

**National Oceanic and Atmospheric Administration  
 OCIO/HPCC  
 R&D HPCS  
 006-48-01-17-01-3804-00  
 Operational Analysis  
 2010**

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**Executive Summary**

The R&D HPCS provides the computational resources necessary to support continued advances in the environmental modeling capabilities and addresses other HPC requirements that may arise within NOAA and at other partner agencies. The R&D HPCS includes the HPC systems, complementary storage devices and interconnects, communications hardware interfaces, software, networking equipment, facilities, power, system maintenance, support services, IT security, and necessary infrastructure enhancements.

The program management support for this project is provided by the NOAA Office of the Chief Information Officer High Performance Computing and Communications Office. The on site management of the three R&D HPCS subsystems are provided by OAR/ESRL at Boulder, CO., OAR/GFDL at Princeton, NJ., and NWS/NCEP at Gaithersburg, MD.

This report focuses on the operational state of the program as of October 01, 2010, and is based on guidance developed by the Department of Commerce. The Research & Development (R&D) High Performance Computing System (HPCS) project directly facilitates NOAA's Strategic Goals to "Serve Society's Needs for Weather and Water Information" and "Understand climate variability and change to enhance society's ability to plan and respond".

The current project meets established cost, schedule and performance parameters.

This operational analysis (OA) is an annual, in-depth review of the program's performance based on the following:

- Customer Results
- Strategic and Business Results
- Financial Performance
- Innovation

## **1.0 Customer Results**

NOAA's R&D HPCS resources enable scientists to attack long-lead-time problems associated with the physical processes that govern the behavior of the atmosphere and the ocean. Advanced climate models are the only means for distinguishing between natural and forced climate variations, assessing future impacts, and hence providing a capability to adapt to climate change and to explore mitigation strategies. These models are crucial for understanding some of the most critical climate issues of today. Major economic decisions of national importance are being made on issues impacted by climate without being based on the best possible science.

These resources are utilized for a number of shorter-range meteorological research projects, including the development of next generation weather and climate forecast models, National Test Bed, and Satellite Data Assimilation projects. They will also facilitate applied meteorological research and development for purposes of improving and creating short-term warning and weather forecast systems, models, and observing technology.

### **1.1 Customer Requirements and Costs**

The R&D HPCS stake holders include members of the Environmental Modeling Program, High Performance Computing Board, NWS, OAR, researchers (weather and climate), NOAA CIO, AGO, NOAA CFOs, DOC CFO and CIO, NITRB, DOC IRB, NITRD, CSC, and Raytheon.

Each year the stakeholders are required to provide performance measures for the coming year. At the end of each year the stakeholders are asked to provide the actual results. The majority of the funding for this project is locked into multi-year fixed price contracts. Funding decisions are made and agreed to during the acquisition process by the stakeholders.

The majority of the contracts for this program are competitively awarded to ensure best value to the stakeholders.

## 1.2 Performance Measures

**Table 1: Customer Results Performance Measure**

| Measurement Area      | Indicator             | FY 10 Baseline | FY 10 Actual Result | Comments |
|-----------------------|-----------------------|----------------|---------------------|----------|
| Customer Requirements | System Availability   | 96%            | 99%                 |          |
|                       | Data Availability     | 98%            | 99.16%              |          |
|                       | % of Allocations used | 100%           | 96.32%              |          |

## 2.0 Strategic and Business Results

The R&D HPCS project is meeting its own goals and objectives as well as those of the agency. Program management and controls are in place to ensure the project continues to meet its goals and objectives and monitor how well the R&D HPCS project performs.

### 2.1 R&D HPCS Helps to Achieve Strategic Goals

The R&D HPCS supported these NOAA strategic goals:

- Weather and Water – Serves society’s needs for weather and water information
- Climate – Understand climate variability and change to enhance society’s ability to plan and respond

