National Oceanic and Atmospheric Administration
NOAA Research
Scientific Computing Support
006-48-01-13-01-3504-00-108-023
Operational Analysis
January 2006 – December 2006

Executive Summary

NOAA Research Mission Statement

To conduct research, develop products, and provide scientific information and leadership to foster NOAA's evolving environmental and economic mission.

NOAA Research Vision Statement

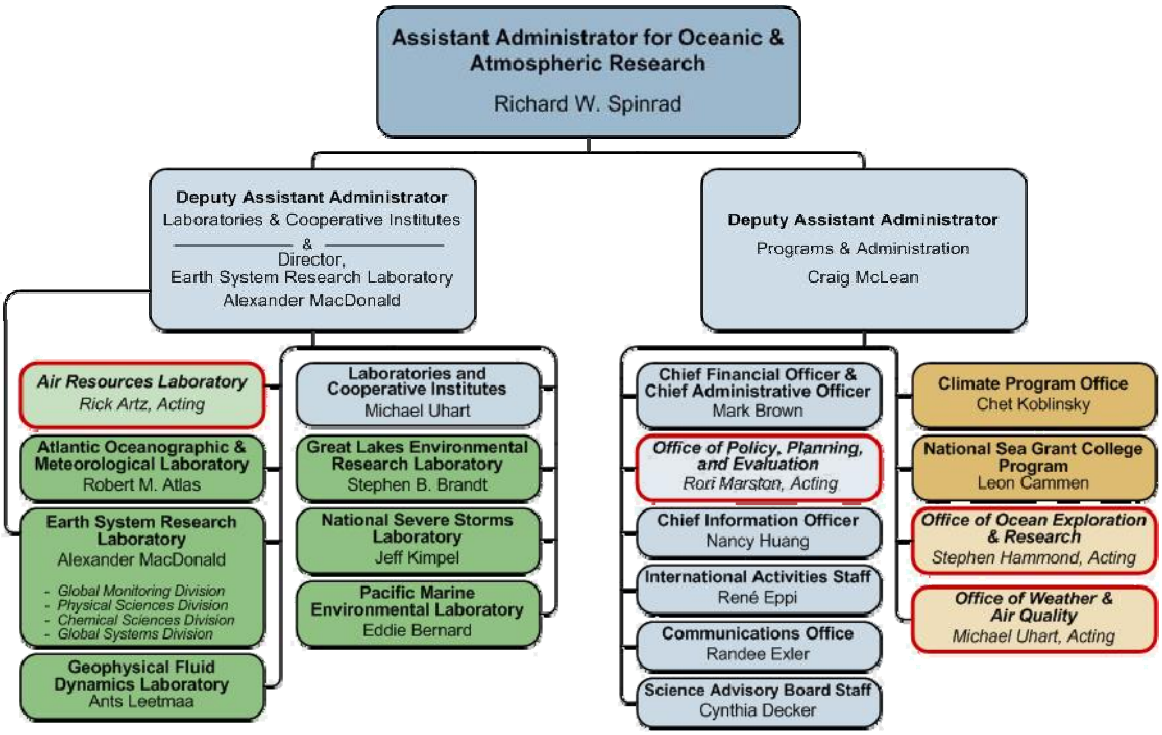
Societally relevant research that forms the scientific basis for more productive and harmonious relationships between humans and their environment.

NOAA Research activities contribute to NOAA's mission goals to:

- *Protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management,*
- *Understand climate variability and change to enhance society's ability to plan and respond,*
- *Serve society's needs for weather and water information, and*
- *Support the Nation's commerce with information for safe, efficient, and environmentally sound transportation.*

NOAA's research, conducted through the Office of Oceanic and Atmospheric Research (OAR), is the driving force behind NOAA environmental products and services that protect life and property and promote sustainable economic growth. Research, conducted by programs within NOAA and through collaborations outside NOAA, focuses on enhancing our understanding of environmental phenomena such as tornadoes, hurricanes, climate variability, changes in the ozone layer, El Niño/La Niña events, fisheries productivity, ocean currents, deep sea thermal vents, and coastal ecosystem health. NOAA research also develops innovative technologies and observing systems. The NOAA Research network consists of internal Research Laboratories, programs for Undersea Research and Ocean Exploration, a grants program through the Climate Program Office, external research at Sea Grant universities and programs, and Cooperative Joint Institutes with academia. Through NOAA and its academic partners, thousands of scientists, engineers, technicians, and graduate students participate in furthering our knowledge of natural phenomena that affect the lives of us all.

Appendix A provides a brief summary of the science performed by each Laboratory, named in the organization chart below.



1.0 Customer Results

1.1 Customer Requirements and Costs

NOAA's research serves diverse customers. The average citizen benefits through earlier warnings of threatening weather, healthier coasts and fisheries, or a broader understanding of environmental processes. The private sector uses NOAA data to make business decisions and also employs technology developed and transferred by NOAA scientists. Federal agencies, state governments, and local authorities rely on NOAA research expertise for the sound scientific basis of crucial policy decisions related to environmental protection and restoration strategies. NOAA researchers are recognized as international leaders on environmental issues. With their international counterparts, NOAA scientists contribute to the understanding and assessment of issues such as ozone depletion and climate variability which must be addressed worldwide to ensure success.

The scientific computing needed to support NOAA's research is a steady state investment. It is critical to provide an infrastructure that delivers Program products and services using information technology solutions that meet the needs of the science and the scientists.

IT Technical refresh is performed based on established industry practices, routinely on a 3 year cycle for desktops, and 4 years for server systems and communications equipment due to their higher cost. NOAA Research desktop operating systems include linux, MacIntosh, and Windows. According to Gartner **(Use Processes and Tools to Reduce TCO for PCs, 2005-2006 Update, 13 January 2006),** PC hardware and operating system choices are no longer the greatest determinants of PC total cost of ownership (TCO).

The implementation of policies, best practices and processes offers the main opportunities for enterprises to reduce the TCO of their PC installed base across its life cycle.

Very loosely coupled clusters can be created by combining together otherwise idle desktop computers in an ad-hoc cluster, thus allowing a dual use of certain resources. Such clusters allow researchers to use otherwise "wasted cycles" by combining computer resources that would be idle overnight to tackle specific jobs. In particular, ESRL has been running a loose cluster of 60 Macintosh desktop computers for the past 2 years which is managed as a desktop system and as a node in a loose cluster.

Environmental modeling applications are processor intensive, and when compute systems are replaced, compute cluster technology is purchased to ensure scalability and load balancing. A compute cluster is a group of loosely coupled computers that work together closely so that in many respects they can be viewed as though they are a single computer. The components of a cluster are commonly, but not always, connected to each other through fast local area networks. Clusters are usually deployed to improve performance and/or availability over that provided by a single computer, while typically being much more cost-effective than single computers of comparable speed or availability. Cost efficiencies can be achieved because a cluster does not have to be replaced when more processor power is needed – instead, it can grow by acquiring additional processors.

