Climate Data and Information, and Weather-Climate Connection.

**PROPOSED LEGISLATION:**

**None.**

**SUMMARIZED FINANCIAL DATA**

(Dollars in thousands)

Subactivity: Climate Research	FY 2005 ACTUALS	FY 2006 CURRENTLY AVAILABLE	FY 2007 BASE PROGRAM	FY 2007 ESTIMATE	INCREASE / DECREASE
Line Item: Climate Operations					
Climate Operations	-	363	358	886	528
<b>TOTAL</b>	-	363	358	886	528
FTE	-	-	-	-	-

Note: The dollars in this table represent budget authority.

**PROGRAM CHANGES FOR FY 2007:**

**Regional Climate Services (+0 FTE and \$528,000):** NOAA requests an increase of 0 FTE and \$528,000 to sustain climate services operations at the national and regional levels. Through this capability, NOAA will provide America with operational service outlets and customer interfaces for climate data and information products and climate forecasts and their regional and local impacts. This activity also forms the backbone of the customer service and information distribution to be leveraged for the National Integrated Drought Information System (NIDIS), meets future requirements encompassed in the White House Subcommittee on Disaster Reduction Grand Challenge on Drought, and directly supports the decision support aspects of the Administration’s Climate Change Science Program (CCSP). The activity will continue to provide NOAA customers – farmers, utilities, land managers, business owners, energy, re-insurance, weather risk industry, and decision makers – with the ability to assess climate variability and make informed decisions to mitigate impacts of extreme climate events, such as droughts and El Nino. For example, the Pacific ENSO Applications Center (PEAC) in Honolulu will continue to improve climate products and services for the western Pacific islands and Hawaii.

**Statement of Need**

Climate and its variability and change currently are key topics of intense interest and concern for scientists, the general public, the media, and economic sectors, such as energy and reinsurance. From speculation about changes in hurricane frequency and strength to persistence of drought, particularly in the West, there is a critical need for the U.S. to ensure that its investment in climate research, data, information, and predictions can be used to evaluate and mitigate the identified impacts of climate.

Climate services operations meet the basic climate service needs of NOAA's customers and partners. It is a point where the NOAA investment in climate observations and research pay-off in terms of operationally supported and delivered products, predictions, and other services. The vision and execution of this exercise is consistent with and necessary for the Administration's CCSP and consistent with recommendations made by the National Research Council in a 2001 report (*A Climate Services Vision*) which calls for:

- Creating user-centric functions within agencies;
- Ensuring a strong and healthy transition of U.S. research accomplishments into predictive capabilities that serve the nation;
- Developing regional enterprises designed to expand the nature and scope of climate services; and
- Enhancing the understanding of climate through public education.

### **Proposed Actions**

Restored support for the program in FY 2007 will continue to equip national and regional climate program managers with resources necessary to interact with national, regional, and state decision makers to enhance the usability and utility of climate products and services. It will continue NOAA's commitment to education through training its workforce in issues of climate services for addressing variability and change. It will ensure that forecast enhancements at the local level already begun will make it into operations, and will continue to provide a conscience for the U.S. climate observing system, necessary for determining and evaluating climate change. Additionally, support for the program will ensure that NOAA engages and leverages partners, including other federal agencies, to accomplish climate services nationwide in a cost-effective manner.

Efforts include:

- Training program (\$188,000): Develop residence, online, and distance learning modules that will equip national, regional, and local climate services providers and partners with the tools they need to ensure that NOAA climate products and data services are efficiently and optimally used, and that forecasts are properly and easily explained. This activity is preparing to provide expanded training in drought to provide field support for NIDIS, when it is implemented, which can be leveraged by NOAA, partners, and other state and federal agencies involved in NIDIS.
- Enhanced web tools and forecast product development (\$270,000): Continue to provide enhanced services through the Internet, including access to NOAA climate data, information, predictions, and services. Continue to augment forecasts at the local levels in the form of seasonal precipitation outlooks at 4,000 stations across the U.S. and for a suit of local ENSO-based impacts forecasts to be issued during an El Niño or La Niña event.
- Sustained customer interaction (\$70,000): The primary responsibility of climate services has been to ensure that NOAA climate products are readily accessible, well understood, and optimally used by customers, decision makers, and the general public at the local, regional, and national levels. This includes stakeholder interaction for product improvements, soliciting requirements for new products and services, and ensuring that NOAA's observing systems are operated to maintain the integrity of the climate record.

