

BUDGET ACTIVITY: OCEANIC AND ATMOSPHERIC RESEARCH

For FY 2013, NOAA requests a net increase of \$25,926,000 and 3 FTE above the FY 2012 base level for a total of \$413,820,000 and 758 FTE for the Office of Oceanic and Atmospheric Research (OAR). This includes \$3,176,000 and 0 FTE in adjustments-to-base.

OAR is the primary center for research and development (R&D) within NOAA. NOAA looks to OAR to meet key NOAA science challenges; to lead advances in Earth system research using observations, analysis, and modeling; and to play an expanded role as the innovator, incubator and integrator of science and technology across NOAA. The Agency relies on OAR to coordinate and develop research and technology for such emerging and integrative subjects as ocean acidification, “warn on forecast,” climate and weather testbeds, diagnosing and forecasting the behavior of the Earth system, ocean exploration, unmanned aircraft systems, and autonomous underwater vehicles. OAR conducts weather and climate research necessary to provide society with useful information, such as information to help decision-makers manage regional water resources and plan for extreme events in a variable and changing climate. OAR also serves as the programmatic lead for environmental modeling as we move to truly integrated modeling that spans the full domain of physical, chemical, and biological systems. When mature, the products and the information produced will inform a broad range of users, sectoral interests, and transition appropriate advances to another Line Office for operation or application.

BASE JUSTIFICATION FOR FY 2013:

The OAR budget is organized into four subactivities under the Operations, Research, and Facilities (ORF) account (377,598,000 and 755 FTE):

- Climate Research (\$184,517,000 and 366 FTE) includes Laboratories and Cooperative Institutes and competitive research that seek to establish a greater understanding of and ability to predict climate variability and change to enhance society’s ability to plan and respond.
- Weather and Air Chemistry Research (\$68,471,000 and 210 FTE) includes Laboratories and Cooperative Institutes as well as Research Programs that develop improved understanding and forecast capabilities for atmospheric events that endanger lives and property.
- Ocean, Coastal, and Great Lakes Research (\$115,664,000 and 166 FTE) includes Laboratories and Cooperative Institutes, the National Sea Grant College Program, Office of Ocean Exploration and Research, and Other Ecosystem Programs. Collectively, activities funded here seek to better understand habitats, processes, and resources in the oceanic, coastal, and Great Lakes environments and lead to innovative and useful management tools that help NOAA meet its mission.
- Information Technology Research and Development (\$8,946,000 and 13 FTE) includes High Performance Computing Initiatives, which seeks to accelerate the adoption of advanced computing, communications, and information technology throughout NOAA.

The Procurement, Acquisition, and Construction (PAC) account (\$10,296,000 and 0 FTE) includes the following subactivity:

- System Acquisition, which includes NOAA’s investments in Research High Performance Computing.

OAR operates through a national network of laboratories and other university-based research programs. Through FY 2012, OAR has managed its budget through seven organizational components: Laboratories and Cooperative Institutes, Climate Program Office, National Sea Grant College Program, Office of Ocean Exploration and Research (OER), Other Ecosystem Programs, Office of Weather & Air Quality (OWAQ), and the NOAA High-Performance Computing and Communications (HPCC) Program. Beginning in FY 2013, the NOAA Undersea Research Program under OER is proposed for termination.

With its diverse research capabilities and ability to increase its breadth and depth of expertise from our many partners, OAR provides national and international leadership on critical environmental issues and addresses the environmental R&D needs of internal NOAA customers as well as of states, industry, the Department of Commerce (DOC), and other Federal agencies.

OAR Laboratories and Cooperative Institutes

OAR has seven laboratories across the United States that administer and manage its programs, emphasize theoretical and analytical studies, and conduct laboratory experiments and field observations. These laboratories collaborate with numerous external partners, including NOAA-funded cooperative institutes. The primary purpose of the laboratories and cooperative institutes is to improve NOAA products and services and to provide the basis for improved decision making by policy makers and the public.



Research Laboratories

- **Air Resources Laboratory (ARL)**, headquartered in Silver Spring, MD, and with offices in Oak Ridge, Tennessee, Idaho Falls, Idaho, and Las Vegas, Nevada, carries out research on

air chemistry, atmospheric dispersion, and climate, with a focus on conditions near the Earth's surface that affect people and ecosystems. More information about ARL is available at <http://www.arl.noaa.gov/>.

- **Atlantic Oceanographic and Meteorological Laboratory (AOML)**, in Miami, Florida, conducts research in oceanography, tropical meteorology, atmospheric and oceanic chemistry, and acoustics. More information about AOML is available at <http://www.aoml.noaa.gov/>.
- **Earth System Research Laboratory (ESRL)** in Boulder, Colorado, represents a combination of climate and weather research capabilities aimed at observing and understanding the Earth system and developing environmental information products and services on global to local scales. ESRL primarily works to understand the roles of gases and particles that contribute to climate change, provides weather and climate information related to water management decisions, improves weather prediction, studies the recovery of the stratospheric ozone layer, and develops air quality forecast models. ESRL has four divisions:
 - **Chemical Sciences Division (CSD)** conducts research aimed at discovering, understanding, and quantifying the processes that control the chemical makeup of Earth's atmosphere to better understand its future. More information about CSD is available at: <http://www.esrl.noaa.gov/csd/>.
 - **Global Monitoring Division (GMD)** conducts sustained observations and research related to global distributions, trends, sources and sinks of atmospheric constituents that are capable of forcing change in Earth's climate and environment. GMD also conducts research on the depletion of the global stratospheric ozone layer and Antarctic ozone hole, ultraviolet radiation, and ozone-depleting gases, including those regulated by the Montreal Protocol. More information about GMD is available at: <http://www.esrl.noaa.gov/gmd/>.
 - **Global Systems Division (GSD)** incorporates new findings in atmospheric, oceanic, and hydrologic sciences into systems designed to improve understanding of weather and intraseasonal climate and through new observation techniques, innovative diagnostic and predictive models, advanced computational analysis, and leading-edge workstation display technology. More information about the Global Systems Division can be found within the Earth System Research Laboratory web site: <http://www.esrl.noaa.gov/gsd/>.
 - **Physical Sciences Division (PSD)** conducts the physical process research needed to provide a seamless suite of information and forecast products, ranging from short-term weather forecasts to longer-term climate forecasts and assessments. In so doing, the program advances NOAA's abilities to observe, understand, and critically evaluate and advance the ability of existing and emerging models to predict behaviors of the atmosphere, ocean, cryosphere, hydrosphere, land, and related impacts on global-to-local and days-to-decades time scales. To meet needs for science-based information, the program works closely with its internal partners and a broad external user community. This research is conducted with support from the Cooperative Institute for Research in Environmental Studies (CIRES). More information about PSD is available at: <http://www.esrl.noaa.gov/psd/>.
- **Geophysical Fluid Dynamics Laboratory (GFDL)**, in Princeton, New Jersey, conducts the cutting-edge research necessary to understand, project and predict Earth's climate on a range of space and timescales. Research at GFDL addresses many topics through advanced mathematical modeling of the climate and Earth system, including natural climate

variability, anthropogenic climate change, weather and hurricane forecasts, El Niño prediction, and stratospheric ozone depletion. More information about GFDL is available at: <http://www.gfdl.noaa.gov/>.

- **Great Lakes Environmental Research Laboratory (GLERL)** in Ann Arbor, Michigan, conducts integrated interdisciplinary environmental research in support of resource management and environmental services in coastal and estuarine waters, with a primary emphasis on the Great Lakes. More information about GLERL is available at: <http://www.glerl.noaa.gov/>.
- **National Severe Storms Laboratory (NSSL)**, in Norman, Oklahoma, conducts weather research aimed at improving the accuracy and timeliness of forecasts and warnings of hazardous weather events such as thunderstorms, blizzards, ice storms, flash floods, tornadoes, and lightning. More information about NSSL is available at: <http://www.nssl.noaa.gov/>.
- **Pacific Marine Environmental Laboratory (PMEL)**, in Seattle, Washington, carries out interdisciplinary scientific investigations in oceanography, marine meteorology, and related subjects. PMEL also supports an undersea observation and research program in Newport, Oregon. More information about PMEL is available at: <http://www.pmel.noaa.gov/>.

Cooperative Institutes (<http://www.nrc.noaa.gov/ci>)

OAR has Cooperative Institute partnerships with academic and scientific institutions to foster long-term collaborations dedicated to advancing oceanic and atmospheric research. These Cooperative Institutes are usually co-located with one or more NOAA facilities to promote scientific exchange and technology transfer, and provide valuable capabilities and expertise to supplement OAR laboratory work.

The primary purpose of each institute is to create a mechanism to bring together the resources of a research-oriented university or institution, OAR, and other branches of NOAA in order to develop and maintain a center of excellence in research. Each Cooperative Institute represents a synergy that has brought together NOAA and premier academic and scientific institutions in a mutually beneficial arrangement to address issues of national and international significance unique to these partnerships. The institutes are:

- The **Cooperative Institute for Climate Applications and Research (CICAR)**, located at the Lamont-Doherty Earth Observatory Campus of Columbia University in Palisades, NY, conducts research on Earth system modeling, modern and paleo-climate observations, and climate variability and change applications. CICAR collaborates primarily with GFDL.
- The **Cooperative Institute for Climate Science (CICS)**, located at Princeton University's Forrestal Campus in Princeton, NJ, conducts research on Earth system modeling development and analysis, Earth system modeling applications, and data assimilation. CICS collaborates primarily with CPO and GFDL.
- The **Cooperative Institute for Climate and Satellites (CICS-M)** is a national consortium of academic, non-profit and community organizations with leadership from the University of Maryland and North Carolina State University. CICS-M conducts research on climate and satellite research and applications, climate and satellite observations and monitoring, and climate

research and modeling. CICS-M collaborates primarily with ARL, the Center for Satellite Applications and Research in NESDIS, and the Climate Prediction Center in NWS.

- The **Cooperative Institute for Alaska Research (CIFAR)**, located at the University of Alaska-Fairbanks, Alaska, conducts research on ecosystem function, coastal hazards, and climate change and variability. CIFAR collaborates primarily with CPO and PMEL.
- The **Cooperative Institute for Limnology and Ecosystems Research (CILER)** is a ten-member consortium of academic institutions in the Great Lakes region. CILER is administratively housed at the University of Michigan in Ann Arbor, Michigan. CILER conducts research on Great Lakes forecasting, invasive species, observing systems, protection and restoration of resources, and integrated assessment. CILER collaborates primarily with GLERL.
- The **Cooperative Institute for Marine and Atmospheric Studies (CIMAS)**, located at the University of Miami in Miami, Florida, conducts research on climate variability, fisheries dynamics, regional coastal ecosystem processes, human interactions with the environment, air-sea interactions and exchanges, and integrated ocean observation. CIMAS collaborates primarily with AOML and the NMFS' Southeast Fisheries Science Center.
- The **Cooperative Institute on Marine Ecosystems and Climate (CIMEC)**, located at Scripps Institution of Oceanography (SIO) at the University of California-San Diego, conducts research on climate and coastal observations, analysis, and prediction, research on biological systems, research in extreme environments, and R&D on observations systems CIMEC collaborates primarily with the Climate Laboratories and Southwest Fisheries Science Center. (Formerly titled the Joint Institute for Marine Operations (JIMO).)
- The **Cooperative Institute for Mesoscale Meteorological Studies (CIMMS)**, located at the University of Oklahoma in Norman, Oklahoma, concentrates its research efforts and resources on basic convective and mesoscale research, forecast improvements, climatic effects of and controls on mesoscale processes, socioeconomic impacts of mesoscale weather systems and regional-scale climate variations, Doppler weather radar R&D, and climate change monitoring and detection. CIMMS collaborates primarily with NSSL and several NWS components.
- The **Cooperative Institute for Marine Resource Studies (CIMRS)**, located at Oregon State University, Corvallis, Oregon, conducts research on West Coast fisheries, ocean environment, and marine mammal acoustics. CIMRS collaborates primarily with PMEL and NMFS' Northwest Fisheries Science Center.
- The **Cooperative Institute for the North Atlantic Region (CINAR)**, located at Woods Hole Oceanographic Institution, Woods Hole, MA, conducts research on ecosystem forecasting, ecosystem monitoring, ecosystem management, protection and restoration of resources, and sustained ocean observations and climate research. CINAR collaborates primarily with the Climate Laboratories and Northeast Fisheries Science Center.
- The **Cooperative Institute for Ocean Exploration, Research, and Technology (CIOERT)**, located at Florida Atlantic University's Harbor Branch Oceanographic Institution in Boca Raton, Florida, conducts research on the development of advanced underwater technologies, exploration and research in the frontier regions of the eastern U.S. continental shelf, and vulnerable deep and shallow coral reefs. CIOERT collaborates primarily with OER as a NOAA Undersea Research Program (NURP) regional center. Since this center replaced four NURP

undersea research centers on the East Coast, it is identified as an undersea research center on the above OAR map.

- The **Cooperative Institute for Research in the Atmosphere (CIRA)**, located at the Colorado State University in Fort Collins, Colorado, conducts research on satellite algorithm development training and education, regional to global scale modeling systems, data assimilation, climate-weather processes, and data distribution. CIRA collaborates primarily with the Boulder Labs and NESS satellite programs.
- The **Cooperative Institute for Research in Environmental Sciences (CIRES)**, at the University of Colorado, in Boulder, CO, conducts research on advanced modeling and observing systems, climate system variability, geodynamics, integrative activities, planetary metabolism, and regional processes. CIRES collaborates primarily with CPO and ESRL.
- The **Joint Institute for Marine and Atmospheric Research (JIMAR)**, located at the University of Hawaii in Honolulu, Hawaii, conducts research on tsunamis and other long-period ocean waves, equatorial oceanography, climate, fisheries oceanography, tropical meteorology, and coastal research. JIMAR collaborates primarily with NOAA's Boulder labs and NMFS programs.
- The **Cooperative Institute for Marine Ecosystems and Climate (CIMEC)**, located at Scripps Institution of Oceanography (SIO) at the University of California-San Diego, conducts research on climate and coastal observations, analysis, and prediction, research on biological systems, research in extreme environments, and R&D on observations systems. CIMEC collaborates primarily with CPO and PMEL.
- The **Joint Institute for the Study of the Atmosphere and Ocean (JISAO)**, located at the University of Washington in Seattle, Washington, conducts research on climate, environmental chemistry, marine ecosystems, and coastal oceanography. JISAO collaborates primarily with PMEL and NMFS programs.
- The **Northern Gulf Institute (NGI)** is a consortium of universities, led by Mississippi State University, which includes the University of Southern Mississippi, Louisiana State University, Florida State University, and the Dauphin Island Sea Lab, at Stennis Space Center, MS. NGI conducts research on ecosystem management, geospatial data integration and visualization in environmental science, climate change and climate variability effects on regional ecosystems, and coastal hazards. NGI collaborates primarily with AOML, PMEL, and GLERL.

NOAA Climate Program Office

The NOAA Climate Program Office (CPO) manages the OAR Climate Competitive Research, Sustained Observations and Regional Information and Climate Data and Information budget lines under the OAR Climate Research subactivity, and coordinates with the climate programs in the OAR Laboratories. CPO coordinates climate activities with other line offices (including NESDIS, NWS, NMFS, and NOS) and works with many external partners. CPO manages competitive grant programs and seeks to understand climate variability and change to enhance society's ability to plan and respond. CPO develops integrated ocean and atmospheric observing systems, sponsors research into the forcings and feedbacks contributing to changes in the Earth's climate, improves climate predictive capability from weeks to decades, and develops climate products and services to enhance decision making capabilities across all sectors of society. Finally, CPO serves as the NOAA focal point for such national and international climate efforts as:

- Maintaining the National Integrated Drought Information System (NIDIS) Office in Boulder, CO;
- Managing NOAA's international research activities in the terrestrial, atmospheric, and marine Arctic, Bering Sea, North Pacific, and North Atlantic regions;
- Leading U.S. involvement in the SAON (Sustaining Arctic Observing Networks) and the Circumpolar Marine Biodiversity Monitoring Plan;
- Implementing and maintaining nearly half of the global ocean observing system;
- Participating in multilateral and bilateral policy discussions through interaction with the Global Earth Observing System of Systems (GEOSS), the UN Framework Convention on Climate Change (UNFCCC), the Intergovernmental Panel on Climate Change (IPCC), the World Meteorological Organization (WMO), key bilateral partners, and other climate leadership organizations;
- Promoting climate literacy and outreach activities; and
- Leading the National Climate Assessment.

More information about CPO can be found at <http://www.climate.noaa.gov>.

Office of Weather & Air Quality

The Office of Weather & Air Quality (OWAQ) has two major missions. The first is to provide R&D that supports more accurate and timely warnings and forecasts of: (a) high-impact weather that causes loss of life and property and (b) air quality parameters, including ozone and aerosols/particulate matter which impact human health, cause crop damage, and affect private-sector power-generation planning. The second is to support research that provides the scientific basis for air-quality decision-makers to develop policies and plans that effectively protect public health while also maintaining a vital economy. The Office manages the U.S. Weather Research Program (USWRP).

National Sea Grant College Program

Congress established the National Sea Grant College Program in 1966 to enhance the development, use, and conservation of the Nation's coastal, marine and Great Lakes resources. The legislation establishes a network of Sea Grant Colleges to conduct education, training, and research in all fields of marine study. It also directs that grants and contracts may be awarded to "any individual; any public or private corporation, partnership, or other association or entity (including any Sea Grant College, Sea Grant Institute or other institution) or any State, political subdivision of a State, or agency or officer thereof." The National Sea Grant College Program Office is located in Silver Spring, Maryland. Currently, there are 32 university-based Sea Grant programs located in every U.S. coastal and Great Lakes state, Vermont, and Puerto Rico. These programs have aligned their efforts around the NOAA National Sea Grant College Program Strategic Action Agenda, which focuses on four critical areas: Safe and Sustainable Seafood Supply, Sustainable Coastal Development, Healthy Coastal Ecosystems and Hazard Resilience in Coastal Communities. More information about the National Sea Grant College Program can be found at <http://www.seagrant.noaa.gov>.

Office of Ocean Exploration and Research (OER)

OER is currently comprised of the Ocean Exploration (OE) Program and the NOAA Undersea Research Program (NURP), which is proposed for termination in FY 2013. OER's two primary functions are exploration and research:

- *Exploration*: This program supports: (1) exploring unknown and poorly known ocean areas; (2) mapping the physical, geological, biological, chemical, and archaeological aspects of the oceans; (3) utilizing new sensors and systems for ocean exploration; and (4) engaging a wide variety of

audiences by innovative means, including new telepresence technologies. OER operates the *Okeanos Explorer*, a NOAA ship dedicated to the ocean exploration missions.

- *Research:* OER operates a network of regional centers and two institutes to focus on the following areas: (1) core research based on national and regional undersea priorities, (2) development, testing, and transition for advanced technologies associated with ocean observatories, submersibles, advanced diving technologies, remotely operated vehicles, autonomous underwater vehicles, and new sampling and sensing technologies; (3) discovery, study, and development of natural resources and products from ocean, coastal, and aquatic systems; and (4) undersea science-based education and outreach.

More information about the Office of Ocean Exploration and Research can be found at <http://explore.noaa.gov>.

Other Ecosystem Programs

Other Ecosystem Programs is comprised of the Integrated Ocean Acidification Program. The Integrated Ocean Acidification Program's primary function is to complement, accelerate, and enhance current NOAA Ocean Acidification (OA) activities and provide comprehensive research, dedicated monitoring, and enhanced forecasting capabilities leading to adaptive strategies toward improved management of living marine resources impacted by OA. This is a coordinated effort throughout NOAA. Both the Federal Ocean Acidification Research and Monitoring Act of 2009 and the Magnuson Stevens Reauthorization Act designate NOAA as the lead agency for ocean acidification research in the U.S. and as liaison with international efforts.

NOAA High Performance Computing and Communications Program (HPCC)

HPCC supports many NOAA Strategic Plan objectives through support of information technology (IT) research targeted at improving NOAA's mission, services, and science education. HPCC seeks to make major improvements in the ability to forecast weather and climate, and to disseminate environmental information by stimulating modernization of NOAA's computationally-intensive services. HPCC provides NOAA with "mission" agency representation in the Networking and Information Technology Research and Development (NITRD) program.

Research Supercomputing

OAR supports the management of a high-performance computing system, which provides a key platform to characterize and quantify climate variations and change through the following leveraged research activities: long-term simulations using better and improved global climate models that include interactive atmospheric chemistry and aerosols; Earth System modeling to determine the fate of the anthropogenic carbon in the land and oceans; research on decadal predictability of the unforced and forced climate system including dependence on initialization and assimilation techniques; and progressively higher resolution atmospheric and oceanic modeling for regional climate change information.

Research and Development Investments

The NOAA FY 2013 Budget estimates for its activities, including R&D programs, are the result of an integrated requirements-based strategic planning process. This process provides the structure to link NOAA's strategic vision with programmatic detail and budget development, with the goal of maximizing resources while optimizing capabilities. OAR requests \$378,924,000 for investments in R&D and infrastructure to support R&D in the FY 2013 budget.

NOAA's R&D planning is tied to the goals, enterprises, and associated objectives outlined in NOAA's Next Generation Strategic Plan. Specifically, NOAA's Science and Technology Enterprise and

underlying objectives of holistic understanding of the Earth system through research; accurate and reliable data from observing systems; and an integrated environmental modeling system, provide the basis for a set of internal implementation plans covering a 7-year period which guide NOAA's research and development activities. The NOAA Research Council - an internal body composed of senior scientific personnel from every line office in the agency - informs the annual updates to these implementation plans, and is developing the next 5-Year Research and Development Plan for NOAA (FY 2013-2018), which will be publicly available when completed. This new plan will reflect NOAA's strategic objectives, provide a single guiding document for our scientists, the public, and our partners, and inform future internal planning efforts.

Significant Adjustments-to-Base (ATBs):

NOAA requests an increase of 0 FTE and \$3,176,000 to fund adjustments to current programs for OAR activities. The increase will fund the estimated 2013 Federal pay raise of 0.5 percent. The increase will provide inflationary increases for non-labor activities, including service contracts, utilities, field office lease payments, and rent charges from the General Service Administration (GSA).

NOAA also requests the following transfers for a net change of \$0 and 0 FTE:

From Office	PPA	To Office	PPA	Amount/FTE
OAR	Weather and Air Chemistry Research (W&ACR) - USWRP	OAR	Weather and Air Chemistry – Laboratories & Cooperative Institutes	\$0/12 FTE
OAR	Climate Operations	OAR	Climate Data & Information	\$908,000/0 FTE

NOAA requests a transfer of \$0 and 12 POS/12 FTE from U.S. Weather Research Program (USWRP) to the Weather & Air Chemistry Research (W&ACR) Labs & CI's line item to clarify the funding source for the FTE working on the USWRP program. In addition, NOAA requests to transfer the funding and functions of the small Climate Operations line item to its Climate Data and Information line item. These programs work interactively, and managing them together will allow for greater flexibility.

Administrative Cost Savings:

The Administration is continuing its pursuit of an aggressive government-wide effort to curb non-essential administrative spending. As a result, the Department of Commerce continues to seek ways to improve the efficiency of programs without reducing their effectiveness. The Department's total savings target for FY 2013 is \$176 million, which includes \$142.8 million in savings initiated in FY 2012 and an additional \$33.2 million planned for FY 2013. Building on OAR's administrative savings planned for FY 2012 (\$6.6 million), an additional \$0.23 million in savings is targeted for FY 2013 for a total savings in FY 2013 of \$6.9 million.

Headquarters Administrative Costs:

In FY 2013, OAR Line Office headquarters will use \$10,846,443 in funds to support general management activities, financial and budgeting, and IT related expenses, as well as supporting facilities and other general operating costs. These funds also include support for service contracts, utilities, and rent charges from the General Services Administration. Specifically, OAR will use headquarters administrative funds to support the following:

Headquarters Program Support Type	Description	FY 2013 Amount	FY 2013 FTE associated with OAR HQ
General Management & Direction/Executive Management	Includes Assistant Administrator's office, public affairs, information services	\$3,767,000	23.2
Budget & Finance	Includes Budget, Finance and Accounting	\$2,460,000	15.5
Information Technology	Includes IT-related expenses and other CIO related activities	\$1,008,000	6.7
Facilities/Other Administrative (CAO Functions)	Includes Facilities and Security costs, as well as other CAO related activities	\$1,330,000	0
Human Resources	All HR services, including EEO	\$1,413,000	9.5
Acquisitions, and Grants		\$867,000	7
Total		\$10,846,000	61.9

Narrative Information:

Following this section are base justification materials and program change narratives by subactivity for this line office. Please note that no program change narrative is provided for program changes of less than \$100,000, however, a summary exhibit is provided at the end of each subactivity showing the object class detail for the small program changes. Please contact the NOAA budget office if details for any of these changes are required.

APPROPRIATION ACCOUNT: OPERATIONS, RESEARCH, AND FACILITIES
SUBACTIVITY: CLIMATE RESEARCH

The objectives of the Climate Research subactivity are to:

- Describe and understand the state of the climate through sustained atmospheric observations and research related to global distributions, trends, sources and sinks of atmospheric constituents that are capable of forcing change in the climate of the Earth;
- Understand and predict climate variability and change from weeks to decades to centennial timescales;
- Conduct advanced mathematical modeling of the climate and Earth systems, including natural climate variability, anthropogenic climate change, weather and hurricane forecasts, El Niño prediction, and stratospheric ozone depletion to improve the prediction of climate phenomena;
- Sustain the observing systems essential for climate, oceanographic, monitoring, and data management;
- Conduct physical process research to advance a seamless suite of information and forecast products, ranging from short-term weather forecasts to longer-term climate forecasts and assessments; and
- Understand how decision makers use climate information to improve the ability of society to plan for and respond to climate variability and change.

Climate research has the mission of monitoring and understanding the Earth's climate system to predict both the potential long-term changes in global climate as well as shorter-term climate variations that are of societal and economic importance. More information on OAR's climate research is available at: <http://www.oar.noaa.gov/climate/>.

LABORATORIES AND COOPERATIVE INSTITUTES

Modeling

The focus of OAR's climate modeling research is to better understand natural climate variability and anthropogenic climate changes via the development and improvement of global Earth System models. Research is conducted at Geophysical Fluid Dynamics Laboratory (GFDL) with the Cooperative Institute for Climate Sciences, partners across NOAA, and a range of national and international partners to provide expert assessments of changes to regional, national, and global climate conditions. Research efforts are focused on two major areas: 1) comprehensive long lead-time climate research fundamental to expanding the scientific understanding of the physical and biogeochemical processes governing the behavior of the atmosphere, cryosphere, land, and oceans and their ecosystems and 2) short-term warning and forecast products that cover a broad spectrum of environmental events with timescales from several minutes to several months. Improved Earth System models will reduce uncertainties in sea level rise projections, address gaps in the understanding of the Arctic climate system, characterize and quantify uncertainties in the terrestrial carbon cycle and future biogeochemical feedbacks on climate, and enable better understanding of possible decadal climate predictability and abrupt climate change.

A key rationale for this research is to generate applications and to transition new techniques and models to operations – for example:

- State-of-art global Earth System models, which provide a suite of climate products for decision support by policy-makers by supporting a scalable high-performance computer

system that provides critical computing, storage, and analysis capabilities as well as model development infrastructure support and data services. This allows NOAA to leverage the world-class research staff at GFDL to provide the best possible information and reliable products on climate variability and change to policy-makers and the public.

- Numerical models that are used to predict short-term atmospheric phenomena, such as hurricanes and coastal storms, and longer-term events, such as the climatology of storm tracks over the oceans and El Niño Southern Oscillation (ENSO) cycles.

Physical Sciences

The Physical Sciences Division has an essential core capability to conduct physical science research across time and space scales to advance NOAA's capacity to observe, understand, critically evaluate and advance prediction of the behavior of the atmosphere, ocean, cryosphere, hydrosphere, land, and related impacts on global-to-local scales over periods of time from days to decades. These Physical Sciences activities have five strategic goals: (1) improve observations and understanding of Earth-system processes and maintain its world-class capabilities in water resource research and boundary layer science common to weather and climate; (2) integrate climate, weather, and water research; (3) diagnose, understand, explain, and improve the prediction of extremes such as droughts, heat waves, and floods in a variable and changing climate; (4) advance understanding of regional processes and critically assess the skill of associated predictive tools; and (5) conduct research and develop prototypes to improve NOAA environmental information and services. To meet needs for science-based information, the program works closely with its internal partners and a broad external user community. This research is conducted with support from the Cooperative Institute for Research in Environmental Studies (CIRES).

Chemical Sciences

The Chemical Sciences Division, in partnership with CIRES, conducts studies that are fundamental to our understanding and prediction of the Earth's climate, U.S. air quality, and the stratospheric ozone layer. Related meteorological, dynamical, and radiative processes also are addressed when necessary. These goals are met through studies in the laboratory, extensive measurements in the atmosphere in focused field studies, diagnostic analyses, representation of these processes in models (in collaboration with others in NOAA and the extramural community), and interpreting the results to elucidate the roles of these processes. NOAA provides this information to its customers in government, industry, and the public through the preparation of assessments and evaluations of the current and future states of the Earth's stratosphere (ozone layer), climate, and air quality, as well as the processes that link them.

Global Monitoring and Research

The Global Monitoring Division (GMD), in partnership with CIRES, conducts sustained observations and research related to global distributions, trends, sources and sinks of atmospheric constituents that are capable of forcing change in Earth's climate and environment. This research advances climate projections and provides scientific policy-relevant, decision support information to enhance society's ability to plan and respond by providing the best possible information on atmospheric constituents that drive climate change, stratospheric ozone depletion, and baseline air quality. Sustained observations are conducted through globally distributed observing networks which include six manned Global Atmospheric Baseline Observatories, and as many as 250 different atmospheric parameters are measured. They provide valuable information on: (1) the state and recovery of the ozone layer; (2) global carbon dioxide and other greenhouse gases impacting the global climate; and (3) the quality of the air entering and departing the United States. GMD supports several components of the U.S. Global Change Research Program (USGCRP), much of the World Meteorological Organization (WMO) Global Atmospheric Watch program, and other international programs, including the Global Climate Observing System, the Baseline Surface Radiation Network,

and the Global Earth Observing System of Systems. The U.S. scientific community coordinates its carbon cycle activities through the USGCRP North American Carbon Program, which aims to quantify, understand, and project the evolution of global carbon sources and sinks in order to better predict future climate. With input from other agencies, the CarbonTracker analysis tool forms the foundation for routine spatial carbon maps and is essential for other USGCRP reports and products, such as periodic “State of the Carbon Cycle” reports and assessments that keep scientists and policy-makers abreast of progress in understanding the North American carbon cycle.

Climate Observations and Monitoring

OAR’s Climate Observations and Monitoring provides and interprets oceanographic data and conducts research relevant to decadal climate change and coastal ecosystems. On a global scale, Atlantic Oceanographic and Meteorological Laboratory (AOML) scientists use observations and models to understand and characterize the role of the oceans in climate variability and change. Observations of ocean currents, temperature, and salinity, provide a basis for studying interactions between oceans, climate, and coastal environments. Monitoring and estimating carbon dioxide both taken up and released by the ocean’s surface contributes to understanding the effects of carbon dioxide on global warming and climate change, including changes in the pH of ocean waters (ocean acidification).

In support of these studies, AOML partners with OAR’s Climate Program Office to manage all or significant portions of the following NOAA contributions to the internationally coordinated Global Ocean Observing System (GOOS) and other climate research activities: Global Drifter Program; U.S. Argo Program; Global Ship of Opportunity Program; CLIVAR CO₂ Repeat Hydrography Program; Prediction and Research Moored Array in the Tropical Atlantic Program (PIRATA); Ocean reference stations (including the Western Boundary Time Series Program and the South Atlantic Meridional Overturning Circulation program); Tropical Atlantic Variability; and Global Climate Variability.

These activities, described under the Climate Competitive Research, Sustained Observations, and Regional Information line item, include the design, implementation, maintenance, and enhancement of the observational network, real-time quality control of the data for use by operational forecast agencies, delayed mode quality control of the data for use in scientific projects, and the production and provision of ocean products used by operational and research communities. This research is conducted through numerous open-ocean cruises aboard NOAA’s research vessel, the *Ronald H. Brown*, and commercial shipping vessels, autonomous vehicles, and expendable instruments. These data lay the framework for future research that promises to improve the ability of climate models to predict summer rainfall and hurricane activity for the Western Hemisphere. In addition, AOML’s carbon dioxide monitoring program and related studies in ocean acidification exemplify climate research that intersects with NOAA’s Healthy Oceans goal to improve understanding of how ecosystems will respond to a changing climate. AOML regularly produces reports on the state of the ocean for the scientific community demonstrating excellence in: implementing and maintaining the ocean observing system, distributing data to science and operational centers, and monitoring and assessing critical ocean parameters related to climate. AOML collaborates with the National Science Foundation (NSF) and NASA, as well as NOAA’s NWS, NOS, and NMFS.

The following is a more detailed description of the AOML Climate Research currently being conducted:

- Meridional Overturning Circulation (MOC): AOML conducts monitoring and research to document the current state and changes in the global ocean circulation through several programs in the North and South Atlantic Oceans. Together with its partners, AOML

maintains long-term observations across the Atlantic Ocean through the Western Boundary Time Series in the Straits of Florida, the RAPID/MOCHA/WBTS array in the subtropical Atlantic, and the South Atlantic MOC program. AOML deploys, maintains, and collects data from the instrumentation associated with these programs and performs data analysis that leads to improved understanding of the global ocean's impacts on climate.

- Tropical Atlantic Variability: The upper ocean waters of the Tropical Atlantic Ocean play an important role in determining regional weather and climate on seasonal to inter-annual time scales and beyond. Using global data sets and statistical-numerical models, AOML conducts diagnostic studies of the multi-scale behavior of the Atlantic and its impact on climate, oceans and weather such as hurricanes, seasonal rainfall and drought.
- Global Climate Variability: AOML is a NOAA partner in the global effort to obtain high-quality, high spatial and vertical resolution measurements of a suite of physical, chemical, and biological parameters over the full water column through the CLIVAR program. In partnership with PMEL, AOML conducts vital research to understand the ocean's role in the global carbon cycle. This research is critical to calculating changes caused by increased production of carbon dioxide, of particular importance due to the impacts of these changes on living organisms in the ocean (e.g. ocean acidification). AOML carries out research projects with the objective of estimating and understanding the variability of surface and subsurface currents and chemistry using observations from surface drifting buoys, Argo floats, volunteer observing ships, buoys, moorings and satellite altimetry. AOML houses data acquisition centers for Argo, drifters and XBTs and is responsible for the world-wide dissemination of this data onto the Global Telecommunications System (GTS).

Climate Observations and Analysis

OAR's Climate Observations and Analysis program provides core infrastructure activities (including research, technology development and observing system implementation) that are central to meeting NOAA's climate goals and has a strong history of innovation to meet the challenge of fielding a robust, accurate observation activity. These include: (1) providing instrumentation (funded by NWS) to support the Tropical Moored Observations in the Pacific (TAO); (2) establishing and maintaining moored buoys in the Atlantic (PIRATA) and tropical moored buoy arrays in the Indian Ocean (RAMA); (3) conducting Argo float deployment and research activities; (4) monitoring ocean carbon uptake and storage; (5) conducting moored and underway CO₂ measurements; (6) conducting research (funded by the Integrated Ocean Acidification Program) on the issue of Ocean Acidification; (7) conducting NOAA/NSF operations in support of the global CLIVAR Repeat Hydrography program; (8) maintaining global ocean reference station time series moored arrays; (9) conducting Marine Aerosol, Atmospheric Chemistry, and Air Quality research cruises; (10) conducting autonomous glider sections of western boundary currents in the Solomon Sea; (11) observing ocean modeling system adequacy studies; (12) participating in ocean data management and information technology activities; and (13) supporting climate observations critical to international assessments, such as the United Nations established Intergovernmental Panel on Climate Change (IPCC), the leading scientific body assessing climate change. While most of these activities are conducted in partnership with OAR's Climate Program Office (and are described in more detail under the Climate Competitive Research, Sustained Observations, and Regional Information line item), there are several highly innovative activities that should be cited here:

- *Atmospheric Chemistry Program* coordinates with coastal states on research ranging from coastal investigations to larger-scale experiments downstream of major continental land masses and industrialized areas. Recent efforts have focused on offshore and coastal regions of Texas and California to determine the sources of airborne aerosol particles and particulate matter from industrialized areas and to determine the effects of these aerosols on the environment. FY 2012 efforts are planned in the North Atlantic and in the Indian Ocean.

This program also operates an Unmanned Autonomous Vehicle System which was deployed to Svalbard, Norway, in April 2011 as part of the Soot Transport Absorption and Deposition Study, which is the NOAA component of the 2011 Coordinated Investigation of Climate-Cryosphere Interactions, studying black carbon in the Arctic.

- *Autonomous Glider Sections* have been made in the Solomon Sea by PMEL and Scripps Institute of Oceanography scientists, who have used autonomous gliders to make a series of detailed current observations along pre-programmed transect routes in the Solomon Sea. This research coordinated between NASA, NOAA, and NSF has completed eleven sections since 2007. Western Boundary Currents being studied in the Solomon Sea provide key information about ocean circulation patterns and their impact on global climate.
- *Data Management and Communication (DMAC)* activities of the Global Integrated Ocean Observing System has supported a PMEL-led partnership with NOS and NESS to improve management and availability of the wide array of ocean-related data collected by member nations.

These programs provide a major portion of the U.S. contribution to the global ocean observations for climate, which are required to monitor, understand, and forecast the Earth's climate system. This information is crucial for the future health of the entire planet. It contributes to forecasts of natural disasters such as major El Niños, which occur on interannual time scales. A major El Niño, such as the unpredicted 1981-1982 event, can cost the U.S. economy billions of dollars. Floods, droughts, heat waves, and extreme weather events are all influenced by the climate system. Our ability to predict them depends on ongoing climate measurements, especially in the 70 percent of the globe covered by the ocean. For example, sea-level rise depends on the heat content of the ocean, which is monitored by both the Argo float and repeat hydrography programs. This program supports cross-cutting activities at the NSF and NASA, as well as activities within NOAA's NWS, NOS, and NMFS.