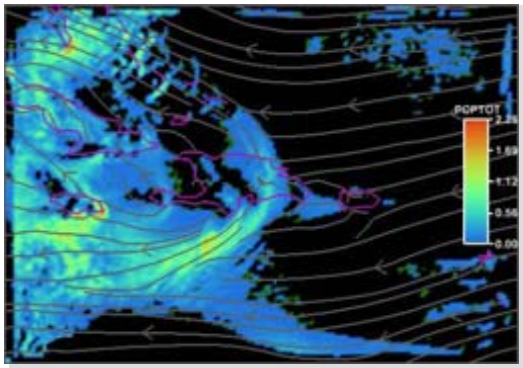
Appendix C provides a detailed description of NSSL's SGI Altix 3700 and the benefits of this technology. NSSL's cutting-edge WRF research is made possible by a 64-processor system with 128GB of memory and running SUSE® Linux Enterprise Server 10 from Novell®. SGI Altix is built on a massively scalable architecture, and today supports up to 1,024 processors under one Linux SSI. While Altix handles both distributed- and shared-memory applications, NSSL runs WRF in MPI mode, assigning specific tasks to each of the system's 64 Intel® Itanium® 2 processors to optimize production of the time-sensitive weather forecasts. With these runtime parameters, the Altix produces the daily high resolution 36-hour forecasts in about seven to eight hours, providing timely delivery to forecasters and leaving computer time to support related research and model development on the same system.

1.2 Performance Measures

NOAA Research has a direct impact on lives and property. Below are selective highlights from FY2006 project accomplishments that demonstrate performance results to the citizens of the US. These measures align with the "Customer Results Measurement Area" of the Performance Reference Model developed by the Federal Enterprise Architecture Program Managemenet Office (FEA-PMO).

- Discovered new factors that cause ozone pollution in the Houston, Texas area and observed that leaks of reactive gases from petrochemical refineries prevalent in the region are a much larger factor than were previously expected.

  Payoffs: NOAA's research findings regarding ozone pollution in the Houston area have altered the policy approach of Texas air quality managers, improving air quality forecasting in the area and saving 70,000 jobs and $10 billion for the state.



Pictured is a 12-hour rain forecast provided by the Weather Research and Forecasting (WRF) model. The WRF model will greatly increase the accuracy and specificity of such weather forecasts

- Established that forests and agriculture in North America may be sequestering a sizable fraction of the carbon dioxide produced by fossil fuel combustion in the US.

  Payoffs: This finding opens possibilities that forestry and agricultural practices may be modified to reduce the rate of increase of global carbon dioxide in the atmosphere.

- Implemented a new and innovative approach called an observational "testbed" method, which employs a suite of weather observation instruments to determine the best dataset that can be used to improve forecasts of precipitation and runoff in mountainous coastal regions. Such short-term forecasts in coastal areas are not as advanced as those in the interior U.S. because of limited offshore observations and the blockage of conventional weather radar beams by mountains.

  Payoffs: The focus on testing new observing capabilities in regional testbeds translates into improvements in NOAA's observing system and forecasts. The improved forecasts have been used, for example, to mitigate the effects of major floods over the U.S. west coast.

NOAA's Science on a Sphere™ enthralls both children and adults as they learn about the atmosphere, land, oceans, and biology of the "whole-Earth" system.

- Established a multiagency Developmental Test Center in Boulder to test new short-range numerical weather prediction techniques, which is initially focusing on the development of the Weather Research and Forecasting (WRF) model as both an operational model and as a research vehicle for the larger modeling community.

  Payoffs: The WRF model will greatly increase the accuracy and specificity of weather and air quality forecasts.

- Educated hundreds of students and parents about the changing Earth and its processes through Science on a Sphere^{TM}, which presents NOAA's global science in an exciting way through a three-dimensional representation of our planet as if the viewer were looking at the Earth from outer space.

  Payoffs: Science on a Sphere^{TM} has become a powerful and revolutionary system for educating the public on the holistic nature of the Earth's atmosphere, land, oceans, and biology.

2.0 Strategic and Business Results

2.1 NOAA Research Helps to Achieve Strategic Goals

Selected Research accomplishments that demonstrate NOAA Research's ability to help achieve NOAA Strategic Goals, across all goals:

- Developed tools to provide reliable air quality forecasts in the U.S.

- Advanced hurricane models and monitoring to significantly improve hurricane track and intensity forecasts used by local forecasters, emergency managers, and millions of US residents.

- Discovered a key component in the formation of the Antarctic ozone hole and continue long-term monitoring, modeling, and analysis benefiting policy makers focused on the recovery of the ozone layer.

- Improved understanding of oceanic uptake of carbon emitted from human activities and enhanced models detecting the effect of increased carbon dioxide to better understand and predict global climate change.

- Developed a method to detect the presence of human adrenovirus, a cousin of hepatitis A, in watersheds.

- Taught marine safety and survival to more than 4,000 fishermen in 65 Alaskan ports, reducing fatalities by 50% over a period of 10 years.

- Reduced the threat of aviation accidents due to in-flight icing on aircraft surfaces by developing a ground-based remote sensing system to detect hazardous icing conditions.

- Advanced modeling of Lake Michigan beach contamination, making progress towards development of water quality forecasts for drinking water, beach closures, and harmful algal blooms.

- Developed a seamless mosaic of all 130 National Weather Service radars across the U.S. to provide data on storms and precipitation to private sectors, universities, and government.

- Led the development of environmentally responsible aquaculture technology, stimulating the start-up of new companies, new products, and new jobs valued at more than $100 million and producing more than 100 tons of high-quality marine fish with minimal environmental impacts.

- Built international and interagency partnerships to observe and assess the dramatic environmental changes in the Arctic and their impact on U.S. weather and climate.

- Increased knowledge of the South Pacific Ocean during a 10,000 nautical mile international ocean expedition that discovered new species, determined new ranges for known species, and gathered data on undersea volcanoes and the rare interface of life based on sunlight with chemosynthetic organisms.

- Assisted in eradicating the invasive "killer seaweed" *Caulerpa taxifolia* in California.

- Advanced the Global Ocean Observing System to 51% completion and brought the global surface drifting buoy array to its 1250 buoy design goal, making it the first fully implemented component of the Observing System.
- Developed CM2, one of the world's best coupled climate models, and used CM2 to provide nearly 500 GB of data for the International Panel on Climate Change Fourth Assessment Report on Climate Change.

- Accurately predicted a 1 centimeter tsunami off the coast of Oregon on June 14, 2005, demonstrating the value of a Tsunami Forecast System prototype for improving the speed and accuracy of tsunami warnings.

- Contributed to developing an operational forecast tool for 6-10 and 8-14 day probabilistic climate forecasts.

- A new study has clearly demonstrated the impact of the Atlantic Multidecadal Oscillation (AMO) on regional climate over Africa, India, Western Europe and North America. A warm phase of the AMO (warm North Atlantic ocean) leads to enhanced summer rainfall over India and the Sahel region of Africa, positive temperature anomalies over the United States and Western Europe, and atmospheric circulation changes that may be conducive for hurricanes. It is hypothesized that the AMO is related to slow fluctuations in Atlantic Ocean circulation. This finding is crucial to improving our understanding of the causes and impacts of Atlantic variablity. (*Zhang and Delworth, 2006, Geophysical Research Letters, Vol 33, L17712,doi:10.1029/2006GL026267*.)