**Benefits**

The desired outcome of this activity is to continue to assist the U.S. in mitigating the \$3 trillion of the national economy that is susceptible to impacts of weather and climate and to be positioned to provide enhanced services for pressing future environmental concerns, should resources allow. This activity has, and will continue to offset losses and leverage positive impacts from climate events such as El Nino (\$4 billion loss, \$25 billion total impact during the 1997-1998 event, *NOAA Economic Statistics 2004*), drought (\$6-8 billion annually, *NOAA Economic Statistics 2004*), and will continue to provide information and support activities such as USDA drought disaster declarations and FEMA disaster declarations, such as hurricanes (each totaling billions of dollars each year - especially noticeable this past year in the wake of Hurricane Katrina). NOAA’s National Weather Service is the logical federal agency positioned to lead this activity because of its long history of providing these, and similar, services and its unique and expansive nation-wide infrastructure of regional and local offices and extensive partner support.

**Performance Goals and Measurement Data**

This increase will support the Department of Commerce goal "Advance understanding and predict changes in the Earth’s environment to meet America’s economic, social, and environmental needs" under the DOC strategic goal of "Observe, protect, and manage the Earth’s resources to promote environmental needs." It addresses the Climate Change Science Program goal "Explore the uses of and identify the limits of evolving knowledge to manage risks and opportunities related to climate variability and change." It also addresses the NOAA goal "Understand Climate Variability and Change to Enhance Society’s Ability to Plan and Respond." Specifically, this increase directly supports the DOC/NOAA Climate Goal and is being considered for integration into an FY 2008 GPRA performance measures for NOAA Climate Regional Decision Support.

<b>Performance Goal: Climate</b> <b>Performance Measure:</b> NOAA’s NWS regions with supported climate services programs	<b>FY 2005</b>	<b>FY 2006</b>	<b>FY 2007</b>	<b>FY 2008</b>	<b>FY 2009</b>	<b>FY 2010</b>	<b>FY 2011</b>
Without Increase	6	0	0	0	0	0	0
With Increase	6	0	6	6	6	6	6

**Subactivity: Climate Research**  
**Line Item: Climate Data & Information**

**GOAL STATEMENT:**

**NOAA's Climate Data and Information Program** manages the Nation's resource of global climatological in-situ and remotely sensed data and information to promote global environmental stewardship; to describe, monitor and assess the climate; and to support efforts to predict changes in the Earth's environment. This effort requires the cooperation of national and international meteorological services for the acquisition, quality control, processing, summarization, dissemination, and preservation of a vast array of climatological data.

**BASE DESCRIPTION:**

The primary goal of climate observing networks is to assemble, develop, and communicate data and information about the trends and predictions of climate and weather events to public and private sector decision makers (e.g., energy, agriculture, state and local officials). To accomplish this goal, NOAA must develop the required infrastructure which addresses: (1) improving access and data management activities with, large-volume climate databases supplied by satellite and ground-based instruments; (2) implementation of operational updates to NOAA's long-term ocean and atmospheric reference data sets; and (3) improving the performance of the observational network consisting of the U.S. Surface Hourly, Upper-Air, and Buoy Networks. The following activities are funded under the Climate Data and Information line item:

- **The U.S. Climate Reference Network (USCRN)** (previously funded under CO&S) provides baseline, high-quality surface observations of air temperature and precipitation in order to detect long-term changes in climate through a robust climate record. The Climate Reference Network is an integral component of NOAA's plans for IOOS and contributes to the integrated GEOSS. USCRN observations will provide benchmark measurements for an improved National climate and weather monitoring network. CRN data already serve over 100,000 users each year from government, academia, and the private sector. Full implementation of the network of reference stations, will fulfill the ultimate goal of routinely explaining at least 95% of national annual average precipitation variance and 98% of national annual average temperature variance for the contiguous U.S. The network is currently 52% complete (58 commissioned out of 110 planned stations); full implementation of the network is slated for 2009.
- **Data and Information Products:** The improvement in the quality and integrity of observed datasets is fundamental to our Nation's and the global climate and weather monitoring programs. Early detection and remediation of network problems that can adversely affect the quality of data records and diminish our ability to evaluate climate variability and change will be provided through NOAA's Observing System Monitoring Program. This will alert Observing System Managers in near real time to problems that in the past have been discovered long after the data became part of the historical archive, and thus too late to take immediate corrective action.

