National Oceanic and Atmospheric Administration
National Weather Service
Data Assimilation and Modeling
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Operational Analysis
2010

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Executive Summary

The mission of the Data Assimilation and Modeling project is to implement improved numerical forecast guidance products to serve NOAA's operational mission. Guidance is implemented on NOAA's operational supercomputers. Guidance covers prediction for the atmosphere, ocean, land surface, cryosphere, ecosystems, air quality and space weather. Numerical forecast systems are composed of observations ingested into data assimilation systems, forecast models and ensemble model systems, post processed products for use by operational forecasters, the commercial sector, research organizations and the public.

The achievement over the past year are described relative to the establish FY2010 milestones listed below.

1. Add 3-6 km CONUS and Alaska nests with North American Model NEMS-based system The CONUS and Alaska nest forecast system was developed and tested. Computer and personnel constraints have moved the implementation data into FY2011.

2. Implement global real-time ocean forecast system with Navy HYCOM model
   The HYCOM-based ocean forecast system was developed and readied for implementation. Continued development of final products for users will occur in FY11 before final operational implementation occurs.
3. Implement coupled Hurricane WRF system with HYCOM
   Upgrades to the Hurricane WRF (HWRF) system were implemented into operations. Pre-implementation tested showed that the HWRF-HYCOM system still did not meet operational standards, so implementation was delayed until system performance was diagnosed and remedied.
4. Implement OCONUS Air Quality forecasts and improved chemical mechanism for all domains
   The NCEP Air Quality Forecast System was implemented for OCONUS domains (Alaska and Hawaii) with improved chemical mechanisms in Q4 of FY10.
5. Implement North American Land Surface Data Assimilation System (NLDAS)
   The NLDAS was run routinely to support the NOAA Drought Monitor in FY10. The code was moved from an experimental status on a non-operational computer to the NCEP backup computer in preparation for operations. Several issues remain before operational implementation in FY11. The NLDAS was also included in the NCEP Climate Forecast System Reanalysis (CFSR), a state of the science system for analyzing the atmosphere, ocean and land surface states from 1979 to the present.
6. Develop hindcast execution for Global Ensemble system
   A hindcast execution plan was finalized with NOAA's Earth System Research Laboratory. Computing resources have been obtained through the Department of Energy.
7. Program Management
   Improved program management occurred for the Data Assimilation and Modeling program. A new financial and project management data base is being developed. Two new contracts, for Scientific Support Services and IT Services, were initiated with an overall estimated savings to the Government of $13.5 M over the 5 year contract lifetime.
8. Operations and Maintenance
   All numerical forecast systems were performance monitored. Increased interaction with users and customer service occurred, particularly for seasonal climate forecasting. Work began on revising the implementation process to make it more streamlined and cost effective. Strategic agreements with interagency involvement were put into place for major development items for the next 3 years.

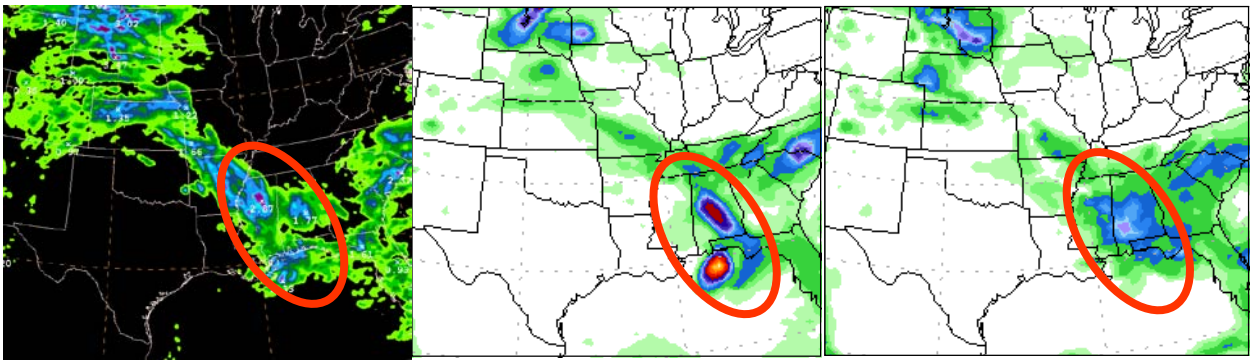
This report focuses on the operational state of the program as of September 30, 2010 and is based on guidance developed by the Department of Commerce. The Data Assimilation and Modeling program directly facilitates NOAA's Strategic Goals for a Weather-Ready Nation, Climate Adaptation and Mitigation, and Resilient Coastal Communities and Economies. The current program 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

A major upgrade to the NCEP operational Global Forecast System (GFS) was implemented in July 2010. The performance was increased in critical forecast parameters and user satisfaction was extremely high, indicating that this improvement was the largest single improvement in the past 10 years. Fig. 1 illustrates the improvement in forecast precipitation along the southern US coast.