- Simulations of the Southern Ocean with state-of-the-art climate models have been analyzed. Due mainly to errors in the simulation Southern Hemisphere atmospheric jet stream, the Southern Ocean simulation is relatively poor in most models. Since the Southern Ocean is the region where most of the oceanic heat uptake occurs when the climate changes, the poor simulation increases the uncertainty associated with projections of future climate change. (*Russell et al., 2006, Importance of oceanic heat uptake in transient climate change. Geophysical Research Letters, 33(17), L17704, doi:10.1029/2006GL027242*.)

- Analysis of the IPCC/AR4 climate model simulations by the world's climate models, conducted by GFDL scientists and collaborators, have isolated many robust aspects of the hydrological and

circulation responses to global warming in these models and provided simple physical arguments supporting the plausibility of these responses. These responses include strong subtropical drying, weakening of large-scale tropical circulations, including the Walker circulation, and poleward expansion of the circulation. Feedback analyses designed by GFDL scientists have shown that, contrary to conventional wisdom, nearly all models generate positive cloud feedback.

- GFDL's Data Portal is used to serve climate model data to the research community. Over 10,000 gigabytes of data is currently available, primarily from experiments conducted for the IPCC Fourth Assessment Report. During the past year, over 600 individual users have made over 54,000 requests for data and have downloaded approximately 12,000 gigabytes of data.

2.2 Business Results

2.2.1 Program Management and Controls

At the NOAA level, the NOAA's Program Planning and Integration (PPI) and Programming, Analysis and Evaluation (PA&E) offices provide management oversight from Planning to Programming to Budgeting to Execution (PPBES) using the PPBES process. At the Line Office level, the Climate Program Office provides management oversight for the Climate Goal Programs (Observations and Analysis, Climate Forcing, Projections and Predictions, Ecosystem, Regional Decision Support).

2.2.2 Monitoring Cost, Schedule and Performance

Program funding increases to meet planned Program Initiatives are requested through the NOAA PPBES process. Each PPBES Program capability in the Program Operating Plans (POPs) provides cost, schedule, and performance information.

Quarterly, Quad Charts are prepared for the NOAA Budget Office to track Cost, Schedule, and Performance, and update the NOAA CFO and PA&E on Risks and Issues and mitigation strategies.

Below is a sample form the Observations and Analysis POP submitted in April 2006.

Cost: POP Current Program Resources

	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	TC	BOE
CL-COA Observations									Attached Documents [0]	
Funding ($K)	57479	64824	66721	77721	90521	94021	94021	94021		
FTE	175.5	182	182	189	193.5	193.5	193.5	193.4		e - Similar Projects or Activities
NOAA Corps	0	0	0	0	0	0	0	0		
Contractors (Total #)	172.5	183.5	193	251	286.5	291.5	291.5	291.5		
USCRN Stations Installed (Total #/yr)	0	18	16	7	0	0	0	0	114 FY 09 100%	
USHCN Sites Modernized (Total #/yr)	7	74	74	74	100	138	138	138	~1,000 FY 15 100%	
Soil Sensors (Moisture & Temperature) Installed as part of USCRN Station (Total #/yr)	0	0	12	18	21	21	21	21	114 FY 13 100%	
Integrated SEBN Stations Operational (Total #/yr)	0	0	1	1	1	1	1	1	~21 FY 13 100%	
AK CRN stations Installed (Total #/yr)	0	0	0	0	0	0	0	0	29 FY 13 100%	
GCOS Surface Stations Installed/Upgraded (Total #/yr)	0	4	4	4	4	4	4	4	~75 FY 24 100%	
GCOS Upper Air Stations Installed (Total #/yr)	0	0	2	4	4	4	4	4	~30 FY 16 100%	
TAO Buoys Refreshed (Total #/yr)	0	2	17	17	17	16	16	17		
RRS DCS: Stations Capable of Dual Launches (Total #/yr)	0	0	0	0	0	0	0	0		
RRS DCS: Dual Sonde Continuity Flights (Total #/yr)	0	0	0	0	0	0	0	0		

Schedule: POP Program Schedule

	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13
CL-COA Observations						Attached Documents [0]		
USHCN-M Spatial Distribution & Deployment Plan Completed		Q2						
Start USHCN-M Deployments		Q3 (start)						Q4 (done)
Complete USCRN Network Installations				Q4				
Deploy Soil Sensors at USRCN sites (NIDIS			Q1 (start)				Q4 (done)	
SEBN Spatial Distribution and Deployment Plan Completed		Q4						
GCOS Surface Stations OSE (spatial disribution/locations) Plan Completed		Q4						
GCOS Upper air Stations OSE (spatial distrinution/locations) Plan Completed			Q4					
Install SEBN Prototype Installed at EROS DC			Q3					
Begin SEBN Deployments				Q2 (start)				Q4 (done)
Refresh TAO Buoys (102 buoys)			Q1 (start)					Q4 (done)
TAO Transition to NWS NDBC Complete								Q4
Arctic Coastal Baseline Observatories - 4 operational						Q4		

Performance: POP Current Program Outputs

	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13
CL-COA Observations						Attached Documents [0]		
USCRN Stations Installed (Cumulative Total #)	73	91	107	114	114	114	114	114
USHCN Sites Modernized (Cumulative Total #)	7	81	155	229	329	467	505	643
Soil Sensors (Moisture & Temperature) Installed as part of USCRN Station (Cumulative Total #)	0	0	12	30	51	72	93	114
Integrated SEBN Stations Operational (Cumulative Total #)	0	0	1	2	3	4	5	6
AK CRN Stations Installed (Cumulative Total #)	0	0	0	0	0	0	0	0
GCOS Surface Stations Installed/Upgraded (Cumulative Total #)	0	4	8	12	16	20	24	30
GCOS Upper Air Stations Installed (Cumulative Total #)	0	0	2	6	10	14	18	22
TAO Buoys Refreshed (Cumulative Total #)	0	2	19	36	53	69	85	102
Number of RRS Transfer Functions computed and available (Cumulative Total #)	0	0	0	0	0	0	0	0

2.3 Reviews

OMB PART Reviews. The Climate Program was reviewed 2/6/2006. Individual component weights/scores: Purpose and Design (20%/80%); Planning (10%/90%); Management (20%/82%); Results (50%/74%) for an Average Score of 78.4%.

NOA/Department of Commerce Review Process.

March 2006. DOC Acquisition Review Board (ARB) review of the NOAA IT Consolidated Services (renamed STRIPES) in March 2006 and DPA approval in September 2006. This Infrastructure Optimization Initiative provides NOAA Research with a $67 million ceiling to meet current and planned business infrastructure and scientific computing infrastructure support services requirements. A projected phase-in schedule for task orders under this contract is planned over a 6 year period of performance. Services currently supported within the labs and allowed under this contract include HPC Programming Support, Help Desk for Scientific Computing Support, Programmatic Application Support, Environmental Modeling, IT Security (Architecture, implementation, internal testing, documentation, C&A coordination, O&M, and Contingency and D/R planning and testing), Technical Consulting Services (IT Studies, Assessments, Training), and the Boulder Campus Infrastructure Support (ESRL).