Atmospheric Observations & Monitoring / Plume Dispersion

OAR's Atmospheric Observations & Monitoring efforts, overseen by ARL, include:

- Making and organizing high quality observations of climate variability and change and key physical and chemical processes that influence climate. For example, water from the soil and plants is transferred to the air, affecting atmospheric humidity and temperature and influencing agriculture and drought. Such information is important for evaluating and improving models of the climate, as the fluxes of energy and moisture between the land and air are important factors in climate variability and change. Another example of promoting climate-grade observations is leading the establishment of an international network to take highly accurate and reliable measurements of the atmosphere above the Earth's surface.
- Analyzing climate observations to determine what natural climate variability and what climate trends have occurred in the past. These analyses are used to evaluate and improve climate models and to inform national and international climate assessments.
- Investigating how regional climate models and observations can be effectively combined to improve projections of the future, improving the Nation's ability to understand localized impacts of climate change. Reducing uncertainties via these models is essential for improving the understanding of natural climate variability and climate trends and for improving projections of future climate to inform mitigation and adaptation decisions.

ARL also oversees OAR's Monitoring/Plume Dispersion research in which it tracks, characterizes and predicts dispersion of airborne hazardous materials, including smoke, harmful chemicals, radioactive materials, and biological agents (released either accidentally or intentionally). These plume dispersion activities provide essential information for first responders and emergency

management in the government, as well as industrial, agricultural, and transportation sectors to minimize risks to health, safety, and economic activities. Knowledge of where hazardous materials will spread enables emergency managers to effectively evacuate people from harm's way and helps industrial and transportation companies to take protective measures for a wide range of situations, including oil drilling platform disasters, chemical plant explosions, containment failures at nuclear reactors, and the spread of plant pathogens. Thousands of people and groups use these tools, including NWS; other Federal agencies (e.g., the Forest Service, Nuclear Regulatory Commission, and the Environmental Protection Agency); other countries' weather services; international organizations (e.g., International Atomic Energy Agency); universities; and the private sector. These dispersion tools have also been applied to natural causes of degraded air quality issues, such as wildfire smoke, dust, and volcanic ash.

CLIMATE DATA AND INFORMATION

NOAA's Climate Data and Information Program manages the resource of global climate *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. Climate observing networks assemble, develop, and communicate data and information about the trends and predictions of climate and weather events to decision makers (e.g. energy, agriculture, state and local officials). NOAA is responsible for infrastructure that addresses: (1) improving access and data management activities associated 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; and (4) value-added data visualization, contextualization and interpretation of climate trends and conditions. NOAA supports the following under the Climate Data and Information Program:

- The U.S. Climate Reference Network (USCRN) provides baseline, high-quality surface observations of air temperature and precipitation to detect long-term changes in climate through a robust climate record. Observations from this network will provide benchmark measurements for an improved national climate and weather monitoring network. The USCRN also supports the National Integrated Drought Information System (NIDIS)¹ through the inclusion of soil moisture sensors, which provide data critical to understanding drought.
- The U.S. Drought Portal is part of NIDIS and it provides users with the ability to determine the potential impacts of drought and their associated risks, while also providing needed decision support tools. More information is available at: <http://www.drought.gov>.
- NOAA's Observing System Monitoring Program provides early detection and remediation of network problems that can adversely affect the quality of data records and diminish the ability to evaluate climate variability and change. The Observing System Monitoring Program will alert observing system managers in near-real time to problems that can distort the historical archive, providing the opportunity to take corrective action.
- The Climate Model Data Archive will generate and house model-based data records and implement an operational archive and access capability for the next generation, high resolution, weather and climate reanalysis datasets.
- The Climate Model Data Archive addresses the recommendation of the NOAA Science Advisory Board (SAB) that NOAA develop products and access capabilities derived from climate model

¹ The NIDIS program is funded both through the Climate Data and Information program, and also through the Climate Competitive Research, Sustained Observations and Regional Information program. See page 23 for more information with regards to NIDIS base funds.

outputs. The Climate Model Data Archive provides a single point of access to several new key NOAA datasets, and will improve the linkages between research findings and the transfer of those findings into operational capabilities and will facilitate model and observational data access issues.

- In FY 2012, NOAA transitioned the Climate Portal Prototype to a phase of active development of the comprehensive Portal, which will represent the full breadth and depth of NOAA's climate sciences and available services and serve as the public's primary online point of entry. Existing data and new products in formats that are readily usable by decision-makers in government agencies and businesses will be available. These geospatial tools enable resource managers to place information on impacts and affected resources in a place-based context relevant to planning or permitting. The full Portal's scope, product content, and functionality will evolve based on user needs and expectations for data and information.
- In addition, OAR's Climate Operations programs provide accurate and timely climate information and operational forecasts. Public and private users and NOAA's mission goals demand this information on a broad range of timescales from sub-seasonal through interannual and beyond. Through Climate Operations, NOAA is working to improve its ability to produce and disseminate operational forecast products by improving model performance, developing new forecast designs, and upgrading existing data sets.

CLIMATE COMPETITIVE RESEARCH, SUSTAINED OBSERVATIONS, AND REGIONAL INFORMATION

The Climate Competitive Research, Sustained Observations, and Regional Information program supports three main capabilities: 1) the development and sustained use of observations, 2) improved scientific understanding through the use of competitive research, and 3) the development of climate products generated from observations and research to address the demands for regional information. This program allows NOAA the flexibility to develop these complementary climate capabilities in a coordinated way.

The Climate Competitive Research, Sustained Observations, and Regional Information program supports sustained ocean and atmospheric observations, and it addresses an important aspect of global change – understanding the global climate system. It sponsors scientific research aimed at improving predictions and assessments of climate variability over seasonal to decadal time scales and beyond in an effort to better understand how society can best adapt and respond to climate variability and change. Both climate observations and research provide the foundation to develop and deliver regional information to respond to decision maker needs.

Research Programs

The Climate Competitive Research, Sustained Observations, and Regional Information program funds high-priority climate science within NOAA and with our academic partners to advance our understanding of Earth's climate system, including its atmospheric, oceanic, land, and snow and ice components, as well as the impacts of climate on society. This science contributes to knowledge about how climate variability and change affect our health, economy, and well-being. The program supports research that is conducted in regions across the United States, at national and international scales, and globally. The program also provides strategic guidance and oversight for the agency's climate science and services programs.

The grant activities are organized within three program activities:

Climate Monitoring

The Climate Monitoring (CM) activity contributes to the development of continuous records and analyses of a range of ocean and atmosphere parameters. CM ensures that the data sets researchers need to understand the climate system are available for analysis. CM supports projects that document and study variations in climate on time scales ranging from less than one year to periods of 100 years and longer, i.e., both instrumental and paleoclimate eras. CM also provides data and information management support for national and international climate assessment projects. Analysis products support other program efforts in modeling of the climate system and development of targeted services to better inform society about climate impacts and response options.

CM comprises the following focus areas:

1. Develop long-term, continuous, and consistent data sets that can be used to diagnose changes in the behavior of extreme climate and weather events
2. Reconstruct the climate history over the last two millennia at sufficient resolution to allow extreme events to be identified and characterized
3. Perform diagnostic studies of observed and modeled patterns of climate variability and change to enable the detection and attribution of regional extremes

Earth System Science

The Earth System Science (ESS) activity provides the process-level understanding of the climate system through observation, modeling, research analysis and field studies to support the development of improved climate models and predictions in support of NOAA's mission. Major activities include:

1. Understanding and improving the prediction of tropical convection, with a focus on identifying the key processes involved in linking convection with environmental moisture and responsibility for the dynamic evolution of cloud populations on intra-seasonal time scales
2. Identifying the location, magnitude, dynamics, and variability of global carbon sources and sinks; understanding how ocean ecosystems are impacted by changes in carbon cycling and the role of these ecosystems in regulating the ocean's carbon uptake
3. Improving understanding of the role of aerosols and chemically-active greenhouse gases in the global climate system

ESS-sponsored research is carried out at NOAA and other Federal laboratories, NOAA Cooperative Institutes, and academic institutions and is coordinated with major national and international scientific bodies including the World Climate Research Programme, the International Geosphere-Biosphere Programme, and the U.S. Global Change Research Program.

Modeling, Analysis, Predictions, and Projections

The mission of the Modeling, Analysis, Predictions, and Projections (MAPP) activity is to enhance the Nation's capability to predict variability and changes in Earth's climate system. MAPP focuses on the coupling, integration, and application of Earth system models and analyses across NOAA, among partner agencies, and with the external research community. Primary objectives include:

1. Improving Earth system models,
2. Developing a national multi-model ensemble prediction system for intra-seasonal to inter-annual time scales, and
3. Advancing decadal climate predictions and climate projections out to a century and beyond.

MAPP includes targeted infrastructure support, competitive grants programs, and mechanisms to support transferring research findings into NOAA's operations.

More information on the wide variety of climate research programs is available at:
http://www.climate.noaa.gov/cpo_pa/.

Observing Systems

The Competitive Research, Sustained Observations, and Regional Information Program includes several major observing systems for the oceans and atmosphere:

- *Global Ocean Observing System (GOOS)* – GOOS is maintained by the Climate Program Office and is necessary for climate research and prediction as well as long-term monitoring for climate change detection and attribution. NOAA provides the major U.S. contribution to the Global Component of the Integrated Ocean Observing System (IOOS), as codified in the Integrated Coastal and Ocean Observation System Act of 2009. IOOS is also the U.S. contribution to the GOOS and the ocean baseline of the Global Earth Observation System of Systems (GEOSS). This international observation system is based on measuring a set of core variables (for example: ocean temperature, surface winds, salinity, sea level, carbon dioxide) that have been agreed to nationally and internationally as necessary to provide the information needed by the United States and the other nations to effectively plan for and manage their response to climate variability and change. In addition, GOOS includes Arctic observations as part of the U.S. contribution to the International Arctic Observing Network. The major elements of GOOS are: 1) Argo Profiling Floats, 2) Surface Drifting Buoys, 3) Tide Gauge Stations, 4) Tropical Moored Buoys, 5) Ocean Reference Stations, 6) Ships of Opportunity (SOOP), 7) Ocean Carbon Networks, 8) Arctic Ocean Observing System, 9) Dedicated Ships, 10) Data Management, Data Assimilation, and Analysis. Satellites are also critical elements of this composite system, but they are listed elsewhere in the NOAA and NASA budgets. All of these interdependent elements work together to provide the needed system.

Argo Profiling Floats

These floats provide the subsurface measurements of ocean temperature and salinity that are necessary, along with the satellite altimeter measurements, to monitor global sea level change and upper ocean heat content. This is an international effort with 22 nations plus the European Union currently maintaining 3,000 floats. Development of deep diving Argo floats is underway with deployment of test floats anticipated for FY 2014.

Surface Drifting Buoys

Sea surface temperature is the single most important ocean variable for the global heat, water, and carbon cycles. NOAA maintains with its 14 international partners, a global array of 1,250 surface drifting buoys. This array is used to calibrate satellite observations and reduce errors in global measurement of this critical ocean climate variable. The drifters also measure surface currents globally and provide sea surface data under hurricanes to help improve hurricane intensity and landfall predictions.

Tide Gauge Stations

Sea level rise is one of the most immediate impacts of climate change. NOAA in cooperation with 66 nations is implementing the Global Climate Observing System (GCOS) sea level reference network of 170 tide gauge stations. The stations measure sea level change at the coast and are used to calibrate and validate the satellite altimeter measurements of the deep ocean. They report in near-real-time and are also used for the tsunami warning system, storm surge, navigation, and other coastal 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 patterns. Together with international partners, NOAA is working to instrument all three tropical oceans - the Pacific - Tropical Atmosphere Ocean (TAO) Array; Atlantic; and Indian Ocean - for continuous real-time measurement of ocean-atmosphere exchanges that affect the way our climate varies from year to year.

Ocean Reference Stations

NOAA, in cooperation with the National Science Foundation and international partners, is implementing a sparse global network of the highest quality ocean reference station moorings, to provide the most accurate long-term climate data records of oceanic and near-surface atmospheric parameters in key ocean regions. The surface and subsurface measurements from these Reference Stations have been a cornerstone of the documentation of long term changes in the ocean and provide "ground truth" for improvement of forecast models. This network also monitors major ocean currents (for example, the Gulf Stream) 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. The Ships of Opportunity are also the system's primary vehicle for deployment of the Drifting Buoys and Argo Floats.

Ocean Carbon Networks

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, supplemented by autonomous carbon dioxide sampling instruments on the ships and the moored buoys to measure the air-sea exchange of carbon dioxide seasonally.

Arctic Ocean Observing Network

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 co-leading with the NSF and joining with other Federal agencies and international collaborators to begin a long-term effort to deploy an Arctic Ocean Observing Network. Current NOAA efforts focus on developing quantitative estimates of the transport of heat, salt, nutrients and total water volume through the Bering Strait and the Chukchi Sea, periodic characterization of the impacts of climate change on marine ecosystems in the Chukchi Sea, pilot deployments of buoys to measure Arctic sea ice thickness and ice mass balance changes, and a small network of circum-Arctic coastal observatories to track atmospheric factors that control sea ice and other aspects of Arctic climate.

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 the highest quality reference data sets, the platforms for the ocean carbon

surveys, and 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 infrastructure is essential to the vision of a sustained and integrated 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 elements of the global ocean observing system.

- *Baseline Observatories* – NOAA’s Global Atmospheric Baseline Observatories 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 (since 1957). In addition, NOAA funds operations at its 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.
- *Carbon Cycle Atmospheric Observing System* – 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 launched a network of airborne and tall-tower based sampling sites over North America. 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.

Regional Information

NOAA has extensive regional climate capabilities and also partners with Federal agencies; state, local, and tribal governments; universities; the private sector; and non-governmental organizations (NGOs). The Climate Competitive Research, Global Ocean Observations and Regional Information Applications program includes funding for both internal and external research and development programs. NOAA coordinates these regional capabilities and produces and delivers regional information which are used in other more operational areas within NOAA and by the external community.

Climate and Societal Interactions

The NOAA Climate and Societal Interactions (CSI) activity provides national leadership in developing interdisciplinary science and services, including assessments, for application in climate-sensitive sectors and regions. The goals of CSI are: 1) identification and articulation of user-community requirements in multiple sectors, initially with regard to water resources and the coastal zone then branching to related sectors; 2) R&D of innovative and broadly applicable approaches to support decision-making, especially for risk characterization, both through a broad network of regionally scoped, long-term efforts and stakeholder-specific efforts; and 3) promotion of the transfer of knowledge, tools, and products across climate research efforts (within NOAA, across the Federal government, nationally, and internationally).

In addition, several of CSI's initiatives support the Coping with Drought initiative of the National Integrated Drought Information System (NIDIS) by supporting regions threatened by drought. CSI's focus areas are:

- Regional Integrated Science and Assessments (RISA) – supports research that addresses complex climate sensitive issues of concern to decision-makers and policy planners at a regional level through the establishment of RISA teams;
- Sectoral Applications Research Program (SARP) – addresses the needs of a specific stakeholder or set of stakeholder within key socioeconomic sectors (e.g., water resources, agriculture, health, etc.) grappling with pressing climate-related issues;
- Coastal and Ocean Climate Applications (COCA) – supports interdisciplinary applications research on the impacts of climate variability and change on coastal communities and coastal and marine ecosystems to inform decision making; and
- International – supports decision-making and stakeholder networks internationally.

Information and data from the above activities (CM, ESS, MAPP, and CSI) are used to assess climate forcing, climate feedbacks, climate response, ozone depletion and baseline, urban, and regional air chemistry, to develop and test diagnostic and predictive models, and to keep the public, policy makers, and scientists abreast of the current state of our atmosphere. This program addresses the NOAA Next Generation Strategic Plan goal of Long Term Climate Adaptation and Mitigation and its objectives for (1) Improved scientific understanding of the changing climate system and its impacts, (2) Assessments of current and future states of the climate system that identify potential impacts and inform science, service, and stewardship decisions, (3) Mitigation and adaptation choices supported by sustained, reliable, and timely climate services and (4) A climate-literate public that understands its vulnerabilities to a changing climate and makes informed decisions.

National Integrated Drought Information System (NIDIS)

The NIDIS program (\$8,363,000 under the Climate Competitive Research, Sustained Observations, and Regional Information program) includes Coping with Drought Grants, drought modeling and regional drought early warning system development. Additional activities (\$3,753,000) under the NIDIS program (including soil moisture sensors for the U.S. Climate Reference Network and the U.S. Drought Portal) are funded by the Climate Data and Information program for a total funding level of \$13,616,000 (see page 16).

Assessment Services

The Global Change Research Act of 1990 (GCRA) calls for the President (through a Federal interagency body) to prepare and submit to the Congress, on a periodic basis (not less frequently than every 4 years), an assessment which: 1) integrates, evaluates, and interprets the findings of the Federal interagency research effort and discusses the scientific uncertainties associated with such findings; 2) analyzes the effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity; and 3) analyzes current trends in global change, both human-induced and natural, and projects major trends for the subsequent 25 to 100 years. The next National Assessment is due in 2013. The demand for climate information at regional to local scales for decision making requires increased resolution of the Nation's mandated assessment product.

Communication and Education Program

The Climate Competitive Research, Sustained Observations and Regional Information program also conducts a Communication and Education Program (CommEd) that has missions to improve public

climate science literacy, and to raise public awareness, understanding of, and engagement with NOAA's climate science and services programs.

Schedule and Milestones:

FY 2013 – FY 2017

GFDL

- Modeling

Schedule/Milestones	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
National and International Assessment Products	Submit papers for inclusion in IPCC AR5 report; IPCC lead author work continues	IPCC AR5 Working Group I report completed and released.	Use ESM to conduct suite of regional climate change projections	Develop quarter degree model for reduction in tropical uncertainties of climate projections	Continuing ESM development	Continuing ESM development
Experimental Decadal Forecasts	Decadal Predictability studies continue	Develop capability for nowcasting of Atlantic MOC	Extend decadal predictions to applications: drought and hurricanes	Decadal projections using higher resolution coupled model	Decadal Predictability studies continue	Decadal Predictability studies continue

- Improved understanding decadal-to-centennial climate change, variability and predictability, and increasing confidence in climate projections, using coupled-climate model (CM2.5) at 4 times the resolution of recent IPCC-class coupled climate models.
- Robust simulations of regional climate change around the world (including tropical storms) using 25-km resolution global atmospheric model.
- Improved realism of the NOAA Earth System Models by closing the nitrogen cycle, and major feedback on the global carbon cycle.
- Reduction in percentage uncertainty in possible twenty-first century sea level rise
- Development of initial physical formulations to incorporate soot and dust aerosol impacts on snow and ice albedo in climate models, and improved sea ice models essential to developing a predictive understanding of Arctic climate change.
- Enhanced contributions to assessments of human impacts on climate through inclusion of more realistic physical processes & important feedbacks in climate models, and analysis of causes of past climate change; greater confidence in projections of regional climate impacts.

ESRL / PSD

- Earth System Analysis

Schedule/Milestones	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Cumulative field projects advancing water resources	1	1	2	3	4	5

Cumulative assessments of extreme weather and climate events, anomalies, and trends	1	1	2	2	3	3
Advance Ensemble Kalman Filter (ENKF) techniques for transition to operations for extended range forecasting	1	1	-	-	-	-
Increase utilization of Earth system observations in the Russian Arctic as measured by cumulative publications	1	2	3	4	5	6
Carry out analysis of oceanic weather-climate observations in the tropics as measured by cumulative publications	0	1	2	2	3	4

- Co-lead and complete the execution and data processing phase of the DYNAMO experiment in the Indian Ocean to better understand the dynamics of the Madden-Julian Oscillation which may improve sub-seasonal prediction over the United States.
- Terminate the next generation historic reanalysis at higher resolution.
- Assess the improvement in boundary layer wind forecasting at successive time scales using real-time assimilation of radar wind profiler data drawing from resources from WFIP (Wind Forecast Improvement Project) sponsored by DOE.
- Assess the causes for recent variations in U.S. national and regional seasonal temperature, precipitation and drought.
- Complete a study of inter-basin transport between the San Joaquin Valley (SJV) and the Los Angeles (LA) Basin using a combination of wind profiler analysis and numerical models in support of the CalNex program.
- Carry out field study and analysis of boundary layer effects on surface chemistry in the Uintah Basin Ozone Study in support of GMD and CSD.
- Complete Delivery of a global Ensemble Kalman Filter system to operational forecast centers for pre-operational testing (an EnKF is a data assimilation technique for making atmospheric analyses and forecasts).
- Complete analysis of HMT and CalWater experiments in terms of understanding the role of atmospheric rivers and aerosols in water supply and extreme precipitation.
- Quantify baseline performance on NOAA extreme precipitation forecasts over previous 10 years.

ESRL / CSD

- Chemical Sciences

Schedule/ Milestones	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Climate-Air Chemistry field campaigns	Assess climate/air chemistry interactions using 2010 California mission	Climate and air chemistry study in the southeastern USA	To be based on earlier findings	Climate and air chemistry study in the USA	To be based on earlier findings	To be based on earlier findings

	(CalNex) data					
Field campaigns on aerosol-cloud interactions	Assess impact of aerosols on cloud systems in SE Pacific and Caribbean	Participate in aerosol-cloud field study in Brazil	To be based on earlier findings	To be based on earlier findings	To be based on earlier findings	To be based on earlier findings
Field campaigns on upper tropospheric water vapor and cirrus	Deploy new water vapor instrument in an independent assessment of water vapor measurement techniques and sensors	Analyze measurements of water vapor	To be based on earlier findings	To be based on earlier findings	To be based on earlier findings	To be based on earlier findings
Climate research on upper tropospheric water vapor to improve models that provide a predictive understanding of the physical processes	Develop a new fully automated instrument to measure water vapor concentrations for use on board high-altitude research aircraft	To be based on earlier findings	Continue analyses	To be based on earlier findings	Continue analyses	To be based on earlier findings
Laboratory study of climate agents	Evaluation of climate-related properties of one compound proposed as a replacement for ozone-depleting substances	Initiate study of compound #2 to address key uncertainties	Continuing	Initiate study of compound #3 to address key uncertainties	Continuing	Initiate study of compound #4 to address key uncertainties
Modeling study of climate processes and agents	Analyze models and data to quantify role of water vapor, ozone, and other forcing agents on climate and stratospheric ozone	Initiate study #2 to address key uncertainties	Continuing	Initiate study #3 to address key uncertainties	Continuing	Initiate study #4 to address key uncertainties
Laboratory studies related to air chemistry	Laboratory assessment of one chemical reaction relevant to stratospheric ozone chemistry and climate-chemistry coupling	Initiate kinetic study of compound #2 to address key uncertainties	Continuing	Initiate kinetic study of compound #3 to address key uncertainties	Continuing	Initiate kinetic study of compound #4 to address key uncertainties
Evaluation of emission	Top-down evaluations of	Continuing	To be based on earlier	Continuing	To be based on earlier	

inventories	greenhouse emission inventories using data from the California field campaign (CalNex)		findings		findings	
Black carbon studies	Assessment of black carbon emissions	To be based on earlier findings	Continuing	To be based on earlier findings	Continuing	To be based on earlier findings

ESRL / GMD

- Global Monitoring and Research

Schedule/Milestones	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
High quality, calibrated, traceable measurements of ~250 atmospheric, climate, & radiatively important species at each of the 6 Atmospheric Baseline Observatories (Total #/yr/site)	250	250	250	250	250	250
NOAA Annual Greenhouse Gas Index (AGGI) Indicator: Number of Updates Unit of Measure: Cumulative number of updates	8	9	10	11	12	13
NOAA Ozone Depleting Gas Index (ODGI) Indicator: Number of Updates Unit of Measure: Cumulative number of updates	7	8	9	10	11	12

- Continue to conduct sustained observations and research related to global distributions, trends, sources and sinks of atmospheric constituents that are capable of forcing change in the climate of the Earth. Continue to advance climate projections and provide scientific policy-relevant, decision support information to enhance society's ability to plan and respond. Continue research of improving instruments, reducing uncertainty values, economies of scale, calibration techniques, and statistical analysis of data.
- Updates to Daily/Monthly/Annual GHGP Products suite as appropriate (<http://www.esrl.noaa.gov/gmd/dv/>).
- Publish Annual Greenhouse Gas Index (<http://www.esrl.noaa.gov/gmd/aggi/>) and Ozone Depleting Gas Index Update (<http://www.esrl.noaa.gov/gmd/odgi/>).
- Updates and refinement to CarbonTracker (<http://www.esrl.noaa.gov/gmd/ccgg/carbontracker/>)
- Maintain current Arctic observation capability in support of Arctic science as directed by the AGM/NGSP

AOML

- Observing Systems:
 - Continue to maintain observing systems, monitoring and analysis of critical climate-related parameters such as ocean heat content, meridional heat advection, sea level trends, ocean acidification, and ocean currents.

- Complete twelve new reports using observations from ocean temperature and salinity profiles (via XBTs and Conductivity Temperature density platforms), Argo floats, and mooring observations that describe the state of the ocean and meridional heat transport and heat storage.
- Complete four reports or publications on the state of the ocean describing estimates of global surface currents based on observations from ocean drifters
- Complete four reports or publications describing carbon dioxide exchange at the ocean surface globally based on underway observations of carbon dioxide from ships of opportunity and research vessels.

PMEL

- Ocean Climate Stations: Maintain OceanSITES mooring in the Kuroshio Extension region and at station PAPA. Moorings are visited and refreshed at least once each year.
- Argo Floats: Provide approximately 50 Argo floats per year to replace older floats that have reached the end of their useful lives. The global array consists of 3000 floats, each with an expected life span of four years.
- Atmospheric Chemistry Program: Conduct a major survey cruise to monitor marine aerosols and air quality approximately every other year.
- Tropical Moored Arrays for Climate: RAMA array in the tropical Indian Ocean is planned for completion in 2014, although the schedule of completion could slip due to uncertainties in international partnerships.
- Autonomous Glider Sections in the Solomon Sea: Complete two sections per year across the Solomon Sea, and conduct numerical modeling studies to help interpret the observations.

AOML and PMEL

- Tropical Moored Arrays for Climate:
 - PIRATA array maintained in the tropical Atlantic.
 - Deploy and maintain moorings, and visit and refresh each mooring at least annually
- Ocean Carbon Uptake and Storage: Repeat hydrography cruises are carried out approximately every year. These are repeats of sections originally conducted more than ten years ago, during other international ocean monitoring programs, and show the long-term changes in ocean temperature, salinity, CO₂ and other chemical concentrations, and other water properties. Ocean heat content can be inferred from the data.
- Air-Sea CO₂ Exchange: Maintain instruments that collect CO₂ underway measurements by three ships in the equatorial Pacific and three ships off the Pacific coast of North America. This is a very cost-effective way to monitor the oceans, requiring no funded research ship time and little intervention by scientists.
- CO₂ Time Series: PMEL will maintain 15 existing moorings and deploy an average of 5 additional moorings each year (FY 2013 – FY 2017), provided adequate funding support from the Climate and Ocean Acidification program offices.

ARL

- Climate Assessments: Contribute to national/international climate assessments (e.g., Intergovernmental Panel on Climate Change) to inform climate mitigation and adaptation (ongoing).
- Climate Observing Systems: Conducts studies on the design and evaluation of an international climate-quality observation system for the atmosphere above the surface, which will provide essential information for understanding and predicting climate change.

- Atmospheric Studies: Conduct studies characterizing the climatology of the lowest portion of the atmosphere, which is the portion of the atmosphere that directly affects people, agriculture, and ecosystems.
- Spatial Variability: Perform studies of spatial variability around surface climate stations to improve interpretation of regional climate variability and change and to support evaluation of models (ongoing).
- Snow Measurement Technology: Report on automated snow measurement technologies to improve characterization of snowfall variability and change—an important influence on water resources in cold and mountainous regions. Remote sensing technologies will be evaluated with respect to uncertainty and ability to be transitioned from research to operations by FY 2013.
- Surface Energy Fluxes: Initiate regional evaluation studies of physical energy fluxes in different regions of the continental United States to improve land service model parameterizations and to improve seasonal predictions of water resources.
- Urban Meteorology: Improve dispersion predictions (ongoing).
- Dispersion Forecast System: Complete updates to dispersion forecast system, used for local to international incidents annually.
- Wind Power Study: Report on efforts to improve the prediction of hub height winds that will translate into improved operational support for wind energy production.

Climate Competitive Research, Sustained Observations and Regional Information

Climate Monitoring

Schedule/Milestones	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Grants awarded in support of the development and delivery of climate analysis products, such as climate indices, USGCRP deliverables, Climate Data Records, etc. (number per year)	16	16	16	16	16	16
Research climate data sets transitioned to operations (number per year)	1	1	1	1	1	1
Paleoclimate reconstructions (number per year)	4	4	4	4	4	4

FY 2013 - 2017: Solicit annual calls for proposals for competitive awards. These awards will address priority research topics in the areas of climate monitoring; Earth system science; modeling, analysis, predictions, and projections; and climate and societal interactions.

The deliverables for the competitive grants program are based upon the call for proposals in FY 2012; Priorities targeted for the FY 2013 call for research proposals have not been finalized, but may include:

- *Climate Monitoring*- Climate data set development and diagnostics to identify climate variability and change; climate change detection and attribution with a focus on regional scales; and paleoclimatology with a focus on reconstructions of the late Holocene
- *Earth System Science*- Decadal climate variability and predictability, including identification of climate signals such as the Atlantic Meridional Overturning Circulation; understanding and improving prediction of Tropical convection, with a focus on climate processes being studied as part of the Dynamics of the Madden-Julian Oscillation (DYNAMO) field campaign; improving the understanding and modeling of land surface processes/interactions; global carbon cycle, including variability of carbon sources and sinks and carbon cycle/ecosystem interactions; aerosols, atmospheric chemistry and climate with a focus on aerosol-cloud interactions.
- *Modeling, Analysis, Predictions, and Projections*- Development of next-generation global climate models and evaluate uncertainties in regional-scale climate predictions/projections; advance intra-seasonal to inter-annual prediction through the creation of multi-model ensembles; support community-wide modeling approaches by ensuring the interoperability of model components.
- *Climate and Societal Interactions*- Initiate new RISA programs and advance regional assessment services; climate impacts on urban water resource planning and drought; coastal resource management in a changing climate, with a focus on coastal ecosystems and sea level rise; transition of water resource and coastal information products into operational settings, integration of climate information into resource management and planning models and processes; analyses and communication of uncertainties surrounding climate predictions and projections; improvements to climate impacts models; newsletters containing climate impacts and prediction information and articles on climate impact issues of significance to the region; presentations on research results to resource managers, planners and scientists; and workshops, surveys, focus groups, and ongoing dialogue with decision makers in the region.

NIDIS

- Develop monitoring gaps analysis, develop improvements in monitoring (e.g. stream flow and snow), perform spatial analysis of water demand for the Pilot basins.
- Develop and improve drought indicators and indices, such as: (1) the NRCS update to the Surface Water Supply Index (SWSI); (2) improve and utilize low flow impacts database; (3) custom drought index server; and (4) water demand projections and revised triggering criteria (threshold for making management decisions).
- Develop state, Federal, tribal and private partnerships through workshops to sustain early warning systems after the pilot stage, including development of drought coordinator capacities (NIDIS Implementation Plan, 2007). For example, develop communities through the Drought Portal that can develop drought early warning processes and can provide input to the Drought Monitor.

NIDIS Milestones	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target	FY 2017 Target
Number of soil moisture sensors reporting in real-time	114	114	114	114	114	114
Number of interoperable drought systems accessible through the US Drought Portal	20	24	28	32	36	40

Assessment Services

- FY 2012/ 2013: Produce limited set of regional scale projections of key climate variables for the United States.
- FY 2013: Incorporation of draft regional and sectoral assessments into National Climate Assessment.
- FY 2013/ 2014: Completion and delivery of the National Climate Assessment synthesis report.
- FY 2014/ 2015: Completion of several regional assessments, reviewable drafts of additional regional updates, reviewable drafts of key sectoral updates with new projections where feasible.
- FY 2015/ 2016: Completion of additional regional and sectoral updates, and draft one key cross-regional and cross-sectoral assessments (e.g. climate impact on "oceans, food and health").
- FY 2017: Completion and publication of National Climate Assessment synthesis.

Communication and Education

- FY 2013/15: Build out social media tools with sectoral and regional stakeholder communities to facilitate integration of climate data and services into societal decision-making contexts.
- FY 2013/15: Build out geospatial tools that enable resource managers to place information on impacts and affected resources in a place-based context relevant to planning or permitting.
- FY 2012-14: Sustain an annotated collection of thoroughly reviewed existing digital educational resources.
- FY 2013-15: Courses, workshops, and training on climate science and adaptation offered for NOAA's and partners' staff and the international community.
- FY 2013-15: Publish narratives and data visualizations that show how NOAA advances climate science understanding, and how those advances benefit society.

Ocean Observations

Schedule/Milestones	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target	FY 2017 Target
Ocean Reference Stations deployed (Cum Total #)	11	11	10	10	10	9
Drifting Buoy Array deployed (Total #/year-reseeding the array)	1,000	950	950	950	950	950
Argo Array deployed (Total #/year – reseeding the array)	400	400	400	400	400	400
Deep Argo floats deployed (Cum Total #)	0	0	0	0	0	10
Tropical Moored Buoys (TAO/PIRATA/RAMA) installed (Cum Total #)	86	86	89	89	89	89
Tide Gauge Reference Stations (Cum Total #)	63	63	63	63	63	63
Tide Gauge Reference Stations w/GPS installed (Cum Total #)	110	110	110	110	110	110
Ice Buoys/Stations Operating (Cum Total #) Typically 2-yr life-cycle refresh.	4	4	4	4	4	4
Ocean Carbon Surveys conducted	15	17	18	18	18	18

(Cum Total #)						
Dedicated ship support (Cum Total days at sea)	508	524	524	524	524	524

By FY 2016, NOAA will contribute annually the following to the International Arctic Observing Network (IAON):

- 4 Ice Buoys (7 percent of U.S. total planned contribution to IAON)
- 8 Moorings (20 percent of U.S. total planned contribution to IAON)
- 2 Annual Ship Lines (16 percent of U.S. total planned contribution to IAON)
- 3 International Coastal Observatories with our Canadian, Russian, and Norwegian partners

Deliverables:

The value of the ocean observing system can be assessed by the type and quality of products derived from it and from its scientific and operational value. The current observing system was designed with the objective to assess key climate-related parameters. The full implementation of the observing system will lead to better analysis of climate signals and reduction of errors in climate forecasts.

For each of the observational programs the deliverables and outputs are the observational data, quality controlled, and made available on a publically accessible web site. For programs such as Argo, involving measurements by multiple institutions, a single data center web site is typically maintained with the data from all providers available from the single site. The remaining deliverables are scientific papers in the peer-reviewed literature, giving the results of the research done with the data sets and other studies.

Performance Goals and Measurement Data:

Performance Measure:	FY						
Percent of labs that have had formal expert peer reviews in the past 5 years and were rated effective in terms of quality, mission relevance, and performance	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	100%	100%	100%	100%	100%	100%	100%
Description: This performance measure is recognized by the National Academy of Sciences report <i>Evaluating Federal Research Programs</i> , which states “The most effective means of evaluating Federally funded research programs is expert review.”							

Modeling

Performance Measure:	FY						
Cumulative number of new decadal prototype forecasts and predictions made with high-resolution coupled climate models	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	1	1	2	3	4	5	6
Description: One of the goals of this activity is to develop new prototype forecasts and predictions on decade time-scales for climate changes and impacts such as sea level rise, Arctic climate impacts, and rapid climate change. These forecasts and predictions are dependent on the development of state-of-the-art climate models.							

Physical Sciences

Performance Measure:	FY 2011 Actual	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target	FY 2017 Target
Cumulative site-years of data collection for cryospheric, boundary layer mean and turbulent properties, hydrometeorological, and oceanic process studies	8	10	20	30	40	50	60
Description: Process studies in the polar regions, over the ocean, in coastal watersheds, and mountainous terrain depend on precise, robust, routine, and relevant observations of the Earth System at time and space scales to diagnose its behavior and to assess the skill of predictive tools used to forecast its future.							

Performance Measure:	FY 2011 Actual	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target	FY 2017 Target
Number of physical science related articles published in the peer-reviewed literature	125	90	90	95	100	105	110
Description: These publications are a measure of the credibility of information, tools, and diagnoses of the Earth system provided to other NOAA partners, other agencies, states, private sector, and various sectoral, societal, and economic interests.							

Chemical Sciences

Performance Measure:	FY 2011 Actual	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target	FY 2017 Target
Cumulative number of climate-related articles published in the peer-reviewed literature.	54	70	105	140	175	210	245
Description: The information in these publications provided the information needed by stakeholders and decision-makers to develop effective policies and adaptation strategies for a changing climate.							

Performance Measure:	FY 2011 Actual	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target	FY 2017 Target
Cumulative number of reports to stakeholders and decision-makers that provide a policy-relevant scientific synthesis of results from intensive field studies, process studies, and analyses.	N/A	1	1	2	3	3	4
Description: Reports provide a distillation of key scientific findings on emissions, transport, atmospheric processing, and impacts of climate forcing agents, their precursors and species related to air quality degradation to inform policy development and emission management strategies for climate and air quality.							

Performance Measure:	FY 2011 Actual	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target	FY 2017 Target
Cumulative number of substances, proposed as replacements for stratospheric ozone depleting industrial compounds (e.g., solvents; refrigerants) whose ozone	N/A	1	2	2	3	3	4

depleting potential and greenhouse-warming potential (GWP) have been evaluated.							
Description: Provides to industry stakeholders critical information on climate impacts of proposed replacement stratospheric ozone depleting chemicals prior to manufacture.							

Performance Measure:	FY						
Cumulative number of individual emission sources and source regions relevant to climate and air quality whose inventories have been evaluated for accuracy via top-down analyses.	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	N/A	1	2	2	3	3	4
Description: Provides verification of critical inputs to climate models resulting in reduced uncertainty in model outputs, which provides decision-makers greater confidence in establishing policies and emission management strategies.							