- **Global Climate Atmospheric Observing System:** Under the new FY 2007 OAR budget structure, the Climate Data and Information line item remains as defined in the FY 2006 budget with one additional change. In addition to climate activities funded under former CO&S lines: Regional Assessments Education and Outreach, Climate Data and Information, and Climate Reference Network, the Climate Data and Information line item now includes the Global Climate Atmospheric Observing System.

**PROPOSED LEGISLATION:**

**None.**

**SUMMARIZED FINANCIAL DATA**

(Dollars in thousands)

Subactivity: Climate Research	FY 2005 ACTUALS	FY 2006 CURRENTLY AVAILABLE	FY 2007 BASE PROGRAM	FY 2007 ESTIMATE	INCREASE / DECREASE
Line Item: Climate Data & Information					
Climate Data & Information	3,942	2,401	2,362	6,266	3,904
<b>TOTAL</b>	3,942	2,401	2,362	6,266	3,904
FTE	-	4	4	4	-

Note: The dollars in this table represent budget authority.

**PROGRAM CHANGES FOR FY 2007:**

**Global Climate Observing System (+0 FTE and \$2,743,000):** NOAA requests 0 FTE and \$2,743,000 to support activities under NOAA’s Cross-Cutting Priority for the 21<sup>st</sup> Century, “Develop an Integrated Global Environmental Observation and Data Management System”. The U.S. Global Climate Observing System (GCOS) project has tremendous synergy with NOAA’s desire to invest in needed climate quality observations globally and encourage other national and international investments to provide a comprehensive observing system in support of climate assessments and forecasts. Furthermore, U.S. GCOS is a central NOAA and U.S. project that proactively seeks to increased number of partnerships that promote regional, and local cooperation in global (land and open/coastal ocean regions) observations and data management programs. This activity is in direct alignment with NOAA’s corporate practice of developing Effective Strategic Partnerships and Integrated Information Services. U.S. GCOS is a key driver for supporting a sustained global infrastructure of complementary in situ and data management and access subsystems, adequate to accurately document the state of the climate system on a global basis that would provide necessary inputs to enable more reliable climate predictions and projections. U.S. GCOS activities are significant contributors to the US IEOS and the GEOSS strategic plans.

**Statement of Need**

The users of GCOS data include the United Nations Framework Convention on Climate Change (UNFCCC), the International Panel on Climate Change (IPCC) researchers who utilize GCOS data as key input for their assessments that are intended for high-level government policymakers for making decisions related to mitigating the effects of climate change. GCOS has been identified as the formal climate component of the Global Earth Observation System of Systems (GEOSS) and is thus directly related to the societal benefit entitled “Understand, Assess, Predict, Mitigate, and Adapt to Climate Variability and Change”.

The U.S. Department of State Climate Change Office supports the U.S. GCOS effort as it has been a key activity in a number of climate bi-lateral agreements entered into by the U.S. U.S. GCOS is critical to fulfilling some key U.S. commitments to the UNFCCC and is in line with President Bush's June 2001 Rose Garden speech where he stated that "...*national and international bodies have "identified the building of a global observing system to monitor climate as being crucial to improving our understanding of the science of climate change."* The President went on to state that, "*the United States will provide resources to help build climate observation systems in developing countries throughout the world.*" GCOS is formally recognized under the UNFCCC as the sustainable climate observing network, and GCOS occupies a prominent role in the US National Climate Action Report 3 published in 2002 and the soon-to-be published Climate Action Report 4 in 2005, and has been lauded by the UNFCCC as a superior program. Finally, U.S. GCOS provides will be provide key support to the Gleneagles G-8 July 2005 Summit where the U.S. signed on to a resolution related to global climate observations and monitoring.