Budget Increase Review. IOOS (FY2008 initiative for $2.5M) for the following NOAA IOOS systems: National Current Observations, National Water Level Observation Network (NWLON), Physical Oceanographic Real Time System (PORTS) (C&T Goal); Coastal Marine Automated Network (C-MAN), DART, Weather Buoys, (W&W Goal); Coastal Change Analysis Program (C-CAP), a System-Wide Monitoring Program (SWMP) for National Estuarine Research Reserves (Ecosystems goal) to enable eight NOAA observing systems to be made inter-operable consistent with guidance provided in the Ocean US Data Management and Communications (DMAC) plan.

NOAA Research Review Process.

NOAA CIO Review Process. Each lab is represented by a Senior IT Manager. The Senior IT Managers meet annually face-to-face, monthly via VTC, and weekly via teleconference with the NOAA Research CIO and staff to discuss the management and technical issues and challenges associated with DOC and NOAA policy as it impacts NOAA Research enterprise IT planning, IT security/information assurance, acquisition strategies, and web presence. The Technical Committee for Computing Resources (TCCR) meets at least annually to evaluate and share technical solutions across labs.

Laboratory Review Process. IT investments are reviewed by lab project managers to determine if Program benefits have been realized in areas such as lowered cost, reduced cycle time, increased quality, additional quantity of services, and increased speed of service delivery. Technology maintenance and refreshment is applied, if indicated in post implementation reviews, based on the following indicators, for COTS software, scientific desktop systems, applications, and server/networking equipment and services:

- upgrades - dependencies are vendor announcements of new technology and industry trends (e.g., Linux verses proprietary operating systems);

- refreshers - includes reaching a predefined age, component failure, repeated maintenance calls on the component failure to meet the system requirement, mission failure, planned obsolescence of the component resulting in the vendor's inability to maintain the component, vendor has gone of business or been acquired;

- insertion - dependencies are vendor or developer announcements of a product line that meets or increases component capability, vendor or developer announcements of a product line that decreases cost industry trends (e.g. Linux vs. proprietary operating systems), announcements of a milestone of research and development effort resulting in a new capability that can be applied to the laboratory or Program Office.

IT investments are refreshed with the periodic replacement of COTS components; e.g., processors, displays, computer operating systems, commercially available software (CAS), and communications capabilities within larger systems to assure continued supportability of that system through an indefinite service life under the following criteria:

- existing system component has malfunctioned and either cannot be repaired, or the repair costs exceed the replacement costs,

- existing system component has reached its life expectancy

- surrounding technical infrastructure has evolved and is incompatible with the existing component under consideration,

- newer technology has come to market that provides more capability for the same or lower Total Cost of Ownership, and

- requirements of the system have evolved to the extent that the system cannot meet the requirements with the existing technology

2.4 **Security**

The NOAA Research Scientific Computing Support system is accredited under requirements spelled out in NOA 212-13 (08/06/90) that is based on OMB and NIST guidance. System Security Plans, Risk Assessments, and Contingency Plans were certified and accredited for all systems that are components of the NOAA Research Scientific Computing Support system in September of 2005. Management, operational, and technical security controls are adequate to ensure the confidentiality, integrity and availability of information.

All OAR systems contributing to the NOAA Research Scientific Computing Support system are scheduled to be re-certified and re-accredited by FY08 (with half being completed in FY07). All

systems are continuously monitored for security incidents by the NOAA Computer Incident Response Team (N-CIRT) and undergo quarterly vulnerability assessments and annual self-assessments of all security controls.

2.5 Performance Measures

Performance management at the NOAA corporate level consists of a suite of performance measures called Corporate Performance Measures (CPMs). These performance measures help the NOAA Administrator and senior management ensure the organization is moving towards strategic planning goals and outcomes, and organizational priorities. CPMs focus on high-level Program and Goal outcomes and the performance objectives that lead to these outcomes. They should serve to communicate NOAA's corporate performance to external audiences and provide a basis for the internal evaluation of NOAA's progress to plan.

Year	Area	Category	Grouping	Indicator	Baseline	Planned	Actual
2006	Mission and Business Results	Environmental Management	Environmental Monitoring and Forecasting	Climate Observation and Analysis: Integrated Ocean Observing System (IOOS) Implemented	55%	55%	57%
2006	Mission and Business Results	Environmental Management	Environmental Monitoring and Forecasting	Climate Observation and Analysis; Climate Data Records (CDRs) Operational	0	3 at level 3	3 at level 3
2006	Mission and Business Results	Environmental Management	Environmental Monitoring and Forecasting	Improved estimates of the magnitude, associated error, and sources of variability on atmospheric forcing agents	21	34	34
2006	Mission and Business Results	Environmental Management	Environmental Monitoring and Forecasting	Increase contribution to national and international climate-relevant products and assessments	.03	.2	.2
2006	Mission and Business Results	Environmental Management	Environmental Monitoring and Forecasting	U.S. temperature forecasts (cumulative skill score ove the regions where predictions are made)	17.7	18	25
2006	Mission and Business Results	Environmental Management	Environmental Monitoring and Forecasting	Increased number of ecological forecasts and living marine resource assessments used by managers that incorporate indices of climate variability and change	0	1	1
2007	Technology	Information and Data	External Data Sharing	Customer public access to GODAE products and services	2006 - 0%	2007 - 80% 2008 - 90% 2009 - greater than 90% 2010 - greater than 90% 2011 - greater than 90%	

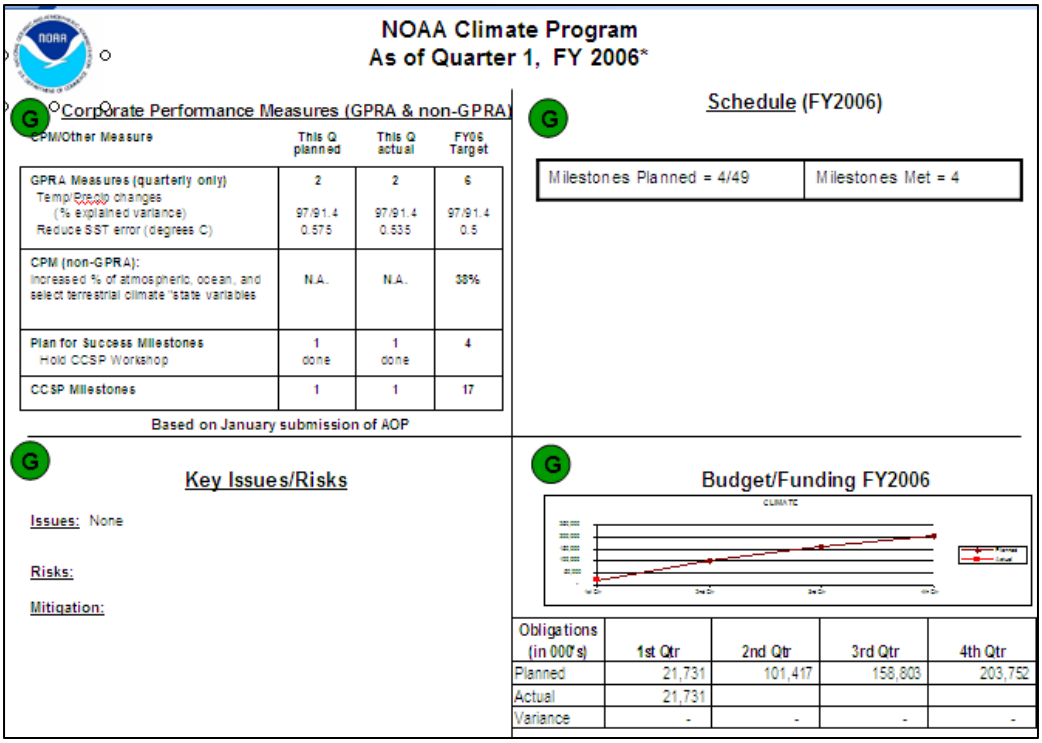
3.0 Financial Performance

3.1 Current Performance vs. Baseline

NOAA Research's Financial Management System (FDMS) tracks commitment funding and uses data from the Commerce Financial Management System to track obligations and commitments. The FDMS system tracks funding down to the project level for each laboratory.