Global Monitoring and Research

Performance Measure:	FY						
Reduced uncertainty in the magnitude of the North American Carbon Sink (million tons Carbon/year) (Measure 16b)	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	400	400	410	420	430	440	450
Description: The provision of NOAA scientific guidance to policymakers concerned with managing emissions of carbon dioxide requires NOAA to assess and quantify the sources of carbon variability. This GPRA measure demonstrates the scientifically accepted level of confidence in carbon measurement that is needed to accurately evaluate levels of carbon emissions in North America. The uptake of atmospheric carbon (mainly as carbon dioxide) by the biosphere across North America is of the order of one billion tons (one petagram) per year.							

Climate Observations and Monitoring

Performance Measure:	FY						
Percent reduction in the error of the observed estimates of ocean and meridional heat transport	2011	2012	2013	2014	2015	2015	2017
	Actual	Target	Target	Target	Target	Target	Target
	0.2%	0.5%	0.9%	1.2%	1.6%	1.9%	2.2%
Description: As a result of observations, research, and reports on the state of the ocean, heat storage, and meridional heat transport in the Atlantic Ocean, there will be increased knowledge for scientists creating modeled estimates of heat transport over time, leading to less uncertainty in those models. Accurately describing heat is a key part of climate models, and increased longevity in datasets leads to a more accurate average or mean measurement of these systems. This contributes to developing a framework for future research that promises to improve the ability of climate models to predict summer rainfall and hurricane activity for the Western Hemisphere, helping local communities and economies.							

Performance Measure:	FY						
Percent certainty associated with the carbon dioxide exchange at the ocean surface globally	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	50.5%	51%	51.5%	52%	52.5%	53%	53.5%

Description: Based on observations, studies, and publications quantifying the exchange of carbon dioxide (CO₂) at the ocean surface, there will be improvement in the understanding of the oceans' capacity to sequester CO₂. This in turn controls the atmospheric CO₂ that is the major greenhouse gas. The resulting changes in ocean chemistry (ocean acidification) will also be better described, providing a framework for determining the impacts of ocean acidification on ecosystems.

Climate Observations and Analysis

Performance Measure:	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Cumulative number of data collection platforms deployed by PMEL in support of the Global Ocean Observing System (GOOS)	Actual	Target	Target	Target	Target	Target	Target
	495	518	571	620	665	706	741

Description: This measure represents a significant portion of PMEL's contribution to GOOS. The measure identifies each Argo float deployed and each moored buoy from the PIRATA, RAMA, and ocean climate station programs as a unit; TAO is not included as it is maintained by the National Data Buoy Center (NWS). Completion of GOOS is analogous to the global weather observing system since fully-implemented GOOS will provide ocean data that all nations can use to provide improved ocean-related analytical and predictive products (forecasts).

Performance Measure:	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Number of journal articles published in peer-reviewed literature	Actual	Target	Target	Target	Target	Target	Target
	91	60	60	60	60	60	60

Description: PMEL conducts basic research and reports the results in peer-reviewed journal articles. The annual publication total is a measure of the laboratory climate research output. Past research papers have addressed such topics as describing the predictability of El Niño and La Niña events and describing the negative impacts on marine ecosystems of ocean acidification. These publications document advances in scientific understanding that lead to improved capabilities (analyses, forecasts, etc.) or identify "next steps" for research.

Performance Measure:	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Cumulative number of regions for which a surface flux study has been conducted	Actual	Target	Target	Target	Target	Target	Target
	0	0	1	2	3	4	5

Description: "Surface flux" refers to the exchange of energy (e.g., heat) and substances (e.g., water) between the land surface and the atmosphere. These fluxes are critical drivers of climate change because they affect air and land temperatures and other important aspects of the climate. These fluxes also drive important climate-related phenomena such as droughts and such weather-related phenomena as the development of storms. Surface fluxes vary significantly with surface and weather conditions. The measurements taken in this work and the related analyses will provide essential information for improving the representation of the fluxes in climate and weather models, improving the accuracy of both weather and climate forecasts.

Atmospheric Observations and Monitoring

Performance Measure:	FY						
Cumulative number of studies on the design and evaluation of an international climate-quality observation system for the atmosphere above the surface	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	0	1	1	1	1	2	2
Description: Sustained observations of Essential Climate Variables (ECV) will (1) ensure that climate scientists will be able to more confidently identify upper-air climate change signals and (2) provide essential calibration data for satellite observing systems so that significant progress can be made in the generation of global climate products and derived information to manage the Nation's response to the climate and climate change. This measure refers to publication of studies to optimize the design and implementation of a reference upper-air observing network.							

Plume Dispersion

Performance Measure:	FY						
Cumulative number of dispersion prediction system updates provided to NWS	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	2	3	4	5	6	7	8
Description: The updates of the HYSPLIT dispersion model provided to NWS for operational implementation will contribute to improved outcomes by improving the accuracy and usefulness of NWS dispersion prediction products. The updates will also improve the ease of use and flexibility of the software for meeting NWS needs. NWS uses HYSPLIT for dispersion predictions for applications ranging from local chemical releases to international radiological incidents, providing information to customers ranging from local emergency managers to the World Meteorological Organization.							

Climate Competitive Research, Sustained Observations and Regional Information Applications

Performance Measure:	FY						
Number of regionally and sectorally focused climate impacts and adaptation studies communicated to decision makers.	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	N/A	27	27	27	27	27	27
Description: Number of peer-reviewed publications and reports published and released in one fiscal year. The publications/reports are developed through interaction with and/or communication to stakeholders. Publications and reports are collected from investigators conducting climate impacts and adaptation research in cooperation with stakeholders. The goal of this research is to better understand and enhance the use of NOAA products and information to meet user requirements for natural resource management information in various sectors (e.g. drought and water resources, fire risk, ecosystem and coastal impacts, sea-level rise, human health, agriculture, etc.)							

NIDIS Early Warning Systems (to support Regional Services delivery)

Performance Measure:	FY						
Number of states and territories working with NIDIS to incorporate drought early warning information into their	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	N/A	4	5	7	10	15	22

drought adaptation and mitigation plans. (Cumulative)							
<p>Description: The performance measure is based on the number of states and territories that partner with NIDIS to incorporate drought early warning information into their drought planning activities. Activities that count toward this measure include: local or regional drought planning/management groups; use of tailored information from the U.S. Drought Portal to establish drought indicators and set management triggers in state and territory drought adaptation and mitigation plans; and incorporation of information from basin specific drought monitors developed through the drought early warning information systems into either state and territory drought adaptation and mitigation plans or as part of state and territory drought planning and management groups.</p>							

Performance Measure:	FY						
Number of U.S. coastal states and territories demonstrating 20% in annual improvement in resilience capacity to climate hazards. (Each Year)	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	11	12	14	16	18	20	22
<p>Description: As an indicator for this measure, data is used from the existing hazards resilience GPRA Measure 18e “Percentage of U.S. coastal states and territories demonstrating 20 percent or more annual improvement in resilience capacity to weather and climate hazards.” To meet the 20 percent or more improvement in resilience capacity, coastal counties representing at least 20 percent of the state’s coastal population must meet or exceed predefined performance targets for each of the contributing areas of training, technical assistance, and outcomes.</p>							

Performance Measure:	FY						
Number of states or territories using new or tailored climate services (tools, information, technical assistance, or products) as a result of regional, state and local interaction with decision makers (Each Year)	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	N/A	4	5	7	8	9	10
<p>Description: The number of products and services, provided or existing products and services that are modified/expanded for new user groups or regions. ‘Products and services’ includes technical assistance, training, and guidance documents to enable planning and decision making. [This measure is partially based on the current GPRA: Number of regionally and sectorally focused climate impacts and adaptation studies communicated to decision makers.]</p>							

Performance Measure:	FY						
Annual percentage of U.S. states and territories that use NOAA climate information and services to improve decision-making in the face of a changing climate (Measure 16d)	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	N/A	22%	22%	24%	25%	27%	29%
<p>Description: Number of states and territories where climate information is integrated into state and territory planning and decision making (e.g., changes in policies, plans, and actions), as well as indicators of success such as training and technical assistance. Percentage of improvement in state and territory resilience to climate hazards. This measure is an indicator of</p>							

societal benefit derived from the use of NOAA climate information in public decision making in states and territories. This performance measure will track the numbers of states and territories that are benefiting from the inclusion of NOAA climate information in their decision making processes. It will also show how these decisions will lead to better results or improved decisions based on inclusion of this climate information.

Assessment Services

Performance Measure:	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Number of climate-change related impact, vulnerability, adaptation, or mitigation information topics addressed in the Assessments	Actual	Target	Target	Target	Target	Target	Target
	17	8	8	8	8	8	8

Description: This performance measure will demonstrate the role of formal climate change assessments in decisions to address climate change impacts by identifying the number of topics addressed in the assessments that are considered by business, government, or the public that affected decisions related to improved climate resilience. Information topics are based on the U.S. GCRP report, “Global Climate Change Impacts in the U.S.” This measure will track the extent to which the USGCRP topical information items are used by industry, etc., to inform their key decisions on how to mitigate or adapt to climate change.

Communication and Education

Performance Measure:	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Percentage improvement in the Quality of Relationship with users in the delivery and communication of climate information and services (Quality of relationship is a formal method of measuring indicators like trust, satisfaction and reliability). Expect growth as a decreasing % relative to previous year’s index value (Measure 16f)	Actual	Target	Target	Target	Target	Target	Target
	N/A	0%	5%	4%	3%	2%	1%

Description: Quality of Relationship is comprised of formal measures of these key indicators: awareness, trust, satisfaction, and usability. The goal is to capture the increasing Quality of Relationship for each of our priority publics as they access, understand, and integrate climate information, products, and services into the tools and algorithms they use for decision-making, ultimately resulting in an increase in the frequency and proficiency with which they use NOAA climate data and services in their lives and livelihoods. The measure will be a combination of surveys and focus groups to establish a baseline measurement and perform annual follow-up measurements to determine the annual percentage improvement in the Quality of Relationship as climate services are increased and improved.

Ocean Observations

Performance Measure:	FY	FY	FY	FY	FY	FY	FY 2017
Reduce the error in global measurement of sea surface temperature (°C) (Measure 16c)	2011	2012	2013	2014	2015	2016	Target
	Actual	Target	Target	Target	Target	Target	
	0.51	0.50	0.51	0.51	0.55	0.55	0.55
<p>Description: This measure is intended to document progress in accurately measuring the global sea surface temperature (SST) using in situ drifting buoys to verify that satellite SST data are accurate and representative. This reflects how improvements in ocean observations will decrease the uncertainty in global sea surface temperature measurements, which will ultimately play a role in calculations of the ocean-atmosphere exchange of heat and the heat storage in the global ocean. The sea surface, covering over 70% of the Earth surface, has a tremendous influence on global climate because it is where the atmosphere responds to the ocean via the transfer of heat either to or from the atmosphere. Since sea surface temperature is measured by buoys, ships, and satellites, this performance measure is well-suited as an indicator of the effectiveness of our integrated ocean observing system and the more accurate estimates of sea surface temperature will improve our ability to detect changes in the climate system. Success in this performance measure requires the maintenance and increase of in situ ocean sensors. The goal is to reach an indicator value of 0.3 degrees Celsius, which has been specified by the international Global Ocean Observing System (GOOS) as the required accuracy for measurement of sea surface temperature.</p>							

Performance Measure:	FY						
Increased percentage of global in-situ ocean observing system implementation	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	61%	61%	60%	58%	58%	57%	56%
<p>Description: This measure tracks the percentage of global coverage of the Global Ocean Observing System. There are eight (8) individual ocean observing systems and one data management system that make up GOOS. The % completion of the eight systems determines the cumulative total % of this PM. A predictive understanding of the Earth's climate is critically dependent on quantitative measurements of ocean parameters - the ocean is second only to the sun in effecting climate change and variability.</p>							

PROGRAM CHANGES FOR FY 2013:

Climate Research Laboratories and Cooperative Institutes (Base Funding: 249 FTE and \$53,184,000; Program Change: 0 FTE, \$166,000): NOAA requests an increase of \$166,000 and 0 FTE for a total of \$53,350,000 and 249 FTE to continue research activities within its Laboratories and Cooperative institutes for monitoring and understanding the Earth's climate system and to predict both the potential long-term changes in global climate as well as shorter-term climate variations that are of societal and economic importance.

Proposed Actions:

NOAA has a long history of key research and observations that have led to greater understanding of the state of the climate including global distributions, trends, sources and sinks of atmospheric constituents that are capable of forcing change in the climate of the Earth. NOAA's climate research works to understand and predict climate variability and change from weeks to decades to centennial timescales and produces information and forecast products, ranging from short-term weather forecasts to longer-term climate forecasts and assessments.

These labs focus their resources on the most productive avenues of research, and will use this increase for conducting advanced mathematical modeling of the climate and Earth systems, including natural climate variability, anthropogenic climate change, weather and hurricane forecasts, El Niño prediction, and stratospheric ozone depletion to improve the prediction of climate phenomena. In addition, these funds will be used to sustain the observing systems essential for climate, oceanographic, monitoring, and data management.

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Office of Oceanic and Atmospheric Research
Subactivity: Climate Research

Object Class	2013 Decrease
11 Personnel compensation	
11.1 Full-time permanent	\$0
11.3 Other than full-time permanent	0
11.5 Other personnel compensation	0
11.8 Special personnel services payments	0
11.9 Total personnel compensation	0
12 Civilian personnel benefits	0
13 Benefits for former personnel	0
21 Travel and transportation of persons	0
22 Transportation of things	0
23.1 Rental payments to GSA	0
23.2 Rental Payments to others	0
23.3 Communications, utilities and miscellaneous charges	0
24 Printing and reproduction	0
25.1 Advisory and assistance services	0
25.2 Other services	0
25.3 Purchases of goods & services from Gov't accounts	0
25.4 Operation and maintenance of facilities	0
25.5 Research and development contracts	0
25.6 Medical care	0
25.7 Operation and maintenance of equipment	0
25.8 Subsistence and support of persons	0
26 Supplies and materials	0
31 Equipment	0
32 Lands and structures	0
33 Investments and loans	0
41 Grants, subsidies and contributions	166
42 Insurance claims and indemnities	0
43 Interest and dividends	0
44 Refunds	0
99 Total obligations	166

Climate Data & Information: Climate Model Data Archive (Base Funding: \$617,000 and 0 FTE; Program Change: +\$1,736,000 and 0 FTE): NOAA requests an increase of \$1,736,000 and 0 FTE for a total of \$2,353,000 and 0 FTE to generate and safely store model based data records and support an adequate operational archive and access capability for the next generation, high-resolution weather and climate reanalysis datasets.

Proposed Actions:

This project will further develop and implement a Climate Model Data Archive capability for the next generation climate analyses currently running on supercomputers across NOAA and its collaborators (NSF, DOE, and others). NOAA will provide an operational data stewardship and user access capability for the next generation of climate reanalysis products derived for the utilization of major advancements in model physics and coupling across the ocean, air and land interfaces. The Climate Model Data Archive leverages existing supercomputer resources to provide a unified and consistent suite of climate information to users at all levels so that they can make better decisions about their specific management needs. Information will be provided on time scales from days (weather), to months (El Niño), to years and decades (climate variability and change).

These climate model reanalysis products will total over 2 PetaBytes (2,000 TeraBytes) of data and include:

- Coupled Climate Forecast System Reanalysis and Reforecast (CFSRR) dataset, a modern era reanalysis
 - The first coupled 30 year global reanalysis of the atmosphere, ocean, land, and cryosphere (sea ice) ever developed by NOAA
- Climate Prediction Center Reanalysis (CPCR), a long time series historical upper-air reanalysis (1850 to present)
- Surface Pressure historical reanalysis currently underway at NOAA's Earth System Research Laboratory (ESRL)

The architecture is based on 3 main components: the Portal, the Catalog Node, and the Data Repository. The Portal is the users' interface to the system, where they can manage requests, download data, receive user input and browse the catalog. The Catalog Node is the heart of the system and concentrates on connecting partners, metadata, search and discovery and peer-to-peer connectivity. It will integrate fully with the existing NOAA Climate Portal (www.climate.gov) and remove barriers to data format and system incompatibilities.

Statement of Need and Economic Benefits:

Decision makers are increasingly seeking information that will help their communities plan and respond to climate variability and change. The Climate Model Data Archive will develop an operational archive and access capability for the next generation, high-resolution weather and climate reanalysis data sets derived from model outputs. Reanalysis output and products will improve our understanding of various climate phenomena, including: verification, detection, and determination of drought severity and location; verification and improvements to forecasts of El Niño occurrence and persistence; and verification and improvements to our understanding of the hydrologic cycle and water resources. The Climate Model Data Archive will be designed to convey key aspects of complex scientific data in a manner accessible to non-specialists and NOAA's climate information user communities.

Base Resource Assessment:

The base resources for this activity are described in the Climate Data and Information base narrative.

Schedule and Milestones:

FY 2012: Ingest, archive, and access to reanalysis data leading to an on-going analysis of the climate system

FY 2013: Expanded capabilities and products from reanalysis datasets, including toolsets for data intercomparisons, etc, to better understand and evaluate the Climate System

FY 2014: Implementation of access capabilities for new reanalysis datasets and products

FY 2015 - 2017: Ongoing implementation of data access and user capabilities for new reanalysis datasets and products, which will continue to be developed during this period

Deliverables:

- NOAA Reanalysis Web Page for collection of user requirements and input.
- Data Stewardship and Access for the next generation reanalysis datasets (CFSRR, CPCRR, SFC Historical), along with other reanalyses, which are generated as follow-on development.
- Customer service support capability and a research quality help desk supporting users of Climate Model Data Archive.
- Re-analysis clearinghouse to provide access to consensus (satellite, in-situ, and radar) datasets for the next series of NOAA reanalysis.
- Toolsets and user capabilities to better utilize and inter-compare model output, in-situ data, etc.

Performance Goals and Measurement Data:

Performance Measure:	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Increased reanalysis data available 24x7 to operational and research users, from the next suite of NOAA's climate weather reanalysis and reforecast datasets in an interoperable Web Service architecture (Increase in TB/year)	Actual	Target	Target	Target	Target	Target	Target
With Increase	N/A	N/A	1,250	1,500	1,750	2,000	2,000
Without Increase	500	500	500	500	500	500	500
Description: One of the goals of this activity is to increase the terabytes of data made available to users for the next generation climate analyses by developing and implementing an operational archive and user access capability and interoperable Portal. Data records will be produced from three main current and planned reanalysis projects and will be uploaded to the Portal as they are completed.							

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Office of Oceanic & Atmospheric Research
Subactivity: Climate Research

Object Class	2013 Increase
11 Personnel compensation	
11.1 Full-time permanent	0
11.3 Other than full-time permanent	0
11.5 Other personnel compensation	0
11.8 Special personnel services payments	0
11.9 Total personnel compensation	0
12 Civilian personnel benefits	0
13 Benefits for former personnel	0
21 Travel and transportation of persons	16
22 Transportation of things	0
23.1 Rental payments to GSA	0
23.2 Rental Payments to others	0
23.3 Communications, utilities and miscellaneous charges	0
24 Printing and reproduction	0
25.1 Advisory and assistance services	0
25.2 Other services	0
25.3 Purchases of goods & services from Gov't accounts	0
25.4 Operation and maintenance of facilities	0
25.5 Research and development contracts	1,160
25.6 Medical care	0
25.7 Operation and maintenance of equipment	0
25.8 Subsistence and support of persons	0
26 Supplies and materials	0
31 Equipment	410
32 Lands and structures	0
33 Investments and loans	0
41 Grants, subsidies and contributions	150
42 Insurance claims and indemnities	0
43 Interest and dividends	0
44 Refunds	0
99 Total obligations	1,736

Climate Data & Information: NOAA Climate Portal (Base Funding: \$958,000 and 0 FTE; Program Change: +\$542,000 and +2 FTE: NOAA requests an increase of \$542,000 and 2 FTE for a total of \$1,500,000 and 2 FTE to continue supporting development of the NOAA Climate Portal that will facilitate public online access to NOAA's climate data, information, and services.

Proposed Actions:

With the funds requested, OAR will work with partners across NOAA to continue to build a comprehensive web-based Climate Portal, transitioning from the current operational phase. The Portal will be a central component of NOAA's commitment to integration and delivery of services by enhancing public access to useful climate data and information. In addition to climate science information and data and decision support tools, the Portal will offer a broad array of climate communications, outreach, and educational materials.

As the public's primary online point of entry into NOAA's climate science and services, the Portal will have audience-focused sections designed to serve four key segments of society: (1) climate science decision makers and policy leaders; (2) scientists and applications-oriented data users (e.g., resource managers and business leaders); (3) educators; and (4) members of the public. Recent developments in web-based technologies make it possible for NOAA to present both existing data and new products in formats that are readily usable by decision-makers in government agencies and businesses (e.g., geospatial tools that enable resource managers to place information on impacts and affected resources in a place-based context relevant to planning or permitting).

With the funds requested, NOAA will include improvements to the Portal's interface, add a new section, called "Climate Conditions," which presents a data-driven digest of recent and near-future climate trends of interested and relevance to society, and hire full-time administrative personnel to manage the system. Additionally, the agency will create an overarching Portal home page that integrates timely and topical content from each of the Portal's sections.

NOAA will work with the authors of such reports as the State of the Climate, Seasonal Climate Outlooks, the Arctic Report Card, the National Climate Assessment, and others to provide easy access for the Portal's audiences, and will work with NSF, NASA, and NOAA grant projects to build an online library of climate science education resources of the highest quality.

The full Portal's scope, product content, and functionality will evolve based on user needs and expectations for climate data and information. User feedback on products and services available through the Portal will also provide important insights into user applications and climate information needs.

Statement of Need and Economic Benefits:

Societal interest in climate is growing, as indicated by the rising number and complexity of the questions and requests for climate data and services submitted to NOAA in recent years. From 2009 to 2010, NOAA saw an 86 percent increase in climate-related data provided from its data centers, a 57 percent increase in climate-related website hits, and an 11 percent increase in individual customer requests for climate information via phone calls, emails, and other direct correspondence. Individuals and organizations are seeking easy access to credible climate science information from NOAA at finer geographic and time scales to help them manage climate-related risks and opportunities in their lives, businesses, and communities.

However, users report having difficulty locating and using NOAA's online data products and services. Thus, resolving this online accessibility issue will be one of the Climate.gov Portal's main benefits. The use of portal technology and emerging data integration and visualization tools provide an

opportunity for NOAA to bring together multiple datasets from diverse disciplines and sources to deliver a more comprehensive picture of affected resources, communities and businesses.

Base Resource Assessment:

Base resource assessment can be found in the base narrative for Climate Data and Information.

Schedules and Milestones:

- FY 2013: Implement global redesign of portal interface
- FY 2013: Add new “Climate Conditions” section
- FY 2014: Expand the scope and refine the functionality of Climate Conditions section
- FY 2014: Increase the size, accessibility, and usability of reviewed climate education resource collections and ensure connectivity to other related portals
- FY 2015-2016: Launch new social media tools for science-based problem solving, designed to foster and facilitate interdisciplinary communities of practice that collaborate to address NOAA’s and its partners’ climate-related societal challenges
- FY 2016-2017: Make user-driven refinements in the Portal’s interface design and functionality

Deliverables:

Improved access to NOAA’s climate data and information via a single, comprehensive Web portal with four audience-focused interfaces and a comprehensive assessment and evaluation of the Portal’s overall impacts on our target audiences.

Performance Goals and Measurement Data:

Performance Measure:	FY 2011	FY	FY	FY	FY	FY	FY
Percentage growth in number of unique visits to NOAA’s Climate Portal over the preceding year’s measure.	Actual	2012	2013	2014	2015	2016	2017
		Target	Target	Target	Target	Target	Target
With Increase	N/A	N/A	10%	10%	10%	10%	10%
Without Increase	N/A	N/A	5%	5%	5%	5%	5%
Description: This performance measure will show the ongoing increase in the average number of unique visits to the Portal among the four target audiences the CS Portal serves.							

PROGRAM CHANGE PERSONNEL DETAIL

Activity: Office of Oceanic and Atmospheric Research
 Subactivity: Climate Research

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
IT Specialist	Charleston, SC	ZP-IV	1	81,823	81,823
IT Specialist	Asheville, NC	ZP-IV	1	81,823	81,823
Physical Scientist	Camp Springs, MD	ZP-IV	1	89,033	89,033
Total			<u>3</u>		<u>252,679</u>
less Lapse		25%	<u>1</u>		<u>63,170</u>
Total full-time permanent (FTE)			2		189,509
2013 Pay Adjustment (0.5%)					948
TOTAL					190,457

Personnel Data

	<u>Number</u>
Full-Time Equivalent Employment	
Full-time permanent	2
Other than full-time permanent	<u>0</u>
Total	2
Authorized Positions:	
Full-time permanent	3
Other than full-time permanent	<u>0</u>
Total	3

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Office of Oceanic and Atmospheric Research
Subactivity: Climate Research

Object Class	2013 Increase
11 Personnel compensation	
11.1 Full-time permanent	\$190
11.3 Other than full-time permanent	0
11.5 Other personnel compensation	0
11.8 Special personnel services payments	0
11.9 Total personnel compensation	190
12 Civilian personnel benefits	58
13 Benefits for former personnel	0
21 Travel and transportation of persons	0
22 Transportation of things	0
23.1 Rental payments to GSA	0
23.2 Rental Payments to others	0
23.3 Communications, utilities and miscellaneous charges	0
24 Printing and reproduction	0
25.1 Advisory and assistance services	0
25.2 Other services	294
25.3 Purchases of goods & services from Gov't accounts	0
25.4 Operation and maintenance of facilities	0
25.5 Research and development contracts	0
25.6 Medical care	0
25.7 Operation and maintenance of equipment	0
25.8 Subsistence and support of persons	0
26 Supplies and materials	0
31 Equipment	0
32 Lands and structures	0
33 Investments and loans	0
41 Grants, subsidies and contributions	0
42 Insurance claims and indemnities	0
43 Interest and dividends	0
44 Refunds	0
99 Total obligations	542

Climate Data and Information: Climate Operations (Base Funding: \$908,000 and 0 FTE; Program Change: -\$589,000 and 0 FTE): NOAA requests a decrease of \$589,000 and 0 FTE for a total of \$319,000 and 0 FTE to maintain support for the transition of regional information applications to operational production and dissemination capabilities.

Proposed Actions:

With the remaining funding, NOAA will maintain support for the transition of regional information applications to operational production and dissemination capabilities. As part of that effort, NOAA will focus on development of new seasonal ice prediction products. With the requested decrease, NOAA will no longer develop the Local Climate Analysis Tool, which allows NWS and other NOAA users to operationally identify local climate variability and change impacts and catalogs local climate studies. NOAA will also cease training for local climate services staff and technical users for these products.

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 to improve the forecast timing and location of extreme weather events, thereby minimizing their impacts on lives and property. By focusing remaining resources on transition of regional information applications to operational products, NOAA will be able to begin to address that issue.

Base Resource Assessment:

The base resources for this activity are described in the Climate Research subactivity base narrative.

Schedules and Milestones:

- FY 2013: Development of a new seasonal sea-ice prediction product

Deliverables:

- Development of one seasonal sea ice prediction product

Performance Goals and Measurement Data:

There is no performance measure associated with this decrease.

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Office of Oceanic and Atmospheric Research
Subactivity: Climate Research

Object Class	2013 Decrease
11 Personnel compensation	
11.1 Full-time permanent	0
11.3 Other than full-time permanent	0
11.5 Other personnel compensation	0
11.8 Special personnel services payments	0
11.9 Total personnel compensation	<u>0</u>
12 Civilian personnel benefits	0
13 Benefits for former personnel	0
21 Travel and transportation of persons	(35)
22 Transportation of things	0
23.1 Rental payments to GSA	0
23.2 Rental Payments to others	0
23.3 Communications, utilities and miscellaneous charges	0
24 Printing and reproduction	(5)
25.1 Advisory and assistance services	0
25.2 Other services	(544)
25.3 Purchases of goods & services from Gov't accounts	0
25.4 Operation and maintenance of facilities	0
25.5 Research and development contracts	0
25.6 Medical care	0
25.7 Operation and maintenance of equipment	0
25.8 Subsistence and support of persons	0
26 Supplies and materials	(5)
31 Equipment	0
32 Lands and structures	0
33 Investments and loans	0
41 Grants, subsidies and contributions	0
42 Insurance claims and indemnities	0
43 Interest and dividends	0
44 Refunds	<u>0</u>
99 Total obligations	<u>(589)</u>

Climate Competitive Research, Sustained Observations and Regional Information: Earth System Modeling for Urgent Climate Issues (Base Funding: \$2,600,000 and 4 FTE; Program Change: +\$8,000,000 and +10 FTE): NOAA requests an increase of \$8,000,000 and 10 FTE for a total of \$10,600,000 and 14 FTE to enable continued development and use of state-of-the-art Earth System Models to address urgent climate issues, including sea level rise and Arctic climate change.

Proposed Actions :

Sea level rise and the Arctic constitute two of the most rapidly changing and potentially impactful aspects of the global climate. NOAA will use this funding to expand capacity with a combination of 10 FTE, post-doctoral researchers, contracts and grants managed primarily by its Geophysical Fluid Dynamics Laboratory with assistance from the Earth System Research Laboratory and US academic community. The Climate Program Office will manage the grants for this request. This will allow NOAA to continue development of Earth System Models to:

Reduce uncertainties in sea level rise projections (\$2,750) by incorporating ice sheet dynamics, ocean-ice shelf and ocean-iceberg interactions, ice shelf cavity circulations and processes driving regional variations in sea level rise and inundation into NOAA's Earth System Models. These models will include routine global ocean data assimilation capabilities linked to Global Ocean Observing System observations and innovative approaches to achieving high resolution in regions of interest including coasts, shelves and marginal seas.

Reduce uncertainties in the terrestrial carbon cycle and future biogeochemical feedbacks on climate (\$2,240K) through more realistic model treatment of the terrestrial biosphere including: modeling the nitrogen and phosphorous cycles, biomass burning, wetland and freshwater biogeochemistry, and land-use management. This includes data assimilation.

Address gaps in the understanding of the Arctic climate system, including rapid changes and future projections (\$1,000K). The sea ice component of the NOAA's Earth System Model will be enhanced to include ridging of ice sheets and improved radiation treatment. Influences of soot and dust aerosol on ice albedo will be examined. A new modeling framework for Arctic climate change will be developed for assessing various causes of past Arctic changes.

Augment Decadal Climate Predictions and Abrupt Change (\$2,010K) to complete decadal prediction model evaluation, assess predictability of high-impact climate extremes (heat waves, flooding, etc.) and of ocean ecosystem responses, and assess the causes of past/ongoing decadal climate changes.

Statement of Need and Economic Benefits:

Numerical models that simulate the Earth System are the Nation's principal tool for understanding fluctuations in past climate and predicting future climate change. The increased demand for projections of climate change at regional scales and understanding of potential climate impacts requires greater resolution and realism in models, as well as improved scientific understanding of the reliability of models and downscaling techniques for various regional climate applications. This effort to address urgent climate issues by improving Earth System Models, developing decadal prediction systems, and integrating earth system model development with regional ecosystem and coastal process models will be supported directly by recent investments in high performance computing resources for climate modeling in the American Recovery and Reinvestment Act of 2009. Societal benefits include:

- Sea level rise has the potential to be among the most costly consequences of climate change. Coastal states support 81 percent of the U.S. population and generate approximately 83 percent (\$11.4 trillion in 2007) of U.S. gross domestic product (GDP) (National Ocean Economics

Program, "State of the U.S. Ocean and Coastal Economies," 2009). The homes and livelihoods of millions of Americans and infrastructure worth billions would be imperiled by sea level rise of a few feet. Improved models to help narrow uncertainty on future global sea level rise, as well as its regional variations, will help decision-makers form mitigation and adaptation responses to mitigate costs to society and harm to near-shore ecosystems.

- Developing Earth System Models with ocean data assimilation capability and ocean resolutions sufficient to represent shelf, estuarine and coastal processes will greatly enhance NOAA's ability to manage marine ecosystems that are sensitive to climate change. The models will serve ecosystem managers, because many marine ecosystems are sensitive to changes in ocean conditions associated with climate change.
- Reduced uncertainty in climate predictions and projections will help decision makers consider strategies to mitigate or adapt to the impacts of climate variability and change. For example, the absence of an interactive carbon cycle was a serious limitation in the global climate models used for the Intergovernmental Panel on Climate Change Fourth Assessment Report (IPCC AR4), which will be addressed through improved representation of the terrestrial biosphere to better understand how the carbon cycle and its feedbacks could reduce or amplify anticipated global warming by several degrees by 2100.
- Better understanding and possible prediction of rapid changes in the Arctic will help decision-makers address key impacts on: Arctic citizens and their livelihoods; Arctic ecosystems; shipping; homeland security; fisheries; and strategic energy resources.
- Developing decadal climate predictions of sea surface temperature may lead to skillful decadal predictions of several phenomena of great economic importance, including hurricanes, drought, heat waves, and ecosystems.

Base Resource Assessment:

The base resources for this activity are described in the Climate Competitive Research, Sustained Observations, and Regional Information base narrative.

Schedule & Milestones:

FY 2013: Develop new modeling capabilities and initiate synthesis efforts for application to Earth System Models.

FY 2014: Further develop and implement new Earth System Modeling capabilities for use in climate change assessments. Perform initial integrations of new Earth System Models. Continue process studies and report results in peer-reviewed publications.

FY 2015-17: Continue long-term development and refinement of Earth System Modeling capabilities for use in future national and international climate change assessments. Simulate 20th and 21st century sea level rise using prototype next-generation models of ice sheet dynamics and other physics. Report on Arctic climate change assessment. Communicate Earth System Modeling research findings to policymakers and other stakeholders through assessments, publications and climate services.

Deliverables:

- Sea level rise projections with improved model physics, representation of physical processes, and reduced uncertainty relative to current projections.
- Global ocean models with data assimilation capabilities that can be run at resolutions sufficient to fundamentally improve our understanding of important ecosystem processes and their responses to climate changes.
- State-of-the-art Earth System Models with improved representation of the terrestrial biosphere and reduced uncertainty in future carbon cycle feedbacks.

- Assessments of the causes of recent and ongoing Arctic climate changes through improvements to sea ice modeling and Arctic climate process models. More confident projections of future climate changes in the Arctic.
- A decadal climate prediction system, including an assessment of the level of predictability realizable from the system, in terms of sea surface temperature predictions, and predictions of related changes in extreme events (hurricane activity, drought, heat waves, flooding, etc.).
- Enhanced contributions to assessments of human impacts on climate through inclusion of more realistic physical processes & important feedbacks in climate models; greater confidence in projections of regional climate impacts.

Performance Goals and Measurement Data:

Performance Measure:	FY 2011	FY	FY	FY	FY	FY	FY
Number of regional scale projections for assessments & decision support (cumulative)	Actual	2012	2013	2014	2015	2016	2017
		Target	Target	Target	Target	Target	Target
With Increase	N/A	N/A	3	5	7	8	8
Without Increase	0	2	2	2	2	2	2
<p>Description: Regional scale projections will contribute to international assessments (e.g. IPCC AR5, scheduled for 2013), national assessments under the U.S. Global Climate Research Program, and other assessments as requested. The number of meaningful regional projections possible will increase as NOAA's Earth System Model increases in realism and complexity. Examples of regional scale projections include: regional sea level rise projections that require explicit representation of the global eddy field in the ocean models; projections of parameters essential to ocean and coastal ecosystem forecasting; assessment of regional carbon budgets; and projections of climate change in the Arctic region that require improved sea ice models.</p>							

Performance Measure:	FY 2011	FY	FY	FY	FY	FY	FY
Percentage uncertainty in possible 21 st century sea level rise (0-1m = 100% uncertainty)	Actual	2012	2013	2014	2015	2016	2017
		Target	Target	Target	Target	Target	Target
With Increase	N/A	N/A	74%	65%	55%	50%	40%
Without Increase	75%	75%	74%	73%	72%	71%	70%
<p>Description: This metric is calculated using the IPCC 4th Assessment Report estimates for the range of 21st century global-mean sea level rise. Completion of the proposed effort will reduce the uncertainties by almost half as a result of modeling that better captures the more accurate measurements of ice-sheet discharge, thermal expansion, and regional anomalies due to ocean circulation and heat storage. Reducing the uncertainty in sea level rise will allow government and industry to have better information on projected sea level rise and therefore tailor their planning and actions to address the impacts.</p>							

PROGRAM CHANGE PERSONNEL DETAIL

Activity: Office of Oceanic and Atmospheric Research
 Subactivity: Climate Research

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
Physical Scientist	Princeton, NJ	ZP-IV	10	92,259	922,590
Oceanographer	Princeton, NJ	ZP-III	1	64,729	64,729
Physical Scientist	Boulder, CO	ZP-IV	2	87,815	175,630
Total			<u>13</u>		<u>1,162,949</u>
less Lapse		25%	<u>3</u>		<u>290,737</u>
Total full-time permanent (FTE)			<u>10</u>		<u>872,212</u>
2013 Pay Adjustment (0.5%)					<u>43,611</u>
TOTAL					<u>915,822</u>

Personnel Data

	<u>Number</u>
Full-Time Equivalent Employment	
Full-time permanent	10
Other than full-time permanent	0
Total	<u>10</u>
Authorized Positions:	
Full-time permanent	13
Other than full-time permanent	0
Total	<u>13</u>

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Office of Oceanic and Atmospheric Research
Subactivity: Climate Research

Object Class	2013 Increase
11 Personnel compensation	
11.1 Full-time permanent	\$916
11.3 Other than full-time permanent	0
11.5 Other personnel compensation	0
11.8 Special personnel services payments	0
11.9 Total personnel compensation	916
12 Civilian personnel benefits	275
13 Benefits for former personnel	0
21 Travel and transportation of persons	21
22 Transportation of things	0
23.1 Rental payments to GSA	0
23.2 Rental Payments to others	0
23.3 Communications, utilities and miscellaneous charges	0
24 Printing and reproduction	0
25.1 Advisory and assistance services	0
25.2 Other services	360
25.3 Purchases of goods & services from Gov't accounts	0
25.4 Operation and maintenance of facilities	0
25.5 Research and development contracts	467
25.6 Medical care	0
25.7 Operation and maintenance of equipment	0
25.8 Subsistence and support of persons	0
26 Supplies and materials	0
31 Equipment	0
32 Lands and structures	0
33 Investments and loans	0
41 Grants, subsidies and contributions	5,961
42 Insurance claims and indemnities	0
43 Interest and dividends	0
44 Refunds	0
99 Total obligations	8,000

Climate Competitive Research, Sustained Observations, and Regional Information: Climate Science on the Global Carbon Cycle, Aerosols, and Atmospheric Chemistry to Improve Climate Models and Predictions (Base Funding: \$28,709,000 and 2 FTE; Program Change: +\$6,491,000 and 0 FTE): NOAA requests an increase of \$6,491,000 and 0 FTE for a total of \$35,200,000 and 2 FTE to provide a process-level understanding of the climate system through observation, modeling, analysis, and field studies to support the development of improved climate models for use in climate assessments.