Updated GFS physics package eliminates grid-point precipitation "bombs"

Fig. 1. 24 hour accumulated precipitation for 12 UTC 14 July 2009 from observations (left), previous operational model (center) and newly implemented GFS (right). The newly implemented GFS does not exaggerate the rainfall over Alabama and the northern Gulf of Mexico.

The North American Mesoscale (NAM) model nested grid system, based on the NOAA Environmental Modeling System (NEMS) architecture was developed and tested in FY10. High resolution nested domains over CONUS and Alaska provide increased accuracy and detail for users as shown in Fig. 2. Computer and personnel constraints have moved the implementation data into FY2011.

A global real-time ocean forecast system with Navy HYCOM model was developed and readied for implementation (Fig. 3). This new system, resulting from an interagency collaboration with the Naval Research Laboratory, will provide the basis for downscaled applications for ecosystem forecasting in future years and will enable initial ocean conditions for hurricane forecasts globally. Coupling of the GFS, NCEP's Wavewatch Wave model system, and the global HYCOM will also enable improved wave forecasts for global shipping interests. Continued development of final global HYCOM products for users will occur in FY11 before final operational implementation occurs.

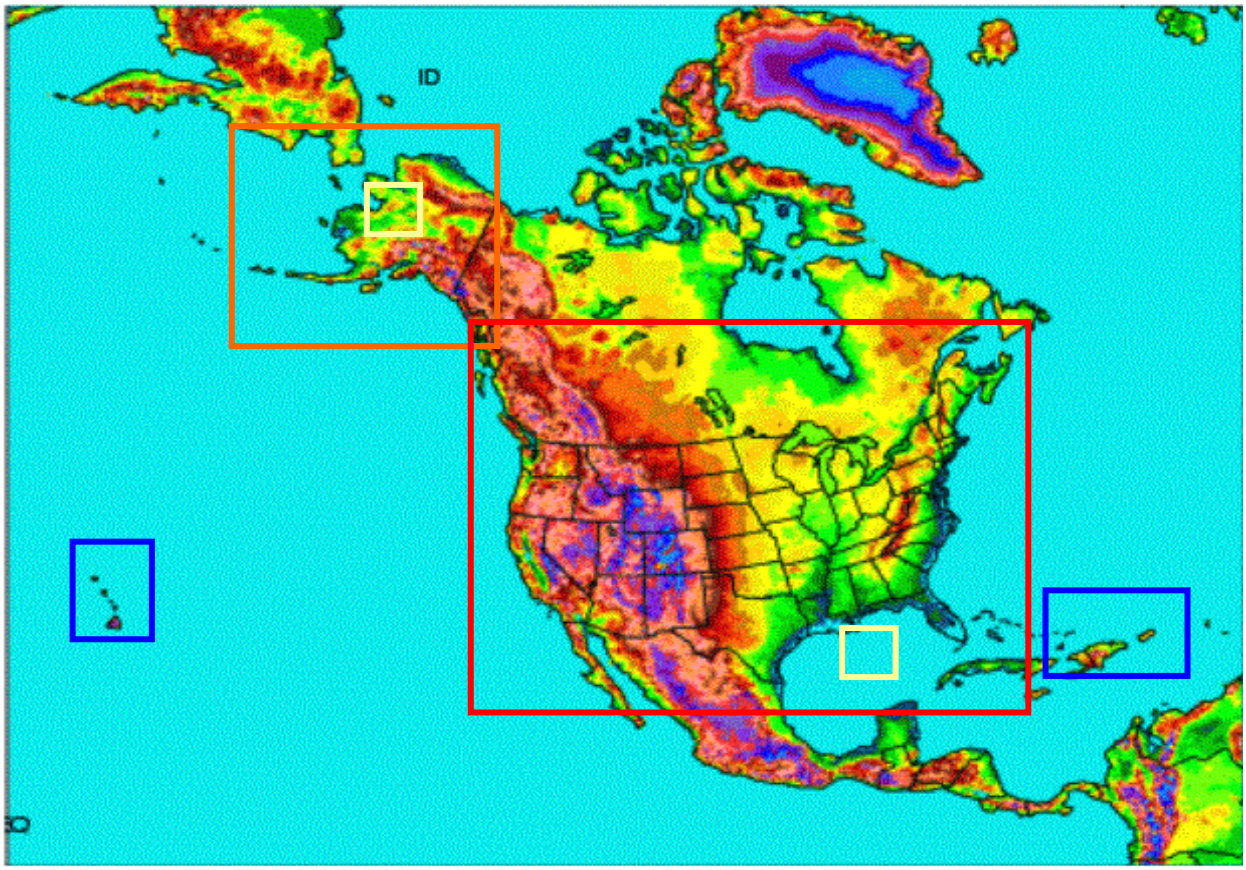


Fig. 2. NAM model domains for the NEMS nested system. Nest resolutions are: outer domain (12 km), CONUS (4 km), Alaska (6 km), Hawaii and Puerto Rico (3 km). Additional 1-2 km resolution domains will service Fire Weather and Severe Weather applications and can be generated at run time.