3.2 Performance Measures

Via the PPBES Quad Chart reporting, program performance measures are mapped to project milestone activities, planned and obligated budget spending, and any risks or issues with associated mitigation strategies.



NOAA Climate Program
As of Quarter 1, FY 2006*

Corporate Performance Measures (GPRA & non-GPRA)

CPM/Other Measure	This Q planned	This Q actual	FY06 Target
GPRA Measures (quarterly only)	2	2	6
Temp/Precip changes (% explained variance)	97/91.4	97/91.4	97/91.4
Reduce SST error (degrees C)	0.575	0.535	0.5
CPM (non-GPRA): Increased % of atmospheric, ocean, and select terrestrial climate 'state' variables	N.A.	N.A.	38%
Plan for Success Milestones: Hold CCSP Workshop	1 done	1 done	4
CCSP Milestones	1	1	17

Based on January submission of AOP

Schedule (FY2006)

Milestones Planned = 4/49	Milestones Met = 4

Key Issues/Risks

Issues: None

Risks:

Mitigation:

Budget/Funding FY2006

Obligations (in 000's)	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
Planned	21,731	101,417	158,803	203,752
Actual	21,731			
Variance	-	-	-	-

3.3 Cost Benefit Analysis

In 2006, NOAA CIO Office implemented a process by which the PPBES Goal Team Leads annually provide planned costs for IT. The responses to the cost matrix are coordinated by the Goal Team Leads (e.g., Climate Program Office) and are intended to be used to assess the impact of alternatives proposed to meet gaps in Program capabilities. IT planning costs are estimated in parallel with the Program Operational Plans (POPS) planning phase of the PPBES process.

Climate Goal IT FY2009 Planning Estimates are included as a table below.

Area	Measure	Cost/Unit	CLF	CPP	RDS	COA
Archiving	Terabytes	$1,100	$4,748.00	$69,609.38		$11,178,200.00
Data Networks (LAN)	Employees	$240	$43,224.00	$42,000.00	$3,960.00	$135,016.00
Desktop Management	Employees	$4,100	$738,410.00	$86,390.00	$67,650.00	$192,700.00
Enterprise Architecture	Employees	$110	$19,811.00	$133,506.82	$1,815.00	$1,705.00
*High Performance Computing						$800,000.00
IT Security	Employees	$1,900	$102,836.00	$927,876.97	$31,350.00	$490,250.00
Metadata	N/A	N/A	$901.00	$132,241.82	N/A	$212,279.00
NOAAnet	Employees	$720	$71,668.00	$70,410.00	$1,188.00	$201,352.00
Tech Refresh (Desktops/Laptops)	Employees	1/4 * $2000	$41,250.67	$66,720.00	$30,000.00	$148,069.33
Tech Refresh (Server)	1/3 #	10K-50K	$25,762.00	$47,883.00	$3,333.33	$1,444,775.00
Tech Refresh (Mainframe)	1/3 to 1/5 #	200K-1M				$3,333.33
Tech Refresh (Router)	1/5 #	8K-80K	$10,475.00	$42,620.00	$600.00	$47,703.60
Tech Refresh (Switch)	1/5 #	5K-70K	$20,559.00	$82,925.00	$16,250.00	$53,685.00
Tech Refresh (storage)	1/3 to 1/5 #	10K-1M	$23,416.00	$42,187.50	$2,812.50	$1,263,935.50
Telecom	Employees	$480	$86,448.00	$84,000.00	$7,920.00	$270,032.00
Web Presence	Employees	$320	$57,632.00	$56,000.00	$5,280.00	$179,688.00
Workforce Collaboration	Employees	$535	$96,353.00	$93,625.50	$8,827.50	$225,181.50
TOTAL $20,350,381.26			$1,343,493.67	$1,977,995.99	$180,986.33	$16,847,905.27

*The IT Planning Matrix Data Call is at the Climate Goal level. Includes HPC budget for all associated IT costs for Tech Refresh. The HPC budget is not part of the Scientific Computing Support E300. These planning costs are included instead in the NOAA R&D High Performance Computing E300.

3.4 Financial Performance Review

On an annual basis, the Senior IT Managers report to the lab Director to identify technical refresh requirements for software, hardware, and services to meet steady state operations within the laboratory's baseline IT budget. These requirements are prioritized and implemented as budgeted.

4.0 Innovation to Meet Future Customer Needs

Onsite partnerships provide a unique opportunity for close collaboration, while sharing infrastructure costs, equipment, and personnel to make better use of technology and lower operating costs.

Facilities. NSSL recently joined other weather researchers and partners in the new National Weather Center, a $67 million severe weather research and forecasting complex designed to increase collaboration and communication within the weather community. The NOAA Weather Partners, located in Norman, Oklahoma, are five federal government organizations involved in severe weather research, forecasting and support. They are: National Severe Storms Laboratory, National Weather Service Forecast Office, NEXRAD Radar Operations Center, Storm Prediction Center and Warning Decision Training Branch.

Technology. PMEL has the capability to collect oceanographic data from any depth at any location in the world's oceans and distribute these data in real-time over the internet. For example, real-time data, products and analyses from moored ocean buoys for improved detection, understanding and prediction of El Niño and La Niña can be displayed and delivered via the internet. (http://www.pmel.noaa.gov/tao/index.shtml)

Technology. Within the past year, NOAA Research Headquarters leadership implemented Video TeleConferencing capability for the organization, helping to reduce travel time and the expenses associated with business meetings (per diem, hotels, etc.). This has allowed NOAA Research to conduct conferences with groups of employees or constituents across the country. NOAA Research's dedicated VTC system includes all required components packaged into a sing piece of equipment. This includes a remote-controlled high quality video camera containing all electrical interfaces, a control console, and software or hardware-based codes necessary for a robust telecommunication. For audio, omnidirectional micro phones are connected to the console.

4.1 Number and Types of Users

The fiscal year 2006 enacted budget for OAR totalled $379.9M. The fiscal year 2007 President's budget request for OAR is $348.7M. OAR has 698 permanent Federal employees and hundreds of cooperative institute and contract employees.

Within NOAA, cross collaboration is across Line Offices (NWS, NESDIS, NOS, and NMFS) in support of other NOAA Programs such as **NOAA's National Marine Sanctuary Program.**

Partnerships also include other Federal agencies such as National Aeronautics and Space Administration and the U.S. Department of Energy.