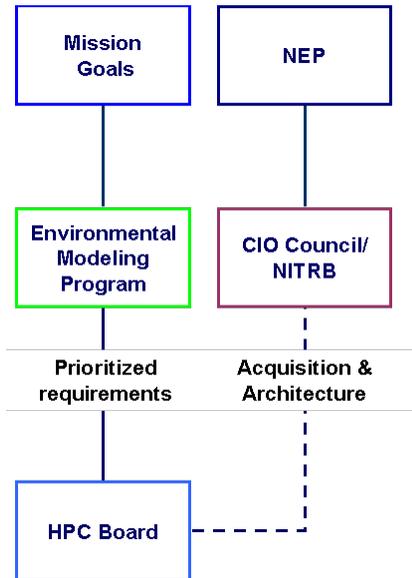
The R&D HPSC supports the following GPRA measures:

| GPRA Measures   | R&D HPCS Projects   |
|---|---|
| U.S. Seasonal Temperature Skill   | Climate Test Bed<br>Seasonal Climate Model R&D<br>Reforecasting R&D<br>Regional Analysis                |
| Precipitation Forecast Day 1 Threat Score   |   |
|   | HMTB<br>Joint Center for Data Assimilation<br>Next Generation Global Model Development<br>Rapid Refresh |
| Improve Society's ability to plan and respond to climate variability and change using NOAA climate products and information |   |
|   | Long-term climate model R&D<br>Climate scenarios (analysis and generation)<br>Climate model calibration |

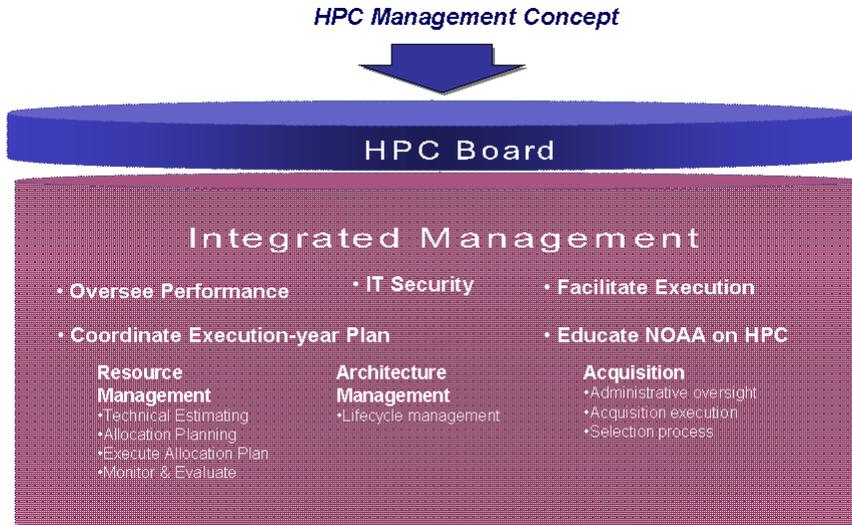
## 2.2 Business Results

NOA-216-110 “Management and Governance of High Performance Computing” describes how NOAA manages its High Performance Computing resources.

### 2.2.1 Program Management and Controls



The above diagram depicts how the R&D HPCS is managed. Requirements flow down from the mission goals to the EMP who then prioritizes and provides funding for those requirements and sends to the HPC Board for execution. The HPC Board is responsible for the acquisition and implementation of the appropriate architecture for meeting the EMP requirements. The HPC Board works with the NITRB on IT architecture planning and with the CIO Council on major acquisition issues. Any issues that cannot be resolved by the HPC Board and CIO Council are elevated to the NEP for resolution.



The HPC Board has established an Integrated Management Team (IMT) to manage the day to day operations of the project. The functions that the IMT performs are shown in the above diagram.

### 2.2.2 Monitoring Cost, Schedule and Performance

Cost – In FY10 several new contracts were implemented and an existing contract was extended for nine additional months in support of the program. All of the contracts were fixed price. These contracts were funded by a combination of base funding and ARRA funding. When vendors submit invoices for payments the COTRs check the invoice amounts against the fixed price cost proposals to make sure that the costs are consistent with the contracts.

Schedule – Each project has a detailed project schedule that is reviewed on a weekly basis by the project team. The program has an integrated schedule, which contains all of the project schedules, which is also reviewed on a weekly basis. Each month the schedule for the ARRA funded projects are briefed to the ARRA review board.

Performance – The program measures both system and data availability to track performance. Each month system and data availability statistics are reported. System availability is required to be 96% and data availability is required to be 98%. Help desk ticket statistics are also reported on a monthly basis. Each quarter a report is provided to the Environmental Modeling Program that measures the allocation usage of the systems by project.

### 2.3 Reviews

In FY10 status reports on the program were provided to the ARRA review board on a monthly basis.

Throughout 2010 the R&D HPCS PM has provided status briefings to the HPC Board.

Quarterly reports are provided to the Environmental Modeling Program.

## 2.4 Security

The R&D HPC system is accredited under requirements spelled out in NOA 212-13 (08/06/90) and are based on OMB and NIST guidance. System Security Plans, Risk Assessments, and Contingency Plans were certified and approved for the R&D HPCS in March 2010. Management, operational, and technical security controls are adequate to ensure the confidentiality, integrity and availability of information.