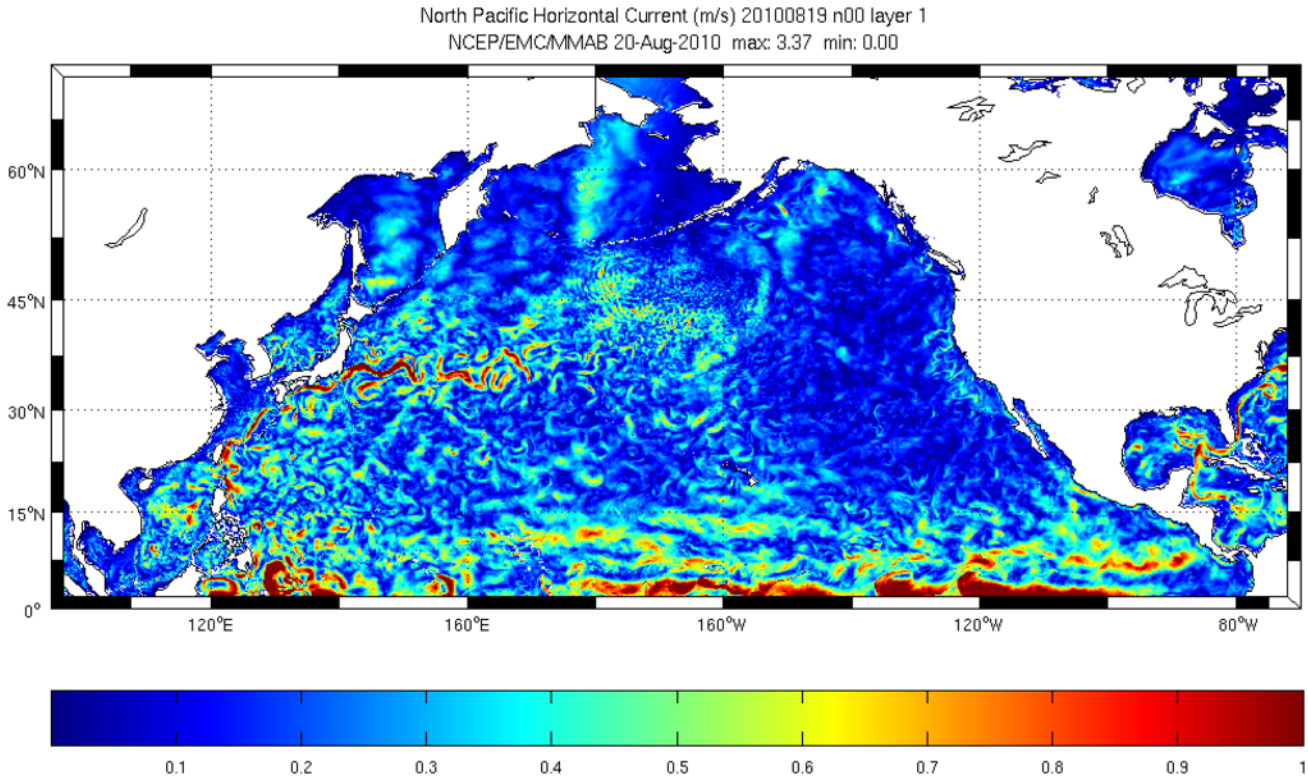


Fig. 3. The North Pacific sector of the Navy HYCOM 1/12 degree ocean model is running at NCEP. This model will provide ocean initial conditions for East Pacific hurricanes and ecosystem models in the future.

Upgrades to the HWRF system were implemented into operations. Pre-implementation tested showed that the HWRF-HYCOM system still did not meet operational standards, so implementation was delayed until system performance was diagnosed and remedied. Testing with a modified HWRF and more sophisticated coupling between the HWRF atmosphere and HYCOM is showing encouraging results.

Air quality forecasts for Alaska (Fig. 4) and Hawaii, using the NCEP Community Air Quality (CMAQ) forecast system were made operational. The new systems used CMAQ version 4.7 with improved chemistry mechanism (CB05) and upgraded emissions with 2010 base year estimates. Anthropogenic sources (point, area and mobile) were included as well as biogenic emissions for vegetation appropriate to Alaska and Hawaii. Upgraded lateral boundary conditions from GEOS-5 Climatological and Hilo Hawaii ozone profiles were also used.