Proposed Actions:

NOAA, in collaboration with its academic partners - including Cooperative Institutes - will advance the understanding of the global carbon cycle and the role of aerosols and chemically-active greenhouse gases in the global climate system. Work will be done in collaboration with members of the NOAA ESRL Carbon Tracker team and the GFDL Climate and Ecosystems group to incorporate new models into CarbonTracker and to improve the ocean component of Earth System Models. In addition, analysis of measurements from past field campaigns and preparation for future field campaigns will be done to improve the understanding of atmospheric composition and climate to take advantage of ongoing improvements in modeling capabilities. In particular, the foci will include elements of the nitrogen cycle that are relevant to stratospheric ozone and climate, aerosol-cloud interactions, as well as monitoring and verification of emissions of greenhouse gases.

Statement of Need and Economic Benefits:

Understanding the processes that govern the carbon cycle and its variability is vital for decision makers, who are increasingly seeking information that will help their communities plan and respond to climate variability and change. The products of this research will improve society's ability to understand and anticipate the global and regional impacts of climate variability and change.

In addition, man-made chemicals are depleting the stratospheric ozone layer, allowing more UV radiation to reach the ground and leading to more cases of skin cancer, cataracts, and other health and environmental problems. This research will measure and quantify atmospheric species that destroy the stratospheric ozone, as well as monitor its recovery. This research is critical to efforts to monitor, report, and verify regional emissions, including those from fossil fuel use to provide an independent check on emissions accounting based on economic inventories. Without this research, the success of efforts to reduce CO₂ and other greenhouse gas emissions in North America cannot be properly quantified. Decision makers will not have sufficient information on verification and mitigation of the global emissions of CO₂. In addition, the most recent and future research will address the connection between air quality and climate, informing stakeholders and decision makers on win-win solutions to mitigating air quality and climate together.

Base Resource Assessment:

The base activities are described in the Climate Competitive Research, Sustained Observations and Regional Information base narrative.

Schedule & Milestones:

FY 2013:

- Employ measurements from past NOAA field campaigns to improve realism of the nitrogen cycle in NOAA Earth System Models, including major feedback on the global carbon cycle.
- Participate (measurements and analysis) in the field campaign in the South East of US where emissions of natural and anthropogenic aerosols are high
- Complete model evaluation of response of the ocean carbon sink to changes in ocean ventilation under increasing atmospheric CO₂ concentrations

- Complete development and analysis of a new "self-assembling" model of marine microbial communities for simulations and sensitivity studies of the changing marine carbon cycle

FY 2014:

- Analysis of measurements taken during the South East US field campaign.
- Complete development of Lagrangian optimization module for CarbonTracker;
- Complete expansion of a prototype regional observing system in the northwest US based on a ground-based network of CO₂ sites;
- Complete provision of new model estimates of the ocean carbon uptake over 1990-present, constrained by WOCE and CLIVAR data;
- Complete an evaluation of the uncertainties in modeled carbon uptake

FY 2015 - 2017:

- Continue supporting studies focusing on air quality – climate interactions that exploit NOAA measurements from recent field campaigns
- Plan and prepare for future NOAA field campaigns
- Complete coupling of a permafrost and soil carbon model, a wetland scheme and simple methane emission model, and a fire module into the present terrestrial biosphere model in CarbonTracker
- Complete development of diagnostic tools to evaluate the performance of global ocean biogeochemical models used in IPCC assessments
- Complete Inter-comparison of ocean heat and carbon uptake in Earth System Model (ESM) simulations conducted for the Coupled Model Inter-comparison Project Phase 5
- Assess the impact of internal variability on estimates of anthropogenic heat and carbon uptake in Earth System Model (ESM) simulations conducted for the Coupled Model Inter-comparison Project Phase 5

Deliverables:

- Complete the design, construction, and evaluation of a novel, in-situ carbonate-ion sensor
- Complete development of a robust and cost effective Dissolved Inorganic Carbon (DIC) sensor that can be deployed in combination with the robust moored pCO₂ sensor (MAPCO₂) previously developed by PMEL
- Peer-review publications from extramural and internal research
- Improved emissions estimates of aerosols precursors, nitrous oxide, methane and other greenhouse gases over California
- Improved understanding of climate-relevant properties of aerosols in South-East US in present and future climate
- Improved estimates of regional CO₂ fluxes over continental US, including the Central Rocky Mountains and Southwestern US
- Explanation of trends in increasing carbon sequestration in the Northeastern US
- Refined estimates of land and ocean carbon sinks
- Reduced uncertainty in the data sets of CO₂ emissions
- Improved estimation of methane emission and uptake in dry Arctic soils and their response to climate variability
- Improved predictions of the responses of the terrestrial ecosystem to changing temperature and precipitation

Performance Goals and Measurement Data:

Performance Measure:	FY 2011 Actual	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target	FY 2017 Target
Reduced uncertainty in the magnitude of the North American Carbon Sink (million tons Carbon/year) (Measure 16b)							
With Increase	N/A	N/A	405	415	425	435	445
Without Increase	400	400	410	420	430	440	450
<p>Description: The provision of NOAA scientific guidance to policymakers concerned with managing emissions of carbon dioxide requires NOAA to assess and quantify the sources of carbon variability. This GPRA measure demonstrates the scientifically accepted level of confidence in carbon measurement that is needed to accurately evaluate levels of carbon emissions in North America. The uptake of atmospheric carbon (mainly as carbon dioxide) by the biosphere across North America is of the order of one billion tons (one petagram) per year. That is about 1/2 of the current emissions from burning fossil fuels on the continent. In order to be able to evaluate annual changes in this ecosystem uptake, we must improve our carbon measurements to a level of uncertainty that is about 1/3 of the total or 300 million tons per year. Obtaining this minimum level of uncertainty requires an expanded observation network and improved modeling effort. The basis (flux estimates) for the measure is publicly available on the web (http://carbontracker.noaa.gov).</p>							

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Office of Oceanic and Atmospheric Research

Subactivity: Climate Research

Object Class	2013 Increase
11 Personnel compensation	
11.1 Full-time permanent	0
11.3 Other than full-time permanent	0
11.5 Other personnel compensation	0
11.8 Special personnel services payments	0
11.9 Total personnel compensation	0
12 Civilian personnel benefits	0
13 Benefits for former personnel	0
21 Travel and transportation of persons	10
22 Transportation of things	0
23.1 Rental payments to GSA	0
23.2 Rental Payments to others	0
23.3 Communications, utilities and miscellaneous charges	0
24 Printing and reproduction	0
25.1 Advisory and assistance services	0
25.2 Other services	50
25.3 Purchases of goods & services from Gov't accounts	0
25.4 Operation and maintenance of facilities	0
25.5 Research and development contracts	570
25.6 Medical care	0
25.7 Operation and maintenance of equipment	0
25.8 Subsistence and support of persons	0
26 Supplies and materials	25
31 Equipment	25
32 Lands and structures	0
33 Investments and loans	0
41 Grants, subsidies and contributions	5,811
42 Insurance claims and indemnities	0
43 Interest and dividends	0
44 Refunds	0
99 Total obligations	6,491

Climate Competitive Research, Sustained Observations and Regional Information: Global Ocean Observing System (GOOS) (Base Funding: \$59,213,000* and 89 FTE; Program Change: +\$4,601,000 and 1 FTE: NOAA requests an increase of \$4,601,000 and 1 FTE for a total of \$63,814,000* and 90 FTE to make progress in critical ocean observations and analysis, Arctic monitoring, and more comprehensive deep ocean monitoring with new full ocean depth profiling floats (Argo) within the Global Ocean Observing System.

[*NOTE: The GOOS base funding of \$59,213,000 includes AOML and PMEL funding and FTE from the Laboratories and Cooperative Institutes PPA.]

Proposed Actions:

Ocean observations serve as the foundation for understanding and forecasting the Earth's climate system, enabling real-time monitoring of ever-changing ocean conditions, and seasonal-to-decadal climate forecasts and analyses for a broad spectrum of societal applications. Although much progress has been made toward development of the Global Ocean Observing System (GOOS), climate requirements still cannot be met satisfactorily. NOAA requests an increase in support for three components of the Global Ocean Observing System: 1) critical ocean observations and analysis; 2) progress in observational efforts in the rapidly changing Arctic; and 3) technology development to improve our understanding of the deep ocean via deployment of Deep Argo Floats that would provide valuable information on sea level rise and the global energy balance.

OCEAN OBSERVATIONS and ANALYSIS

Specific enhancements to the global ocean observing system (both observations and analysis) that will advance monitoring global sea level rise and its drivers include:

- Tide Gauge Stations: Ten tide gauge stations will be deployed and fifteen enhanced reference tide gauge stations will be equipped with GPS receivers and real-time reporting transmitters to provide measurement of absolute sea level rise and satellite ground truth, and to provide real-time monitoring for tsunamis, El Niño, and storm surge events. Costs associated with the support of these upgrades are requested to meet ongoing operations and maintenance of the systems;
- Ocean Reference Stations: One real-time reporting deep ocean monitoring system will be deployed in a boundary current location important to monitor energy and carbon exchanges between the ocean and atmosphere, upper ocean temperature and salinity, and near-surface currents; and for the Operations & Maintenance associated with development and supporting deployment of the new Ocean Reference Station;
- Ocean Analysis and Assimilation: University and government researchers will be engaged to help NOAA analyze and assimilate ocean data in order to evaluate and improve ocean models to make more reliable projections of climate changes, and additionally, to more efficiently assess adequacy of existing and future observing systems;
- Drifting Buoys: Fifty additional drifters are required to provide a full network of sea surface temperature observations as part of the Global Drifter Array. These observations are critical to support monitoring of sea surface temperature and atmospheric pressure;
- South Atlantic Meridional Overturning Circulation: For deep ocean observations and analysis of the South Atlantic in support of the Atlantic Meridional Overturning Circulation (AMOC) objective.

Due to the complexities of the observations and analysis needed for this program, one new Federal employee position is requested.

ARCTIC

The NOAA Arctic program is necessary for addressing immediate and near-term impacts of a changing climate and supporting NOAA's response capabilities to stakeholders, particularly those in Alaska and the Pan-Arctic region, but also throughout the Nation. Arctic observations produce information and applications-driven research outputs, such as nowcasts and forecasts tailored to Arctic stakeholder needs, and projections for planning and policy.

Many of the necessary components for Arctic observations already exist in varying stages of development and execution. However, a greater investment in analysis of recent ocean and atmospheric observations are critical for allowing NOAA to serve as a key provider and contributor of knowledge and information about changes in the Arctic environment such as sea-ice, marine ecosystems, and atmospheric aerosols. These analyses will lead to improved products and knowledge for decision-making as well as continued research efforts across a range of issues affecting or affected by the Arctic. The NOAA Climate Program Office will lead this effort and will utilize the capabilities of the NOAA Joint and Cooperative Institutes as well as NOAA labs.

DEEP ARGO

Another component of the Global Ocean Observing System involving technology development to measure the deep ocean involves Deep Argo floats. A global array of Deep Argo (0-6000 m) conductivity/temperature/depth profiling floats is needed to supplement the present Argo Program's 3,400 upper ocean floats (<http://www-argo.ucsd.edu>) in order to close global budgets of heat, freshwater, and sea level. Deep Argo floats are presently being developed with the capability of multi-year missions (> 100 cycles) from the sea surface to the ocean bottom. Here we propose to deploy pilot arrays, eventually populating two deep ocean basins. These will be the Southwest Pacific Basin and the Northwest Atlantic, and are selected on the basis of known decadal deep ocean signals. The pilot arrays, together with deep ocean repeat hydrographic surveys will demonstrate the capability of Deep Argo to resolve the spatial and depth distribution of decadal signals in the deep ocean. Elements of the pilot array installation include:

- Evaluation and improvement of float design.
- Integration of Deep Argo data into the Argo Data System, including development of protocols for delayed-mode quality control of Deep Argo data. Deep Argo will adhere to the Argo data policy of public release of near-real time and delayed-mode data.

These elements of Deep Argo will be carried out by the U.S. Argo float consortium (Scripps Institution of Oceanography, Woods Hole Oceanographic Institution, University of Washington, NOAA Pacific Marine Environmental Laboratory, NOAA Atlantic Oceanographic and Meteorological Laboratory) together with management functions provided by the Climate Program Office with specific tasks and responsibilities distributed among the partners similarly to the present U.S. Argo Program. International Argo partners are also contributing to Deep Argo, and the efforts of these partners will increase the number of Deep Argo floats and assist the U.S. effort directly through collaborative float deployment.

Statement of Need and Economic Benefits:

Episodes of devastating coastal inundation over the last decade have emphasized the critical importance of fielding an ocean observing system that can continuously monitor for approaching marine hazards and provide early warnings to the coasts for hazard mitigation. Storm surge, El Niño, tsunamis, as well as gradual sea level rise, all originate in the deep ocean well beyond the coastal zone, where much of our observing capacity currently exists. Gradual sea level rise results from an increase in mass due to melting ice and thermal expansion from ocean heating, which causes an

increase in the amount of sea water. Recent studies suggest that much of the ocean heat driving sea level rise may be stored in the deep ocean, beyond routine observation by current technology. Emerging technology, such as deep Argo floats, will be able to better track this heat exchange.

More broadly, the global ocean observing system must deliver continuous real-time measurements that will allow the modeling community to improve data assimilation and therefore improve the accuracy of climate model projections. It must also be capable of delivering quantitative ocean indicators at a few strategic reference locations that will alert the nation and the world if and when major changes are occurring.

Economists project that investment in observing system technology will be amplified by orders of magnitude in socio-economic advantage to the nation in planning for impacts and responses to climate change generally and sea level rise, in particular. The coupling of climate related sea level change with the high water levels due to extreme events such as hurricanes bring billion-dollar socio-economic impacts and dramatic shifts in our coastal marine ecosystems. Over half of the U.S. population resides in a coastal county, and three quarters of the American economy is generated in coastal states. Sea level rise threatens the stability of our coastal communities, economies, and ecosystems. Improving our understanding of and ability to predict sea level rise will allow for improved planning, informed investments, and the development of targeted risk reduction strategies. Further, US contributions to the global system have been historically more than matched by the contributions of international partners.

The Arctic region is currently undergoing profound atmospheric, terrestrial and oceanic changes related to climate variation and change. In many cases, observed changes far exceed the current model projections. These changes impact human health, infrastructure, fisheries, ecosystems, coastal communities, international maritime activity, and regional to mid-latitude climate shifts. Diminishing sea ice cover contributes to significant changes in weather patterns both within and surrounding the Arctic, modifies ecosystems, opens new shipping channels, and provides access to previously unobtainable natural resources. Additionally, the domestic energy industry has increased interest in the Arctic region as a source for oil and natural gas exploration/extraction and as part of a national energy policy.

Base Resource Assessment:

The base resources for this activity are described in the Climate Competitive Research, Sustained Observations and Regional Information base narrative.

Schedules and Milestones:

Ocean Observations

OUTPUT	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target	FY 2017 Target
Deliverables						
Ocean Reference Stations deployed (Cum Total #)	11	11	12	12	12	12
Drifting Buoy Array deployed (Total #/year-reseeding the array)	1000	1000	1000	1000	1000	1000
Deep Argo floats deployed (Cum Total #)	0	0	0	8	12	20
Integration of Deep Argo data into the Argo Data Management System	No	Yes	Yes	Yes	Yes	Yes

Tide Gauge Reference Stations w/GPS installed (Cum Total #)	110	110	111	114	117	120
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Deliverables:

- One additional Ocean Reference Station
- 50 drifting buoys deployed (maintain at 1000)
- 10 tide gauge stations with 10 upgrades of GPS installed on gauges
- NOAA will contribute annually the international Deep Argo Program, including data transmission, data management, and public distribution of all deep Argo data.

Ocean analysis deliverables to be developed and disseminated include observationally-based and model-based products. Observationally-based products (e.g., global maps of observed ocean heat content, salinity, sea level, currents, etc.) will aid in evaluating and improving ocean and climate models, with a view towards providing improved predictions of climate change (e.g., improved predictions of sea level rise). In addition, model-based products (e.g. ocean state estimated from assimilation of ocean data into ocean models) will be queried to produce targeted products on an “as needed” basis in response to emerging climate priorities. Additionally, the supporting data analysis and delivery infrastructure will be enhanced to facilitate extracting the maximum information from observational data.

Performance Goals and Measurement Data:

Performance Measure	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017 Target
Reduce the error in global measurement of sea surface temperature (°C). Measure 16c.	Actual	Target	Target	Target	Target	Target	
With Increase	0.51	0.50	0.51	0.50	0.50	0.50	0.50
Without Increase	0.51	0.50	0.51	0.51	0.55	0.55	0.55

Description: This measure is intended to document progress in accurately measuring the global sea surface temperature (SST) using in situ drifting buoys to verify that satellite SST data are accurate and representative. This reflects how improvements in ocean observations will decrease the uncertainty in global sea surface temperature measurements, which will ultimately play a role in calculations of the ocean-atmosphere exchange of heat and the heat storage in the global ocean. The sea surface, covering over 70% of the Earth surface, has a tremendous influence on global climate because it is where the atmosphere responds to the ocean via the transfer of heat either to or from the atmosphere. Since sea surface temperature is measured by buoys, ships, and satellites, this performance measure is well-suited as an indicator of the effectiveness of our integrated ocean observing system and the more accurate estimates of sea surface temperature will improve our ability to detect changes in the climate system. Success in this performance measure requires the maintenance and increase of in situ ocean sensors. The goal is to reach an indicator value of 0.3 degrees Celsius, which has been specified by the international Global Ocean Observing System (GOOS) as the required accuracy for measurement of sea surface temperature.

PROGRAM CHANGE PERSONNEL DETAIL

Activity: Office of Oceanic and Atmospheric Research
 Subactivity: Climate Research

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
Program Manager	Silver Spring, MD	ZP-IV	1	89,033	89,033
					0
					0
Total			<u>1</u>		<u>89,033</u>
less Lapse		25%	<u>0</u>		<u>22,258</u>
Total full-time permanent (FTE)			1		66,775
2013 Pay Adjustment (0.5%)					334
TOTAL					67,109

Personnel Data

	<u>Number</u>
Full-Time Equivalent Employment	
Full-time permanent	1
Other than full-time permanent	0
Total	<u>1</u>

Authorized Positions:

Full-time permanent	1
Other than full-time permanent	0
Total	<u>1</u>

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Office of Oceanic and Atmospheric Research
Subactivity: Climate Research

Object Class	2013 Increase
11 Personnel compensation	
11.1 Full-time permanent	\$67
11.3 Other than full-time permanent	0
11.5 Other personnel compensation	0
11.8 Special personnel services payments	0
11.9 Total personnel compensation	67
12 Civilian personnel benefits	20
13 Benefits for former personnel	0
21 Travel and transportation of persons	0
22 Transportation of things	0
23.1 Rental payments to GSA	0
23.2 Rental Payments to others	0
23.3 Communications, utilities and miscellaneous charges	0
24 Printing and reproduction	0
25.1 Advisory and assistance services	0
25.2 Other services	878
25.3 Purchases of goods & services from Gov't accounts	0
25.4 Operation and maintenance of facilities	0
25.5 Research and development contracts	0
25.6 Medical care	0
25.7 Operation and maintenance of equipment	0
25.8 Subsistence and support of persons	0
26 Supplies and materials	0
31 Equipment	2,336
32 Lands and structures	0
33 Investments and loans	0
41 Grants, subsidies and contributions	1,300
42 Insurance claims and indemnities	0
43 Interest and dividends	0
44 Refunds	0
99 Total obligations	4,601

Climate Competitive Research, Sustained Observations and Regional Information: Regional Integrated Sciences and Assessments (RISA) (Base Funding: \$6,512,000 and 2 FTE; Program Change: +\$3,100,000 and +1 FTE): NOAA requests an increase of \$3,100,000 and 1 FTE for a total of \$9,612,000 and 3 FTE to expand capability for regional research and information services.

Proposed Actions:

With the funds requested, OAR will increase its support of external research teams who work with resource managers and planners to develop and utilize new information about the impacts of climate on communities, natural and managed resources, infrastructure, transportation, and health. A new region would be competitively awarded funding under this augmentation. Furthermore, funds will be used to augment and ensure explicit collaborative partnering with NOAA's regional information system components (e.g. NIDIS, NESDIS Regional Climate Service Directors, NOS Coastal Services Centers, NWS Regional offices, NMFS regional offices) as well as other federal, state and private providers. RISAs will develop a new suite of applied research products specifically to inform regional networks of information providers, assess the extent to which the regional network is providing "actionable science" able to be taken up into practical decision making, and provide research-based decision support for adaptation (e.g. understanding economic costs benefits).

Statement of Need and Economic Benefits:

RISA scientists provide information that decision makers can use to cope with drought, understand climatic influences on wildfire, and assess climate impacts on the transportation sector, coastal communities and human health. Stakeholders can use such information to evaluate potential climate change impacts on water supplies and hydroelectric power and support disaster management planning. RISAs are helping farmers, ranchers, and fishermen use climate information to produce the nation's foods and fibers, and Pacific Islanders to figure out how to weave climate information into their quest for sustainability.

With each passing year, the impacts of climate variability and change on water availability, wildfire regimes, public health, agriculture, energy issues, and coastal communities become more acute. At the same time, climate sciences are making great strides in producing knowledge that could aid decision makers dealing with these issues.

As climate prediction skill improves, much of the nation stands to benefit from regional RISA activities. The RISA goal is to conduct the kinds of research and product development needed to help society make decisions in the face of climate variability and change, using experts from NOAA and other partner institutions.

Base Resource Assessment:

The base resources for this activity are described in the Climate Competitive Research, Sustained Observations and Regional Information base narrative.

Schedules and Milestones:

- FY 2013: RFP for new proposals to develop the research products that will contribute to and deepen partnerships with regional information providers
- FY 2013: RFP for a new RISA in partnership with USDA in an area of major agricultural productivity and climate sensitivity
- FY 2014: Launch new RISA
- FY 2014/FY 2015: Initiate 1-2 new research partnerships between RISA and NOAA information providers

- FY 2016/FY 3017: Initiate 1-2 new research partnerships between RISA and NOAA information providers

Deliverables:

- In four or five new states located in the Midwest and Great Plains, expand applied research support of local, state, and regional decision makers (i.e. state and city governments, coastal managers, farmers, private and public water utilities and more) with two new, five-year cooperative agreement centers who focus on:
 - Development of new and/or enhance existing climate science for use in risk management (records of past climate and projections of seasonal, interannual, and decadal climate variability)
 - New approaches for analyzing and assessing environmental change, risk, impacts, and for developing response options (per the U.S. Global Change Research Act)
 - Socio-economic research on human impacts from climate variability and change
 - Scenarios of environmental change integrating climate, land use, water, sea level and vegetation
 - Tools (including trainings, guidebooks, websites, etc) to support ongoing decision-making to manage and respond to climate risks
 - Expansion of drought early warning systems in priority areas of the National Integrated Drought Information System
- In partnership with the US Department of Agriculture and the Department of the Interior, develop or enhance research priorities for regional climate science and services.

Performance Goals and Measurement Data:

Performance Measure:	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Number of regionally and sectorally focused climate impacts and adaptation studies communicated to decision makers.	Actual	Target	Target	Target	Target	Target	Target
With Increase	N/A	N/A	27	28	29	29	30
Without Increase	N/A	27	27	27	27	27	27
<p>Description: Number of peer-reviewed publications and reports published and released in one fiscal year. The publications/reports are developed through interaction with and/or communication to stakeholders. Publications and reports are collected from investigators conducting climate impacts and adaptation research in cooperation with stakeholders. The goal of this research is to better understand and enhance the use of NOAA products and information to meet user requirements for natural resource management information in various sectors (e.g. drought and water resources, fire risk, ecosystem and coastal impacts, sea-level rise, human health, agriculture, etc.). Actuals are not available for FY 2011 due to the baselining of this new performance measure in that year.</p>							

Performance Measure:	FY 2011	FY	FY	FY	FY	FY	FY
Number of states or territories using new or tailored climate services (tools, information, technical assistance, or products) as a result of regional, state and local interaction with decision makers (Each Year)	Actual	2012	2013	2014	2015	2016	2017
		Target	Target	Target	Target	Target	Target
With Increase	N/A	N/A	5	8	9	11	12
Without Increase	N/A	4	5	7	8	9	10
<p>Description: The number of products and services, provided or existing products and services that are modified/expanded for new user groups or regions. 'Products and services' includes technical assistance, training, and guidance documents to enable planning and decision making. Actuals are not available for FY 2011 due to the baselining of this new performance measure in that year. [This measure is partially based on the current GPRA: Number of regionally and sectorally focused climate impacts and adaptation studies communicated to decision makers.]</p>							

PROGRAM CHANGE PERSONNEL DETAIL

Activity: Office of Oceanic and Atmospheric Research
 Subactivity: Climate Research

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
Physical Scientist	Silver Spring, MD	ZP-IV	<u>1</u>	89,033	<u>89,033</u>
Total			<u>1</u>		<u>89,033</u>
less Lapse		25%	<u>0</u>		<u>22,258</u>
Total full-time permanent (FTE)			1		66,775
2013 Pay Adjustment (0.5%)					334
TOTAL					67,109

Personnel Data

	Number
Full-Time Equivalent Employment	
Full-time permanent	1
Other than full-time permanent	<u>0</u>
Total	1

Authorized Positions:

Full-time permanent	1
Other than full-time permanent	<u>0</u>
Total	1

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Office of Oceanic and Atmospheric Research
Subactivity: Climate Research

Object Class	2013 Increase
11 Personnel compensation	
11.1 Full-time permanent	\$67
11.3 Other than full-time permanent	0
11.5 Other personnel compensation	0
11.8 Special personnel services payments	0
11.9 Total personnel compensation	67
12 Civilian personnel benefits	20
13 Benefits for former personnel	0
21 Travel and transportation of persons	0
22 Transportation of things	0
23.1 Rental payments to GSA	0
23.2 Rental Payments to others	0
23.3 Communications, utilities and miscellaneous charges	0
24 Printing and reproduction	0
25.1 Advisory and assistance services	0
25.2 Other services	413
25.3 Purchases of goods & services from Gov't accounts	0
25.4 Operation and maintenance of facilities	0
25.5 Research and development contracts	0
25.6 Medical care	0
25.7 Operation and maintenance of equipment	0
25.8 Subsistence and support of persons	0
26 Supplies and materials	0
31 Equipment	0
32 Lands and structures	0
33 Investments and loans	0
41 Grants, subsidies and contributions	2,600
42 Insurance claims and indemnities	0
43 Interest and dividends	0
44 Refunds	0
99 Total obligations	3,100

Climate Competitive Research, Sustained Observations and Regional Information

Applications: Assessment Services (Base Funding: \$5,081,000 and 0 FTE; Program Change +\$2,619,000 and 0 FTE): NOAA requests an increase of \$2,619,000 and 0 FTE for a total of \$7,700,000 and 0 FTE to support a permanent capability to produce climate assessments at national and regional scales. In particular, this increase will support ongoing regional and sectoral assessment activities, the development of regional model and scenarios resources from new Global Climate Model output, and support for the Global Change Information System to increase access and usability of the National Climate Assessment.

Proposed Actions:

As part of a sustained assessment process, NOAA requests funding for ongoing regional and sectoral activities leading to the development of relevant and authoritative regional assessments targeted to regional stakeholders. Funding will also support coastal and nascent ocean 'sectoral' assessment activities that will build on the initial work done in FY 2011 and FY 2012 analysis with new observed and modeled data.

NOAA, in conjunction with its partners, will also develop regional, national and sectoral-focused model and scenario output. In particular the availability of new model results through the international Coupled Model Intercomparison Project Phase 5 (CMIP5) program will need to be evaluated and manipulated for regional assessments and decision support. A key aspect of this effort will be to assess model validity in regions and at the coastal margin and ocean regions of interest to the United States economy. This output will constitute core data in the development of the regional assessments discussed above, and NOAA's regional partners will be heavily engaged in the production of appropriate climatologies and scenarios as well as regional data and information access associated with the regional assessments.

In addition, to support access to the National Climate Assessment and its data and source information, NOAA will lead and further contribute to the interagency Global Change Information System (GCIS). Initial investment has been made in FY 2011 and FY 2012, and in FY 2013 this investment will support the development of a robust data access infrastructure for assessment datasets, prototyping the NCA's commitment to transparency and traceability for assessment data and conclusions. In addition a user-focused interface, linking foundational assessment information with other tools and applications across the Government is planned.

Statement of Need and Economic Benefits:

The Global Change Research Act of 1990 (GCRA) calls for the President (through a Federal interagency body) to prepare and submit to the Congress, on a periodic basis (not less frequently than every 4 years), an assessment which: 1) integrates, evaluates, and interprets the findings of the Federal interagency research effort and discusses the scientific uncertainties associated with such findings; 2) analyzes the effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity; and 3) analyzes current trends in global change, both human-induced and natural, and projects major trends for the subsequent 25 to 100 years. The last two of these assessments have been completed under existing NOAA scientific leadership. NOAA is taking the lead role through the U.S. Global Change Research Program in the next National Assessment, which is due in 2013. More information about the National Climate Assessment, including a list of participating Federal agencies, can be found at: <http://www.globalchange.gov/what-we-do/assessment>.

Regional and national assessments will meet an increasing range of demands for climate change decision support across the Nation. Building on the past two decades of experience,

and pairing existing expertise with emerging capacity, NOAA will support a collaborative, participatory assessment process that engages scientists, government officials, businesses, and communities in the investigation of climate impacts and effective mitigation and adaptation.

Cumulatively, the assessments will contribute to ongoing efforts to understand what climate change means for the United States and what services are necessary to allow for informed decision-making. This information will provide an objective basis for adaptation and mitigation strategies at a variety of temporal and spatial scales. These assessments will also contribute to the legislatively mandated National Climate Assessment and future international assessments, including those of the Intergovernmental Panel on Climate Change.

Climate assessments will involve both operational and research elements of NOAA, and will build upon many existing NOAA resources and functions including research in the physical, biological, and social sciences, observing, data management, modeling and forecasting, education and outreach. NOAA will also enhance its capabilities and tailor its products through partnerships with other Federal agencies, and the academic, public and private sectors.

Base Resource Assessment:

The base resources for this activity are described in the Climate Competitive Research, Sustained Observations and Regional Information base narrative.

Schedule & Milestones:

- FY 2012 - 2013: Produce regional scale projections for key climate variables from existing projections. Begin to develop regional analysis of new CMIP5 projections.
- FY 2012 - 2013: First reviewable draft of approximately 2 additional regional assessments for a total of 8 and one sectoral assessment
- FY 2013: Completion of 2 additional regional chapters, for a total of 8 and one sectoral chapter. (First reviewable draft of the National Climate Assessment.) Prototype version of the Global Change Information System.
- FY 2013 - 2014: Public deployment of the prototype Global Change Information System. (Completion and delivery of a National Climate Assessment synthesis report.)
- FY 2014: Updates of regional projections from new model results.
- FY 2014 - 2015: Draft updates of 2 additional regional assessments for a total of 8, and improve and update Global Change Information System.
- FY 2015 - 2016: Complete updates of existing regional and sectoral assessments.
- FY 2016: Reviewable draft of the National Climate Assessment, update of assessment content online.
- FY 2017: Completion and publication of National Climate Assessment synthesis.

Deliverables:

- FY 2012/FY 2013: Produce regional scale projections of key climate variables for the United States.
- FY 2012/FY 2013: First reviewable draft of two additional regional assessments for a total of 8 and one sectoral assessment.
- FY 2013: Completion of two additional regional assessments for a total of 8 and one sectoral assessment; first reviewable draft of the National Climate Assessment; draft of prototype Global Change Information System
- FY 2014: Public deployment of the prototype Global Change Information System. Completion and delivery of the National Climate Assessment synthesis report

- FY 2015: First reviewable draft of regional assessments (with updated projections)
- FY 2016: Completed regional assessments; first reviewable draft of National Climate Assessment synthesis report
- FY 2017: Completion and delivery of the National Climate Assessment synthesis report

Performance Goals and Measurement Data:

Performance Measure:	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Number of climate-change related impact, vulnerability, adaptation, or mitigation information topics addressed in the Assessments	Actual	Target	Target	Target	Target	Target	Target
With Increase	N/A	N/A	14	14	14	14	14
Without Increase	17	8	8	8	8	8	8
<p>Description: This performance measure will demonstrate the role of formal climate change assessments in decisions to address climate change impacts by identifying the number of topics addressed in the assessments that are considered by business, government, or the public that affected decisions related to improved climate resilience. Information topics are based on the U.S. GCRP report, "Global Climate Change Impacts in the U.S." This measure will track the extent to which the USGCRP topical information items are used by industry, etc., to inform their key decisions on how to mitigate or adapt to climate change. The FY 2011 actuals were, in part, a result of more rapid progress than anticipated on initial products and significant, unexpected collaboration.</p>							

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Office of Oceanic and Atmospheric Research
Subactivity: Climate Research

Object Class	2013 Increase
11 Personnel compensation	
11.1 Full-time permanent	0
11.3 Other than full-time permanent	0
11.5 Other personnel compensation	0
11.8 Special personnel services payments	0
11.9 Total personnel compensation	0
12 Civilian personnel benefits	0
13 Benefits for former personnel	0
21 Travel and transportation of persons	0
22 Transportation of things	0
23.1 Rental payments to GSA	0
23.2 Rental Payments to others	0
23.3 Communications, utilities and miscellaneous charges	0
24 Printing and reproduction	0
25.1 Advisory and assistance services	0
25.2 Other services	0
25.3 Purchases of goods & services from Gov't accounts	0
25.4 Operation and maintenance of facilities	0
25.5 Research and development contracts	500
25.6 Medical care	0
25.7 Operation and maintenance of equipment	0
25.8 Subsistence and support of persons	0
26 Supplies and materials	0
31 Equipment	0
32 Lands and structures	0
33 Investments and loans	0
41 Grants, subsidies and contributions	2,119
42 Insurance claims and indemnities	0
43 Interest and dividends	0
44 Refunds	0
99 Total obligations	2,619

Climate Competitive Research, Sustained Observations and Regional Information: National Integrated Drought Information System's Regional Drought Early Warning Information Systems (Base Funding: \$8,363,000* and 1 FTE; Program Change: +\$1,500,000 and 0 FTE):

NOAA requests an increase of \$1,500,000 and 0 FTE for a total of \$9,863,000 and 1 FTE to develop Regional Drought Early Warning Information Systems (RDEWS) by providing focused drought impacts research and applications development to underserved regions of the country. Extending products, tools and knowledge to areas outside of the NIDIS Pilots is the final stage of implementing a national early warning information system for drought.

[*NOTE: The NIDIS program also includes an additional \$3,753,000 of base funding from the Climate Data and Information program, for a total request of \$13,616,000 in FY 2013]

Proposed Actions:

NOAA requests an increase for additional competitive research grants and contracts to develop and expand the Regional Drought Early Warning Information System (RDEWS) to the Pacific Northwest; as identified by NOAA partners including through a Memorandum of Understanding with the Western Governors; and in the Mid-west agricultural belt. Additional resources will be applied to the Carolinas, especially in collaboration with the Coastal Services Center on early warning of low flow conditions from major streams, such as the Catawba and Yadkin Pee-Dee, into the near-shore environment that affects water supply in large population centers, as well as increasing salinity intrusion into near-shore coastal ecosystems with important economic value to those states.. With the new resources NOAA will develop ongoing drought information outlook products (information sheets on drought conditions that improve on the national drought monitor by emphasizing local conditions, impacts assessments, and inputs into federal, state and tribal plans).

Currently, the Upper Colorado early warning system is operational with ongoing impacts assessment feeding to weekly webinars. The Southeast pilot in the Apalachicola-Chattahoochee-Flint is near completion, and the California pilots are underway in four locations (including southern California) selected by NOAA partners (Federal and state) in the state. In addition, drought information outlooks involving NOAA, federal and state and private sector partners, led by NIDIS, have been created in response to the ongoing severe drought in Texas, Oklahoma, and New Mexico. Planning and design workshops are also being developed for the Chesapeake Bay.

Statement of Need and Economic Benefits:

Economic, environmental, and societal drought impacts are severe. The 1988 drought cost the United States \$40 billion in that year alone (in 1988 dollars) (The Geological Society of America, (2006) Managing Drought and Water Scarcity in Vulnerable Environments: Creating a Roadmap for Change in the United States.)” Factors that will continue to increase this cost include: population growth and shifts into areas at risk from severe drought impacts (especially in the west, mid-west, and southeast); land use changes; increased water resource demands from sectors such as agriculture, energy, recreation, and ecosystems; increasing aridity in specific regions; etc. Implementing a national DEWS addresses the requirements of the 2006 NIDIS Act, the 2007 NIDIS Implementation Plan: (“Foster and support a research environment focusing on risk assessment, forecasting, and management... [and] Provide a framework for public awareness and education about droughts”), and the 2004 Western Governors’ report on Creating a Drought Early Warning System for the 21st Century. Implementing the DEWS is particularly critical now because of the recent severe drought in California and the continued drought in SW U.S. and other regions. This research supports: planning activities in anticipation of impacts of El Niño Southern Oscillation; early warning system design, development of decision support tools; and evaluation to meet demands from constituents (e.g., watershed managers, partner states, and agencies).

NIDIS will create a network of partners to assess and adopt innovations in drought warning and planning including, RISAs, Regional Climate Centers, State Climatologists, USDA Extension Offices, and others. It will increase the Nation's capacity to use climate forecasts and data in decision making in key regions and within prime socioeconomic sectors. This funding will provide new tools, models and methodologies to enhance decision makers' ability to plan for climate variability and change. The results from these studies will be key inputs into early warning systems that will serve NIDIS partners in Federal, state, tribal and private sectors.