The R&D HPCS C&A was completed and approved on March 25, 2010  
Security control testing was completed on March 29, 2010.

## 2.5 Performance Measures

The performance measures in Table 2 show the contribution that the R&D HPCS project's performance made with respect to Mission and Business Results.

**Table 2: Business Results Performance Measures**

| FY   | Strategic Goal(s) Supported                                    | Measurement Area             | Category                 | Measurement Grouping                     | Measurement Indicator   | Baseline   | Target   | Actual Results  |
|------|--|------------------------------|--------------------------|--|---|--|--|---|
| 2010 | 3.2 Advance understanding of climate variability and change.   | Mission and Business Results | Environmental Management | Environmental Monitoring and Forecasting | Uncertainty in climate model projections remains higher than desirable                              | Implement at least one new or updated component into the Earth System Model                              | Decrease uncertainty in climate system processes and long term climate projections measured through improvements in Earth System models                          | GFDL Earth System models have incorporated COBALI, a biogeochemical model that includes higher trophic levels up to large zooplankton. Over 250 simulation years have been run in FY10.   |
| 2010 | 3.2 Advance understanding of climate variability and change.   | Mission and Business Results | Environmental Management | Environmental Monitoring and Forecasting | Perform climate model scenarios with physical climate and Earth System models, as resources permit. | Perform enhanced climate scenarios designed to address specific decision issues regarding climate change | Simulate 5000 equivalent model years towards the 5th Climate Model Intercomparison Project (CMIP5), in preparation for the IPCC AR5 on NOAA and DOE HPC systems. | Over 9000 equivalent model years was simulated towards the 5th Climate Model Intercomparison Project (CMIP5), in preparation for the IPCC AR5 on NOAA and DOE HPC systems.  |
| 2010 | 3.2 Advance understanding of climate variability and change.   | Mission and Business Results | Environmental Management | Environmental Monitoring and Forecasting | Contribute research findings to peer-reviewed literature  | Provide focused report based on climate scenarios  | Complete a study of the performance of the simulated ozone holes in coupled chemistry climate models worldwide   | This study was complete and a paper has been submitted to a peer-reviewed journal.  |
| 2010 | 3.3 Provide accurate and timely weather and water information. | Mission and Business Results | Environmental Management | Environmental Monitoring and Forecasting | Reduce by 20% in 10 years   | Hurricane Track Error  | Reduce by 25% in 10 Years  | Official hurricane forecast results are reported as part of the NWS GPRA at the end of the season - after November 30th, preliminary results indicate that expected results appear to be on track to meet the 10 year objective |
| 2010 | 3.3 Provide accurate and timely weather and water information. | Mission and Business Results | Environmental Management | Environmental Monitoring and Forecasting | Reduce by 8% in 10 years  | Hurricane Intensity Error  | Reduce by 12% in 10 years  | Official hurricane forecast results are reported as part of the NWS GPRA at the end of the season - after November 30th, preliminary results indicate that expected results appear to be on track to meet the 10 year objective |

**Table 3: Technology Performance Measures**

| FY   | Strategic Goal(s) Supported                                  | Measurement Area | Category                     | Measurement Grouping   | Measurement Indicator                             | Baseline | Target | Actual Results   |
|------|--|------------------|------------------------------|------------------------|---|----------|--------|--|
| 2010 | 3.2 Advance understanding of climate variability and change. | Technology       | Efficiency                   | Technology Improvement | ORNL Peak Computational Performance               | 0        | 260    | 260  |
| 2010 | 3.2 Advance understanding of climate variability and change. | Technology       | Information and Data         | External Data Sharing  | Number of sites connected                         | 0        | 2      | Two of the 4 sites have been connected (Princeton and Oak Springs). In FY 11 Boulder Camp Springs, and the new site in Fairmont WV are expected to be connected.   |
| 2010 | 3.2 Advance understanding of climate variability and change. | Technology       | Reliability and Availability | Availability           | ORNL System Availability                          | 0%       | 96%    | The ORNL system was delivered in 9/2010, however due to some stability issues the system has not been placed in a production mode as of this report, therefore no system availability numbers will be reported for FY10 they will be reported in FY11. |
| 2010 | 3.2 Advance understanding of climate variability and change. | Technology       | Reliability and Availability | Availability           | ORNL Data Availability                            | 0%       | 98%    | The ORNL system was delivered in 9/2010, however due to some stability issues the system has not been placed in a production mode as of this report, therefore no data availability numbers will be reported for FY10 they will be reported in FY11.   |
| 2010 | 3.2 Advance understanding of climate variability and change. | Technology       | Reliability and Availability | Availability           | % System Availability at Princeton                | 95%      | 95%    | 98.05%   |
| 2010 | 3.3 Provide accurate and timely weather and water            | Technology       | Reliability and Availability | Availability           | % System Availability at Boulder and Gaithersburg | 97%      | 97%    | 99.71%   |
| 2010 | 3.2 Advance understanding of climate variability and change. | Technology       | Reliability and Availability | Availability           | % Data Availability Princeton                     | 95%      | 95%    | 98.77%   |
| 2010 | 3.3 Provide accurate and timely weather and water            | Technology       | Reliability and Availability | Availability           | % Data Availability at Boulder and Gaithersburg   | 99%      | 99%    | 99.62%   |