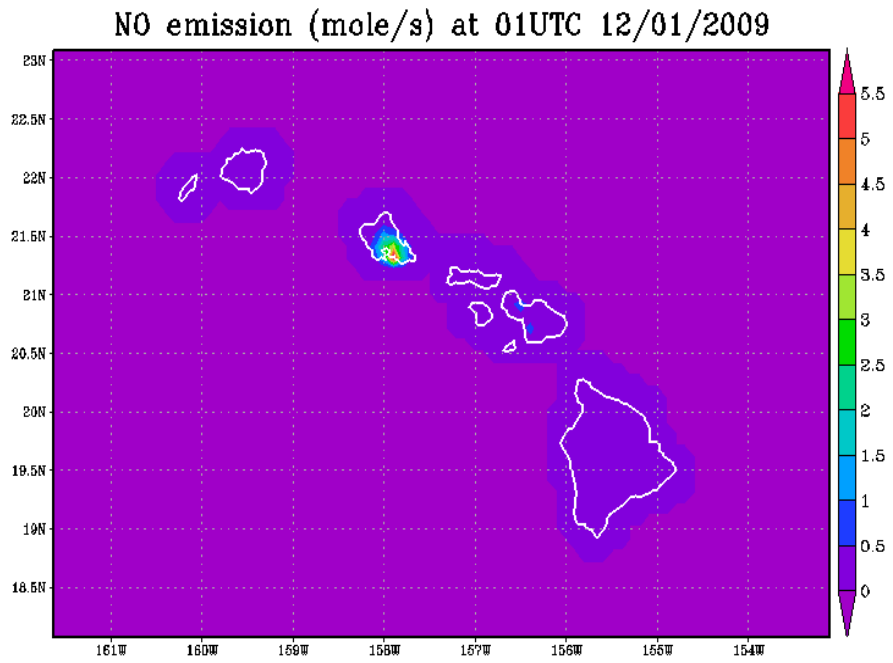


Fig. 4. CMAQ Major anthropogenic Nitrogen Oxide (NO) sources (e.g.: Honolulu) for the Hawaii air quality forecast system.

The North American Land Surface Data Assimilation System (NLDAS) was run routinely to support the NOAA Drought Monitor in FY10. The code was moved from an experimental status on a non-operational computer to the NCEP backup computer in preparation for operations. Several issues remain before operational implementation in FY11. The NLDAS was also included in the NCEP Climate Forecast System Reanalysis (CFSR), a state of the science system for analyzing the atmosphere, ocean and land surface states from 1979 to the present.

A hindcast execution plan for the NCEP Global Ensemble system was finalized with NOAA's Earth System Research Laboratory. Computing resources have been obtained through the Department of Energy. The hindcast system will enable improved ensemble forecasts by removal of forecast bias and improved distribution of forecast.

Program Management (PM) capabilities are being enhanced at NCEP/EMC with the development of an on-line PM-Financial System (PMFS). The system will be available for initial testing in November 2010. The system enables tracking of project milestones and contractor and civil servant costs for each major Data Assimilation and Modeling project. Tracking of resulting operational implementations will ensure results produce benefit to the users.

The EMC Support Services Contract was renewed in FY10 and the new contractor (IMSG) began work on 26 July 2010. All incumbent contractors were transferred over to IMSG and there was no loss of continuity in productivity. The new contract is estimated to save $13.5 M over the course of the next 5 years while providing for enhanced scientific support services to meet new NOAA Strategic Goals. In addition, a new IT Services contract was put in place for support of Helpdesk and other IT activities. This, too, was a seamless transfer to a new contractor, with no loss of continuity or productivity.

1.1 Customer Requirements and Costs

The annual NCEP Production Suite Review (NPSR) was held in December 2009. The attendees are the principal customers and stakeholders for NCEP's forecast guidance: the National Weather Service Regions, the National Ocean Service, the NCEP Service Centers (e.g. the National Hurricane Center), research partners in NOAA, National Center for Atmospheric Research. Programs are modified in accordance with feedback obtained at this meeting, and annual updates report progress back to the customers. NCEP's Annual Operating Plan is finalized after the NPSR and contains customer-relevant milestones and commitments within budgetary constraints. All operational implementations have a mandatory series of tests to ensure the implementation provides a performance benefit, provides the expected reliability in a quasi-operational environment and meets established timeliness requirements. The implementation process provides the most efficient methodology for testing and demonstration of value to the customer. Continuous revisions to the implementation process occur to make best use of available resources, corporate experience and technology.

1.2 Performance Measures

Standard annual GPRA performance measures were used to measure progress due to Data Assimilation and Modeling. They are summarized in Table 1.