Other partnerships include the National Center for Atmospheric Research (NCAR), a National Science Foundation federally funded research and development center.

And university partnerships, such as the Western Water Assessment. (http://wwa.colorado.edu/about/index.html).

The Assessment was created in 1999 and is a joint effort between the Cooperative Institute for Research in Environmental Sciences at the University of Colorado and the National Oceanic and Atmospheric Administration's Climate Diagnostics Center. Both entities are located in Boulder, Colorado. The WWA director and 2 research associates are both housed in ESRL/PSD.

Each laboratory is also co-located, under a DOC/NOAA/OAR Formal Research Partnership, with a Joint and Cooperative Institute.

Over the past thirty two years, the Department of Commerce (DOC), National Oceanic and Atmospheric Administration (NOAA), Office of Oceanic and Atmospheric Research (OAR) through its NOAA Research Laboratories has developed research partnerships to form the Joint Institutes. Each of these Joint and Cooperative Institutes are formal, collaborative long-term research partnerships established under a Memorandum of Understanding (MOU)/Agreement (MOA) between NOAA through the Office of the Under Secretary of Oceans and Atmosphere and participating universities and non-profit research institutions with programs dedicated to oceanographic and/or atmospheric research, education and outreach. By design, most of the Institutes are geographically co-located with one or more NOAA facilities to promote scientific interchange and collaboration.

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 relevant to understanding the Earth's oceans, the Great Lakes, inland waters, Arctic regions, solar terrestrial environment, intermountain west and the atmosphere. These partners provide a pooling of resources for studies to produce the best possible interdisciplinary scientific research and outreach. These exceptionally worthwhile undertakings are substantial, long enduring and represent a synergy that has brought together NOAA, premier academic and oceanographic institutions in a mutually beneficial arrangement to address issues of national and international significance unique to these partnerships.

For detailed information see Appendix B

4.2 Funding Levels

Finding efficiencies to do more with the same amount of resources.

For FY2006, the breakout for the E300 SCS IT costs were: 4% for software; 14.5% hardware; 33.5% services; and 48% other (facilities and other). Of those costs, 8.9% were for IT Security.

Software Licensing and Maintenance. All of NOAA has benefited from NOAA Research's efforts to work with the NOAA Acquisition Community and COTS software publishers in negotiating enterprise software licensing BPAs and Contracts. These products can be costly since they serve a "niche" market of scientists and researchers.

For example, NOAA holds a contract for Interactive Data Language (IDL) – software for data analysis, visualization, and cross-platform application development. The original 5 year contract for IDL software was awarded in 2000 as site licensing to OAR and NESDIS. The contract was re-negotiated in 2006, and NWS NCEP was added as another "site". The commercial cost of a floating network license is $3,900; a single license is $3,000, and a node locked license $2,400; pricing includes one year of maintenance. Under this contract, the FY2006 annual renewal cost for over a 1000 programmers within these Line Offices was $128,000 (approximately $128 per user). NCEP's 200 users paid $175 for a license and a year of maintenance under the new contract. The cost avoidance for NCEP alone, at single license fees, was 58%.

Another cost-efficiency for enterprise software licensing is for Linux (the basic workstation entitlement is discounted 40% from list). ESRL's inventory alone requires licensing and maintenance support for 493 servers, 162 desktops, and 25 laptops. For more details about the BPA negotiated between RedHat's GSA preferred reseller, DLT Solutions, Inc. and the agreement with NOAA, visit http://www.nites.noaa.gov:8080/bpa/display.asp?bpaID=12 .

The NOAA CIOs as a team effort, out of their own IT budgets, fund the contract for ISIResearchSoft EndNote, ProCite, and Reference Manager publishing software. Researchers and librarians use EndNote to search online bibliographic databases, organize their references, images and PDFs in any language, and create bibliographies and figure lists instead of spending hours typing bibliographies, or using index cards to organize their references. EndNote is a valuable all-in-one publishing tool for both Windows and MacIntosh platforms. The site licensing annual renewal, which includes home use, costs $21,600. A single license is priced at $240.

Appendix A

Earth Systems Research Laboratory (ESRL) – http://www.esrl.noaa.gov/

The Earth System Research Laboratory's mission is to observe and understand the Earth system and to develop products through a commitment to research that will advance the National Oceanic and Atmospheric Administration's (NOAA's) environmental information and services on global-to-local scales. The work at the Earth System Research Laboratory includes:

- understanding the roles of gases and particles that contribute to climate change,
- providing climate information related to water management decisions,
- improving weather prediction,
- understanding the recovery of the stratospheric ozone layer, and
- developing air quality forecast models.

National Severe Storms Laboratory (NSSL) – http://www.nssl.noaa.gov/

NSSL studies severe and hazardous weather processes and develops tools to help National Weather Service forecasters, and federal, university and private sector partners use weather information more effectively.

The three research divisions - Forecast, Warning, and Radar - carry out NSSL's core science by blending resources, talent, knowledge and shared goals to:

- Develop enhancements to existing weather radar, and to design and test a new radar system.
- Develop and test tools to improve forecasts and warnings.
- Develop hydrometeorology tools for severe storm monitoring and prediction
- Carry out field research to improve the basic understanding of severe storm processes.

Pacific Marine Environmental Laboratory (PMEL) – http://www.pmel.noaa.gov/

PMEL carries out interdisciplinary scientific investigations in oceanography and atmospheric science. Current PMEL programs focus on open ocean observations in support of long-term monitoring and prediction of the ocean environment on time scales from hours to decades. Studies are conducted to improve our understanding of the world's oceans, to define processes driving the global climate system, and to improve environmental forecasting capabilities for public safety, marine commerce, and fisheries.

Ocean Environment Research

- Tsunami (hazard mitigation)
- VENTS (hydrothermal studies)
- FOCI (fisheries oceanography)
- SEBSCC (ecosystem studies)

Ocean Climate Research

- Argo Profiling Floats
- Atmospheric Chemistry
- Carbon Dioxide
- Chlorofluorocarbons
- TAO (buoy array)
- TMAP (equatorial ocean modeling)

Atlantic Oceanographic and Meteorological Laboratory (AOML) – http://www.aoml.noaa.gov/

AOML's mission is to conduct basic and applied research in oceanography, tropical meteorology, atmospheric and oceanic chemistry, and acoustics. The research seeks to understand the physical characteristics and processes of the ocean and the atmosphere, both separately and as a coupled system.

The Physical Oceanography Division of AOML carries out interdisciplinary scientific investigations in the field of Ocean and Climate. Specific research goals are: Determine the role of the ocean in long term climate change; Study ocean variability and its influence on short term climate and weather and to provide data analysis and assimilation tools for ocean prediction.

PhOD is a main partner in the development of a sustained Ocean Observing system for Climate to support NOAA mission requirements. As such the overall mission of the Physical Oceanography Division of AOML is to provide quality ocean data and products in a timely and cost-effective manner to satisfy NOAA nowcast, forecast, detection, attribution and research mission requirements.