Base Resource Assessment:

The base resources for NIDIS are described in both the Climate Data and Information and the Climate Competitive Research, Sustained Ocean Observations and Regional Information base narratives.

Schedule and Milestones:

Research must be conducted before outputs can be quantified, which creates a lag between research and product delivery.

- FY 2013 – FY 2015: Award grants and or contracts for regional and sectoral drought impacts research and transition projects that have been identified as critical by NOAA's regional partners (e.g., socio-economic, agriculture, urban, and water resource management).
- FY 2013: Produce and deliver drought impacts research and products to regionally-specific information products on the U.S. Drought Portal. Use products to develop regionally specific drought monitors and early warning system indicators and triggers in three areas above. Identify research gaps and further user communication and awareness of drought information and its integration into drought planning processes in support of NIDIS.
- FY 2013: Identify drought decision support tools (e.g., to assess impacts) and drought research including forecasts that contribute towards preparedness and coordination methods developed and tested in pilots and other regions. Transition drought decision support tools to the U.S. Drought Portal and to these new regions. Integrate modeling, forecasting and GIS-based products from the Climate Prediction Center and the Climate Test-beds into NOAA River Forecast Centers and promote governmental drought training and scenario development.
- FY 2013-2014: Evaluate value of drought impacts research undertaken and revisit priorities in light of progress made on NIDIS implementation. Continue transition of drought decision support tools and methodologies to the U.S. Drought Portal. Test application of tools in new areas. Assimilate drought impacts data and information into a database for use with different types of drought conditions across climate timescales into drought and water management plans. This database will assist users to identify high risk and potential hotspots at the watershed scale within sectors (e.g., agriculture, energy, ecosystem and water management).
- FY 2014 – FY 2015: Award new grants and or contracts to address research gaps and user needs identified in FY 2013. Continue transition of drought decision support tools, methodologies and related research and products to the Drought Portal and to new regions.

Deliverables:

Drought products (assessments, forecasts, tools, and scenarios) incorporated into stakeholder drought planning and decision-making would be developed in new geographic regions (the Pacific Northwest, the Upper mid-West and the Carolinas). These would be conducted in direct coordination with existing NIDIS pilots and be incorporated into the drought portals (as subset of the U.S. Drought Portal) at region-specific scales.

Activities that could result from additional funding include: dynamic drought indices; fire outlooks; paleo-climate web-tools for water managers; guidance tools for planning and management of urban drainage systems such as the Carolinas coasts; closer engagement and reduced vulnerability of the tribes in the Great Plains; development of a decision support system specifically designed to help forage producers; forecasts and GIS products from the CPC and the Climate Test-beds used by NOAA River Forecast Centers, U.S. Geological Survey (USGS), U.S. Army Corps of Engineers, and Bureau of Reclamation; and full integration of regional NIDIS Early Warning Systems into RISAs, Regional Climate Centers, and NWS field and State Climatologist offices as focal points for NIDIS in new geographic regions to produce a fully sustainable national drought early warning system.

Performance Goals and Measurement Data:

Performance Measure:	FY						
Number of states, and territories working with NIDIS to incorporate drought early warning information into their drought adaptation and mitigation plans. (Cumulative)	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
With Increase	N/A	4	6	8	12	17	24
Without Increase	N/A	4	5	7	10	15	22
<p>Description: The performance measure is based on the number of states and territories that partner with NIDIS to incorporate drought early warning information into their drought planning activities. Activities that count toward this measure include: local or regional drought planning/management groups; use of tailored information from the U.S. Drought Portal to establish drought indicators and set management triggers in state, watershed, and territory drought adaptation and mitigation plans; incorporation of information from basin specific drought monitors developed through the drought early warning information systems into either state and territory drought adaptation and mitigation plans or as part of state and territory drought planning/management groups.</p>							

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Office of Oceanic and Atmospheric Research
Subactivity: Climate Research

Object Class	2013 Increase
11 Personnel compensation	
11.1 Full-time permanent	\$0
11.3 Other than full-time permanent	0
11.5 Other personnel compensation	0
11.8 Special personnel services payments	0
11.9 Total personnel compensation	0
12 Civilian personnel benefits	0
13 Benefits for former personnel	0
21 Travel and transportation of persons	0
22 Transportation of things	0
23.1 Rental payments to GSA	0
23.2 Rental Payments to others	0
23.3 Communications, utilities and miscellaneous charges	0
24 Printing and reproduction	0
25.1 Advisory and assistance services	0
25.2 Other services	250
25.3 Purchases of goods & services from Gov't accounts	0
25.4 Operation and maintenance of facilities	0
25.5 Research and development contracts	0
25.6 Medical care	0
25.7 Operation and maintenance of equipment	0
25.8 Subsistence and support of persons	0
26 Supplies and materials	0
31 Equipment	25
32 Lands and structures	0
33 Investments and loans	0
41 Grants, subsidies and contributions	1,225
42 Insurance claims and indemnities	0
43 Interest and dividends	0
44 Refunds	0
99 Total obligations	1,500

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APPROPRIATION ACCOUNT: OPERATIONS, RESEARCH, AND FACILITIES
SUBACTIVITY: WEATHER AND AIR CHEMISTRY RESEARCH

NOAA proposes a change in the title of the subactivity from "Weather and Air Quality Research" to "Weather and Air Chemistry Research." This change reflects NOAA's focus on the research and monitoring of chemical processes in the atmosphere that impact the NOAA mission, including atmospheric composition, natural and human-caused emissions of gaseous and particle (aerosol) pollutants and their precursors, and deposition of nutrients and acidic compounds on coastal and other ecosystems.

The objectives of the Weather and Air Chemistry Research subactivity are to:

- Support R&D that provides the Nation with more accurate and timely warnings and forecasts of high impact weather events and their broader impact on issues of societal concern such as weather and air quality; and
- Support research that provides the scientific basis for informed management decisions about weather, water, and air quality.

Researchers at the labs and CIs have been key players in the modernization of the NWS through research to better understand severe weather events and through technological advancements in weather modeling and observing. OAR scientists strive to continually improve upon NOAA's capabilities to provide more accurate and timely warnings and forecasts of various high-impact weather, water and air quality events, such as floods, droughts, heat waves, severe storms, tsunamis and deposition of nutrients, heavy metals, and toxic organic substances to the surface of the earth. More information on this sub-activity is available at <http://www.research.noaa.gov/weather/>.

LABORATORIES AND COOPERATIVE INSTITUTES

Hurricane Research

OAR's Hurricane Research, within the Atlantic Oceanographic and Meteorological Laboratory (AOML), focuses on improving the understanding and prediction of hurricane track and intensity change through directed research with the goal of eventual transfer of these improved capabilities to NOAA's operational hurricane forecast components. AOML's hurricane research supports NOAA's long-term goal of a weather-ready nation by reducing forecast uncertainty and unnecessary evacuations that result in economic impacts to communities. NOAA research and transition efforts include:

- Coordination of NOAA's annual hurricane field program, the Intensity Forecast Experiment (IFEX), a partnership among AOML, NWS Environmental Prediction and Tropical Prediction Centers, and NESDIS, and supported by the NOAA Aircraft Operation Center's research/reconnaissance aircraft;
- Theoretical and numerical modeling research to improve hurricane forecast guidance, including the preparations of storm surge atlases and wind field diagrams;
- Analysis of data from models and field programs to improve understanding of physical processes that effect hurricane track and intensity changes;
- Providing leadership and critical assistance to the NOAA Hurricane Forecast Improvement Project (HFIP); and
- Active participation in and support of the Joint Hurricane Testbed.

Severe Storms Research

OAR's Severe Storm Research seeks to improve the accuracy and timeliness of forecasts and warnings of hazardous weather events such as thunderstorms, tornadoes, flash floods, lightning, and

winter weather. NSSL accomplishes this goal through a balanced research program that conducts research in three general areas, including severe and hazardous weather research, storm-scale hydrometeorology research, and weather radar research development. These programs aim to:

- Advance the understanding of weather processes;
- Improve and develop new forecast and warning techniques and applications and evaluate them for operational use in the Hazardous Weather Testbed (HWT);
- Transfer knowledge, techniques, and applications to NWS and other agencies;
- Develop enhancements for the NEXRAD Doppler weather radar, the cornerstone of the radar network now operated by NWS offices across the United States;
- Develop new radar technologies (e.g., dual-polarization and phased-array radar); and
- Conduct field programs that use mobile, in-situ, and remote observational capabilities to collect data that support theoretical research.

Air Chemistry Research

NOAA proposes a change in the title of this activity from "Air Quality Research" to "Air Chemistry Research." This change will eliminate confusion between the missions of NOAA and the Environmental Protection Agency (EPA). The EPA regulates air quality, whereas NOAA conducts research and monitoring to better understand the chemical processes in the atmosphere that have an impact on the NOAA mission, such as atmospheric composition, natural and human-caused emissions of gaseous and particle (aerosol) pollutants and their precursors, and deposition of nutrients and acidic compounds on coastal and other ecosystems.

OAR's air chemistry activities respond to significant societal needs. Air pollutants are a primary cause or significant contributor to a number of important societal issues. These include health impacts such as illness and/or premature death due to respiratory effects, permanent neurological damage (affecting tens of thousands of newborns annually), and environmental degradation caused by exposure to air pollutants and deposition of nutrients, mercury, and other toxic substances.

Air Resources Laboratory

ARL conducts field studies and long-term measurements and develops numerical models to address a wide range of critical air chemistry and deposition issues. ARL addresses pollutants including mercury, nitrogen oxides, smoke, and volcanic ash, which can have significant impacts on and implications for human and ecosystem health and for industrial and transportation activities. Field activities include development and evaluation of new measurement approaches, short-term field experiments to characterize key chemical and physical processes, and long-term monitoring of selected trends. ARL develops to forecast selected pollutants over the U.S. and to better understand sources and receptors of pollution. As the recent Icelandic volcano eruption demonstrated, accurate volcanic ash predictions have very large economic impacts and are essential to safe operation of aircraft. Accurate information about air chemistry trends and sources of pollution affecting key ecosystems is also required to optimize the resources spent on current and potential future air pollution controls, to inform international regulations, and to help managers assess nutrient loadings to coastal ecosystems.

ESRL – Chemical Sciences Division

The goal of the Chemical Sciences Division's research is to understand and quantify the chemical emissions of gaseous and particle (aerosol) pollutants and their precursors and the processes responsible for their transport and transformation in the atmosphere, with the aim of understanding the impacts on US air quality and ultimately climate. An integrated program of laboratory studies, intensive field experiments, and analyses is used to develop linkages between emissions and air

quality and climate impacts. The information developed provides the scientific underpinning for policy development and management decisions related to air quality.

Weather Models and Advanced Technologies

Next-generation weather model development on global and regional domains is conducted at the ESRL Global Systems Division (GSD). To improve medium-range to interseasonal forecasts, new coupled global model capabilities are developed with atmospheric, ocean, and inline chemistry components using an icosahedral horizontal grid. This global model effort improves forecasts of hurricanes and other tropical phenomena and better characterizes stratospheric-tropospheric interactions. Collaborations in this effort include research organizations and operational services such as the National Weather Service and the Navy. GSD's global modeling capability is also designed to provide an improved research tool for dynamical-chemical-hydrological-ocean-land-surface interactions. For regional domains, GSD leads in the development of very short-range, storm-resolving modeling and advanced data assimilation capabilities for severe weather watches and warnings, heavy precipitation events, water management, renewable energy production, aviation safety, transportation efficiency, and wildfire management. Next-generation ensemble-based assimilation methods at global and regional scales will result in clear improvements in global model forecast skill. GSD also investigates, develops and applies advanced technologies to optimize the high performance computing of models, to provide advanced visualization and decision aids that allow faster and more comprehensive access to critical weather information, to assess the forecast impact of meteorological observations and observing systems, and to educate current and future generations about Earth system science.

GSD is exploring alternative high-performance computing architectures to increase both computing capability and significantly reduce the cost of producing high-resolution models due to the enormous computing resources required for such models. To promote efficiency and effectiveness, high-resolution models are being developed to serve multiple purposes and users, providing significant value to commercial aviation, civilian, and military weather forecasting, energy generation, regional air and global pollution prediction, and emergency preparedness.

Tsunami Research

OAR's Tsunami Research supports the NWS Tsunami Warning Centers by conducting R&D to improve NOAA's tsunami forecasting capabilities. PMEL's Tsunami Program seeks to mitigate tsunami hazards in all the coastal states and territories through improved tsunami warnings using state-of-the-art instrument systems developed by NOAA's Center for Tsunami Research (NCTR). NCTR works closely with partner agencies, such as NWS, who has operational responsibility for the observational network of Deep-ocean Assessment and Reporting of Tsunamis (DART) systems and NESDIS, who conducts extensive data searches to construct the digital elevation models used by NCTR to develop the tsunami forecast models. The Tsunami Research Program is linked to stakeholders in coastal states through the National Tsunami Hazard Mitigation Program (NTHMP), created in 1995 to provide improved tsunami warning services to coastal communities. All states and territories, NOAA, FEMA, and the U.S. Geological Survey (USGS) are members of the NTHMP.

PMEL-developed engineering technology and numerical models have greatly improved the delivery of reliable and accurate tsunami forecasts to citizens in coastal communities. The integration of observational data from these technologies and output from the numerical models in the NOAA Tsunami forecast system has been proven effective in seventeen tsunami events since testing of this system began. During the Honshu, Japan tsunami in March 2011, the system provided very accurate forecasts of wave amplitude as shown by comparison with coastal tide gauge observations available on the PMEL tsunami webpage. R&D efforts to expand the coverage to additional communities, to improve the cost-effectiveness of tsunami-measuring buoys, and to enhance the

utility of tsunami-related products all strive to make the government a more effective service provider and helps to keep communities safe.

Unmanned Aircraft Systems

OAR's Unmanned Aircraft Systems (UAS) program is an initiative that accelerates the research, development, and transition of innovative new observational platforms and forecast tools to advance NOAA's Earth-system product, service, and information enterprise. UAS platforms represent a collaborative effort of several organizations within NOAA, including NOAA laboratories and cooperative institutes, NWS, NOS, and OMAO; as well as partnerships with NASA, DOE, and other agencies. This initiative is linked closely to the needs of multiple federal, state, and local agencies. Specific UAS applications in weather research are hurricane reconnaissance and research to help improve hurricane track and intensity forecasts; and monitoring of Pacific atmospheric river moisture transport and characteristics to help improve West Coast winter precipitation and flood forecasts.

Modeling

As part of its weather research activities, modeling activities centered at Geophysical Fluid Dynamics Laboratory (GFDL) focus on long lead-time research to understand the predictability of weather on both large and small scales and to translate this understanding into improved numerical weather prediction models. These activities improve our understanding of atmospheric circulations ranging in scale from hurricanes to extra-tropical storms and the general circulation, with an emphasis on extreme weather events and the interplay between weather phenomena and climate variability and change, using high resolution atmospheric modeling as the central tool. This effort is augmented by research to improve our understanding of the interactive three-dimensional structure of the climate system from the surface and troposphere to the upper stratosphere and mesosphere on various time and space scales. With an emerging focus on understanding the relationship between the physical climate and the Earth's biogeochemical cycles, GFDL works to understand the interactions and feedback of the earth's biosphere with its climate and assess the impact of natural variability and past, present, and future human activities, including the interplay of sea-level rise, coastal physical processes, and ecological processes and the Earth System's hydrologic cycle accounting for the interactions between the atmosphere and biosphere. This research is a key aspect of developing comprehensive Earth System models that extend current climate predictive capability to land and ocean ecosystems.

Physical Sciences

The Physics Science Division (PSD) provides NOAA with the essential core capability to conduct physical science research across time and space scales with an emphasis on extreme events in the Earth system that lead to floods, droughts, and heat waves. Examples include: (1) the role of the Hydrometeorological Testbed in elucidating the role of Atmospheric Rivers that can create flooding conditions in U.S. coastal areas and deliver water to inland basins; and (2) improving surface parameterizations in hurricane models to better represent the role of surface process such as sea spray in hurricane intensity changes. In the conduct of this research, the program advances NOAA's abilities to observe, understand, and improve the credible prediction of the behavior of the atmosphere, ocean, cryosphere, hydrosphere, land, and related impacts on global-to-local and days-to-decades timescales.

Global Monitoring and Research

The Global Monitoring Division (GMD) conducts long term observations by balloon-borne, cryogenic frost point hygrometers launched from Boulder, Colorado; Hilo, Hawaii; and Lauder, New Zealand to obtain vertical profiles of water vapor in the upper troposphere and lower stratosphere (to ~30 km). Water vapor soundings over Boulder (since 1980) provide a unique long-term data record that may reveal changes in atmospheric dynamics resulting from climate change. Water vapor is a natural and

very important component of the Earth's atmosphere. Its distribution influences many physical and chemical properties of the atmosphere, including weather, clouds, precipitation, lightning generation, convective uplift, and the Antarctic ozone hole.

Schedule and Milestones:

FY 2013

- Complete study assessing methods of providing severe weather forecast uncertainty.
- Perform case studies with Warning on Forecast/High-Resolution Rapid Refresh (WoF-HRRR model) nesting design, including new data assimilation techniques at HRRR and WoF scales.
- Determine which data assimilation methods are most accurate and cost-effective when applied to radar data at convection-resolving scales.
- Complete specification of basic components of a complete WoF system, including data conversion and quality control, ensemble initialization, storm-scale forecast model, data assimilation system, display, and diagnostic software, along with all needed computer communication packages.
- Transition Mobile Atmospheric River Monitoring System /Quantitative Precipitation Estimation (MARMS/QPE) to the National Climatic Data Center (NCDC).
- Further investigate and utilize the Dual Polarization data from the WSR-88D.
- Evaluate and document performances of the operational Dual Polarization WSR-88D radar quantitative precipitation estimation from different seasons and different geographical regions.
- High quality observations from a yearly Intensity Forecast Experiment in partnership with NWS, NESDIS, and AOC to improve hurricane track and intensity forecasts (FY 2013 – FY 2015)
- Develop and test new instrumentation, in particular a scanning microwave radiometer (HIRAD) for surface wind field estimation in partnership with NASA.
- Complete HYSPLIT-Hg model development, testing, and configuration.
- Conduct intensive field study in the southeastern United States to advance understanding of the production of secondary organic aerosol from biogenic hydrocarbon emissions.
- Conduct laboratory evaluation of ozone-depletion and greenhouse-warming potentials of an industry-proposed replacement compound.
- Validate and improve emission inventory for species important for climate and air chemistry using data from CalNex study.
- Develop and conduct two tests of observing system sensitivity analysis in each active storm using ensemble Kalman filter data assimilation system and NOAA's operational Hurricane Weather Research and Forecasting (HWRF) model. Focus will be on developing synthetic airborne Doppler radar and Lidar observations from high-resolution nature runs of hurricanes (FY 2013 – FY 2015)
- Two tests of the advanced nesting capability in each active storm for possible implementation into HWRF to enable simulations at resolutions down to 1 km with a focus on coupling the new nests with the operational ocean and wave models.
- WoF/Hazardous Weather Testbed, and Renewable Energy forecasts.
- Test one WoF component in the Hazardous Weather Testbed.
- Complete a field study of ammonia exchange between the air and agricultural land.
- Maintain current hydrometeorological testbeds in meteorologically distinct regions of the Nation (FY 2013 – FY 2016)
- Continue development of HRRR weather model using advanced data assimilation methods (FY 2013-FY 2017)
- Perform model analysis and evaluate the meteorological models (FY 2013–FY 2017)

- Upgrade GFDL Hurricane Prediction System (FY 2013 – FY 2015)
- Robust stimulations of regional climate change around the world (including tropical storms) using 25-km resolution global atmospheric model.

FY 2014

- Complete a demonstration within the Hazardous Weather Testbed of a WoF system during the severe weather season with WoF nested inside the HRRR.
- Complete report documenting major findings from VORTEX2.
- Develop a statistically-based algorithm from the WSR-88D historical reanalysis severe weather detections to identify uncertainty parameters and produce a probabilistic warning guidance prototype for severe weather.
- Incorporate Dual Polarization radar data to improve QPE
- Continue evaluation and documentation of the operational Dual Polarization WSR-88D radar QPE from different seasons and different geographical regions (FY 2014 – FY 2017)
- Integrate environmental data and develop advanced multi-sensor Dual Polarization radar QPEs for warm season.
- Perform radar data analysis to improve understanding of convective weather systems through comparisons among various radar systems and partnering with data assimilation experts.
- Continue the analyses of aerosol-cloud interactions using data from the Caribbean and the Amazon.
- Provide to stakeholders a scientific synthesis report of results from southeastern U.S. study.
- Continue analyses of climate-stratospheric chemistry interactions.
- Provide assessment of effects of complex terrain on boundary layer transport and processes.
- Incorporate surface hydrometeor types and their liquid equivalents from dual polarization radar and modify prototype flash flood system to account for different precipitation phases and their interaction with surface conditions (e.g., rain-on-snow events).
- Develop and test new instrumentation, in particular a Doppler wind Lidar (DWL) in partnership with NASA.
- Tests of advanced physics packages in each active storm for possible implementation into a HWRF to enable simulations at resolutions down to 1 km. Focus will be on air-sea fluxes and boundary layer.
- Development of initial physical formulations to incorporate soot and dust aerosol impacts on snow and ice albedo in climate models, and improved sea ice models essential to developing a predictive understanding of Arctic climate change.

FY 2015

- Complete a report documenting the readiness of WoF technology and utility of transitioning WoF functionality to operations.
- Assess the use of frequently updated national scale and local ensembles for probabilistic forecasts in the WoF context and determine methods for best communicating uncertainty in warnings to both forecasters and non-NOAA customers with help from social scientists.
- Test and evaluate a Probabilistic Hazard Information grid in the HWT based on the results of the historical reanalysis of WSR-88D and other sensor data.
- Expand HL-RDHM and QPE testbeds to other seasons/regions.
- Conduct intensive field study to advance understanding of climate-air chemistry interconnections - region TBD.
- Provide scientific assessment of the impact of aerosols on cloud systems.

- Conduct laboratory evaluation of ozone-depletion and greenhouse-warming potentials of an industry-proposed replacement compound.
- Perform radar data analysis to improve data quality and usability through signal processing improvements. Signal processing improvements may be used to identify and mitigate Wind-farm clutter and to detect tornado signatures using spectral analysis.
- Evaluate the impact of dual polarization radar data on flash flood forecasts.
- Demonstrate improved QPE accuracy for flash flood events in warm season.
- Collect ground truth data for cool season precipitation events.
- Begin integration of space-borne radar data from Global Precipitation Mission (GPM) with ground-based radar QPE to improve the QPE accuracy in the U.S. mountainous west.
- Tests of advanced physics packages in each active storm for possible implementation into HWRF to enable simulations at resolutions down to 1 km. Focus will be on microphysics and aerosol.
- Testing of HRRR Ensemble model and data assimilation system.
- Testing of an hourly-updated global Rapid Refresh data assimilation and model in preparation for NextGen mid-operational capability.
- Expand number of scientific dataset visualizations for NOAA Science On a Sphere for use by government and museum partners.
- Complete a field study of ammonia exchange between the air and agricultural land in a coastal region.
- Complete HYSPLIT-Hg simulations of the atmospheric fate and transport of mercury from global sources.
- Provide scientific synthesis report from intensive field study.
- Continue analyses of climate-stratospheric chemistry interactions.
- Improved realism of the NOAA Earth System Models by closing the nitrogen cycle, and major feedback on the global carbon cycle.

FY 2016

- Develop the initial data mining applications to identify severe weather signatures in model analyses.
- Demonstrate and test a probabilistic warning system using model assimilation analyses as a prototype for WoF.
- Improve temporal/spatial resolution of MARMS/QPE.
- Continue to maintain and develop research radar systems (NO-XP, KOUN, mobile radars) to support scientific inquiry. Maintenance and development activities include the hardware and software required to collect data, as well as the software needed to perform data analysis and display.
- Utilize storm-scale precipitation forecasts from high-resolution NWP models that assimilate radar data into flash flood forecast systems to increase lead-time.
- Continue evaluation and documentation of the operational Dual Polarization WSR-88D radar QPE from different seasons and different geographical regions.
- Transfer to operations the advanced multi-sensor Dual Polarization radar QPE techniques for warm season.
- Continue integration of space-borne radar data from GPM with ground-based radar QPE.
- Develop advanced multi-sensor Dual Polarization radar QPEs for cool season.
- Coordinate and conduct yearly Intensity Forecast Experiment in partnership with NWS, NESDIS, and AOC to collect high quality observations in support of operations and HFIP need to improve hurricane track and intensity forecasts. Continue development and testing of new instrumentation.

- Continue tests of ensemble Kalman filter data assimilation system for possible implementation in NOAA's operational HWRF. Test impact of assimilation of satellite microwave radiance data using OSSE and OSE approaches.
- Develop and test advanced physics packages for possible implementation into HWRF to enable simulations at resolutions down to 1 km. Focus will be on microphysics and aerosol.
- Complete post-HYSPLIT-Hg source-receptor analysis, GIS analysis, model evaluation ("ground-truthing")
- High-quality hurricane observations from airborne experiments for use in hurricane regional model data assimilation and evaluation, in particular dropsondes, Doppler radar, in-situ, and stepped frequency microwave radiometer (FY 2016 – FY 2017)

FY 2017 and Beyond

- Expand the number of stations feeding observations data to the Meteorological Assimilation Data Ingest System to 100,000
- Address fundamental science questions that may limit WoF utility, including effects of model error on thunderstorm evolution, needed accuracy of storm environmental conditions, and errors in conversions from model data to observational data. VORTEX2 data will assist this evaluation (2018).
- Provide NOAA management with information needed to decide whether to make WoF operational, including the total costs of going forward (2018). Conduct real-time tests of WoF system in HWT in collaboration with NWS forecasters and collect data needed to verify WoF predictions. Collaborate with NWS forecasters to evaluate WoF and develop new display capabilities for use in warning operations. Evaluate WoF predictions using rigorous verification measures and use knowledge gained to further improve WoF system (2020).
- Evaluate accuracy and lead-time improvements through the use of inputs from quantitative precipitation forecasts.
- Continue development of advanced multi-sensor Dual Polarization radar QPEs for cool season.
- Demonstrate improved QPE accuracy for flash flood events in cool season.
- Transfer to operations the advanced multi-sensor dual-polarization radar QPE techniques for cool season.
- Complete biennial regional field studies of ammonia exchange between the air and agricultural land.
- Conduct intensive field study to advance understanding of climate-air chemistry interconnections - region TBD.
- Conduct laboratory evaluation of ozone-depletion and greenhouse-warming potentials of an industry-proposed replacement compound.

Water Cycle

- Assess and document the ability of gap filling radars to augment legacy observing systems (e.g. NEXRAD) in the west to provide better precipitation and water supply information.
- Conduct field experiments (Hydrometeorology Testbed & CaWater) focused on extreme precipitation events and their role in the water cycle - required for better climate projections and forecasts for flood and water supply.
- Couple ensemble precipitation forcing to hydrological models for two key watersheds.
- Deliver a preliminary report on quality of precipitation and runoff forecasts.
- Document and coordinate model development and operations plan to increase number of communities served by stream and river forecasts for the CERIS region.

Weather and Climate Physics

- Bring SEARCH Tiksi observatory to 30 percent capacity and maintain Alert BSRN/Aerosol with GMD.
- Make public version 10 of the PSD hurricane flux algorithm.
- Generate data archive of ship and aircraft observations from participation in the NOAA/NSF DYNAMO field program in the Indian Ocean.
- Repackage W-band radar for future installation on NOAA P-3.

Deliverables:

- Report documenting the relative value of different data sources, new data assimilation and modeling techniques appropriate for use in WoF and a design to optimize WoF via nesting inside the HRRR. Report assessing the ways of providing weather forecast uncertainty.
- Report documenting the major components of a WoF system with demonstration in the Hazardous Weather Testbed of some WoF components in the pseudo-operational environment of the HWT.
- Hold a major workshop on future directions in flash flood warnings research.
- Recommendations for improvements to address seasonal biases in particulate matter forecasts.
- High-quality hurricane observations from airborne experiments for use in hurricane regional model data assimilation and evaluation, in particular dropsondes, Doppler radar, in-situ, and stepped frequency microwave radiometer.
- Observing system sensitivity analysis capability utilizing the ensemble Kalman filter data assimilation system and the improved nesting for HWRF.
- Fully coupled advanced nesting capability for testing and evaluation in the operational HWRF model system.
- Report documenting major findings of the VORTEX2 field phase.
- Report documenting the assessment of flash flood warnings effectiveness and future directions using high-resolution (<1km) and rapid update (<5min) grid of CONUS (Continental United States) mosaic QPE.
- High-quality hurricane observations from airborne experiments for use in hurricane regional model data assimilation and evaluation, in particular dropsondes, Doppler radar, in-situ, and stepped frequency microwave radiometer.
- Report documenting the impact of improved physics for air-sea fluxes and boundary layer on hurricane track and intensity forecasts using regional HWRF model system.
- Report documenting the impact of assimilating DWL and radar on hurricane track and intensity forecasts using the regional HWRF model system
- Deliver code for the Flow-following finite-volume Icosahedral Model (FIM) to NWS National Centers for Environmental Prediction as a member of a global ensemble model
- Preliminary development of a tornado debris signature algorithm using Dual Polarization radar data.
- High-quality hurricane observations from airborne experiments for use in hurricane regional model data assimilation and evaluation, in particular dropsondes, Doppler radar, in-situ, and stepped frequency microwave radiometer.
- Report documenting the impact of improved physics for microphysics and aerosol on hurricane track and intensity forecasts using the regional HWRF model system.
- Report documenting the impact of assimilation radar reflectivity on hurricane track and intensity forecasts using the regional HWRF model system.

- High Resolution Rapid Refresh (HRRR) model at NWS/National Centers for Environmental Prediction (NCEP) depending on availability of necessary high performance computing resources
- Complete evaluation of WoF predictions using rigorous verification measures and use knowledge gained to further improve the WoF system (2020).

Performance Goals and Measurement Data:

Performance Measure:	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Percent of labs that have had formal expert peer reviews in the past 5 years & were rated effective in terms of quality, mission relevance, & performance	Actual	Target	Target	Target	Target	Target	Target
	100%	100%	100%	100%	100%	100%	100%
Description: This performance measure is recognized by the National Academy of Sciences report <i>Evaluating Federal Research Programs</i> , which states “The most effective means of evaluating Federally funded research programs is expert review.”							

Hurricane Research

Performance Measure:	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Reduction in uncertainty of hurricane processes that drive track and intensity change based on high-quality observations from airborne experiments	Actual	Target	Target	Target	Target	Target	Target
	N/A	4%	6%	8%	10%	12%	14%
Description: Data collected about the hurricane environment from hurricane hunter flights during the annual field program is invaluable to increasing knowledge of how hurricanes develop, move, and intensify. As a result of research and publications based on these observations, there will be increased knowledge that will be incorporated by the hurricane modeling community, resulting in increased accuracy in hurricane models. This observation program serves as the foundation for meeting NOAA’s weather ready nation goal of reducing forecast uncertainty and unnecessary evacuations that result in economic impacts to communities.							

Performance Measure:	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Cumulative percent reduction in error of track and intensity guidance of the HWRF model system	Actual	Target	Target	Target	Target	Target	Target
	N/A	15%	20%	25%	30%	35%	40%
Description: As a result of new and exciting hurricane observing systems, improved nesting capability, and advanced physics packages applicable at 1-km horizontal resolution, hurricane track and intensity forecasts using regional HWRF model system will see a reduction in error. This improved incorporation hurricane data directly addresses NOAA’s weather ready nation goal of reducing forecast uncertainty and unnecessary evacuations that result in economic impacts to communities.							

Severe Storms Research

Performance Measure:	FY 2011 Actual	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target	FY 2017 Target
Cumulative number of severe weather events for which Warn-on-Forecast numerical predictions of tornado lead time exceeds 20 minutes	0	1	1	2	3	3	4

Description: The Warn-on-Forecast program is working to combine high resolution models with high resolution data (from radars and other observations), advanced data assimilation and quality control techniques, and high-end computing to produce a forecast of a tornado that would effectively extend tornado warning lead times well beyond the current national average of 13-14 minutes. This NWS GPRA goal shows the amount of warning the public is given for tornadoes (national average, in minutes) by NWS. NSSL conducts research that leads to improved warning skill scores (higher probability of detection, increased lead times, and reduced false alarms) through the Hazardous Weather Testbed (HWT) experiments.

Performance Measure:	FY 2011 Actual	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target	FY 2017 Target
Historical re-analysis of CONUS WSR-88D data	2	6	10	14	18	22	26

Description: This performance measure shows the cumulative number of years of the CONUS WSR-88D network that have been processed and analyzed with the MRMS system (WRDD). The re-analysis of WSR-88D data will provide storm statistics (probabilistic guidance) that can be used to better inform the public. The probabilistic guidance available from the re-analysis will also set the baseline performance measure for evaluation of Warn-on-Forecast guidance products.

Performance Measure:	FY 2011 Actual	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target	FY 2017 Target
Improvement of flash flood warning skill scores of a prototype national flash flood guidance tool	0.34	0.35	0.36	0.38	0.40	0.42	0.46

Description: This performance measure shows the improvement of the Critical Success Index (CSI) skill score (higher CSI scores show a combined higher probability of detection and reduced number of false alarms) of the prototype flash flood guidance tool compared to the operational flash flood guidance during a demonstration and evaluation in the Hazardous Weather Testbed. Improved flash flood guidance will result in more precise and timely Flash Flood warnings and benefit the public.

Air Chemistry Research

Performance Measure:	FY 2011 Actual	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target	FY 2017 Target
Cumulative number of regional assessments of atmospheric mercury source-receptor relationships	0	1	1	1	1	2	2

Description: This provides key information for air quality and environmental policy-makers and managers and for negotiators for international agreements—enabling them to effectively target mercury emissions reductions.

Performance Measure:	FY						
Cumulative number of completed field studies of ammonia exchange between the air and land	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	0	1	1	2	2	3	3
Description: This provides essential information for air quality, agriculture, and environmental policy-makers and managers to inform federal and state decisions regarding coastal water quality and habitat. It also addresses a key uncertainty in air quality models. Each study addresses different regions/land uses (e.g., fertilized farm fields, concentrated animal feeding operation) and contributes to the scientific understanding of ammonia exchange in peer-reviewed journal publications. Publications are a measure of program depth, quality, and credibility.							

Performance Measure:	FY						
Cumulative number of updates provided to NWS for the volcanic ash forecast system	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	7	8	9	10	11	12	13
Description: This provides improvements to a forecast system used to inform pilots where volcanic ash is located, enabling them to avoid in-flight catastrophes. Examples of improvements include better use of satellite observations to estimate volcano source strength and improved flexibility for configuring simulations for various types of eruptions.							

Weather Models and Advanced Technologies

Performance Measure:	FY						
Cumulative percentage improvement in accuracy (probability of detection of ceiling <1000 ft) of the 3-hour cloud ceiling for aviation forecasts	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	0%	2%	3%	4%	5%	6%	7%
Description: Better awareness of expected cloud ceiling over the next 3-hour period is critical to airline safety and aircraft take-offs and landings. Cumulative percentage improvements (approx. 1% per year) will be derived from operational implementation of a new short-range, rapidly updated model called the Rapid Refresh at NWS/NCEP and continuous updates.							

Performance Measure:	FY						
Cumulative number of major tests and evaluations of numerical weather prediction forecast system component improvements for transitioning to operational numerical weather prediction systems	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	5	10	20	30	40	50	60
Description: The multi-agency Developmental Testbed Center conducts major tests and evaluations of improvements to NWP forecast system components provided by the NWP research and operational communities. These tests and evaluations are critical for selecting proposed changes that need to be transitioned to operational centers. For example, DTC evaluations will be critical for selection of the optimal physics package used for the Weather Research and Forecast (WRF) model and the Hurricane WRF in particular.							

Performance Measure:	FY						
Cumulative number of formal expert peer-reviewed publications (from FY 2011 baseline) (Tsunami Research)	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	10	17	18	19	20	21	22
Description: The number of peer-reviewed publications is widely recognized as being critically important to the advancement of science. It reflects success in conducting research with recognized value and quality and the transfer of scientific information to the public.							

Unmanned Aircraft Systems

Performance Measure:	FY						
Conduct Unmanned Aircraft Systems (UAS) field tests – number of field tests: number of operational transition plans	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	2:1	2:1	2:1	2:1	2:1	2:1	2:1
Description: This measure reflects the ratio of the number of field tests conducted to the number that are transitioned to operational applications. Field tests (with NASA, DOE, & other agencies) focus on data collection over vast, remote areas, including the Gulf of Mexico & Atlantic (e.g., hurricane tests), Central Pacific (e.g., endangered species at the Papahānaumokuākea Marine National Monument), and Arctic (e.g., measuring changes in pack ice).							

WEATHER & AIR CHEMISTRY RESEARCH PROGRAMS

Research Programs encourage cooperation with external experts in critical fields of research. NOAA's external partners include federal, state, and local government entities, universities, and industry. Currently two primary research programs are supported under this line.

Tornado/Severe Storm Research (Multi-Function Phased-Array Radar)

NOAA is developing new technologies for detecting and forecasting severe and hazardous weather, including thunderstorms, tornadoes, flash floods, lightning, and winter storms, and for disseminating this information to emergency managers, the media, and the general public for appropriate action. Multi-function Phased-Array Radar (MPAR) has the potential to significantly extend lead times for detecting tornadoes and other forms of severe and hazardous weather. Electronically steered beams and faster scan rates can reduce the time it takes to make a complete Doppler radar observation from 4.5 minutes to less than one minute. Coupled with artificial-intelligence-based decision-support systems, tornado lead times could be increased from the current 14 minutes to over 20 minutes. By 2020 more than 350 FAA radars and by 2025 nearly 150 weather radars will need to be either replaced or have their service life extended. If MPAR is successful and implemented as a replacement radar, estimated multi-agency savings could total \$4.8 billion in acquisition costs (\$1.8 billion if replacing all existing radars with similar technology) and life cycle costs over 30 years (\$3.0 billion due to fewer radars) (Federal Research and Development Needs and Priorities for Phased Array Radar FCM-R25-2006).