These measures align with the "Customer Results Measurement Area" of the Performance Reference Model developed by the Federal Enterprise Architecture Program Management Office (FEA-PMO). Table 1 summarizes the performance measures.

Table 1: Customer Results Performance Measure

Measurement Area	Indicator	[Reporting Year – 1] Baseline	[Reporting Year] Actual Result	Comments
Customer Requirements	Marine Forecast Improvement Accuracy	72	74.00%	Goal of 69% exceeded; bigger is better
	Aviation Forecast Improvement Accuracy	65	65.00%	Goal met; bigger is better
	Software release aligned with NCEP operating plan	1 per year	1 per year	Goal met
	Faults in operational code delivery	1 per delivery	1 per delivery	Goal met; smaller is better

2.0 Strategic and Business Results

Strategic agreements to improve NCEP's guidance products were put in place in FY2010. An important agreement to develop an advanced data assimilation system within 3 years was signed with the NOAA's Earth System Research Laboratory and the NASA Goddard Space Flight Center Global Modeling and Assimilation Office (GSFC/GMAO). The EMC Marine Branch has installed a copy of the Navy HYCOM global ocean model for development a global ocean prediction capability; this model was implemented in FY2010 (Fig.3). The NCEP Climate Forecast System (CFS) was placed on

a public server and supported to the NSF and NOAA sponsored Center for Ocean, Land and Atmosphere (COLA) Studies.

The Data Assimilation and Modeling Program met all financial goals in FY2010. Costs for Civil Service labor balanced available funds to within $3.0 K in a $7.2 M base labor budget. All NOAA and interagency funds were obligated within established deadlines.

In FY2010, the Data Assimilation and Modeling Program had 19 milestones in its Annual Operating Plan, of which 14 were completed fully on time, 2 were late but completed in FY2010, 1 partially completed and 2 missed (but will be completed in FY2011). Program management and controls are in place to ensure the program continues to monitor progress and take corrective action as appropriate, and to meet its goals and objectives.

2.1 Data Assimilation and Modeling Program Helps to Achieve Strategic Goals

NOAA goals are:

- Climate adaptation & mitigation
- Weather ready nation
- Healthy oceans
- Resilient coastal communities & economies

National Weather Service goals are:

- Improve weather decision services for events that threaten safety, health, the environment, economic productivity or homeland security.
- Deliver a broader suite of improved water services to support management of Nation's water supply
- Enhance climate services to help communities, businesses, and governments to understand and adapt to climate-related risks
- Improve sector-relevant information in support of economic productivity
- Enable integrated environmental services supporting healthy communities and ecosystems

The table below lists systems in the NCEP Operational Production Suite (OPS) relevant to each of the goals. Improvements to these systems help to meet NOAA and NWS goals. Acronyms are listed in the Appendix

NOAA Goal	Relevant NCEP Forecast System(s)
Climate adaptation & mitigation	CFS, NLDAS, GLDAS
Weather ready nation	GFS, GDAS, GENS, NAM, RDAS, SREF, HRW, HUR, RTMA, RAP, AQFS, VOLC, COGART, HYS
Healthy oceans	RTOFS, WAV, WAVENS, SSTA, SIC, MARVIS, VESICE
Resilient coastal communities & economies	RTOFS, WAV, WAVENS
NWS Goal	
Improve weather decision services	GFS, GDAS, GENS, NAM, RDAS, SREF, HRW, HUR, RTMA, RAP, AQFS, VOLC, COGART, HYS

Deliver improved water services	GFS, GDAS, GENS, CFS, NLDAS, GLDAS, NAM, RDAS, SREF, RTMA
Enhance climate services	CFS, NLDAS, GLDAS
Improve sector-relevant information in support of economic productivity	GFS, GDAS, GENS, NAM, RDAS, SREF, HRW, HUR, RTMA, RAP, AQFS, VOLC, GOCART, HYS, WAV, WAVENS, RTOFS, SSTA, SIC, MARVIS, VESICE, CFS, NLDAS, GLDAS
Support healthy communities and ecosystems	RTOFS, WAV, WAVENS, SSTA, SIC, MARVIS, VESICE

2.2 Business Results

2.2.1 Program Management and Controls

EMC produces a set of milestones for its Annual Operating Plan (AOP). These milestones are formulated by accounting for the scientific maturity of work and available computational resources. Milestones are tracked on a weekly basis by management. Progress toward the implementation of upgrades to the NCEP Production Suite follows a generic implementation schedule with milestones and dates assigned according to the complexity of the implementation. Progress is documented in the form of bi-weekly meetings to show results, obtain peer review comments, ensure coordination with other work and obtain approval for proceeding to the next milestone. All progress is assessed relative to resource consumption and cost. Quality is measured through standard, internationally accepted performance scores and scrutiny of diagnostic results. All proposed implementations are reviewed by a Change Control Board (CCB) that reviews results and preparations before submitting implementation software package to NCEP's Central Operations. All software is reviewed by Civil Service Code Managers as part of the CCB process.