The Hurricane Research Division (HRD) is a part of the Atlantic Oceanographic and Meteorological Laboratory (AOML). We are engaged in advancing the basic physical understanding and improving the forecasts of hurricanes and tropical meteorological systems. A key aspect of HRD's activity is its annual field program of flights aboard NOAA's research aircraft (two WP-3D turboprops and a Gulfstream IV-SP jet) flown by NOAA's Aircraft Operations Center.

The Ocean Chemistry Division (OCD) is one of the four scientific research divisions within the Atlantic Oceanographic and Meteorological Laboratory (AOML). The diverse Ocean Chemistry Division scientific staff is comprised not only of chemical oceanographers and atmospheric chemists but also biological oceanographers and geologists. OCD typically employs multi-disciplinary approaches to solve scientific research questions central to National Oceanic and Atmospheric Administration (NOAA) mission requirements. The division's work includes projects that are important both in enhancing our basic understanding of the coupled atmospheric/ocean system but also in assessing the current and future effects of human activities on the coastal and oceanic environments. Detailed information about specific research projects can be found within the major research areas section of this site.

Great Lakes Environmental Laboratory (GLERL) – http://www.glerl.noaa.gov/

GLERL was formed in 1974 to provide a focus for NOAA's environmental and ecosystem research in the Great Lakes. GLERL conucts high-quality research and provides scientific leadership to understand, observe, assess, and predict the status and changes of Great Lakes and coastal marine ecosystems to educate and advise stakeholders of optimal management strategies.

Presently GLERL's research resides under NOAA's Ecosystem Goal Team specifically in the Ecosystem Research Program. During its history, GLERL has made many important scientific contributions to the understanding and management of the Great Lakes and other coastal ecosystems. GLERL scientists thus play a critical role in academic, state, federal, and international partnerships, and GLERL research provides information and services to support decisions that affect the environment, recreation, public health and safety, and the economy of the Great Lakes and coastal marine environments. GLERL's main science issue areas are Physical Environment , Water Quantity, Water Quality, Human Health, Fish Recruitment and Productivity, and Invasive Species

Air Resources Laboratory (ARL) – http://www.arl.noaa.gov/

The Air Resources Laboratory (ARL) studies processes and develops models that relate to air quality and climate, concentrating on technology development and transfer relating to the transport, dispersion, transformation and removal of trace gases and aerosols (the exchange between the atmosphere and the surface), and the role of natural variability. The time frame of interest ranges from minutes to that of the global climate.

ARL research is aligned with the four thematic areas of NOAA Research; **weather and air quality**, **coastal and ocean resources**, **climate**, and **technology development and transfer**, with emphases on homeland security, coastal ecosystems, and arid-zone environments. The specific goal of ARL research is to improve and eventually to institutionalize prediction of air quality, atmospheric deposition, and related variables. ARL operates with research divisions in Idaho Falls, Idaho; Research Triangle Park, North Carolina; Las Vegas, Nevada; Oak Ridge, Tennessee; and Silver Spring, Maryland. On October 1, 2005, the Surface Radiation Research Branch in Boulder, Colorado, formerly a division of the Air Resources Laboratory, was merged into the Earth System Research Laboratory (ESRL).

Geophysical Fluid Dynamics Laboratory – http://www.gfdl.noaa.gov/

The goal of this research is to expand the scientific understanding of the physical processes that govern the behavior of the atmosphere and the oceans as complex fluid systems. These systems can then be modeled mathematically and their phenomenology can be studied by computer simulation methods. GFDL research concerns the predictability of weather on large and small scales; the structure, variability, predictability, stability and sensitivity of global and regional climate; the structure, variability and dynamics of the ocean over its many space and time scales; the interaction of the atmosphere and oceans, and how the atmosphere and oceans influence and are influenced by various trace constituents; the Earth's atmospheric general circulation within the context of the family of planetary atmospheric circulations.

The scientific work of the Laboratory encompasses a variety of disciplines including meteorology, oceanography, hydrology, classical physics, fluid dynamics, chemistry, applied mathematics, and numerical analysis. Research is also facilitated by the Atmospheric and Oceanic Sciences Program (AOSP), which is a collaborative program at GFDL with Princeton University. Under this program, regular Princeton faculty, research scientists, and graduate students participate in theoretical studies, both analytical and numerical, and in observational experiments in the laboratory and in the field. The program is supported in part by NOAA funds. AOSP scientists may also be involved in GFDL research through institutional or international agreements.

Appendix B

Number and Types of Users – University Partnerships

The Joint Research Institutes 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 relevant to understanding the Earth's oceans, the Great Lakes, inland waters, Arctic regions, solar terrestrial environment, intermountain west and the atmosphere.

Cooperative Institute for Arctic Research (CIFAR)
Fairbanks, AK--
CIFAR is designed to serve as a focal point for interactions between NOAA and the Arctic research community through the University of Alaska for research activities related to NOAA's tasks and responsibilities in the Arctic. CIFAR conducts research on a wide variety of issues critical to the Arctic, including fisheries oceanography, hydrographic studies and sea ice dynamics, atmospheric research, climate dynamics and variability, tsunami research and prediction, and environmental assessment and monitoring. CIFAR works closely with researchers from the eight countries of the Arctic Council on climate impact assessments, and is planning joint oceanographic cruises with Russia.

Cooperative Institute for Atmospheric Sciences and Terrestrial Applications (CIASTA)
Las Vegas/Reno, NV--
CIASTA is a cooperative institute among NOAA and the University and Community College System of Nevada (UCCSN). CIASTA is administered by the Desert Research Institute on behalf of the UCCSN. CIASTA brings a formalized focus to a number of research projects and programs encompassing weather research, climate, air quality and terrestrial ecosystems studies related to global change and hydrology and water supply in the arid regions typical of the intermountain West. CIASTA supports university researchers, postdocs and students.

Cooperative Institute for Climate Applications and Research (CICAR)
Palisades, NY--
CICAR is a cooperative institute between NOAA and Columbia University, New York. CICAR research themes include the modeling, understanding, prediction and assessment of climate variability and change; development, collection, analysis and archiving of instrumental and paleoclimate data; and development of the application of climate variability and change prediction and assessment to provide information for decision makers and assess risk to water resources, agriculture, health, and policy. CICAR brings together scientists from NOAA Laboratories, in particular the Geophysical Fluid Dynamics Laboratory in Princeton, New Jersey, and scientist of the Earth Institute at Columbia University, in particular the Lamont Doherty Earth Observatory.

Cooperative Institute for Climate and Ocean Research (CICOR)
Woods Hole, MA--
CICOR is a cooperative institute between NOAA and the Woods Hole Oceanographic Institution. The research activities of CICOR will be organized around three themes: the coastal ocean and near-shore processes, the ocean's participation in climate and climate variability, and marine ecosystem processes analysis. These theme areas, each of which has significant implications for human society, are interrelated, and scientific progress will require collaborations by scientists within and between disciplines. In each case, progress will depend on a combination of fundamental process studies, the development and deployment of technological systems for sustained observation, and the development of predictive models that are based on an understanding of the underlying processes and that assimilate information from observational systems.