### **Proposed Actions:**

- Retrofit GCOS Upper Air Network (GUAN) sites in developing nations, the provision of expendable equipment (e.g., radiosondes and balloons) as well as the installation of new reference GCOS Surface Network (GSN) sites in developing nations and unique climate regimes is at the core of the U.S. GCOS program. This portion of the project has been instrumental in decreasing the number of silent global stations, increased the number of climate reports, helped in rescuing valuable paper data records for addition to the global climate data bases, and in spearheading the need for new reference stations in order to get a better picture of essential variables associated with climate change.
- Continue serving as the GCOS Lead Center for GSN at NCDC, a critical role in the data management of the various global GCOS networks; monitoring the health of the GSN and GUAN networks, vital to ensuring possible problems with data quality are caught and fixed early ensuring that historical data sets retain their integrity; and participating in global assessments of climate as performed by the Intergovernmental Panel on Climate Change.
- Support the Pacific Islands Regional GCOS Program as well as its sister program the Pacific Islands Regional Global Ocean Observing Program have proven to be invaluable in furthering the goals of maintaining a sustainable and robust regional observing program in an important region to climate both based on the fact that due to its geographic there is sparse data in the region, as well as the fact that the Pacific region is the home to major global oscillations such as El Niño and the Pacific Decadal Oscillation that have major impacts on the U.S. climate.
- Continue support to other associated GCOS activities involving the data quality and calibration of global datasets involving precipitation chemistry, solar radiation, regional precipitation networks, as well as support for GCOS related research activities such as the African Monsoon Multidisciplinary Analysis (AMMA) project and basic support for the international GCOS secretariat.

## **Benefits**

This project supports the U.S. leadership role in implementing a sustained, globally deployed system of 1,000 GSN and 150 GUAN stations. The U.S. contribution to this global network, a part of the larger GEOSS, is: a) the installation of 75 new GSN reference stations in lesser developed nations to include 25 high elevation Climate Reference Network quality stations in Africa, South America, and Europe and b) installation and/or upgrades to 75 GUAN stations in lesser developed nations to include; 40 GUAN sites serving as reference stations with high quality reference radiosondes running in dual mode; 3 new Global Atmosphere Watch (GAW) observatories in the Asia Pacific region; 5 new ozonesonde stations in developing nations; 2 Dobson Ozone Regional Calibration Centers in South America and Africa; 1 stratospheric water vapor observing site operating in the Southern Hemisphere; upgrades at 11 existing GAW observatories in developing nations; CO2 flask sampling from a ship plying the western Pacific; 13 in situ water level stations in Africa. The goal is that all the U.S. supported GUAN and GSN will adhere to the NRC and GCOS Climate Monitoring Principles.

## **Performance Goals and Measurement Data**

This increase will support, restores support, to one of NOAA’s primary mission goal objectives to, “Understand Climate Variability and Change to Enhance Society’s Ability to Plan and Respond.” U.S. GCOS spearheads NOAA’s effort to lead a cross-cutting priority for the 21<sup>st</sup> Century by Integrating Global Environmental Observations and Data Management. Officially recognized as part of the climate component of the GEOSS effort chaired by Admiral Lautenbacher, this U.S. GCOS increase directly contributes to the U.S. efforts and role as a leader in implementing and integrating vital global earth observations and data management. The U.S. GCOS performance measures table from the FY08-12 COA Program PBA is provided in the table below.

<b>Performance Measure &amp; Unit of Measure</b>	<b>FY05</b>	<b>FY06</b>	<b>FY07</b>	<b>FY08</b>	<b>FY09</b>	<b>FY10</b>	<b>FY11</b>
<b>GSN explained variance (%) for temperature (developing world)</b>	<b>5</b>	<b>10</b>	<b>15</b>	<b>20</b>	<b>25</b>	<b>30</b>	<b>35</b>
<b>Without Increase</b>	<b>5</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>GUAN stations (%) meeting GCOS requirements (developing world)</b>	<b>5</b>	<b>10</b>	<b>15</b>	<b>20</b>	<b>25</b>	<b>30</b>	<b>35</b>
<b>Without Increase</b>	<b>5</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>GUAN Stations installed (cumulative)</b>	<b>4</b>	<b>8</b>	<b>12</b>	<b>16</b>	<b>20</b>	<b>24</b>	<b>28</b>
<b>GUAN Stations Without Increase</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>GSN Stations Installed cumulative</b>	<b>4</b>	<b>8</b>	<b>12</b>	<b>16</b>	<b>20</b>	<b>24</b>	<b>28</b>
<b>GSN Stations Without Increase</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>