2.2.2 Monitoring Cost, Schedule and Performance

Project status is monitored by reviews as listed in the Appendix. These reviews cover estimated project costs, monitor progress on science and costs for ongoing projects, enable assignment of computing resources and provide project completion status and wrap-up review for all implementations. Attendance for the spectrum of meetings varies from scientific leadership (bi-weekly) to upper management for project implementation.

For scientific development, costs are equivalent to level of effort multiplied by the length of the project. An increased level of effort is very difficult to achieve due to the high level of unique expertise required for the scientific development tasks. Therefore, cost control is achieved by scoping projects to have a 2-3 year time horizon and by maximizing the probability of success within the 2-3 year period. Projects that do not show sufficient performance in the 1-2 year initial period are often abandoned or suspended pending further investigation.

Reviews of the above process are done primarily at the Branch level through bi-weekly meetings. Each project is reviewed 2-3 times per year. Performance is measured by standard scores recognized by the international community.

2.3 Reviews

The annual NCEP Production Suite Review (NPSR) took place on 8-9 December 2009. Representatives from NCEP Service Centers (e.g. National Hurricane Center), National Weather Service Regions, NOAA and external research partners and commercial organizations participated. Review presentations covered all aspects of EMC's development activities, including implementations, and response to user requirements from previous years. More information can be obtained from http://www.emc.ncep.noaa.gov/annualreviews/2009Review/.

The University Corporation for Atmospheric Research (UCAR) did a complete review of the Data Assimilation and Modeling Program in July 2009. Responses to the review, including short and medium term action items, have been assembled in a matrix and are being tracked by National Weather Service Headquarters.

Periodic management reviews of each project occur as listed in the Appendix.

2.4 Security

The Data Assimilation and Modeling Program uses the operational NCEP computer system, which is accredited under requirements spelled out in NOA 212-13 (08/06/90) and meets requirements of the Information Technology Security Policy based on OMB and NIST guidance. Reference should be made to the NCEP operational computer Operational Analysis for further details.

2.5 Performance Measures

The performance measures in Table 2 show the Data Assimilation and Modeling Program's performance with respect to Strategic and Business Results. Strategic and Business Results performance measures are the percent completion of implementation milestones achieved during each fiscal year. These measures align with the "Mission and Business Results Measurement Area," "Processes and Activities Measurement Area" and the "Technology Measurement Area" of the Performance Reference Model developed by the FEA-PMO.

Table 2: Business Results Performance Measures

Measurement Area	Indicator	2009 Baseline [% complete]	2010 Actual Result [% complete]	Comments
Strategic and Business Results	Add 3-6 km CONUS and Alaska nests within North American Model NEMS-based system	0	75.00%	Project is 75% complete.
	Implement global real-time ocean forecast system with Navy HYCOM model	0	90.00%	Project is 90% complete; system running daily
	Implement coupled Hurricane WRF system with HYCOM	0	100.00%	Implementation complete

Measurement Area	Indicator	2009 Baseline [% complete]	2010 Actual Result [% complete]	Comments
	Implement OCONUS Air Quality forecasts and improved chemical mechanism for all domains	0	100.00%	Systems fully implemented
	Implement North American Land Surface Data Assimilation System	0	75.00%	System run routinely to support NIDIS Drought Monitor
	Develop hindcast execution for Global Ensemble System	0	100.00	Execution plan completed
	Program Management	100.00	100.00	All management activities complete for fiscal year
	Operations and Maintenance	100.00	100.00	All operations and maintenance activities complete for fiscal year

2.6 [Other]

Nothing to report.

3.0 Financial Performance

3.1 Current Performance vs. Baseline

Civil Service salary totaled $7.201 M in FY2010. Labor allocation was $7.204 M, so performance was excellent. Non-labor expenditures were $6.082 M. Non labor funding was allocated to contractor support ($5.55 M) and various operating expenses such as IT equipment ($0.25 M), travel ($0.01 M), publications ($0.04 M), office supplies and other operating expenses ($0.23 M). The total non-labor allocation was $6.08 M.

Supplemental funding was received from NOAA and other agencies in FY2010. Other agency contributions were used to hire contractors under the new Scientific Support Services Contract. Contributing agencies were: NASA, FAA, US Fire Service, the GOES-R Program, and the Defense Threat Reduction Agency (DTRA).

3.2 Performance Measures

All financial line items are reviewed on a quarterly basis and variances reported to the NCEP Office of the Director. Spending is reviewed weekly by the EMC budget analyst and contract invoices are reviewed monthly by the NWS Contract Officer. The IT services contract is a fixed price contract and the Scientific Support Services contract is a cost plus fixed fee term contract. Costs for the latter are judged relative to the scientific progress for EMC projects as described in section 2.2.2.