The MPAR program is jointly funded by NOAA and the FAA, and both agencies are coordinating their budget requests. Polarization is not currently available on phased array radars, but is a requirement for NWS to ensure no degradation of service. FAA contributes funding to joint effort to fulfill its requirement for airport terminal weather and aircraft tracking. It is important that the leading agencies continue a joint risk-reduction R&D program given the potential for savings, complexity of

the mission, the technology involved, agency go/no-go decision points, and the long lead times required for interagency acquisition times. Congress established a joint R&D program for NOAA, DOD, and FAA to investigate the feasibility and benefits of using military phased- array radars for improving severe weather forecast and warning systems.

U.S. Weather Research Program (USWRP)

Through its U.S. Weather Research Program (USWRP), NOAA seeks to improve weather and air chemistry forecast information and products by funding, facilitating, and coordinating cutting-edge research to improve weather and air chemistry predictions to protect lives and property of the American public and inform weather sensitive U.S. industry. USWRP works in close collaboration with NWS scientists and OAR academic partners to transition this research into useful weather and air chemistry applications. The USWRP supports societal impact studies in weather and a set of related program projects to provide outreach, linkage, and coordination among NOAA, other government agencies, and the academic and private sectors, both in the U.S. and abroad. Within NOAA, the Office of Weather and Air Quality (OWAQ) Program manages the overall USWRP effort in support of research for air quality forecasting, societal benefits, and related weather research through projects with such internal and external partners as the National Center for Atmospheric Research (NCAR) and NOAA's cooperative institutes. USWRP project activities include weather testbeds, high-resolution numerical model development, weather research partnership projects, and socio-economic research.

- Testbeds provide an infrastructure where the latest research findings and techniques are continuously tested by scientists and evaluated by operational weather forecasters. Testbed funding provides support for managing the testbed activities as well as research conducted within the testbed. Testbeds serve as an effective means of demonstrating the value of research results to operational forecasters at the NWS by providing an environment in which the computer hardware and software used by forecasters is used in evaluating the utility of research results. These testbeds allow for an accelerated transfer of research results into operations.
- High-resolution numerical models are required to support better weather and flood forecasting. OWAQ supports Federal and university partnerships that are needed to develop techniques to quickly incorporate observations from radar (both operational and experimental), satellite, and other sources into models. USWRP will improve existing computer models and develop techniques to produce detailed, probabilistic forecasts in collaboration with the NWS so the users of this information understand the uncertainty associated with the forecast and can make more informed decisions.
- Partnership Projects ensure that research is specifically focused on the needs of forecasters at the NWS. USWRP funds competitive two-year academic-NOAA research partnership projects. The projects often take place outside of the testbed environment because of geographical limitations of the forecaster and/or the researcher. The requirement of an academic-NOAA forecaster partnership ensures that the project will benefit from the expertise in the academic community as well as the experience of NOAA forecasters, and have a direct pathway into NWS operations.
- Socioeconomic Research is necessary to ensure that USWRP research incorporates societal needs for weather forecasts. This research provides information about the economic value of weather research, as well as understanding how society uses and interprets weather information. Socioeconomic research also provides information about improving the communication of weather information to the public.

Schedule and Milestones:

FY 2013

- Complete FY 2013 weather data collection with the National Weather Radar Testbed phased-array radar (NWRT PAR) to increase the sample size of tornadic and non-tornadic storms in support of PAR research.
- Complete test of components needed to display full-temporal and degraded temporal resolution PAR data in AWIPS-2 using both real time and simulated data.
- Complete fabrication, testing, and connection of 1-dimensional array consisting of dual pol panels or complete simulation of multi-panel array (up for negotiation with FAA).
- Continue the Phased-array Radar Innovative Sensing Experiment (PARISE) in the NOAA Hazardous Weather Testbed. During PARISE, data will be collected on forecaster decision making in a simulated real-time environment to assess the impact of radar sampling time on the warning decision process.

FY 2014

- Complete FY 2014 weather data collection with the National Weather Radar Testbed phased-array radar (NWRT PAR) to increase the sample size of tornadic and non-tornadic storms in support of PAR research.
- Complete fabrication, testing, and connection of 2-dimensional array of dual pol panels or complete simulation of 2-dimensional multi-panel array (up for negotiation with FAA).

FY 2015

- Complete FY 2015 weather data collection with the National Weather Radar Testbed phased-array radar (NWRT PAR) to increase the sample size of tornadic and non-tornadic storms in support of PAR research.
- Complete study indicating the MPAR can support both weather surveillance and aircraft tracking functions (Multi-function) simultaneously.

FY 2016

- Complete FY 2016 weather data collection with the National Weather Radar Testbed phased-array radar (NWRT PAR) to increase the sample size of tornadic and non-tornadic storms in support of PAR research.
- Complete research with social scientist on the Phased-array Radar Innovative Sensing Experiment (PARISE) in the NOAA Hazardous Weather Testbed. Complete submission of findings for publication in refereed journal.
- Complete observational case studies of tornadic storms to investigate the importance of sampling time on understanding storm evolution to be submitted for publication.

FY 2017

- Simulation of full array using computer-based models.

Deliverables:

- Joint Hurricane Testbed will evaluate 5 scientific findings per year through FY 2016 for possible inclusion in the tool kit for operational forecasters to use in the forecasting of hurricanes.
- Hydrometeorology Testbed will conduct one field study per year through FY 2016.
- Improved Numerical Weather Models – Test two or more major capability changes in the numerical weather model physics, data set assimilation, or model resolution reduction per year in one of NOAA’s research or operational centers.
- Test/evaluation of dual-polarization panel characteristics and performance.
- Report summarizing MPAR’s potential service improvements.
- Contract out design and fabrication of dual-polarized PAR sub-array antenna with FAA.
- Test/evaluation of dual-polarization sub-array antenna characteristics and performance.
- Participate in FAA’s Investment Analysis Readiness Decision (IARD)

- Define requirements for joint FAA/NOAA MPAR Prototype.
- Publication of research results demonstrating improved tornado warning decision performance produced in collaboration with NWS forecasters within the NOAA hazardous weather testbed (HWT).
- Studies completed to assess MPAR dual-polarized antenna array configurations for both weather (NOAA weather and FAA airport terminal weather mission) and air surveillance operations (FAA mission)

Performance Goals and Measurement Data:

MPAR

Performance Measure:	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Number of major milestones completed to support NOAA and FAA decision point.	Actual	Target	Target	Target	Target	Target	Target
	0	3	7	9	11	14	15
Description: Cumulative number of successfully completed major milestones within Phased Array Radar Risk Reduction Activity such that NOAA and FAA have the information needed to make a Go/No-Go decision on whether to replace existing radar systems with MPAR.							

Performance Measure:	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Cumulative number of events demonstrating improved tornado warning decision performance.	Actual	Target	Target	Target	Target	Target	Target
	1	2	3	3	5	5	7
Description: Cumulative number of events demonstrating improved tornado warning decision performance (e.g. longer lead-times, fewer missed events, fewer false alarms, etc.) using the NWRTP Phased Array Radar data compared to the WSR-88D-like data in matched studies within the Hazardous Weather Testbed.							

USWRP

Performance Measure:	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Joint Hurricane Testbed (JHT) Evaluations	Actual	Target	Target	Target	Target	Target	Target
	10	10	4	4	4	4	4
Description: Evaluation of new scientific findings or development of forecaster tools for potential use in operations that will lead to improved tropical cyclone analysis and prediction. Annually, university and federal scientists receive competitive funding to conduct research that will improve tropical cyclone forecasts. In collaboration with NOAA scientists, the knowledge and tools obtained from these studies are tested and transitioned into NOAA forecast operations.							

Performance Measure:	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Hydro – meteorology Testbed (HMT) Field Studies	Actual	Target	Target	Target	Target	Target	Target
	1	1	1	1	1	1	1
Description: Conduct a field study with experimental data collections, scientific evaluation, and consult with operational forecasters on how to improve flood forecasting.							

Performance Measure:	FY						
Improved Numerical Weather Model Changes or Tests	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	2	2	1	1	1	1	1
Description: Make changes to the physical parameterization of experimental forecast models and address the uncertainties in numerical weather predictions. This contributes to the improvement of the 1-5 day weather forecasts for the U.S.							

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PROGRAM CHANGES FOR FY 2013:

Weather & Air Chemistry Research Labs & Cooperative Institutes: Wind Boundary Layer Research to Support Improved Forecasts (Base Funding: \$0 and 0 FTE; Program Change: +\$855,000 and 0 FTE): NOAA requests an increase of \$855,000 and 0 FTE for a total of \$855,000 and 0 FTE for wind boundary layer research to advance weather forecast quality and accuracy and to provide essential information to the clean energy industry.

Proposed Actions:

NOAA proposes to improve the Nation's understanding of the atmospheric phenomena driving and determining boundary layer winds. Much of what we know now about wind is very low to the ground and at altitudes where aircraft fly and storms occur. Very little is known about the wind at mid-altitudes, the heights in which we deploy wind turbines. A better understanding of those mid-level altitudes will allow us to advance weather forecast quality and accuracy and allow for more accurate predictions of wind power production. To achieve this end, the following two actions are proposed:

1. Deploy wind test beds. To improve short-term operational predictions, NOAA will deploy wind test beds in different regions of the Nation. Regional testbeds are needed because different factors that influence weather, including wind speeds and wind direction, can vary by region. Testbeds will be deployed in two of the following regions, to be determined based on priority and lease availability: the Pacific Northwest, offshore along the Atlantic Coast, the Appalachian region, the inter-mountain west, and California. These test beds will help determine the optimal mix of instrumentation needed for wind resource characterization and forecast improvement. NOAA will perform scientific analyses and develop Numerical Weather Prediction (NWP) models using the data collected at the test beds.

These test beds will be comprised of standard instruments for obtaining wind measurements, such as wind profiling radars and sodars (sound detection and ranging to measure wind profiles). In addition, a pulsed Doppler-lidar (light detection and ranging technology) system will be purchased and adapted for remote operation and read-out. The lidar data will be especially valuable in the post-project analysis of times when the forecasts were wrong, for model initialization during research model runs to diagnose and improve model performance, and for verification of model output.

2. Improve the HRRR weather model. Additional operational observations will be obtained and assimilated into the High-Resolution Rapid Refresh (HRRR) weather model. NOAA will leverage high performance computing investments that the agency has already made to facilitate improved NWP forecasts. The additional observations collected at the test beds will be used to initialize the HRRR model and equip it with more accurate initial values of weather parameters so that it can produce a more accurate forecast of wind speeds and direction. Even a small improvement in wind *speed and direction* forecast accuracy will result in a very large improvement in the accuracy of our wind *power* prediction because an increase in wind speed increases the amount of wind power produced that is equal to the cube of the wind speed.

Funding in FY 2013 will go toward leases; deploying, maintaining and operating the instruments; modeling, data analysis and forecast verification; and high performance computing. Specifically, \$300,000 will be used for purchasing instrumentation, and the remaining \$550,000 will be used to get site leases and to deploy, maintain and operate the first test bed.

NOAA will provide key information to assess the operational observations needed for wind resource characterization and forecast improvement. Recognizing that advances are being made in observing system simulation experiments (OSSEs), NOAA will review the state of the art in OSSEs and will assess the viability of using OSSEs to inform our assessment of an adequate observing system.

Statement of Need and Economic Benefits:

Improved weather predictions will allow the Nation to obtain larger amounts of energy from renewable resources, use current energy sources more efficiently (i.e., fossil fuels and nuclear energy), reduce the cost of renewable energy, and improve grid stability. There are two main reasons that more accurate forecasts of winds will save money. First, improved wind predictions will reduce the “wind-integration cost” levied on wind energy that is based primarily on the fact that wind is a variable energy source (not dispatchable) and there are inaccuracies in predictions of wind energy across given time periods. Improved forecasts of winds and the resulting increases in accuracy of predicting wind energy production will lower wind-integration charges. Second, improved forecasts of winds will allow grid operators to use smaller amounts of fossil fuel reserves. Once grid operators have more confidence that wind farm operators can deliver the amount of wind energy they schedule (promise) to provide in the next few hours and in the next 24 hours, operators will not have to keep as many spinning and operational reserves on-line and ready to compensate for errors in wind energy forecasts. These improvements in observations and predictions are necessary before renewable energy can provide a significant portion of the total U.S. energy supply. Providing weather observations and predictions is a core NOAA mission, and OAR is well positioned to perform this research to develop improved operational forecasts that will benefit the renewable energy industry.

Additionally, this initiative will contribute to improvements in other weather applications, such as aviation forecasts, as well as fire weather, air quality, severe weather, and dispersion predictions for the release of hazardous materials into the atmosphere.

Base Resource Assessment:

Currently no base resources are dedicated to this effort.

Schedule and Milestones:

- Purchase a pulsed Doppler-lidar (light detection and ranging technology) system and adapt for remote operation and read-out (FY 2013).
- Deploy and operate test bed in meteorologically distinct regions of the nation (FY 2014 and FY 2016).
- Improve HRRR weather models (FY 2014-FY 2017).
- Perform model analysis and evaluate the meteorological models (FY 2014-FY 2017). This work continues in FY 2015 and FY 2017 without additional test beds in those years.
- Ingest and assimilate additional observations, e.g., from wind farms, to improve weather forecast model output (FY 2013-FY 2017).

Deliverables:

- Improved research-grade weather forecast capability designed for transition to operations.
- An assessment of the optimal mix of instrumentation needed for wind resource characterization and forecast improvement, for consideration in developing a national network for wind energy.

Performance Goals and Measurement Data

Performance Measure:	FY						
Number of Wind Test Beds Established (yearly)	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
With Increase	N/A	N/A	0	1	0	1	0
Without Increase	N/A	N/A	0	0	0	0	0

Performance Measure:	FY						
Cumulative improvement in accuracy of forecasted wind speed and direction and accuracy of forecasted timing, amplitude, and duration of wind-ramp events (in test bed regions)	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
With Increase	N/A	N/A	0%	2%	3%	4%	5%
Without Increase	N/A	N/A	0	0	0	0	0

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Office of Oceanic & Atmospheric Research
Subactivity: Weather and Air Chemistry Research

Object Class	2013 Increase
11 Personnel compensation	
11.1 Full-time permanent	\$0
11.3 Other than full-time permanent	0
11.5 Other personnel compensation	0
11.8 Special personnel services payments	0
11.9 Total personnel compensation	0
12 Civilian personnel benefits	0
13 Benefits for former personnel	0
21 Travel and transportation of persons	5
22 Transportation of things	5
23.1 Rental payments to GSA	0
23.2 Rental Payments to others	6
23.3 Communications, utilities and miscellaneous charges	4
24 Printing and reproduction	0
25.1 Advisory and assistance services	0
25.2 Other services	5
25.3 Purchases of goods & services from Gov't accounts	0
25.4 Operation and maintenance of facilities	0
25.5 Research and development contracts	275
25.6 Medical care	0
25.7 Operation and maintenance of equipment	0
25.8 Subsistence and support of persons	0
26 Supplies and materials	0
31 Equipment	300
32 Lands and structures	0
33 Investments and loans	0
41 Grants, subsidies and contributions	255
42 Insurance claims and indemnities	0
43 Interest and dividends	0
44 Refunds	0
99 Total obligations	855

Weather and Air Chemistry Research Laboratories and Cooperative Institutes (Base Funding: 201 FTE and \$54,285,000; Program Change: 0 FTE, \$171,000): NOAA requests an increase of \$171,000 and 0 FTE for a total of \$54,456,000 and 201 FTE to continue research activities within its Weather and Air Chemistry Research Laboratories Cooperative Institutes program.

Proposed Actions:

NOAA has a long history of key discoveries and development of better models and more accurate predictions and observing systems, most of which ultimately make critical contributions to the operations of the National Weather Service and private forecast groups. It is no exaggeration to say that, in large part, our Nation's improvement in weather forecasts and warnings over the past several decades has its origin within the NOAA weather and air chemistry labs and their extramural partners.

These labs continually focus their resources on the most productive avenues of research, and will use this increase for weather and air chemistry activities, including improving hurricane track and intensity forecasts, monitoring and modeling the transport of airborne pollutants, creating advances in global positioning system meteorology data, improving the NEXRAD radar, researching storm-electrification and hydrometeorology, implementing NOAA's "Warn-on-Forecast" program, and using unmanned aerial systems for weather data collection.

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Office of Oceanic and Atmospheric Research

Subactivity: Weather and Air Chemistry Research

Object Class	2013 Increase
11 Personnel compensation	
11.1 Full-time permanent	\$0
11.3 Other than full-time permanent	0
11.5 Other personnel compensation	0
11.8 Special personnel services payments	0
11.9 Total personnel compensation	0
12 Civilian personnel benefits	0
13 Benefits for former personnel	0
21 Travel and transportation of persons	0
22 Transportation of things	0
23.1 Rental payments to GSA	0
23.2 Rental Payments to others	0
23.3 Communications, utilities and miscellaneous charges	0
24 Printing and reproduction	0
25.1 Advisory and assistance services	0
25.2 Other services	0
25.3 Purchases of goods & services from Gov't accounts	0
25.4 Operation and maintenance of facilities	0
25.5 Research and development contracts	0
25.6 Medical care	0
25.7 Operation and maintenance of equipment	0
25.8 Subsistence and support of persons	0
26 Supplies and materials	0
31 Equipment	0
32 Lands and structures	0
33 Investments and loans	0
41 Grants, subsidies and contributions	\$171
42 Insurance claims and indemnities	0
43 Interest and dividends	0
44 Refunds	0
99 Total obligations	171

The following exhibit shows the summary object class detail for the Weather and Air Chemistry program changes less than \$100,000. Please contact the NOAA budget office if details for any of these changes are required.

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Office of Oceanic and Atmospheric Research
Subactivity: Weather and Air Chemistry Research

Object Class	2013 Increase
11 Personnel compensation	
11.1 Full-time permanent	\$0
11.3 Other than full-time permanent	0
11.5 Other personnel compensation	0
11.8 Special personnel services payments	0
11.9 Total personnel compensation	<u>0</u>
12 Civilian personnel benefits	0
13 Benefits for former personnel	0
21 Travel and transportation of persons	0
22 Transportation of things	0
23.1 Rental payments to GSA	0
23.2 Rental Payments to others	0
23.3 Communications, utilities and miscellaneous charges	0
24 Printing and reproduction	0
25.1 Advisory and assistance services	0
25.2 Other services	0
25.3 Purchases of goods & services from Gov't accounts	0
25.4 Operation and maintenance of facilities	0
25.5 Research and development contracts	0
25.6 Medical care	0
25.7 Operation and maintenance of equipment	0
25.8 Subsistence and support of persons	0
26 Supplies and materials	0
31 Equipment	0
32 Lands and structures	0
33 Investments and loans	0
41 Grants, subsidies and contributions	45
42 Insurance claims and indemnities	0
43 Interest and dividends	0
44 Refunds	0
99 Total obligations	<u>45</u>

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APPROPRIATION ACCOUNT: OPERATIONS, RESEARCH, AND FACILITIES
SUBACTIVITY: OCEAN, COASTAL, AND GREAT LAKES RESEARCH

The objectives of the Ocean, Coastal, and Great Lakes Research subactivity are to:

- Improve the protection, restoration, and management of coastal and ocean resources;
- Monitor ocean, coastal, and Great Lakes ecosystems, including coral;
- Support ecosystem modeling and forecasting;
- Encourage technology transfer and efficient resource management; and
- Increase the pace of discovery in unknown and poorly known areas of the world's oceans.

To achieve these objectives, OAR conducts research and monitoring activities that support ecosystem management. This includes research to analyze ecosystem management decisions; integrated observing and data management systems; outreach and education to improve public understanding and use of coastal and marine resources; partnerships for place-based ecosystem approaches to management; and international diplomacy, negotiation, and partnerships. More information on research in this sub-activity is available at <http://www.research.noaa.gov/oceans/>.

Ocean, Coastal and Great Lakes Research develop innovative management tools through a better understanding of our ocean, coastal, and Great Lakes habitats and resources. The research serves to increase understanding of coastal and marine processes for the purpose of protecting and restoring ecosystems. Efforts include predicting, monitoring, and mitigating the effects of change on ecosystems over time (e.g., invasive species, human activities such as energy production, land-based sources of pollution, climate change) and gaining a better understanding of the current state of those systems in order to help decision makers manage the resources.

LABORATORIES AND COOPERATIVE INSTITUTES

Great Lakes Research consists of integrated, interdisciplinary environmental research in support of resource management and environmental services in coastal and estuarine waters with a primary emphasis on the Great Lakes. The Great Lakes Environmental Research Laboratory (GLERL) performs field, analytical, and laboratory investigations to improve understanding and prediction of biological and physical processes in estuaries and coastal areas and their interdependencies with the atmosphere and sediments, such as water level changes, erosion, etc. GLERL emphasizes a systematic approach to problem-oriented research to develop environmental service tools. Included in the research conducted at GLERL is Long-Term Ecological Research (GLERL-LTER), which integrates a core set of long-term observations on biological, chemical, and physical variables with process-based studies that will be used as the foundation for developing new concepts and modeling tools to explore impacts of environmental stressors (e.g., invasive species, climate change, nutrient loading, overfishing) on the Great Lakes ecosystem. The program is built around: (1) long-term observations of ecosystems and their dynamics; and (2) focused process studies that allow understanding of the impacts of stressors such as climate and invasive species on ecosystem structure and function. The observations and process studies are being used for the development of models and forecasting capabilities, and to inform management decisions.

GLERL has collected over 30 years of biological, chemical, and physical data from sites in southern Lake Michigan. These databases and active observation networks provide a means to understand changes in the physical environment, and to evaluate biological trends in the context of natural variation. In addition, the Great Lakes Earth System Model (GLESIM), developed at GLERL, is a series of coupled models to explore the interactions and impacts of five subsystems: regional climate, surface hydrology, hydrodynamics, lake ice, and aquatic ecosystems. The model will be

used for ecological forecasting which predicts the effects of biological, chemical, physical, and human-induced changes on ecosystems and their components. The GLESM can inform decisions about how to respond to extreme natural events like storms, how to deal with human impacts from such things as storm water runoff and oil spills, and how best to manage resources such as recreational fisheries. Finally, the GLERL Observation Systems (GOS) team is developing new remote sensing products, observing platforms, and instrumentation to continuously improve NOAA's observational capabilities in the Great Lakes region. New and innovative sensors, sensor deployment systems, and data management techniques are providing data and information needed to improve our understanding of regional ecosystems in all of the Great Lakes, in order to provide decision support for regional resource managers. The observation systems also contribute to forecast model research and support NOAA goals under the U.S. Integrated Ocean Observing System (IOOS).

The **Vents Program** at PMEL conducts ocean exploration and research directed toward understanding and predicting large-scale oceanographic processes and consequences of submarine volcanism and hydrothermal activity. Since the chemistry of the ocean is a result of these processes, they affect all marine ecosystems to some degree. The Vents Program seeks to understand how submarine volcanic and hydrothermal processes create and sustain both living and non-living marine resources. Understanding natural, large-scale ocean environment forcing functions that impact marine ecosystems leads also to discovering and quantifying how such processes are involved in the creation of both biological (e.g., enzymes and metabolites derived from microorganisms living in extreme environments), mineralogical (e.g., rare and precious metals), and process-driven marine resources (e.g., sources and sinks for critical ocean nutrients). A new discovery has led to a third programmatic emphasis: understanding how submarine volcanic and hydrothermal activity contributes to the budgets and cycles of CO₂ in the marine environment. These processes may be relevant factors in ocean acidification and air-sea exchanges of this CO₂.

Ecosystems Fisheries Oceanography Coordinated Investigations (Eco-FOCI) is a collaborative research effort by scientists at PMEL and the Alaska Fisheries Science Center to improve the understanding of the productive ecosystems in the Gulf of Alaska, Bering Sea, and Arctic waters, which support economically valuable fisheries (e.g. pollock, shellfish, and salmon). This research provides predictions and forecasts to the North Pacific Fishery Management Council (NPFMC) which is responsible for allocating fish landings by commercial fishermen. EcoFOCI is part of the Eastern Bering Sea Ecosystem Synthesis Team that provides an annual ecosystem assessment report card, including 10 key ecosystem indicators for the Bering Sea, to the NPFMC. EcoFOCI research supports two integrated ecosystem research programs in the Bering Sea and Gulf of Alaska (physics through human dimensions) that form the basis for two Integrated Ecosystem Assessments (IEAs). EcoFOCI supports other agency missions by providing a platform on biophysical moorings for equipment such as CO₂ sensors and passive listening devices for marine mammals.

The **Integrated Coral Observing Network (ICON) Program** at AOML acquires and integrates near real-time data from in situ, satellite, radar and other data sources at important U.S. and international coral reef ecosystems. These integrated data are utilized to compose ecological forecasts for Marine Protected Area (MPA) managers and researchers to understand and predict coral reef ecosystem response to environmental change, such as coral bleaching, ocean acidification, harmful algal blooms, ocean current shifts, spawning, migration, and other marine phenomena. These growing and highly intensive temporal (hourly) data sets, currently collected from over 120 sites from around the world, are being utilized to establish status and long-term trends against which to measure climate change, and provide information essential for sound management decisions and long-term planning. With a diverse scientific staff of oceanographers and marine biologists, AOML is able to use multi-disciplinary approaches to improve NOAA's management activities and support NOAA's

goals for healthy oceans and the generation of resilient coastal communities, thereby maximizing ecosystem health and economic yield.

Ecosystem Research and Modeling conducts observational research and modeling to assess the impact on marine ecosystems, and human and animal health from land-based sources of pollution and water use practices. Efforts include analysis of oceanographic, nutrient, and microbiological data in order to enable management decisions that protect coastal and marine ecosystems. Scientists work in cooperation with other NOAA Line Offices, other Federal, state, and local authorities (including the EPA and U.S. Army Corps of Engineers), and academia to maximize research capability and results. For example, research and modeling efforts contribute to an integrated ecosystem assessment (IEA) for the South Florida ecosystem restoration that will evaluate remediation efforts and continue to guide the management process for that critical habitat restoration. NOAA's ecosystem research includes development of sensors for ocean chemistry, nutrient detection, microbial species identification (particularly for pathogen detection), and development of data and models that can be used in coastal marine spatial planning, assessment of biodiversity, and in advanced water quality monitoring programs. NOAA's work with regional, national, and international partners is aimed at integrating ecosystem data into management decisions and improving the representation of biological and chemical properties in the suite of parameters included in ocean observation systems.

Schedule and Milestones:

FY 2013

- Conduct ecological forecasts and compile long-term data sets for 120 sites in the ICON (annually through 2017).
- Conduct monthly cruises for monitoring of nutrients and microbes in the coastal zone impacted by treated wastewater and inlet discharges in coastal Florida waters (annually through 2017).
- Establish long-term complementary data sets coincident with each reef-based ocean acidification observing platform (annually through 2017).
- Develop a watershed-coupled Great Lakes Ice-circulation Model that includes all five lakes, and both biological and nutrient components.
- Develop and test community and food web models to assess the potential future biological invaders on Great Lakes ecosystems.
- Conclude synthesis phase of the Bering Sea Integrated Ecosystem Research Program and begin development of an integrated ecosystem assessment.
- Complete field research in the Chukchi Sea (sponsored by DOI/BOEM) consisting of moorings and hydrographic surveys of the water column to determine the relationships among climate change, ice thickness, and biological productivity.
- Complete second field year for the Gulf of Alaska Integrated Ecosystem Research Program in coordination with the North Pacific Research Board and State of Alaska.
- Perform data analysis and evaluation of models for IPCC Assessment Report on Arctic (including Bering Sea) sea ice and temperature, and complete Fifth Assessment Report (IPCC AR5) (annually through 2017).
- Incorporation of NeMO seafloor observatory sensors and systems into the NSF-sponsored Ocean Observatories Initiative cabled observatory.
- Initiate collaboration to acquire time series, *in situ* data from CO₂ venting systems at Eifuku Volcano, Mariana Arc using the site as a natural laboratory for ocean acidification research.
- Partner with the OER for the purpose of conducting the fourth year of the US/Indonesia INDEX partnership. The principal activity will be OER-sponsored Vents participation in an

exploratory expedition to an area contingent on results from the FY2012 expedition (annually through 2014).

FY 2014

- Publish first Synthesis of Arctic Research theme section/special issue.
- Analysis and synthesis of field work in the Chukchi Sea (sponsored by DOI/BOEM) consisting of moorings and hydrographic surveys of the water column to determine the relationships among climate change, ice thickness, and biological productivity (annually through 2016).
- Analysis and synthesis of Gulf of Alaska Integrated Ecosystem Research Program in coordination with the North Pacific Research Board and State of Alaska.

FY 2015

- Ecosystem assessment for the Gulf of Alaska synthesis phase.
- Produce a synthesis of deep volcanic eruption results to provide NOAA and the ocean science community with a quantitative global perspective of both short- and long-term marine ecosystem impacts of deep volcanic, and associated hydrothermal, activity.

FY 2016

- Publish second Synthesis of Arctic Research theme section/special issue.

Deliverables:

- A continuous annual hourly data compilation at Laolao Bay, Saipan for utilization by Saipan's Coastal Resources Management division in characterizing the bay's ecosystem dynamics.
- Four annual characterizations of coastal marine ecosystem sites to support management needs.
- Low-oxygen warning systems will be deployed and real-time results provided to water intake managers, protecting the drinking water quality of over two million coastal Lake Erie residents.
- Vessel-based measurements and other observing systems in the Great Lakes will provide data for satellite ground-truthing. GLERL modeling and ecosystems research, regional resource management, and public safety and recreation.
- Improved forecast of timing for next eruption at the NeMO seafloor observatory site.
- Data and results from numerical models from the Ecosystem Observations in the Chukchi Sea made available to stakeholders and the general public for the purpose of understanding climate change, ecosystem shifts, and potential impacts on oil-development in the Chukchi Sea. (2013, 2014)
- An annual, synthetic, ecosystem-based assessment of the eastern Bering Sea published in the Ecosystem Considerations Chapter of the Stock Assessment and Fishery Evaluation reports delivered to the NPFMC.
- Bering Sea Integrated Ecosystem Research Program special issue, with at least 5 papers authored or co-authored by EcoFOCI scientists, published in an appropriate peer-reviewed journal. (2013)
- Gulf of Alaska Integrated Ecosystem Research Program special issue published in an appropriate peer-reviewed journal. (2014, 2015)
- Two special issues on the Synthesis of Arctic Research (SOAR) published in peer-reviewed journals and information delivered to stakeholders via internet, media, and Native village outreach. (2014, 2016)

- Annual Arctic Report Card and outreach video: <http://www.arctic.noaa.gov/reportcard/>
- Fifth Assessment Report for the Intergovernmental Panel on Climate Change (IPCC) and annual analysis of IPCC data. (2013)
- Coupled trophic model for use in ecosystem assessments for the Bering Sea. (annual)
- Maintenance of the Bering Sea Climate and Ecosystem Observational Network including daily, year-round data contributed to long-term time series from 4 moored arrays in the Bering Sea and at least 5 arrays in the Chukchi Sea. (Annual)
- New/improved ship, seafloor *in situ*, and autonomous systems and sensors
- Updated and more precise forecast of timing for the next eruption at the NeMO and OOI seafloor observatory site in the caldera of Axial Volcano.
- Interdisciplinary quantitative data pertaining to short- and long-term impacts of submarine volcanic activity on marine ecosystems.
- Synthesis of results from Vents contributions to the US/Indonesia INDEX partnership (which will be integrated with an OER synthesis).
- Annual data and results from NOAA's exclusive access to the US Navy's SOSUS arrays as well as the deployable arrays of NOAA hydrophone assets.
- Data from NOAA Vents physical and chemical sensors deployed on the OOI NE Pacific cabled observatory made available in real-time to users.
- Annual data and scientific results Vents sensors and systems on the OOI cable to Axial Volcano.
- Annual data and science results ocean acidification measurements and experiments at Eifuku Volcano
- Automated and validated ecological forecasts of coral bleaching as a result of data integration through the ICON program. Historical field observations and ecosystem forecast models will be used to develop web-based products that forecast coral bleaching events.

Performance Goals and Measurement Data:

Performance Measure:	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Percent of labs that have had formal expert peer reviews in the past 5 years and were rated "effective" in terms of quality, mission relevance, and performance	Actual	Target	Target	Target	Target	Target	Target
	100%	100%	100%	100%	100%	100%	100%
Description: This performance measure is recognized by the National Academy of Sciences report <i>Evaluating Federal Research Programs</i> , which states that "The most effective means of evaluating federally funded research programs is expert review."							

Performance Measure:	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Number of decision support tools developed and effectively implemented to routinely inform ecosystem-based management decisions	Actual	Target	Target	Target	Target	Target	Target
	N/A	4	8	10	14	16	18
Description: This performance measure is used to determine the efficacy of incorporating the most up-to-date science into ecosystem-based management decisions made to guide south Florida ecosystem restoration. These decision support tools are developed primarily from routinely collected oceanographic and meteorological data. This includes the use of data collected by regular							

monitoring cruises to characterize the following four sites: FL Bay, FL Keys Reef Tract, SW FL Shelf and the SE Florida Coral Reef Tract. This performance measure helps to fulfill NOAA's mandates with respect to the South Florida Ecosystem Restoration Program and the Comprehensive Everglades Restoration Plan as mandated by the Water Resources Development Acts of 1996, 2000, and 2007.

Performance Measure:	FY						
Percentage of coral bleaching events successfully forecasted at monitored sites that support management decisions	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	N/A	78%	80%	82%	84%	86%	88%

Description: This performance measure is for the continued improvement and production of coral bleaching forecasts used to identify events and support management decisions. Forecasts are developed using oceanographic data from in-situ sensors at US sites and validated in the field by host site collaborators. By comparing observations of bleaching with predictions made, the hit rate and false alarm rate of predictions can be calculated. The hit rate and false alarm rate are used to compute the Peirce Skill Score (PSS), a quantitative and objective metric. This metric can be used to compare different predictive techniques and measure improvements.

Performance Measure:	FY						
Cumulative number of coastal, marine, and Great Lakes ecosystem sites adequately characterized for management	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	5	7	9	10	12	14	15

Description: This performance measure is for development and validation, by GLERL, of a harmful algal bloom warning system from real-time results provided to water intake managers protecting the drinking water of over 2 million coastal Lake Erie residents. *Microcystis aeruginosa* is the dominant bloom-forming, toxic cyanobacterium occurring in the Great Lakes. Preliminary studies have verified the presence of the cyanotoxin, microcystin in Lake Erie near water intake systems. In particular, microcystin concentrations have exceeded the recommended limit of 1 µg/L for drinking water (World Health Organization, 1998).

Performance Measure:	FY						
Cumulative number of coastal, marine, and Great Lakes ecosystem sites adequately characterized for management	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	2	2	4	6	8	10	12

Description: This performance measure is for development and validation of food-web forecasts used to identify impacts of invasive species on Great Lakes ecosystems and to support management decisions for state and regional resource managers. Recent dramatic changes have alarmed water quality and fishery managers, including: a return of nearshore blooms of *Microcystis* (a hazardous cyanophyte); proliferation of nuisance *Cladophora* (a benthic, filamentous alga); reductions in offshore water-column phosphorus and chlorophyll *a* levels; enhanced water clarity; precipitous declines in *Diporeia*, an important benthic prey for many fishes; reductions in native cladoceran zooplankton in offshore lakes Michigan and Huron; low forage fish biomass in lakes Huron and Michigan; and emaciated commercial fish stocks in lakes Huron, Michigan, and Ontario. When taken together, these observations indicate that many of the Great Lakes (especially Huron,

Michigan, and Ontario) have experienced enhanced benthic biomass and nuisance/hazardous algal blooms in the nearshore, accompanied by the virtual “desertification” of the offshore (save for invasives). This effort will culminate in the creation of the Great Lakes Ecosystem Management Model (GLEMM), consisting of a linked set of lake-specific ecosystem models, allowing the dynamics of upstream lakes to influence downstream lakes.

Performance Measure:	FY						
Number of peer-reviewed papers published in the scientific literature each year documenting research that supports Great Lakes management	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	46	38	38	38	38	38	38
Description: Peer-reviewed publications are a recognized benchmark of scientific productivity and research quality and significance supporting the decisions of managers and policy makers in the Great Lakes including regulation of water levels, siting of freshwater intakes for city water supplies, forecasts of beach contamination, and the forecast of environmental parameters used for recreation and shipping.							

Performance Measure:	FY						
Number of papers published highlighting research results at hydrothermal vent sites	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	35	28	28	28	28	28	28
Description: Peer-reviewed publications are a recognized benchmark of scientific productivity related to PMEL/Vents and Fisheries-Oceanography Coordinated Investigations (FOCI) research. The Vents-related publications will advance our understanding of deep sea ecosystem and those of the EcoFOCI will increase knowledge of the North Pacific, Bering Sea, and Arctic ecosystems that will improve our current understanding, predictive ecosystem models, and management decisions in the face of climate change.							

Performance Measure:	FY						
Number of coastal, marine, and Great Lakes ecosystem sites adequately characterized for management	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	3	3	3	3	3	3	3
Description: Vents interdisciplinary exploration and research will discover and characterize the ocean’s still largely unknown deep micro- and macro-ecosystem diversity as well as provide new scientific data for understanding their critical relationships with ecosystems in the upper ocean’s sunlit zone. Emphasis will be on discovery and characterization of deep ecosystem relationships to important NOAA goals including understanding ocean acidification, discovery and understanding of sources and sinks for carbon (particularly CO ₂) in the deep sea, and deep ocean nutrient sources and cycles. Because of their high potential resource value, particular attention will be directed toward ecosystems in extreme environments associated with submarine volcanic and hydrothermal activity. All of these efforts are essential to enable NOAA to achieve its holistic, global ecosystem mission.							

NATIONAL SEA GRANT COLLEGE PROGRAM (<http://www.seagrants.noaa.gov/>)

The National Sea Grant College Program (Sea Grant) was established by Congress in 1966 (reauthorized in 2008) to enhance the practical use and conservation of coastal, marine, and Great Lake resources to create a sustainable economy and environment. The 32 state Sea Grant programs, located in every coastal and Great Lakes state and Puerto Rico and Guam, form a dynamic national network of more than 300 participating institutions represented by more than 3,000 scientists, engineers, outreach experts, educators and students. As a non-regulatory program, Sea Grant focuses on generating and disseminating science-based information to a wide range of groups who require scientific information to make daily decisions including commercial and recreational fishermen, educators, fish farmers, state and local planning officials, port and harbor commissioners, seafood processors and retailers, and natural resource, water and environmental quality managers. Sea Grant personnel are both trusted community residents and coastal experts charged with providing balanced and reliable science-based information to help stakeholders identify locally relevant solutions to critical coastal issues.