**Climate Reference Network (+0 FTE and \$1,161,000):** The **Climate Reference Network (CRN)** provides baseline, high quality observations of surface air temperature and precipitation in order to detect long-term changes in climate through a robust climate record. The climate reference network is an integral component of NOAA's plans for an Integrated Surface Observing System (ISOS) and directly contributes to the USGEO Integrated Earth Observing System (IEOS). CRN stations provide benchmark measurements used to improve the quality of measurements from other ground, airborne, and satellite based observing platforms. CRN data serves over 100,000 users each year from government, academia, and the private sector. Funding will provide the means to complete the installation and commissioning of the remainder of the full network of 114 stations, as well as provide adequate life cycle operations and maintenance. The requested funding will enable NOAA to continue towards completing its plan for the full implementation of the network, 114 benchmark stations strategically placed across the National, to tracking more than 95% of national annual precipitation variability and 98% of annual temperature variability.

### **Statement of Need**

The CRN observations are a critical source of information that produces climate data sets that are derived in part from NOAA's, NASA's, and international satellites. These data are merged together to enable scientists to track changes in temperature, precipitation, global cloud cover and other essential climate variables, a fundamental to reducing uncertainty in the understanding of climate today and required for many energy and water related applications. The funds will be used to transform complex data on cloud properties, surface albedo, ice, reflectance, radiance, and temperature into common data formats such as GIS and in publications such as Local Climate Data that are widely requested and used by the private sector and the public. The CRN supports NOAA's Observing System Monitoring Program which provides early warnings of network problems that can adversely affect our ability to track variations and changes in climate. It alerts Observing System Managers to problems that in the past have been discovered too late to take corrective action. Funding enables NOAA to reinstitute routine monitoring for the NWS Cooperative Observer Network, the GCOS Upper Air Network, the GCOS Surface Network, and the observations from the new U.S. Upper Air System. All these observing systems are fundamental to our Nation's climate monitoring program and the U.S. contribution to the GEOSS.

### **Proposed Actions**

- Complete OT&E for the 3 installed stations placed into "hibernation" mode due to lack of funding to complete commissioning process.
- Deploy and commission additional CRN CONUS stations until the full network of 114 stations are operational achieving the end state performance measures by the end of FY 09.
- Preclude potential loss of already approved sites: FY 04 and 05 signed site license agreements – SLAs for sites that have delayed more than two years (due to budget cuts in FY 05).

## **Contributing activities**

- Expanded the number of stations that contribute to drought monitoring and extreme events in cooperation with Canada and Mexico.
- Railway transportation research on climatic impacts with Canada.
- After FY 09, all stations installed and operational, provide follow-on instrumentation for National Integrated Drought Information System (relative humidity and soil moisture/temperature).
- Expand real-time support for surface (road and rail) transportation.
- Implement daily operational process that use CRN observations as benchmark ground truth for monitoring and evaluating the performance of satellite sensors and improve the quality and utility of satellite observations.

## **Benefits**

This project provides rapid return on investment when considering the support provided to many sectors of the Nation's economy, especially those that are most sensitive to climate and weather variability. The observations support critical decisions in planning infrastructure to withstand and benefit from climate variations have value that is recognized by the public and by managers. Specific examples of CRN users and associated benefits include:

- The private sector (such as the energy and tourist industries) that need high quality climate data in near-real time to monitor atmospheric conditions that directly impact their company's financial health.
- Utility managers, such as water managers, who need the observations for better planning during periods of drought.
- Climate scientists who are studying and/or monitoring the climate for evidence of variability and change.
- Weather forecasters to improve their forecast accuracy which would result in saving lives and property.
- Society and the economy all benefit due to better forecast accuracy helping protect lives and property, and better monitoring and understanding of the climate for strategic planning.