Results are excellent for 2010.

Annual trend of funding is upward, but not expected to continue. In a constant funding environment, inflation must be controlled. Contractor expenses are expected to trend with federal salary increases. Inflation may be partly controlled by contractors filling Civil Service positions vacated by retirement or other losses. While there is no guarantee (recruitment process is open to all qualified), loss of a senior level contractor to Civil Service can help mitigate inflation by hiring a new, more junior contractor, resulting in 20-30% cost saving per person.

3.3 Cost Benefit Analysis

The US weather sensitive economy is approximately $4 Trillion. The US climate sensitive economy may be larger. The EMC budget, which is responsible for the improvements in weather and climate forecasts, is approximately $21 M. The cost-benefit ratio is huge by any reasonable measure. Weather and climate forecasts save lives, whose cost is incalculable. Cost-benefit of the Data Assimilation and Modeling Program is large and a recognized national asset.

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. Monthly reports from contractors are required to ensure the Government has the information it needs to evaluate cost performance. A detailed review of work and priorities is undertaken if cost is significantly above base lined values. Also, any necessary corrective actions are also identified and implemented.

4.0 Innovation to Meet Future Customer Needs

The major projects accomplished in FY10 to accommodate increasing customer needs have been described in Section 1.0. To address future challenges, better meet customer needs, make better use of technology, and lower operating costs, EMC and NCEP Central Operations are embarking on a major revision of the implementation process and renovation of the NCEP Production Suite software. The goals of this project are:

1. Revise current procedures to increase throughput to satisfy demand
2. Renovate Production Suite to provide increased uniformity across systems

Successful execution of this project will satisfy an increasing demand for implementations, thereby meeting future customer needs for improved products and new products. EMC is working with its research partners within NOAA itself (ESRL, GFDL, NOS, Space Weather Prediction Center (SWPC)) to provide increased input to operational guidance systems. In particular, the ENLIL solar wind prediction system will be tested and implemented in FY11, a collaborative activitity between SWPC and EMC. GFDL and EMC will conduct a science workshop in February 2011 to evaluate progress and plans for future development. ESRL and EMC will collaborate in 2011 to develop the Finite-volume Icosahedral Model (FIM) for use as an ensemble member with NCEP's Global Ensemble

system. Last, NOS and EMC will collaborate on the development of coastal wave prediction for operational implementation and distribution to local forecast offices.

4.1 Number and Types of Users

The users of weather and climate forecast information include: operational forecasters, TV, radio and other communications media, commercial weather and climate sensitive users (e.g. tourism, building industry, aviation and shipping, agriculture), FEMA and local emergency managers, University researchers and other Government Laboratories, the US population, and the international weather and climate user community. All users have requirements for operational guidance, delivered on time and with an increasing skill level, with documented performance history and with documented forecast uncertainty across the forecast domain as a function of forecast projection time.

Project to Address Challenge: *Improved Severe Weather Forecasts*

Savings of life and property resulting from accurate and timely severe weather forecasts (e.g. for tornados, coastal storms and inundation from mid-latitude cyclones, thunderstorms and flash flooding) are demanded by the "Weather Ready Nation" (NOAA Strategic Plan). The system being implemented in FY2011 (see Fig. 2) must be developed further to improve initial conditions for the highest resolution nests (yellow boxes) where severe weather is forecast to occur. This effort will take human and computational resources exceeding NCEP's current capability. EMC intends to enlist the assistance of Universities and Government Laboratories to focus on this problem. EMC also needs additional computing resources (see 4.4 below) to engage in this development effort.

Project to Address Challenge: *Improved Seasonal Climate Forecasts*

Users of seasonal climate forecasts need improved temperature and precipitation forecasts for the US domains (Continental US, Alaska, and Hawaii). At the present time, improved forecast skill is associated with a phenomenon called the "Madden-Julian Oscillation" (MJO). The MJO is a tropical entity and its occurrence demarks regions where tropical cyclogenesis occurs and where it does not. The problem, therefore, is to develop a data assimilation system and forecast model that improves the MJO skill. This project, called the NCEP Climate Forecast System Reanalysis and Reforecast project, is near completion (implementation is scheduled for Q2FY2011), was 6 years in the making and appears to have been extraordinarily successful in meeting its goals as shown in the figure below.