The Sea Grant model integrates research, outreach, and education. On-the-ground experts, located in every coastal and Great Lakes state, translate sound scientific information into tools, products and services that benefit coastal residents and their communities every day. Sea Grant experts implement national priorities at the local and regional level, while also identifying citizens' needs in order to inform state, regional, and national research agendas. This two-way flow of services and information ensures that Sea Grant solutions meet demonstrated needs, help support businesses, and enable policy-makers to make balanced, well-informed decisions.

In accordance with the goals of NOAA's strategic plan, Sea Grant's program activities fall into the following four focus areas and two cross-cutting efforts:

Focus areas:

- Sea Grant *Hazard Resilience in Coastal Communities* objectives are to: (1) Promote widespread understanding of risks to coastal residents and businesses; (2) Increase capacity by helping communities reduce risk, pinpoint vulnerabilities and use technologies to prepare for and mitigate hazards; and (3) Ensure an effective response to coastal catastrophes that allows for the earliest possible recovery.
- Sea Grant *Sustainable Coastal Development* objectives are to: (1) Strengthen local working waterfront economic activities while sustaining the natural coastal environment; (2) Enhance public access to the Nation's beaches and waterfronts; (3) Support sustainable planning processes that identify and pursue economic development policies and programs; and (4) Assist fishing-dependent coastal communities.
- Sea Grant *Safe and Sustainable Seafood Supply* objectives are to: (1) Engage harvesters, recreational fisherman, producers and managers of seafood to minimize threats to, and enhance the productivity and management of, wild fisheries; (2) Support a viable domestic seafood industry through both sustainable wild-caught and farm-raised fisheries, and assist the communities that depend upon them; and (3) Ensure the health and safety of seafood.
- Sea Grant *Healthy Coastal Ecosystems* objectives are to: (1) Support ecosystem-based approaches to managing the coastal environment; (2) Restore the function and productivity of degraded ecosystems; and (3) Promote stewardship of healthy ecosystems.

Cross-Cutting Efforts:

- Sea Grant *Climate Adaptation and Resilience* objectives are to: (1) Assist citizens and decision-makers in understanding climate processes and effects on coastal resources and communities; and (2) Increase capacity of coastal communities to respond to climate impacts.
- Sea Grant *Education* objectives are to: (1) Provide national leadership in ensuring public literacy in marine and coastal issues; and (2) Develop professionals who understand marine and aquatic science.

Aquatic Invasive Species Program (AIS)

Aquatic invasive species can disrupt the function of coastal ecosystems, thereby impairing recreational, economic, and other beneficial uses of coastal resources. They constitute a major threat to coastal ecosystems and economies, and they have been responsible for dramatic fishery losses. Hundreds of millions of dollars are spent each year to mitigate the effects of invasive species and to prevent new invasions. The AIS program provides support to national, regional and state efforts to develop cutting edge control technologies and transfer those technologies into operational use.

The AIS Program cooperates and coordinates with state and local governments, NOAA and other Federal agencies, the academic community, and other organizations and individuals to target the highest priority issues. The AIS program responds to the mandates identified in the National Aquatic Nuisance Prevention and Control Act, the National Sea Grant College Program Act, and Executive Order 13112. This program is proposed for termination in FY 2013.

Marine Aquaculture Program

The United States faces an annual \$8 billion seafood trade deficit, importing more than 80 percent of our seafood, of which half is from foreign aquaculture. Domestic marine aquaculture has the potential to reduce this trade deficit. Sea Grant is at the forefront of efforts to grow the U.S. marine aquaculture industry through an integrated program of research, education, and technology transfer that is focused on key scientific, engineering, environmental, and socioeconomic challenges facing this industry. Sea Grant works with other NOAA line offices (NMFS, NESDIS, NOS) to support NOAA's efforts to increase the domestic production of safe and sustainable seafood via aquaculture in ocean, coastal, Great Lakes areas. Environmentally and economically sustainable aquaculture helps meet the increasing demand for seafood, creates and sustains jobs and stabilizes economies in coastal working waterfronts, and supports efforts to manage and rebuild wild fish stocks.

Schedule and Milestones:

FY 2013 – FY 2017

- National and state program strategic plans aligned and complete.
- State programs hold local and regional requests for proposals.
- Completion of ecological and social science research projects targeted to support production of an invasive species transport vector management model or guidance to help the mid-Atlantic region control the live bait invasion vector.
- Create and transfer at least 175 decision-support tools/technologies to coastal managers.
- Review all 32 programs with external Program Review Panels.
- Complete training of more than 3,000 seafood processors in Hazard Analysis Critical Control Point (HACCP).
- More than 2,800 acres of degraded ecosystems are restored due to Sea Grant activities.

- Engage more than 550 coastal communities in activities (e.g. visioning, resource inventories, analysis of development policies) that address the sustainability of economic and environmental resources.
- Provide 150,000 coastal resource managers with information/training in local hazard resiliency, and hazard mitigation tools, techniques, and best practices.
- Assist 200 coastal communities to adopt smart growth principles.
- Reach more than 1 million students through educators.
- Evaluate all 32 Sea Grant programs against their program plan.

Deliverables:

- An oyster aquaculture industry in one state adopts production and harvesting techniques that increase the delivery of safe oysters to market; twenty oyster aquaculturists adopt appropriate food cost effective harvest restrictions and production methods that reduce *Vibrio* in oysters that result in improved public safety.
- One major aquaculture company will implement new approaches to seafood production that benefits from Sea Grant research and extension on integrated multi-trophic aquaculture.
- 2.4 million resource managers, decision-makers, and the general public will have attended Sea Grant sponsored/organized conferences, workshops and meetings.
- Sea Grant will have leveraged nearly \$200 million from state and other partners.
- 4,200 peer-reviewed journal articles/book chapters will have been published.
- 3,600 graduate students supported.
- 900 students will have received PhD or MS/MA degrees with Sea Grant assistance.
- 100 coastal communities will have implemented climate adaptation measures.
- 15,600 conferences, workshops and meetings will have been sponsored /organized by Sea Grant.
- A domestic aquaculture industry finds alternative sources of feed materials to reduce pressure on wild harvested feed fish species and to ensure that fishing limits on menhaden and anchovy do not limit the growth of the industry.

Performance Goals and Measurement Data:

Performance Measure:	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Percent of Sea Grant College Programs that have had formal expert peer reviews in the past 5 years and were rated "effective" in terms of quality, mission relevance, and performance	Actual	Target	Target	Target	Target	Target	Target
	100%	100%	100%	100%	100%	100%	100%
Description: This performance measure is recognized by the National Academy of Sciences report <i>Evaluating Federal Research Programs</i> that states "The most effective means of evaluating federally funded research programs is expert review."							

Performance Measure:	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Cumulative economic and societal benefits derived from Sea Grant activities since 2008	Actual	Target	Target	Target	Target	Target	Target
Jobs created/retained	8,370	12,000	16,000	20,000	24,000	28,000	32,000

Businesses created/retained	1,415	2,000	2,600	3,200	3,800	4,400	5,000
Economic benefit (millions of dollars)	240	320	400	480	560	640	720

Description: Society benefits from Sea Grant's assistance in developing new businesses/jobs and retaining existing businesses/jobs. This measure includes dollars that communities or businesses save due to Sea Grant assistance (i.e., providing information to help businesses make better decisions and avoid mistakes). This measure also tracks economic (market and non-market) benefits from the development of new ocean, coastal, and Great Lakes resources and technology.

Performance Measure:	FY						
Annual number of coastal communities that adopt/implement hazard resiliency practices to prepare for and respond to/minimize coastal hazardous events	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	190	150	150	150	150	150	150

Description: This metric tracks Sea Grant's contribution to individuals, businesses, and communities that develop comprehensive emergency preparedness and response plans to increase their resiliency and enable them to respond effectively. Sea Grant will contribute to this by building a sound knowledge base to improve forecasting capabilities, by identifying development and best management practices that reduce the vulnerability of people, buildings, and businesses to coastal hazards, and by advancing ways communities can manage and recover from these events when they occur.

Performance Measure:	FY						
Percentage of U.S. coastal states and territories demonstrating 20% or more annual improvements in resilience capacity to weather and climate hazards (%/yr) (Measure 18e)	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	43%	34%	43%	49%	54%	60%	66%

Description: This measure tracks a range of contributions to address coastal community risk, vulnerability, and resilience to coastal hazards. It quantifies NOAA's contributions to this important goal across NOAA's coastal programs, measuring how NOAA is improving the nation's capacity for resilience to hazards and is contributing significantly to NOAA's efforts to improve integration of its coastal programs, and expanding beyond the three coastal integration programs providing inputs to the measure (CSC, OCRM, and Sea Grant).

Performance Measure:	FY						
Annual number of coastal communities that have adopted/implemented sustainable development practices and policies as a result of Sea Grant activities	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	368	220	220	220	220	220	220

Description: This metric tracks communities that have made strides in sustainable development

with Sea Grant aid – moving beyond analysis and planning and into implementation.

Performance Measure:	FY						
Annual number of fishermen, resource managers, consumers, and seafood businesses (harvesters, aquaculturists, processors, and recreational fishermen) who modify their practices using knowledge gained in fisheries sustainability, seafood safety, and the health benefits of seafood	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	37,000	37,000	37,000	37,000	37,000	37,000	37,000
Description: This measure tracks Sea Grant success in having stakeholders adopt responsible fishery practices. For example, Sea Grant efforts to educate fishermen on the benefits of using circle hooks as an alternative to j-hooks has decreased by-catch and increased the survival of hooked and released fish. Responsible harvesting and processing techniques and practices include measures to minimize by-catch and habitat destruction, ensure seafood safety, and support sustainability.							

Performance Measure:	FY						
Cumulative number of regionally-focused climate impacts and adaptation studies, tools, and capacity-building utilized by coastal emergency management	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	0	2	5	7	8	10	12
Description: This measure tracks the cumulative number of regionally-focused climate impacts and adaptation studies, tools, and capacity-building utilized by coastal and emergency management. The use of these products will improve management responses to climate change.							

Performance Measure:	FY						
Cumulative number of tools, technologies, and information services that are used by NOAA partners/customers to improve ecosystem-based management (2010 baseline)	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	485	725	925	1125	1325	1525	1725
Description: This measure tracks success in translating research findings into tools, technologies and information services that improve the use and management of coastal, ocean, and Great Lakes ecosystems. Examples of tools include: land cover data, benthic habitat maps, and environmental sensitivity index maps. Technologies refer to the transfer of new or underused approaches for addressing coastal management (e.g., remote sensing, biosensors, AUVs, genetic markers for fishery stocks) and resource development (e.g. culture systems for aquaculture, marine pharmaceuticals). This includes the application of technology to coastal resource management through synthesis, integration, training, and the development of new management tools.							

Performance Measure:	FY						
Annual number of coastal communities that have restored degraded ecosystems as a result of Sea Grant activities	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	225	125	125	125	125	125	125
Description: The number of coastal communities (including cities, municipalities, small towns even if unincorporated, and neighborhoods if they have a cohesive identity) that have undertaken activities for the purpose of restoring degraded ecosystems, and have succeeded in the goals of that activity. A community that undertakes a project with the goal of partial restoration of an ecosystem, and that significantly meets its goals, would count toward this PM even though the ecosystem was not completely restored.							

Performance Measure:	FY						
Cumulative number of tools, technologies, and information services created for controlling Aquatic Invasive Species	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	4	6	8	10	12	14	16
Description: This work supports the EO 13112-mandated National Invasive Species Management Plan. A variety of control and management tools is needed to assess, remove and contain invasive species populations and guide management decisions." These tools may be informational, educational or administrative practices, or chemical, biological, or mechanical systems. Both research and outreach will play key roles in developing these tools, and in putting them in the hands of the resource managers who need them.							

OCEAN EXPLORATION AND RESEARCH (OER) (<http://explore.noaa.gov/>)

OER was originally created in 2007 by integrating two established programs: the National Undersea Research Program (NURP, formed in 1982) and the Office of Ocean Exploration (OE, formed in 2001). The creation of OER recognized and emphasized that exploration and research are a scientific continuum and are most productive when linked by common objectives and supported by targeted technology development.

OER develops and uses leading-edge technology and sensors to explore and study poorly-known and unknown areas and phenomena in the ocean. It manages the information acquired and generates the knowledge necessary to educate the public and inform environmental resource managers and policy makers on the use and preservation of ocean resources. OER contributes significantly to important NOAA focus areas such as Arctic exploration, global climate change, ocean acidification, biodiversity, new ocean resources such as discovery of new medicines, and coastal and marine spatial planning. OER collects information on new ecosystems, habitats, and resources, and conducts the research necessary to gauge their health, determine how they function and change over time, and to understand how human activities affected their long-term stability. In addition, OER investigates newly observed ocean phenomena such as underwater volcanic eruptions, and ensures that data and information are made available to scientists and decision-makers working on significant environmental challenges such as climate change and ocean acidification. OER core activities includes: (1) supporting interdisciplinary expeditions to characterize new ocean areas and phenomena; (2) conducting cutting edge transformational research to address National priorities and to identify new and emerging issues; (3) working with partners to develop new underwater technologies focused on increasing the pace and efficiency of ocean exploration and research; and (4) engaging a broad spectrum of stakeholders and audiences through education and outreach.

The FY 2013 request proposes to continue funding for the Ocean Exploration Program within OER, but terminate funding for the National Undersea Research Program.

Ocean Exploration Program (OE)

OE efforts focus on the first step of the scientific process – initial investigation of the unknown to characterize natural features and phenomena. Areas to be explored are identified by working with other NOAA programs and Federal agencies, as well as the academic community, and emphasis is given to areas where there is consensus that the potential for discovery is high.

Results from OE efforts include a variety of products such as maps and geospatial databases and models, inventories and samples of living and non-living marine resources, oceanographic and atmospheric data, multimedia products such as video and still images, and peer-reviewed reports and journal articles. These results provide a critical baseline of knowledge which serves to catalyze new lines of research and inquiry, supports management decisions at multiple scales, and improves ocean literacy and stewardship through education and outreach. OE accomplishes its mission in the following distinct ways:

- **Core Exploration Program:** OE provides funding through competitive grants and intra- and interagency transfers to interdisciplinary teams of scientists, explorers and educators focusing on exploring natural environments and phenomena, searching for and identifying shipwrecks and submerged paleo-landscapes once inhabited by humans, and development of advanced underwater technologies.
- **NOAA Ship *Okeanos Explorer*:** In FY 2005, Congress directed the U.S. Navy to transfer the 224-foot survey vessel USNS *Capable* to NOAA for conversion to the nation's first vessel dedicated to systematically exploring the ocean. Renamed the *Okeanos Explorer*, the vessel is outfitted with three primary capabilities: (1) deep-ocean high-resolution multibeam sonar mapping; (2) deep-water high-definition videotaping, sensing and sampling using a sophisticated dual-body remotely-operated vehicle (ROV); and (3) a satellite-based broad-band transmission "telepresence" capability, to allow teams of scientists to lead expeditions from shore-based "Exploration Command Centers" (ECC) and to engage students and the general public in the real-time ocean exploration and discovery with live transmissions from the seafloor. *Okeanos Explorer* Program discovery data has been used by scientists and managers for follow-up research on targeted habitat, species and ecosystems, geologic features, natural resource and hazards identification; oceanographic research and modeling; hydrographic mapping and nautical chart development; fisheries management; damage assessment; discovery and preservation of maritime heritage resources; and extension of the U.S. continental shelf (see "Extended Continental Shelf Mapping" below). The program of exploration aboard the ship also serves as a test-bed for developing advanced exploration sensors and technology, new data products, and data processing and management.
- **Education:** A component of OE's mission is to enhance understanding of science, technology, engineering, and mathematics used in exploring the ocean; and build interest in careers that support ocean-related work. Education materials are developed to encourage educators and students to become personally involved with the voyages and discoveries of the NOAA Ship *Okeanos Explorer* and other expeditions supported by the program. Educator professional development is designed to increase understanding of deep-sea exploration and discoveries and the technologies that enable these discoveries, and improve the teaching about ocean science and the importance of knowledge in the supporting disciplines of technology, engineering and mathematics.

- **Partnership Projects:** OE invests in a variety of small- and large-scale projects with Federal and non-Federal partners who have a shared interest in ocean exploration, as well as funding they can apply to leverage the OE investment. The following three examples highlight large-scale, multiyear exploration partnerships:
 - *Telepresence:* In June 2009, the University of Rhode Island established the “Inner Space Center” (ISC) to: receive data and information from the *Okeanos Explorer* and transmit it to the shore-based ECCs; and conduct live events during expeditions and develop post-event processed videos and other products. Further, the University of New Hampshire also partnered to acquire, process, and develop products from the multibeam mapping system on the *Okeanos Explorer*.
 - *Extended Continental Shelf Mapping (ECS):* In FY 2007, OE joined an interagency task force formed under the Interagency Committee on Ocean Science and Resource Management (ICOSRMI) to plan and prepare for new investments in field surveys to identify potential extensions of the U.S. Exclusive Economic Zone (EEZ) using criteria set forth in Article 76 of the U.N. Convention on the Law of the Sea, which defines how coastal States may define their ECS. In collaboration with several federal agencies, OE invests funds to support bathymetric mapping, geophysical and seismic surveys, data management and analysis, and the development of products to help define the ECS. In addition to mapping unknown territory, information on habitat and resources is also collected.
 - *National Ocean Partnership Program (NOPP):* Through NOPP, OE partners with the Bureau of Ocean Energy Management (BOEM) to investigate and characterize offshore lease blocks for decision support on permitting oil and gas exploration and development in the Gulf of Mexico. Under this partnership, OE provides the ships and a submersible to BOEM-funded peer-reviewed scientific investigations. OE and BOEM are now applying this approach to investigating and characterizing deep water canyons located on the continental shelf and slope in the Mid-Atlantic Bight, and have engaged in discussions concerning extending these investigations into the Arctic Ocean.

National Undersea Research Program (NURP)

NURP was created in 1982 following the recommendations of a 1980 National Academy of Sciences Report. The report recommended the creation in NOAA of a network of regional undersea science and technology centers located at major universities and other oceanographic facilities to focus its research on NOAA’s mission responsibilities and to advance underwater technologies. Through this model, NURP leveraged the skills and resources of its academic partners to meet NOAA undersea research objectives. The NURP mission was to place scientists underwater to support underwater research necessary to further our understanding of ocean ecosystems, their resources, how they function, and the impacts of natural changes and human activities.

In FY 2012, the NURP network consists of an East Coast Cooperative Institute for Ocean Exploration, Research, and Technology (CIOERT), the Aquarius Reef Base (University of North Carolina, Wilmington), the Hawaii Undersea Research Laboratory (HURL), and the West Coast and Polar Regions (WCPR) Undersea Research Center.

- CIOERT focused on identifying and investigating habitats on the eastern continental shelf and slope from the Great Lakes to the Caribbean, developing new sensors and systems to support underwater research, and works closely with the NOAA Coral Reef Conservation

Program on research efforts associated with deep and shallow water coral ecosystems in response to management needs.

- The University of North Carolina, Wilmington, operated the NOAA-owned Aquarius Undersea Laboratory, the world's only research saturation facility, to conduct marine ecosystem and coral research, undersea technology testing, training and outreach.
- HURL operated the Pisces IV and the NOAA-owned Pisces V, which are 2000m depth capable submersibles to support studies on the effect of invasive species on black coral habitats, assess Pacific monument and fisheries habitats, and survey marine cultural heritage resources.
- The WCPR at the University of Alaska, Fairbanks supported development of sensors for extreme environment (undersea and high latitude) studies, development and use of miniature oceanographic data recorders carried by marine mammals and other pelagic species and supports technologically innovative undersea research in the polar waters of the Arctic and Antarctic, including the Bering, Beaufort and Chukchi Seas, and in offshore and nearshore waters of Alaska, California, Oregon and Washington and the northeastern Pacific Ocean.

Schedule and Milestones:

- One to two BOEM-NOAA Partnership joint expeditions per year to explore and characterize habitats and ecosystems in deep water areas.
- The *Okeanos Explorer* will explore unknown and poorly known regions in the Atlantic Ocean, Gulf of Mexico, and Caribbean Sea beginning in FY 2012.
- Develop annual extramural competition for OER exploration and discovery missions.
- Develop annual extramural competition for an OER Marine Archaeology program.
- Develop peer-reviewed and approved professional education products for use in local, regional, and national curricula for Ocean Exploration Signature Mission.
- During FY 2012 - 2017, release funds when available after the annual OER Marine Archaeology program announcement of opportunities.
- During FY 2012 - 2017, Conduct 10 professional development workshops for educators annually using educational materials expressly tied to OER's mission to bring authentic science, mathematics, engineering and technology into classrooms.
- Close out the National Undersea Research Program.

Deliverables:

- Complete BOEM-NOAA Partnership Joint expeditions to explore and characterize habitats and ecosystems in deep water areas.
- Conduct Autonomous Underwater Vehicle (AUV) mapping and habitat characterization surveys.
- Conduct systematic exploration, mapping and characterization of unknown areas in national and international waters using the NOAA Ship *Okeanos Explorer* and provide information and products to multiple users through telepresence links and publicly accessible web sites and data archives.
- Develop peer-reviewed and approved professional education products for use in local, regional, and national curricula for Ocean Exploration Signature Missions.
- Transition results of exploration expeditions and projects to catalyze targeted research and to support management decisions.

Performance Goals and Measurement Data:

Performance Measure:	FY 2011 Actual	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target	FY 2017 Target
Annual number of coastal, marine, and Great Lakes ecosystem sites adequately characterized for management	1	2	1	2	2	2	2
Description: Conduct joint expeditions with DOI's BOEM to explore and characterize habitats and ecosystems in deep water areas of the Gulf of Mexico and the Mid-Atlantic Bight.							

Performance Measure:	FY 2011 Actual	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target	FY 2017 Target
Develop undersea technology tools (to advance exploration, research, and measurement of ocean characteristics)	1	1	1	2	2	2	2
Description: OER is a NOAA and national focal point for the design, development, deployment, testing, evaluation, application, and transition to operational status of new marine technologies including instrument systems, sensors, and platforms.							

Performance Measure:	FY 2011 Actual	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target	FY 2017 Target
Conduct targeted research to follow-up and transition discoveries to management and operations	7	6	0	0	0	0	0
Description: Research within OER conducted by the National Undersea Research Program (NURP).							

Performance Measure:	FY 2011 Actual	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target	FY 2017 Target
Conduct mapping and ecosystem surveys per ECS task force directives	2	1	2	2	2	2	2
Description: The Extended Continental Shelf mapping (ECS) effort is a high-level interagency multi-year effort to define the potential extension of the US continental shelf under international law. The ECS mapping effort is expected to conclude by 2017. Within NOAA, OER intends to use this information strategically to make informed decisions regarding comprehensive exploration and research.							

Performance Measure:	FY 2011 Actual	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target	FY 2017 Target
Conduct regional analysis of potential ECS based on data collected during surveys	0	1	1	1	1	1	1
Description: The ECS effort is a high-level interagency multi-year effort to define the potential extension of the US continental shelf under international law.							

Performance Measure:	FY						
Explore, map and visualize maritime wrecks and paleo-landscapes	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	2	2	2	2	2	2	2
Description: OER Marine Archaeology program explores and discovers maritime heritage sites significant to American and World history using the latest in advanced technology. Sites include shipwrecks, prehistoric submerged landscapes, and other maritime cultural sites. The program supports the research and protections standards enumerated in the UNESCO Convention on the Protection of the Underwater Cultural Heritage.							

Performance Measure:	FY						
Conduct systematic exploration, mapping and characterization of unknown areas in national and international waters using the NOAA Ship <i>Okeanos Explorer</i> Program and provide information and products to multiple users through telepresence links (Number of unknown areas characterized, mapped, and explored)	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	7	8	8	8	8	8	8
Description: The <i>Okeanos Explorer</i> offers a new approach to discovery: systematic exploration. This approach includes: (a) telepresence, the ability to bring scientific expertise virtually to the vessel through live connections between shore and sea, (b) a next-generation multi-beam sonar system, and (c) a highly sophisticated, ROV. The ship's telepresence system delivers live images from the ship's ROV and maps from its multi-beam sonar to support live interactions between dedicated centers located throughout the world and the <i>Okeanos Explorer</i> .							

Performance Measure:	FY						
Conduct AUV mapping and habitat characterization surveys	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	2	1	2	2	2	2	2
Description: Autonomous Underwater Vehicles (AUVs) provide NOAA with a capability that significantly improves on its ability to collect marine observation data for all of its mission areas. AUVs provide a broad and synoptic view of our ocean and marine environments to meet the needs of government, environmental managers, scientists, business, and the public. OER utilizes and manages AUVs through its extramural partners, and supports the development of new technologies and approaches for the efficient use of NOAA AUVs.							

Performance Measure:	FY						
Annually prepare education products expressly tied to OER's mission for use by formal and informal educators to enhance ocean science literacy	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	8	8	8	8	8	8	8
Description: The goal of OER's education product development is to increase formal and informal							

educator access to, understanding of, and appreciation for systematic deep-ocean exploration and its importance in forming the baseline for ocean research, management, and policy decisions.

OTHER ECOSYSTEMS PROGRAMS

Integrated Ocean Acidification (OA)

NOAA's investment in the research described in the NOAA Ocean and Great Lakes Acidification Research Plan will accelerate understanding to a pace that can adequately inform national and international mitigation and adaptation decision-making that will best conserve marine ecosystems and sustain the critical services that oceans, coastal, and Great Lakes ecosystems provide to the national economy. OA activities will include: (1) develop and deploy of advanced technologies and sensors on mooring platforms in the Pacific, Atlantic, and Gulf of Mexico to track chemical changes in open and coastal waters relevant to potential ecosystem impacts; (2) establish a coral reef monitoring network, as well as carbon parameter analytical capabilities to ensure consistent sampling and measuring methods; (3) conduct in-house (NMFS) and extramural field and laboratory organism response experiments to assess physiological vulnerability of commercial and recreational important species to OA which will lead to modeling of ecosystem level and socioeconomic impacts as identified in the NOAA Ocean and Great Lakes Acidification Research Plan; (4) development of new technologies for geochemical and ecosystem monitoring (5) coordination of OA monitoring and impacts research with other Federal, academic, national and international ocean science bodies including (6) if possible, coordinated, multi-agency supported, competitively awarded grants under the National Oceanographic Partnership Program.

The value of ocean acidification research is evident in the Pacific Northwest where oyster hatcheries on the verge of collapse just a few years ago are again major contributors to the \$111 million West Coast shellfish industry. Beginning in 2005, production at some Pacific Northwest oyster hatcheries began to decline at an alarming rate, posing severe economic impacts and challenging a way of life held by shellfish growers for over 130 years. Oyster production represents 76 percent of the West Coast shellfish industry, which supports more than 3,000 jobs. A \$500,000 investment in monitoring coastal seawater, which enables hatchery managers to schedule production when water quality is good, is helping to restore commercial hatcheries and expected to reap an estimated \$35 million for coastal communities in Oregon and Washington. This example highlights the urgency of this problem and the value of ocean acidification research and monitoring.

Schedule and Milestones:

FY 2013 – FY 2017

- Deploy and maintain OA moorings
- Deploy and maintain coral reef monitoring sites.
- Instrument and maintain OA sensors on NOAA Research and Volunteer Observing Ships
- Ocean Acidification summer cruise--Alaska Coast
- Single species experiments (vulnerable economically-important and protected species)
- Multi-species and mesocosm experiments
- Test/evaluate existing global and regional models
- Develop high-resolution physical-biogeochemical-ecosystem models
- Develop coastal early-warning system
- Coordination through OA data management with archival center
- Data Synthesis
- Integrated synthesis workshops and reports
- Education and outreach planning

- Develop curricula and outreach products

Deliverables:

- NOAA established as the lead agency for ocean acidification research and monitoring (as mandated in the Federal Ocean Acidification Research and Monitoring Act of 2009) coordinated through a NOAA Ocean Acidification Program office and the Joint Subcommittee on Ocean Science and Technology (JSOST) Interagency Working Group on Ocean Acidification;
- Integrated assessments of the ecological and societal impacts of ocean acidification in each U.S. coastal region and the Great Lakes to identify vulnerable communities where mitigation and adaptation strategies may be needed;
- Improved public understanding of the threats of ocean acidification and the solutions to preserving our ocean and Great Lakes ecosystems via public lectures and web-based information;
- Standardized chemical and biological monitoring protocols for the measurement of CO₂ system parameters and physiological effects on marine organisms;
- Predictions of pH and carbonate saturation in the future ocean using global climate change model projections;
- Comprehensive evaluation and characterization of the threat ocean acidification poses by resolving the direct and indirect ecological impacts to economically-important species and NOAA-managed protected species;
- Regional biogeochemical and ecological models developed through the synthesis efforts of existing models and the incorporation of new knowledge gained on the impact of ocean acidification;
- Recommended atmospheric limit for CO₂ based on projected losses of marine resources, ecosystem services, and economic losses due to the degree of ocean acidification at different CO₂ emission scenarios;
- Decision support tools and requisite scientific knowledge for understanding and responding to ocean acidification in support of ecosystem based management and other related management schemes, such as fisheries management and coastal and marine spatial planning;
- Educational and outreach products and services (e.g., aquarium and museum exhibits, interactive website, K–12 curriculum, informational and training workshops, short web documentaries, summary literature, community lecture series, and interpretive signage) to increase the dialogue among scientists, policy-makers, teachers, and the public.

Performance Goals and Measurement Data:

Performance Measure:	FY						
	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
Percent of U.S. coastal and open ocean ecosystems for which there is high confidence (with low uncertainty) in the understanding of the impacts of ocean acidification. (IPCC reports* % Low - High ratings)							
	5%	10%	10%	15%	20%	25%	30%
Description: The uncertainty is a designated level of understanding assessed by a panel of NOAA investigators with regards to the anticipated impacts of ocean acidification on each of the ten Large Marine Ecosystems (LME) based upon the IPCC criteria (including likelihood and confidence). This designation is evaluated on an annual basis and expresses an aggregate of the uncertainties							

associated with each of the critical LME's facets posited to be impacted by ocean acidification.

* From the IPCC Third Assessment Report: "An explicit uncertainty range is a likely range. Estimates of confidence are: very high (95 %); high (67-94 %); medium (33-66 %); low (5-32 %); very low (< 5 %).

Performance Measure:	FY						
	2011	2012	2013	2014	2015	2016	2017
Percent of U.S. coastal and open ocean ecosystems where there are in situ-based fixed platforms that are accurately measuring the carbon parameters needed to calculate mean annual ocean acidification index (Aragonite Saturation State) determined to be within 0.2 units of the actual mean	Actual	Target	Target	Target	Target	Target	Target
	6	11	12	14	16	18	18

Description: This measure represents an annual inventory of in situ-based fixed and underway observing platforms dedicated to monitoring the magnitude, and rate of biogeochemical changes in response to increasing atmospheric carbon dioxide. Monitoring sites will be located in ecologically and economically important marine ecosystems. These ocean acidification observing platforms are defined by their inherent ability to fully constrain the carbonic acid system and must be capable of resolving decadal changes in ocean chemistry in response to ocean acidification. The data provided will be used by federal and state regulatory agencies and commercial fisheries organizations.

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PROGRAM CHANGES FOR FY 2013:

Ocean, Coastal and Great Lakes Research Laboratories and Cooperative Institutes: Ocean Research Advisory Panel (Base Funding: \$0 and 0 FTE; Program Change: + \$300,000 and 0 FTE)

NOAA requests an increase of \$300,000 and 0 FTE for a total of \$300,000 and 0 FTE to support the activities of the Ocean Research Advisory Panel (ORAP). The Administration will submit legislation to transfer ORAP responsibly from the Department of Defense to NOAA. As the nation's premier ocean research agency, NOAA is the appropriate place to support this organization. ORAP's role is to advise the National Ocean Research Leadership Council (NORLC) and to provide independent recommendations. ORAP members include individuals from the National Academies, state government, academia, and ocean industries, representing marine science, marine policy, and other related fields.

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Office of Oceanic & Atmospheric Research
Subactivity: Ocean, Coastal, & Great Lake Research

Object Class	2013 Increase
11 Personnel compensation	
11.1 Full-time permanent	\$0
11.3 Other than full-time permanent	0
11.5 Other personnel compensation	0
11.8 Special personnel services payments	0
11.9 Total personnel compensation	<u>0</u>
12 Civilian personnel benefits	0
13 Benefits for former personnel	0
21 Travel and transportation of persons	0
22 Transportation of things	0
23.1 Rental payments to GSA	0
23.2 Rental Payments to others	0
23.3 Communications, utilities and miscellaneous charges	0
24 Printing and reproduction	0
25.1 Advisory and assistance services	300
25.2 Other services	0
25.3 Purchases of goods & services from Gov't accounts	0
25.4 Operation and maintenance of facilities	0
25.5 Research and development contracts	0
25.6 Medical care	0
25.7 Operation and maintenance of equipment	0
25.8 Subsistence and support of persons	0
26 Supplies and materials	0
31 Equipment	0
32 Lands and structures	0
33 Investments and loans	0
41 Grants, subsidies and contributions	0
42 Insurance claims and indemnities	0
43 Interest and dividends	0
44 Refunds	0
99 Total obligations	<u>300</u>

Ocean Coastal and Great Lakes Research Laboratories and Cooperative Institutes (Base Funding: 119 FTE and \$23,490,000; Program Change: -0 FTE, -\$1,000,000): NOAA requests a decrease of \$1,000,000 and 0 FTE for a total of \$22,490,000 and 119 FTE to reflect a reduced need for Cooperative Institute support for planned research projects in FY 2013.

Proposed Actions:

NOAA will narrow the focus of funding for research, broadly spread across its Cooperative Institutes partners, to particular key areas in FY 2013 such as:

- Improved protection, restoration, and management of coastal and ocean resources;
- Monitoring of ocean, coastal, and Great Lakes ecosystems, including coral;
- Supporting ecosystem modeling and forecasting; and
- Encouraging technology transfer and efficient resource management.

Research in areas such as the following is considered lower priority and will be delayed or reduced, as NOAA focuses on the high priority initiatives mentioned above:

- (1) Ecosystem management – characterization and modeling of coastal wetland and fisheries habitats;
- (2) Geospatial data integration and visualization in environmental science – development of data visualization techniques and tools for inland/watershed-coastal waters and resources, with a particular focus on the research, development, prototype testing and transition of scientifically-based geospatial observations;
- (3) Climate change and climate variability effects on regional ecosystems - climate assessments and impact models in the Gulf of Mexico and other areas; and
- (4) Coastal hazards - integration of storm surge and wetland erosion models

NOAA will continue its traditional relationships with the Cooperative Institutes in accomplishing the above objectives. However, rather than a dedicated pool of funding available for such efforts, the NOAA research labs will continue to involve CI researchers using their base resources and making awards to the CI's in those instances where they can make significant advances through such partnerships.

Base Resource Assessment:

The base resources for this activity are described in the above Ocean, Coastal, and Great Lakes Research Laboratories and CI's base narrative.

Schedule and Milestones:

Most of the work under this line item will continue with the funding requested. Listed below are only those schedule and milestones that are impacted. See the Base narratives for a complete list of schedule and milestones that will be accomplished under this program:

- Develop and test a coupled wave, surge, and sediment transport model system for coastal wetlands
- Test three-dimensional flood visualization software package in the operational environment of a river forecasting center
- Complete integrated ecosystem assessments for select estuaries in the northern Gulf Mexico

Deliverables/Outputs:

Most of the work under this line item will continue with the funding requested. Listed below are only those deliverables that are impacted. See the Base narratives for a complete list of deliverables that will be provided under the larger line item.

- Coupled wave, surge, and sediment transport model system for coastal wetlands
- Next generation flood visualization software package for testing in a broader operational environment
- Ecosystem model incorporating pressures and drivers of ecosystem change in select estuaries in the northern Gulf of Mexico

Performance Goals and Measurement Data:

Performance Measure:	FY						
Complete beta testing for next generation flood visualization software package (cumulative).	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
With Decrease	0	0	0	0	0	0	0
Without Decrease	0	0	1	1	1	1	1
Description: Beta testing is testing of software with a limited user audience, in this case, one National Weather Service River Forecasting Center. Once beta testing is complete, testing with a wider operational audience is the next step.							

Performance Measure:	FY						
Cumulative number of estuaries and bays in the northern Gulf of Mexico with a completed integrated ecosystem assessment and an ecosystem model.	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
With Decrease	0	0	0	0	0	0	0
Without Decrease	0	0	1	2	3	4	4
Description: The ecosystem assessment and ecosystem model will be ready for use by resource managers.							

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Office of Oceanic and Atmospheric Research

Subactivity: Ocean, Coastal, and Great Lakes Research

Object Class	2013 Decrease
11 Personnel compensation	
11.1 Full-time permanent	0
11.3 Other than full-time permanent	0
11.5 Other personnel compensation	0
11.8 Special personnel services payments	0
11.9 Total personnel compensation	0
12 Civilian personnel benefits	0
13 Benefits for former personnel	0
21 Travel and transportation of persons	0
22 Transportation of things	0
23.1 Rental payments to GSA	0
23.2 Rental Payments to others	0
23.3 Communications, utilities and miscellaneous charges	0
24 Printing and reproduction	0
25.1 Advisory and assistance services	0
25.2 Other services	0
25.3 Purchases of goods & services from Gov't accounts	0
25.4 Operation and maintenance of facilities	0
25.5 Research and development contracts	0
25.6 Medical care	0
25.7 Operation and maintenance of equipment	0
25.8 Subsistence and support of persons	0
26 Supplies and materials	0
31 Equipment	0
32 Lands and structures	0
33 Investments and loans	0
41 Grants, subsidies and contributions	-1,000
42 Insurance claims and indemnities	0
43 Interest and dividends	0
44 Refunds	0
99 Total obligations	-1,000

Ocean, Coastal, and Great Lakes Laboratories and Cooperative Institutes: Great Lakes Environmental Research Laboratory (GLERL) (Base Funding: \$10,000,000 and 57 FTE; Program Change: -\$1,665,000 and -2 FTE): NOAA requests a decrease of \$1,665,000 and -2 FTE for a total of \$8,335,000 and 55 FTE to scale back GLERL research operations.