Another measure that is used for this investment to gauge customer satisfaction involves measuring how much actual work is being performed by the users of the R&D HPCS. The Environmental Modeling Program (EMP) allocated 21 projects to the R&D HPCS for FY2010. EMP specifies the % of each sub-system that is allocated to each of these 21 projects. In FY10 these 21 projects have, on average, utilized 96.32% of their respective allocations. The 3.68% variance was in part attributed to interruptions in service that each system experienced during the course of the year

### 3.0 Financial Performance

#### 3.1 Current Performance vs. Baseline

| Milestone Number | Description of Milestone             | Total Cost    |               | Current Baseline |           | End Date  |           | Percent Complete |        |
|------------------|--------------------------------------|---------------|---------------|------------------|-----------|-----------|-----------|------------------|--------|
|                  |                                      | Planned       | Actual        | Planned          | Actual    | Planned   | Actual    | Planned          | Actual |
| 3                | <b>FY10 Annual Operations review</b> | \$108,724,000 | \$117,992,000 | 10/1/2009        | 10/1/2009 | 9/30/2010 | 9/30/2010 | 100              | 99.56  |
| 3.1              | Base Funding                         | \$23,724,000  | \$23,228,000  | 10/1/2009        | 10/1/2009 | 9/30/2010 | 9/30/2010 | 100              | 98     |
| 3.2              | ARRA Funding                         | \$79,200,000  | \$88,964,000  | 10/1/2009        | 10/1/2009 | 9/30/2010 | 9/30/2010 | 100              | 100    |
| 3.3              | NCEP use of HPC R&D                  | \$5,800,000   | \$5,800,000   | 10/1/2009        | 10/1/2009 | 9/30/2010 | 9/30/2010 | 100              | 100    |

#### 3.2 Performance Measures

The vendor invoices the Government on a monthly basis. Invoices are checked against the contract cost schedule to verify that they match and the contract performance measures (System Availability, and Data Availability). All contracts are fixed price based on cost proposals submitted by the vendors. It is only adjusted when the Government modifies the contract to add more work or when making purchases from the ID/IQ contract CLINS. Each month actual costs are reported in updates to the Exhibit 300.

#### 3.3 Cost Benefit Analysis

The cost benefit analysis was performed during the acquisition process. Prior to exercising the yearly option the project team in conjunction with the HPC Board makes the decision on whether or not to exercise the next contract year based on the contractor's performance.

### **3.4 Financial Performance Review**

Financial performance is typically subjected to a periodic review for reasonableness and cost efficiency. Monthly budget reviews are held with the program manager, CORs and contract managers to ensure contracts are within cost and on schedule.

### **4.0 Innovation to Meet Future Customer Needs**

The following improvements and activities have been implemented in FY2010 to better meet customer needs, make better use of technology, and lower operating costs:

- New Cluster at Boulder was delivered to support Hurricane Forecast Improvement Project
- Delivered and installed a new Graphical Processing Unit Cluster at Boulder
- DOE delivered new supercomputer at ORNL
- First phase of N-Wave high speed wide area network completed
- Lease for new facility, located in Fairmont WV) to house supercomputer signed
- New R&D HPC systems integration contract Awarded
  - Six task orders issued

### **4.1 Number of Users**

Current user profile:

- 400 users at ESRL
- 200 users at NCEP
- 100 users at GFDL

### **4.2 Funding Levels**

Base funding for the project remained constant at \$29.5M. The program received additional funding from ARRA (\$88.9M ) and the HFIP Program (\$3M).