USCRN provides direct benefits and linkages to at least six societal benefits outlined in USGEO. Examples include:

- Understand the Effects of Environmental Factors on Human Health and Well Being.
- Understand, Assess, Predict, Mitigate & Adapt to Climate Variability & Change.
- Monitor and Manage Energy Resources.
- Protect and Monitor Water Resources.
- Improve Weather Information, Forecasting, and Warning.
- Support Sustainable Agriculture and Combating land Degradation.

**Performance Goals and Measurement Data**

This increase will support the objective, “Advance understanding and predict changes in the Earth’s environment to meet America’s economic, social, and environmental needs” under the Department of Commerce strategic goal of “Observe, protect, and manage the Earth’s resources to promote environmental needs.” Specifically, this network provides the most reliable and highest quality source of observations to assess climate variability and change and to support private sector and public in designing and plans to accommodate observed variability. The distribution and quality of the observations also provide benchmark observations for satellite calibration and validation over a wide spectrum of climates in the U.S. Most of the National average annual variability in temperature (98%) and precipitation (95%) will be accounted for when completed.

**Increase Requested**

Performance Measure & Unit of Measure	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
% Explained Var. for temperature (CONUS)	96.9	97.0	97.2	97.6	98.0	98.0	98.0
% Explained Var. for precipitation (CONUS)	91.4	91.4	92.3	93.7	95.1	95.1	95.1
# Installed stations (cumulative total)	72	75	91	107	114	114	114

**Subactivity: Climate Research**  
**Line Item: Other Partnership Programs**

**GOAL STATEMENT:**

The strength of NOAA Research is that it does not operate in isolation but rather in partnership with a multitude of external experts in its fields of research. These partnerships extend to other parts of NOAA; other Federal, state, and local government entities; universities; and industry. The contribution of the unique strengths of each partner greatly enhances the accomplishments of NOAA Research.

**BASE DESCRIPTION:**

Other Partnership Programs contains various programs appropriated by Congress. NOAA Research manages these programs in a manner that leverages their objectives in concert with NOAA's mission responsibilities and requirements.

**PROPOSED LEGISLATION:**

**None.**

**SUMMARIZED FINANCIAL DATA**

(Dollars in thousands)

Subactivity: Climate Research	FY 2005 ACTUALS	FY 2006 CURRENTLY AVAILABLE	FY 2007 BASE PROGRAM	FY 2007 ESTIMATE	INCREASE / DECREASE
Line Item: Other Partnership Programs					
Central CA Ozone Study	247	-	-	-	-
East Tennessee Ozone Study	296	296	-	-	-
Climate System Research Center	739	740	-	-	-
Intl Council for Local Environmental Initiatives	492	-	-	-	-
Climate and Environmental Change	2,438	-	-	-	-
Univ of AL Huntsville Climate Research	986	986	-	-	-
Abrupt Climate Change Research	487	247	-	-	-
Drought Research Study	-	986	-	-	-
Coastal Vulnerability to Climate Change	-	1,480	-	-	-
Center for Urban Environmental Research	-	986	-	-	-
Advanced Study Institute for Environmental Prediction	-	1,479	-	-	-
<b>TOTAL</b>	<b>5,685</b>	<b>7,200</b>	<b>-</b>	<b>-</b>	<b>-</b>
FTE	6	-	-	-	-

**PROGRAM CHANGES FOR FY 2007:**

**TERMINATIONS FOR 2007:** The following programs, or portions thereof, are terminated in FY 2007: Other Partnership Programs (\$7,200,000); East Tennessee Ozone Study (\$296,000); Climate System Research Center (\$740,000); University of Alabama-Huntsville Climate Research (\$986,000); Abrupt Climate Change Research (\$247,000); Drought Research Study (\$986,000); Coastal Vulnerability to Climate Change (\$1,480,000); Center for Urban Environmental Research (\$986,000); Advanced Study Institute for Environmental Prediction (\$1,479,000).