Proposed Actions:

While EPA has a greater overall investment in the Great Lakes under its Clean Water Act mandates, NOAA's unique mission as the primary forecasting agency in the region positions the science conducted at GLERL as important to NOAA's stakeholders as well as interagency and bi-national partnerships in the Great Lakes. With this decrease, GLERL will continue to focus on NOAA's priorities and activities most relevant to its statutory responsibilities, including characterizing Great Lakes ecosystem sites for management through long-term integrated observations; developing ecosystem models; assessing the impact of aquatic invasive species such as zebra and quagga mussels; and providing Great Lakes environmental and ecosystem research products (including, for example, forecasts of toxic harmful algal blooms, wind, waves, fog, ice, water levels, channel depths, rip currents, and delivery of harmful bacteria to beaches).

NOAA proposes to scale back operations at GLERL by 17 percent in FY 2013, in order to focus on the above higher priority research activities. Specifically, NOAA will:

1. Focus on analysis of existing data, development of models, and execution of in-house laboratory experiments rather than collection of new field data in FY 2013.
2. Suspend GLERL's small vessel operations, including those provided in-kind for partner organizations (e.g., for Thunder Bay National Marine Sanctuary), while maintaining fleet capabilities for future years.
3. Reduce other in-kind contributions to NOAA's research partners, such as the use of technical equipment such as sampling gear and survey instruments without additional charges and mechanical troubleshooting and consulting by GLERL engineers or scientists.
4. Reduce administrative costs, specifically by reduced travel, and by delaying the filling of vacancies after attrition of the workforce.

These actions will allow GLERL to continue to make scientific contributions to important resource management decisions in the Great Lakes during FY 2013 and beyond.

Base Resource Assessment:

The base resources for this activity are described in the Ocean, Coastal, and Great Lakes Research base narrative.

Schedule and Milestones:

FY 2013 – FY 2017

- Storage of GLERL's 14 research vessels and data buoys in FY 2013
- Completion of analysis of existing data and model development for several research products, such as beach water quality and rip current forecasting tools

Deliverables:

- Data provided by other NOAA and non-NOAA organizations will be used, as appropriate, to continue forecasting of changes in Great Lakes water levels, ice cover, and harmful algal blooms.

- GLERL scientists' support for NOAA-related projects within the Great Lakes Restoration Initiative Action Plan will only be diminished to the extent that the work was based on GLERL direct appropriations, including limits on travel, new analyses, and major field work.

Performance Goals and Measurement Data:

Performance Measure:	FY						
Cumulative number of coastal, marine, and Great Lakes ecosystem sites adequately characterized for management	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
With Decrease	N/A	N/A	8	8	9	9	10
Without Decrease	5	7	9	10	12	14	15
<p>Description: This performance measure is for development and validation of a harmful algal bloom warning system from real-time results provided to water intake managers protecting the drinking water of over 2 million coastal Lake Erie residents. <i>Microcystis aeruginosa</i> is the dominant bloom-forming, toxic cyanobacterium occurring in the Great Lakes. Preliminary studies have verified the presence of the cyanotoxin, microcystin in Lake Erie near water intake systems. In particular, microcystin concentrations have exceeded the recommended limit of 1 µg/L for drinking water (World Health Organization, 1998). This research will provide predictive models using baseline environmental data. This NOAA-wide performance measure is highlighting only one GLERL component. NOAA will continue to expand the number of ecosystems characterized for management.</p>							

Performance Measure:	FY						
Cumulative number of coastal, marine, and Great Lakes ecosystem sites adequately characterized for management	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
With Decrease	N/A	N/A	4	4	4	4	4
Without Decrease	2	2	4	6	8	10	12
<p>Description: This performance measure is for development and validation of food-web forecasts used to identify impacts of invasive species on Great Lakes ecosystems and to support management decisions for state and regional resource managers. Recent dramatic changes have alarmed water quality and fishery managers, including: a return of nearshore blooms of <i>Microcystis</i> (a hazardous cyanophyte); proliferation of nuisance <i>Cladophora</i> (a benthic, filamentous alga); reductions in offshore water-column phosphorus and chlorophyll <i>a</i> levels; enhanced water clarity; precipitous declines in <i>Diporeia</i>, an important benthic prey for many fishes; reductions in native cladoceran zooplankton in offshore lakes Michigan and Huron; low forage fish biomass in lakes Huron and Michigan; and emaciated commercial fish stocks in lakes Huron, Michigan, and Ontario. When taken together, these observations indicate that many of the Great Lakes (especially Huron, Michigan, and Ontario) have experienced enhanced benthic biomass and nuisance/hazardous algal blooms in the nearshore, accompanied by the virtual “desertification” of the offshore (save for invasives). This effort will culminate in the creation of the Great Lakes Ecosystem Management Model (GLEMM), consisting of a linked set of lake-specific ecosystem models, allowing the dynamics of upstream lakes to influence downstream lakes. This NOAA-wide performance measure is highlighting only one GLERL component. NOAA will continue to expand the number of ecosystems characterized for management.</p>							

Performance Measure:	FY						
Number of peer-reviewed papers published in the scientific literature each year documenting research that supports Great Lakes management	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
With Decrease	N/A	N/A	32	30	30	30	30
Without Decrease	46	38	38	38	38	38	38
Description: Peer-reviewed publications are a recognized benchmark of scientific productivity and research quality and significance supporting the decisions of managers and policy makers in the Great Lakes including regulation of water levels, siting of freshwater intakes for city water supplies, forecasts of beach contamination, and forecasts of environmental parameters used for recreation and shipping.							

PROGRAM CHANGE PERSONNEL DETAIL

Activity: Office of Oceanic and Atmospheric Research
 Subactivity: Ocean, Coastal and Great Lakes Research

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
Ecologist	Ann Arbor, MI	GS-15	-1	123,628	(123,628)
Physical Scientist	Ann Arbor, MI	GS-15	-1	123,628	(123,628)
Total			<u>-2</u>		<u>(247,256)</u>
less Lapse		25%	<u>0</u>		<u>0</u>
Total full-time permanent (FTE)			-2		(247,256)
2013 Pay Adjustment (0.5%)					0
TOTAL					(247,256)

Personnel Data

	<u>Number</u>
Full-Time Equivalent Employmen	
Full-time permanent	-2
Other than full-time permanent	<u>0</u>
Total	-2
Authorized Positions:	
Full-time permanent	-2
Other than full-time permanent	<u>0</u>
Total	-2

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Office of Oceanic and Atmospheric Research
Subactivity: Ocean, Coastal, and Great Lakes Research

Object Class	2013 Decrease
11 Personnel compensation	
11.1 Full-time permanent (by attrition)	(247)
11.3 Other than full-time permanent	0
11.5 Other personnel compensation	0
11.8 Special personnel services payments	0
11.9 Total personnel compensation	(247)
12 Civilian personnel benefits	(101)
13 Benefits for former personnel	0
21 Travel and transportation of persons	(150)
22 Transportation of things	(35)
23.1 Rental payments to GSA	0
23.2 Rental Payments to others	0
23.3 Communications, utilities and miscellaneous charges	0
24 Printing and reproduction	0
25.1 Advisory and assistance services	0
25.2 Other services	(352)
25.3 Purchases of goods & services from Gov't accounts	0
25.4 Operation and maintenance of facilities	0
25.5 Research and development contracts	0
25.6 Medical care	0
25.7 Operation and maintenance of equipment	0
25.8 Subsistence and support of persons	0
26 Supplies and materials	(200)
31 Equipment	(300)
32 Lands and structures	0
33 Investments and loans	0
41 Grants, subsidies and contributions	(280)
42 Insurance claims and indemnities	0
43 Interest and dividends	0
44 Refunds	0
99 Total obligations	(\$1,665)

Marine Aquaculture Program: Marine Aquaculture Research: (Base Funding: 1 FTE and \$4,309,000; Program Change: 0 FTE, +\$247,000): NOAA requests an increase of \$247,000 and 0 FTE for a total of \$4,556,000 and 1 FTE to enhance Sea Grant's support of national grant competitions for marine aquaculture research and technology transfer. Sea Grant facilitates the transfer of aquaculture research and technology into business operations, as well as informs the public and practitioners about key issues and information related to aquaculture. Environmentally and economically sustainable aquaculture helps meet the increasing demand for seafood, creates and sustains jobs, stabilizes economies in coastal working waterfronts, and supports efforts to manage and rebuild wild fish stocks.

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Office of Oceanic and Atmospheric Research
Subactivity: Ocean, Coastal & Great Lakes Research

Object Class	2013 Increase
11 Personnel compensation	
11.1 Full-time permanent	\$0
11.3 Other than full-time permanent	0
11.5 Other personnel compensation	0
11.8 Special personnel services payments	0
11.9 Total personnel compensation	0
12 Civilian personnel benefits	0
13 Benefits for former personnel	0
21 Travel and transportation of persons	0
22 Transportation of things	0
23.1 Rental payments to GSA	0
23.2 Rental Payments to others	0
23.3 Communications, utilities and miscellaneous charges	0
24 Printing and reproduction	0
25.1 Advisory and assistance services	0
25.2 Other services	0
25.3 Purchases of goods & services from Gov't accounts	0
25.4 Operation and maintenance of facilities	0
25.5 Research and development contracts	0
25.6 Medical care	0
25.7 Operation and maintenance of equipment	0
25.8 Subsistence and support of persons	0
26 Supplies and materials	0
31 Equipment	0
32 Lands and structures	0
33 Investments and loans	0
41 Grants, subsidies and contributions	247
42 Insurance claims and indemnities	0
43 Interest and dividends	0
44 Refunds	0
99 Total obligations	247

National Sea Grant College Program (Base Funding: 27 FTE and \$56,911,000; Program Change: 0 FTE, +\$181,000): NOAA requests an increase of \$181,000 and 0 FTE for a total of 27 FTE and \$57,092,000 to enhance Sea Grant's support of coastal communities. Sea Grant research and outreach will help coastal communities maintain working waterfronts and enhance tourism and recreation in order to create jobs and sustain the coastal economy through economic diversification, community development, and preservation of coastal and marine environments.

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Office of Oceanic and Atmospheric Research
Subactivity: Ocean, Coastal & Great Lakes Research

Object Class	2013 Increase
11 Personnel compensation	
11.1 Full-time permanent	\$0
11.3 Other than full-time permanent	0
11.5 Other personnel compensation	0
11.8 Special personnel services payments	0
11.9 Total personnel compensation	0
12 Civilian personnel benefits	0
13 Benefits for former personnel	0
21 Travel and transportation of persons	0
22 Transportation of things	0
23.1 Rental payments to GSA	0
23.2 Rental Payments to others	0
23.3 Communications, utilities and miscellaneous charges	0
24 Printing and reproduction	0
25.1 Advisory and assistance services	0
25.2 Other services	0
25.3 Purchases of goods & services from Gov't accounts	0
25.4 Operation and maintenance of facilities	0
25.5 Research and development contracts	0
25.6 Medical care	0
25.7 Operation and maintenance of equipment	0
25.8 Subsistence and support of persons	0
26 Supplies and materials	0
31 Equipment	0
32 Lands and structures	0
33 Investments and loans	0
41 Grants, subsidies and contributions	181
42 Insurance claims and indemnities	0
43 Interest and dividends	0
44 Refunds	0
99 Total obligations	181

Aquatic Invasive Species Program: Program Closure: (Base Funding: \$999,000 and 3 FTE; Program Change: -\$999,000 and -3 FTE): NOAA requests a decrease of \$999,000 and 3 FTE for a total of \$0 and 0 FTE to terminate the Aquatic Invasive Species Program.

Proposed Actions:

NOAA proposes to eliminate grants for national research and outreach competitions in Aquatic Invasive Species, given the EPA’s more significant efforts in this issue. However, aquatic invasive species research will continue through the efforts of NOAA’s state Sea Grant partners and the current tools, technologies, and information services to control invasive species will be maintained.

Base Resource Assessment:

The base resources for this activity are described in the Ocean, Coastal & Great Lakes Research base narrative.

Schedule and Milestones:

FY 2013

- Completion of ecological and social science research projects targeted to support production of an invasive species transport vector management model or guidance to help the mid-Atlantic region control the live bait invasion vector.

Deliverables: None

Performance Goals and Measurement Data

Performance Measure:	FY11 Actual	FY 12 Target	FY 13 Target	FY 14 Target	FY 15 Target	FY 16 Target	FY 17 Target
Cumulative number of tools, technologies, and information services created for controlling Aquatic Invasive Species							
With decrease	N/A	N/A	6	6	6	6	6
Without decrease	4	6	8	10	12	14	16

Description: This work supports the Executive Order 13112-mandated National Invasive Species Management Plan. From the Plan: "Strategic goal 3: Contain and reduce the spread and populations of established invasive species to minimize their harmful impacts...A variety of control and management tools is needed to assess, remove and contain invasive species populations and guide management decisions." These tools may be informational, educational or administrative practices, or chemical, biological, or mechanical systems. Both research and outreach will play key roles in developing these tools, and in putting them in the hands of the resource managers who need them.

PROGRAM CHANGE PERSONNEL DETAIL

Activity: Office of Oceanic and Atmospheric Research
 Subactivity: Ocean, Coastal and Great Lakes Research

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
Marine Scientist	Silver Spring, MD	ZT-III	-2	51,630	(103,260)
Marine Scientist	Silver Spring, MD	ZT-IV	-1	62,467	(62,467)
Total			<u>-3</u>		<u>(165,727)</u>
less Lapse		25%	<u>0</u>		<u>0</u>
Total full-time permanent (FTE)			-3		(165,727)
2013 Pay Adjustment (0.5%)					0
TOTAL					(165,727)

Personnel Data

	<u>Number</u>
Full-Time Equivalent Employment	
Full-time permanent	-3
Other than full-time permanent	0
Total	<u>-3</u>

Authorized Positions:

Full-time permanent	-3
Other than full-time permanent	0
Total	<u>-3</u>

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Office of Oceanic and Atmospheric Research
Subactivity: Ocean, Coastal & Great Lakes Research

Object Class	2013 Decrease
11 Personnel compensation	
11.1 Full-time permanent	(166)
11.3 Other than full-time permanent	0
11.5 Other personnel compensation	0
11.8 Special personnel services payments	0
11.9 Total personnel compensation	<u>(166)</u>
12 Civilian personnel benefits	(55)
13 Benefits for former personnel	0
21 Travel and transportation of persons	0
22 Transportation of things	0
23.1 Rental payments to GSA	0
23.2 Rental Payments to others	0
23.3 Communications, utilities and miscellaneous charges	0
24 Printing and reproduction	0
25.1 Advisory and assistance services	0
25.2 Other services	0
25.3 Purchases of goods & services from Gov't accounts	0
25.4 Operation and maintenance of facilities	0
25.5 Research and development contracts	0
25.6 Medical care	0
25.7 Operation and maintenance of equipment	0
25.8 Subsistence and support of persons	0
26 Supplies and materials	0
31 Equipment	0
32 Lands and structures	0
33 Investments and loans	0
41 Grants, subsidies and contributions	(778)
42 Insurance claims and indemnities	0
43 Interest and dividends	0
44 Refunds	0
99 Total obligations	<u>(999)</u>

Ocean Exploration and Research: National Undersea Research Program (NURP) (Base Funding: \$3,985,000 and 6 FTE; Program Change: -\$3,985,000 and -6 FTE): NOAA requests a decrease of \$3,985,000 and 6 FTE for a total of \$0 and 0 FTE to complete the termination of the National Undersea Research Program (NURP).

Proposed Actions:

In order to ensure an orderly transition, fund any associated costs, and appropriately dispose of the technologies owned by NOAA, including the Aquarius Undersea Habitat and the Pisces V submersible, notification and transition will be initiated in FY 2012. NURP's academic partners may have the opportunity to continue their efforts through other funding sources.

Schedule & Milestones:

By FY 2013:

- Transition activities, including disposal of the technologies that are part of NURP.
- Begin procedures to close down the centers and CI and properly and safely dispose of and/or transfer of all the equipment within.

Performance Goals and Measurement Data:

Performance Measure:	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Conduct targeted research to follow-up and transition Ocean Exploration discoveries to management and operations	Actual	Target	Target	Target	Target	Target	Target
With Decrease	N/A	N/A	0	0	0	0	0
Without Decrease	7	6	6	6	6	6	6
Description: This performance measure specifically captures research done by the National Undersea Research Program laboratories to further investigate discoveries made during the course of ocean exploration. OAR will continue to ensure the results of exploration are well organized and widely disseminated, making them available to other NOAA programs and other Federal agencies in order to stimulate follow-on research.							

Performance Measure:	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Develop undersea technology tools (to advance exploration, research, and measurement of ocean characteristics)	Actual	Target	Target	Target	Target	Target	Target
With Decrease	N/A	N/A	0	0	0	0	0
Without Decrease	1	1	1	1	1	1	1
Description: This performance measure specifically captures technological tool development done by the National Undersea Research Program laboratories to further investigate discoveries made during the course of ocean exploration. OAR will continue to ensure the results of exploration are well organized and widely disseminated, making them available to other NOAA programs and other Federal agencies in order to stimulate follow-on research.							

PROGRAM CHANGE PERSONNEL DETAIL

Activity: Ocean and Atmospheric Research
 Subactivity: Ocean, Coastal and Great Lakes Research

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
Program Support Specialist	Silver Spring, MD	ZA-II	-1	42,209	(42,209)
Physical Scientist	Silver Spring, MD	ZP-III	-1	62,467	(62,467)
Physical Scientist	Silver Spring, MD	ZP-IV	-3	89,033	(267,099)
Supervisory Physical Scientist	Silver Spring, MD	ZP-V	-1	123,758	(123,758)
Total			<u>-6</u>		<u>(495,533)</u>
less Lapse		25%	<u>0</u>		<u>0</u>
Total full-time permanent (FTE)			-6		(495,533)
2013 Pay Adjustment (0.5%)					0
TOTAL					(495,533)

Personnel Data

	<u>Number</u>
Full-Time Equivalent Employmen	
Full-time permanent	-6
Other than full-time permanent	0
Total	<u>-6</u>
Authorized Positions:	
Full-time permanent	-6
Other than full-time permanent	0
Total	<u>-6</u>

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Office of Oceanic and Atmospheric Research

Subactivity: Ocean, Coastal, and Great Lakes Research

Object Class	2013 Decrease
11 Personnel compensation	
11.1 Full-time permanent	(496)
11.3 Other than full-time permanent	0
11.5 Other personnel compensation	(124)
11.8 Special personnel services payments	0
11.9 Total personnel compensation	(620)
12 Civilian personnel benefits	(155)
13 Benefits for former personnel	0
21 Travel and transportation of persons	(37)
22 Transportation of things	0
23.1 Rental payments to GSA	(64)
23.2 Rental Payments to others	(316)
23.3 Communications, utilities and miscellaneous charges	(5)
24 Printing and reproduction	0
25.1 Advisory and assistance services	(103)
25.2 Other services	0
25.3 Purchases of goods & services from Gov't accounts	0
25.4 Operation and maintenance of facilities	0
25.5 Research and development contracts	0
25.6 Medical care	0
25.7 Operation and maintenance of equipment	0
25.8 Subsistence and support of persons	0
26 Supplies and materials	(13)
31 Equipment	0
32 Lands and structures	0
33 Investments and loans	0
41 Grants, subsidies and contributions	(2,672)
42 Insurance claims and indemnities	0
43 Interest and dividends	0
44 Refunds	0
99 Total obligations	(3,985)

The following exhibit shows the summary object class detail for the Ocean, Coastal, and Great Lakes Research program changes less than \$100,000. Please contact the NOAA budget office if details for any of these changes are required.

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Office of Oceanic and Atmospheric Research
 Subactivity: Ocean, Coastal & Great Lakes Research

Object Class	2013 Increase
11 Personnel compensation	
11.1 Full-time permanent	0
11.3 Other than full-time permanent	0
11.5 Other personnel compensation	0
11.8 Special personnel services payments	0
11.9 Total personnel compensation	0
12 Civilian personnel benefits	0
13 Benefits for former personnel	0
21 Travel and transportation of persons	0
22 Transportation of things	0
23.1 Rental payments to GSA	0
23.2 Rental Payments to others	0
23.3 Communications, utilities and miscellaneous charges	0
24 Printing and reproduction	0
25.1 Advisory and assistance services	0
25.2 Other services	0
25.3 Purchases of goods & services from Gov't accounts	0
25.4 Operation and maintenance of facilities	0
25.5 Research and development contracts	0
25.6 Medical care	0
25.7 Operation and maintenance of equipment	0
25.8 Subsistence and support of persons	0
26 Supplies and materials	0
31 Equipment	0
32 Lands and structures	0
33 Investments and loans	0
41 Grants, subsidies and contributions	95
42 Insurance claims and indemnities	0
43 Interest and dividends	0
44 Refunds	0
99 Total obligations	95

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**APPROPRIATION ACCOUNT: OPERATIONS, RESEARCH, AND FACILITIES
SUBACTIVITY: INFORMATION TECHNOLOGY, RESEARCH & DEVELOPMENT**

The objective of the Information Technology R&D subactivity is to accelerate the adoption of advanced computing, communications, and information technology throughout NOAA. Information Technology R&D supports OAR's High Performance Computing and Communications (HPCC) Initiative. The HPCC program supports OAR through major improvements in weather and climate forecasting, ecosystem and ocean modeling, and environmental information dissemination. These improvements are heavily dependent on major advances in high-end computing power, advanced information technology, and the availability of environmental data and information. These critical investments allow NOAA to meet its mission to deliver vital services and science education.

Through this program, NOAA participates as a mission agency in the Networking and Information Technology Research and Development (NITRD) program. NOAA participates on several NITRD Interagency Working Groups including:

- High End Computing
- Large Scale Networking
- Software Design and Productivity
- Human Computer Interaction and Information Management.

HIGH PERFORMANCE COMPUTING INITIATIVES

HPCC supports a number of objectives in NOAA's Strategic Plan through support of IT research targeted at improving NOAA's mission and services which expands the global understanding of environmental science. The purpose of the HPCC program is to make major improvements in the Nation's ability to forecast the weather and climate, and to disseminate environmental information. At the same time, the program is aimed at stimulating the modernization of NOAA's computationally intensive services through the use of evolving high performance computing and high-speed networking technologies. Improvements in the accuracy and timeliness of NOAA's short-term weather warnings, seasonal forecasts, hurricane forecast improvements, as well as regional and global climate predictions are heavily dependent on major advances. These advances would include high-end computing power, advanced information technology, and the widespread availability of environmental data and information. Timely and responsive dissemination of NOAA's services and information requires full use of modern network and communication technologies. This program provides NOAA's focus for coordinating with external organizations and programs impacting the HPCC Program, through NITRD and its Interagency Coordinating Groups on Information Technology Research and Development (IT R&D), and by establishing agreements with other federal agencies to obtain additional computational cycles to support NOAA's environmental research activities.

The activities that are currently being conducted with program resources and how those resources are allocated are as follows:

<i>Activity</i>	<i>Dollars</i>	<i>FTE</i>
Program Management	\$1.3M	6
HPCC R&D IT Proposals	\$0.0M	0
Environmental Modeling Software Development	\$4.0M	3
R&D HPC Contract	\$3.0M	3

Acquisition Support	\$0.7M	1
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The HPCC program provides NOAA with necessary computational and network resources required to support continued advances in environmental modeling capabilities. Benefits of the HPCC program include:

- Improvements in short term warning and weather forecast systems and models,
- Enabling scientists to attack long-lead time problems associated with the physical processes that govern the behavior of the atmosphere and ocean,
- Maintaining NOAA's leadership position in understanding climate with applications towards critical issues such as hurricanes, drought, sea-level rise, and ice-free arctic, and
- Accelerating modeling and simulation activities and providing relevant decision support information on a timely basis for programs such as the multi-agency Climate Change Science Program.

Schedule and Milestones:

FY 2013

- Update Flow-following finite-volume Icosahedral Model (FIM) global model and updates for operations

FY 2014

- Make decision on whether or not to exercise next 4 year contract option for R&D HPC support services
- Update FIM global model for operations
- Develop 1 km non-hydrostatic Atmospheric General Circulation Model (AGCM)
- Develop 1/50° Ocean General Circulation Model (OGCM)
- Develop high resolution climate/carbon/ice model for Polar Regions for decadal prediction capability for Arctic, assessment of potential for Arctic feedbacks to accelerate global warming, and more accurate estimates of sea level rise rates

FY 2015

- Update FIM global model and updates for operations

FY 2016

- Update FIM global model and updates for operations

Deliverables:

- HPC System availability – Maximum number of computational hours made available to scientists.

Performance Goals and Measurement Data:

Performance Measure:	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
HPCC / R&D System Availability	Actual	Target	Target	Target	Target	Target	Target
	99%	96%	96%	96%	96%	96%	96%
Description: Maintaining high system availability translates into providing NOAA scientists, researchers, and collaboration partners with the maximum number of computational hours available enabling them to conduct important R&D on an almost 24X7 basis. The HPCC program provides NOAA researchers with a reliable computing resource which allows them to plan, with a high degree							

of confidence, their project milestones and deliverables. System outages can adversely affect NOAA initiatives such as meeting the Intergovernmental Panel on Climate Change milestones or cause delays in implementing operational improvements for hurricane track and intensity predictions. Ensuring high system availability enables NOAA to maximize its investment in these resources.

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PROGRAM CHANGES FOR FY 2013:

Information Technology Research and Development: High Performance Computing and Communication (HPCC) (Base Funding: \$8,946,000 and 13 FTE; Program Change:

+\$3,432,000 and 0 FTE): NOAA requests an increase of \$3,432,000 and 0 FTE for a total of \$12,378,000 and 13 FTE to fund advanced networking R&D projects and increase the number of software development projects.

Proposed Actions:

This increase will allow the HPCC program to resume funding advanced networking R&D projects after suspending all funding for networking R&D projects in FY 2012 to accommodate the FY 2012 spend plan funding level. OAR also estimates that the requested funding will allow the program to double the number of software development projects that can be completed. In FY 2013, OAR plans to:

- Incorporate the Flow-following finite-volume Icosahedral Model (FIM) as a member of the operational global ensemble system;
- Incorporate the operational global ocean model (HYCOM) into the NOAA Environmental Modeling System which will allow NCEP to begin coupled atmospheric/ocean testing for numerical weather prediction medium range predictions;
- Continue development and testing of neural networks within the Global Forecast System;
- Continue development and testing of advanced numerical methods in the operational Global Forecast System to achieve higher resolution with minimal computational cost;
- Continue development and testing of a global non-hydrostatic unified modeling system for next generation NOAA operational application;
- Increase quality control levels for data used in the National Climate assessment and international assessments for Ozone and Intergovernmental Panel on Climate Change assessments; and,
- Release new coupled climate models and the component models which they comprise which include the Modular Ocean Model which is used in the operational climate forecast system.

Increased funding will also allow the program to make investments in the R&DHPCS computational infrastructure, facility, and network resources.

The table below shows the allocation of funding that includes the budget increase:

<i>Activity</i>	<i>Dollars</i>	<i>FTE</i>
Program Management	\$1.3M	6
HPCC R&D IT Proposals	\$1.4M	1
Environmental Modeling Software Development	\$5.4M	3
R&D HPC Contract	\$3.6M	2
Acquisition Support	\$0.7M	1

Statement of Need and Economic Benefits:

HPCC supports a number of objectives in NOAA's Strategic Plan through support of IT research targeted at improving NOAA's mission and services which expands the global understanding of

environmental science. The purpose of the HPCC program is to make major improvements in the Nation's ability to forecast the weather and climate, and to disseminate environmental information. At the same time, the program is aimed at stimulating the modernization of NOAA's computationally intensive services through the use of evolving high performance computing and high-speed networking technologies. Improvements in the accuracy and timeliness of NOAA's short-term weather warnings, seasonal forecasts, hurricane forecast improvements, as well as regional and global climate predictions are heavily dependent on major advances. These advances would include high-end computing power, advanced information technology, and the widespread availability of environmental data and information. Timely and responsive dissemination of NOAA's services and information requires full use of modern network and communication technologies. This program provides NOAA's focus for coordinating with external organizations and programs impacting the HPCC Program, through NITRD and its Interagency Coordinating Groups on Information Technology Research and Development (IT R&D), and by establishing agreements with other federal agencies to obtain additional computational cycles to support NOAA's environmental research activities.

Base Resource Assessment:

The base resources for this activity are described in the Information Technology Research & Development base narrative.

Schedule and Milestones:

FY 2013

- Fund approximately 11 HPC and advanced networking R&D projects
- Update Flow-following finite-volume Icosahedral Model (FIM) global model and updates for operations
- Parallelization of FIM dynamics for Intel MIC (type of GPU) to evaluate this technology
- GPU parallelization of WRF physics used in the NIM model
- Integrate global ocean model (HYCOM) into FIM using the NOAA Environmental Modeling System
- Develop and test the use of neural networks with the GFS
- Development and testing of advanced numerical methods in the operational Global Forecast System to achieve higher resolution with minimal computational cost development and testing of a global non-hydrostatic unified modeling system for next generation NOAA operational application
- Continued Quality Control of model data used in the National Climate assessment and international assessments for Ozone and Intergovernmental Panel on Climate Change assessments
- Release new coupled climate models

FY 2014

- Fund approximately 11 HPC and advanced networking R&D projects
- Update FIM global model for operations
- Develop 1 km non-hydrostatic Atmospheric General Circulation Model (AGCM)
- Develop 1/50° Ocean General Circulation Model (OGCM)
- Develop high resolution climate/carbon/ice model for Polar Regions for decadal prediction capability for Arctic, assessment of potential for Arctic feedbacks to accelerate global warming, and more accurate estimates of sea level rise rates

FY 2015

- Fund approximately 11 HPC and advanced networking R&D projects
- Update FIM global model and updates for operations

FY 2016

- Fund approximately 11 HPC and advanced networking R&D projects
- Update FIM global model and updates for operations

FY 2017

- Fund approximately 11 HPC and advanced networking R&D projects

Deliverables:

- HPC System availability – Maximum number of computational hours made available to scientists.

Performance Goals and Measurement Data:

Performance Measure:	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Number of software development projects completed for climate, weather and water environmental R&D	Actual	Target	Target	Target	Target	Target	Target
With increase	N/A	N/A	8	8	8	8	8
Without increase	8	4	4	4	4	4	4

Description: Each year the HPCC program funds software modeling development projects supporting NOAA’s environmental scientists. These models run on NOAA’s R&D supercomputers. These modeling efforts are focused on many different disciplines including climate change supporting the IPCC, hurricane forecast improvement, and advances in models supporting weather forecasting. Other OAR performance measures have direct dependencies on these modeling efforts.

Performance Measure:	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Number of R&D Information technology innovation projects initiated and completed.	Actual	Target	Target	Target	Target	Target	Target
With Increase	N/A	N/A	11	11	11	11	11
Without increase	17	0	0	0	0	0	0

Description: Each year the HPCC program sponsors a program to promote innovation in information technology across all elements of NOAA supporting NOAA’s many missions. The goal in the program is identify promising new and innovative technologies or uses for existing technologies that can rapidly be adopted into operational settings supporting NOAA. See <http://www.cio.noaa.gov/HPCC/innovation/index.html> for more details about this program and its results over the years. More funding was available in FY 2011 than in FY 2012, resulting in more projects being supported that year.

Performance Measure:	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Number of Networking and Information Technology Research and Development (NITRD) interagency activities that NOAA actively participates in	Actual	Target	Target	Target	Target	Target	Target
With Increase	N/A	N/A	5	5	5	5	5

Without increase	5	3	3	3	3	3	3
<p>Description: NOAA has traditionally been an active participant in the White House Office of Science and Technology NITRD program. Funding from HPCC allows NOAA to participate in several NITRD interagency working groups including High End Computing, Human computer interaction and information management, Large scale networking, Software Design & Productivity. The NITRD activity has resulted in many benefits for NOAA including obtaining millions of additional hours of computing on other agency supercomputers as well as facilitating improvements to NOAA's wide area networking capabilities.</p>							

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Office of Oceanic & Atmospheric Research

Subactivity: Information Technology R&D

Object Class	2013 Increase
11 Personnel compensation	
11.1 Full-time permanent	\$0
11.3 Other than full-time permanent	0
11.5 Other personnel compensation	0
11.8 Special personnel services payments	0
11.9 Total personnel compensation	0
12 Civilian personnel benefits	0
13 Benefits for former personnel	0
21 Travel and transportation of persons	0
22 Transportation of things	0
23.1 Rental payments to GSA	0
23.2 Rental Payments to others	0
23.3 Communications, utilities and miscellaneous charges	0
24 Printing and reproduction	0
25.1 Advisory and assistance services	0
25.2 Other services	0
25.3 Purchases of goods & services from Gov't accounts	0
25.4 Operation and maintenance of facilities	0
25.5 Research and development contracts	3,432
25.6 Medical care	0
25.7 Operation and maintenance of equipment	0
25.8 Subsistence and support of persons	0
26 Supplies and materials	0
31 Equipment	0
32 Lands and structures	0
33 Investments and loans	0
41 Grants, subsidies and contributions	0
42 Insurance claims and indemnities	0
43 Interest and dividends	0
44 Refunds	0
99 Total obligations	3,432

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APPROPRIATION ACCOUNT: PROCUREMENT, ACQUISITION, AND CONSTRUCTION
SUBACTIVITY: OAR SYSTEMS ACQUISITION

The objective of this sub-activity is to provide sustained capability of the NOAA Research and Development High Performance Computing System in order to advance climate science and accelerate the development of regional and sub-regional information products and services.

NOAA's Research & Development High Performance Computing System (R&D HPCS) provides computational resources to support advances in environmental modeling crucial for understanding some of the most critical climate issues of today. This investment includes the supercomputing systems, associated storage devices, advanced data communications, security, and necessary data center space. NOAA's R&D HPCS leverages world-class research staff and modeling capabilities now in place at NOAA to address important research problems in climate and weather research. NOAA's on-going model development is advancing the climate research program through NOAA computational research and collaboration with the inter-agency and academic climate research community. The American Recovery and Reinvestment Act funding enhanced NOAA's R&D HPCS, accelerating NOAA's capabilities to provide climate information to decision-makers at regional and state levels.

Schedule and Milestones:

FY 2013

- Improved understanding decadal-to-centennial climate change, variability and predictability, and increasing confidence in climate projections, using coupled-climate model (CM2.5) at 4 times the resolution of recent IPCC-class coupled climate models.

FY 2014

- Robust simulations of regional climate change around the world (including tropical storms) using 25-km resolution global atmospheric model.

FY 2015

- Upgrade Gaea R&D HPCS system at Oak Ridge National Laboratory
- Improved realism of the NOAA Earth System Models by closing the nitrogen cycle, and major feedback on the global carbon cycle.
- Reduction in percentage uncertainty in possible twenty-first century sea level rise

FY 2016

- Upgrade storage capacity of climate model data archive
- Development of initial physical formulations to incorporate soot and dust aerosol impacts on snow and ice albedo in climate models, and improved sea ice models essential to developing a predictive understanding of Arctic climate change.

FY 2017

- Enhanced contributions to assessments of human impacts on climate through inclusion of more realistic physical processes & important feedbacks in climate models, and analysis of causes of past climate change; greater confidence in projections of regional climate impacts.

Deliverables:

- Sustained high availability of the NOAA R&D High Performance Computing system
- Improved credibility of projections of changes of important climatic quantities, such as regional climate change and extreme events, to allow society to efficiently plan for and adapt to climate change.
- Major contributions of model data to the Program for Climate Model Diagnosis and Inter-comparison, in support of national and international climate assessments.

- Capability to develop and provide decadal prototype forecasts and predictions made with high-resolution coupled climate model.

Performance Goals and Measurement Data:

Performance Measure:	FY						
HPCC / R&D System Availability	2011	2012	2013	2014	2015	2016	2017
	Actual	Target	Target	Target	Target	Target	Target
	99%	97%	97%	97%	97%	97%	97%

Description: Maintaining high system availability translates into providing NOAA scientists, researchers, and collaboration partners with the maximum number of computational hours available enabling them to conduct important R&D on an almost 24X7 basis. The HPCC program provides NOAA researchers with a reliable computing resource which allows them to plan, with a high degree of confidence, their project milestones and deliverables. System outages can adversely affect NOAA initiatives such as meeting the Intergovernmental Panel on Climate Change milestones or cause delays in implementing operational improvements for hurricane track and intensity predictions. Ensuring high system availability enables NOAA to maximize its investment in these resources.

Outyear Funding Estimates

Research Supercomputing	FY 2012 & Prior	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	CTC	Total
Change from FY 2013 Base		83	83	83	83	83	N/A	
Total Request	284,677	10,379	10,379	10,379	10,379	10,379	N/A	Recurring

PROGRAM CHANGES FOR FY 2013:

The following exhibit shows the summary object class detail for the Information Technology R&D program changes less than \$100,000. Please contact the NOAA budget office if details for any of these changes are required.

**PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)**

Activity : Office of Oceanic & Atmospheric Research PAC
Subactivity: Information Technology R & D

Object Class	2013 Increase
11 Personnel compensation	
11.1 Full-time permanent	\$0
11.3 Other than full-time permanent	0
11.5 Other personnel compensation	0
11.8 Special personnel services payments	0
11.9 Total personnel compensation	<u>0</u>
12 Civilian personnel benefits	0
13 Benefits for former personnel	0
21 Travel and transportation of persons	0
22 Transportation of things	0
23.1 Rental payments to GSA	0
23.2 Rental Payments to others	0
23.3 Communications, utilities and miscellaneous charges	0
24 Printing and reproduction	0
25.1 Advisory and assistance services	83
25.2 Other services	0
25.3 Purchases of goods & services from Gov't accounts	0
25.4 Operation and maintenance of facilities	0
25.5 Research and development contracts	0
25.6 Medical care	0
25.7 Operation and maintenance of equipment	0
25.8 Subsistence and support of persons	0
26 Supplies and materials	0
31 Equipment	0
32 Lands and structures	0
33 Investments and loans	0
41 Grants, subsidies and contributions	0
42 Insurance claims and indemnities	0
43 Interest and dividends	0
44 Refunds	0
99 Total obligations	<u>83</u>

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