Cooperative Institute for Climate Science (CICS)
Princeton, NJ--

CICS is built upon the strengths of Princeton University in biogeochemistry, physical oceanography, paleoclimate, hydrology, ecosystem ecology, climate change mitigation technology, economics and policy; and those of GFDL in modeling the atmosphere, oceans, weather and climate. CICS is an outgrowth of a highly successful forty-year collaboration between Princeton University's Atmospheric and Oceanic Sciences (AOS) Program and GFDL that contributed to the development of oceanic and atmospheric models, performed research on climate and biogeochemical cycling and educated several generations of postdoctoral researchers and graduate students. The establishment of CICS enhances and extends this long-term partnership by incorporating Princeton University faculty affiliated with the interdisciplinary Princeton Environmental Institute (PEI), thereby augmenting its expertise in the sciences, engineering and policy and facilitating new research collaborations.

Cooperative Institute for Limnology and Ecosystems Research (CILER)
Ann Arbor, MI--
CILER is a cooperative institute between NOAA and the University of Michigan with formal links to Michigan State University and other universities in the Great Lakes Basin. CILER's research activities are organized around five research themes: climate and large-lake dynamics; coastal and nearshore processes; large-lake ecosystem structure and function; remote sensing of large lake and coastal ocean dynamics; and marine environmental engineering. The Institute supports research scientists, postdoctoral research fellows, research support staff, and students at the University of Michigan and other Great Lakes universities.

Cooperative Institute for Marine and Atmospheric Studies (CIMAS)
Miami, FL--
CIMAS is a cooperative institute between NOAA and the University of Miami's Rosenstiel School of Marine and Atmospheric Sciences. Research is conducted within three themes--Climate Variability, Fisheries Dynamics, and Coastal Ocean Ecosystem Processes--in collaboration with ERL and the National Marine Fisheries Service. CIMAS supports 45 university researchers, postdocs, graduate students, and staff.

Cooperative Institute for Mesoscale Meteorological Studies (CIMMS)
Norman, OK--
CIMMS is a cooperative institute between NOAA and the University of Oklahoma. Research fields include basic convective and mesoscale forecast improvements, and climatic effects of controls on mesoscale processes, socioeconomic effects of mesoscale weather systems and regional scale climate variations. The Institute collaborates with the National Severe Storms Lab, and supports the NWS modernization efforts in Norman. CIMMS supports ~130 university researchers, postdocs, students, and staff.

Cooperative Institute for Research in the Atmosphere (CIRA)
Fort Collins, CO--
CIRA is a cooperative institute between NOAA and Colorado State University. The Institute conducts research involving global and regional climate, local and mesoscale area weather forecasting and evaluation, applied cloud physics, applications of satellite observations, air quality and visibility, societal and economic impacts, numerical modeling, and education, training and outreach. The Institute provides an interdisciplinary forum for research collaboration among university scientists/postdocs/staff/students and several NOAA laboratories and line elements including OAR (the Forecast Systems Laboratory and the Environmental Technology Laboratory, the NWS and the NESDIS (Office of Research Applications, Office of Satellite Development and the Data Centers).

Cooperative Institute for Research in Environmental Sciences (CIRES)
Boulder, CO--

CIRES is a cooperative institute between NOAA and the University of Colorado. The Institute conducts research in environmental chemistry and biology, atmospheric and climate dynamics, cryospheric and polar processes, and the solar-terrestrial environment, and brings together government and university researchers, post docs, and students from eight university departments and several NOAA laboratories in a wide-ranging array of scientific collaborations and interdisciplinary research.

Joint Institute for Marine and Atmospheric Research (JIMAR)
Honolulu, HI--
JIMAR is a cooperative institute between NOAA and the University of Hawaii. Research Foci include equatorial oceanography, climate research, tsunamis, fisheries oceanography , tropical meteorology and coastal research. In addition to its partnerships with OAR , JIMAR works closely with the Pacific Regions of the National Marine Fisheries Service and the National Weather Service as well as the Coastal Services Center, Honolulu. JIMAR supports 140 university researchers, post doc, students and staff. JIMAR is housed in the University of Hawaii School of Ocean and Earth Sciences and Technology as are two OAR partners; the Hawaii Sea Grant College Program and the Hawaii Undersea Research Laboratory.

Joint Institute for Marine Observations (JIMO)
La Jolla, CA--
JIMO, located on the Scripps La Jolla campus, is a joint institute between NOAA and the University of California's Scripps Institution of Oceanography. JIMO is collocated with the NOAA Southwest Fisheries Center and maintains collaborative programs with several of the NOAA Laboratories across the country, representing a wide range of mutual interests. The overall goal of JIMO is to create a center of excellence in which the state of the art observation capabilities such as platforms (surface, subsea, and air/spaceborne), sensors, and systems architecture of both NOAA and Scripps are utilized to fill pressing research needs. The specific themes reflect the particular strength at Scripps in the areas of coupled ocean-atmosphere climate research, blue water and littoral oceanography, marine biology/biological oceanography, marine geology and geophysics, and ocean technology. It also lends the strength of the Scripps large fleet of surface and subsurface platforms to the success of observation-based science for NOAA.

Joint Institute for the Study of the Atmosphere and Ocean (JISAO)
Seattle, Washington--
JISAO is a cooperative institute between NOAA and the University of Washington and complements the research at PMEL in climate variability, environmental chemistry, estuarine processes and interannual variability of fisheries recruitment. JISAO supports 35 university researchers, postdocs, and students.

Appendix C

The SGI Altix 3700 has allowed NSSL to make important scientific advances and to strengthen collaborative relationships with several research and operational partners. From a science perspective, this computer has enabled a wide range of research activities related to numerical weather prediction. For example, it has allowed us to make ground-breaking advances in data assimilation using the ensemble Kalman filter techniques. These advances are laying the foundation for a long-term "warn on forecast" strategy that will eventually allow us to assimilate small-scale weather phenomena (such as individual thunderstorms) into computer models. With this assimilation, the models can then be used to predict movement, evolution, and changes in intensity of these features, and hence their threat to life and property, with a high degree of accuracy. The SGI provides a unique combination of computing power, reliability, and functionality that this work requires, but is simply not available with other comparably priced options.

Scientific advances such as these occur most efficiently when there is collaboration with external scientists working on similar problems and with operational forecasters (the end users of computer model guidance). A primary motivation for purchasing the Altix was to promote collaboration between NSSL scientists and operational forecasters in the National Weather Center, and to strengthen ties with the meteorological community in Huntsville, AL, where similar efforts are underway to invigorate interactions between meteorological research and operations. Collaborating with scientists in Huntsville, we have established a real-time forecasting system on the Altix with a high-resolution configuration of the WRF (Weather Research and Forecasting) model. This modeling system runs daily at 0000 UTC and we have worked with IT experts at the Storm Prediction Center and the local NWS forecasting offices in Norman (OUN) and Huntsville (HUN) to import hourly forecasts. This data provides forecasters with a unique look at next-generation model capabilities and potential applications for their specific tasks. In turn, it gives forecasters the opportunity to provide valuable feedback to model developers about specific strengths and weaknesses of the model. Real-time modeling efforts such as these provide a common vested interest for researchers and forecasters and have proven to be exceptionally valuable because they promote interaction and collaboration between the two groups. This activity would not have been possible without the computing speed and dependability of the Altix.