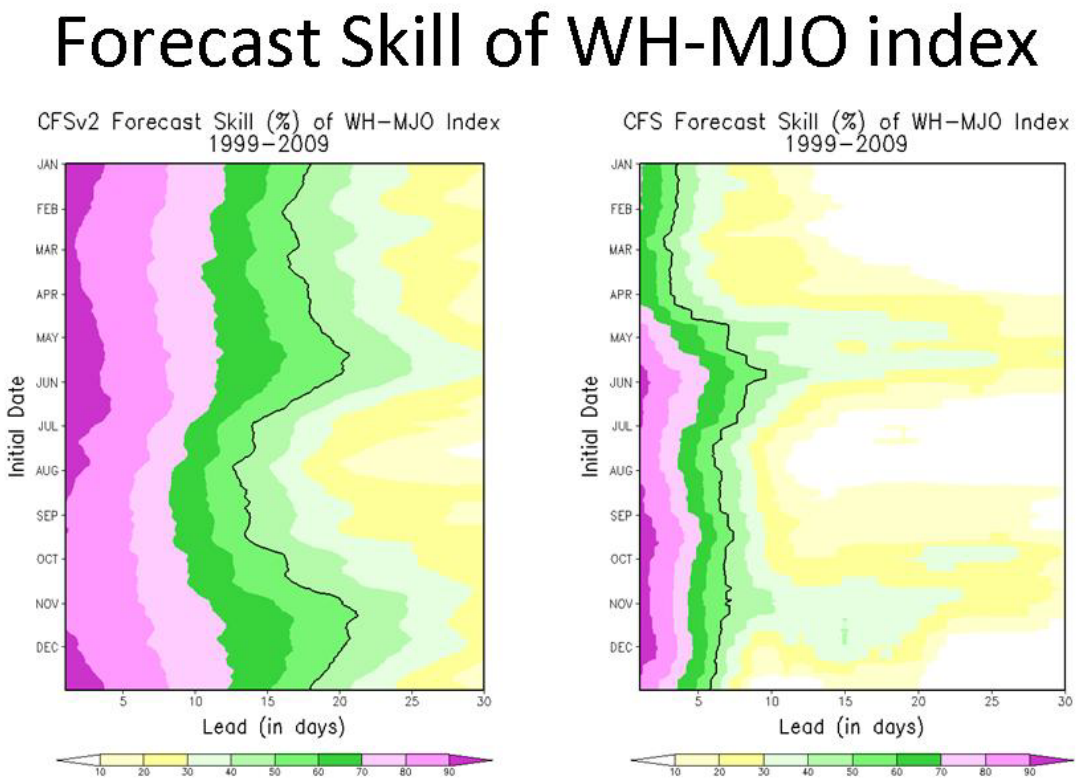


Fig. 5. Skill level for the MJO as a function of initial month (larger is better) for the new Climate Forecast System (V.2, left) versus the operational system (V.1, right).

The major challenge is to improve on the skill level shown in Fig. 5. To do this, two things must happen:

1. new modeling capabilities must be developed and tested, which requires scientific talent focused on this problem from EMC and elsewhere in the scientific community.
2. additional computing resources must be obtained for development and testing (see 4.4 below)

4.2 Use of Innovation and Emerging Technologies

Emerging technologies include making NCEP's operational numerical forecast systems portable to commonly used (non-operational) computer systems, use of emulating technologies (e.g. Neural Networks) to save computing resources, new modeling techniques (e.g. Semi-Lagrangian algorithms) that can reduce computational resources consumption while preserving accuracy, and increasingly sophisticated parameterizations of physical processes.

These items will be addressed with focused development efforts on the above topics. Many of the major NCEP forecast systems are being ported successfully to non-operational platforms. Neural Network algorithms have been applied to the seasonal climate problem and results are being analyzed

currently. A Semi-Lagrangian algorithm is being refined for further testing. New partnerships with Climate Process Teams (CPTs) are producing scientific code that can be tested in NCEP's models. The details exceed the scope of this report.

4.4 Funding Levels

Recent trends in government spending indicate that agencies should not expect significant increases in their budgets. This, coupled with the requirement to accommodate more users and incorporate evolving technology, will force the program to find efficiencies and to do more with the same amount of resources.

Project to Address Challenge: *Sufficient operational computing resources for NCEP*

NCEP's current operational computer is undersized compared to NCEP's mission requirements. In comparison to other operational programs, NCEP has more mission requirements and they are growing. NCEP's operational computer will not be upgraded and delivered until October 2012 at the earliest, two years from now (October 2010). It is estimated to take between 1-2 years (October 2013 at the earliest) to port NCEP's operational systems to the new computer once it has been delivered. Since NCEP's operational computer will be full to capacity by August 2011, current development projects (scheduled for implementation after August 2011) may not be operational for two years or more after completion. Furthermore, NCEP's current computational capacity for further development is a major constraint.

In order to have scientific development that will again result in the kinds of improvements shown in Fig. 5, NCEP will need additional computing resources for testing the next version of its Climate Forecast System (CFS). The partially mitigating action is to port NCEP's forecast system development to other computer systems. The NOAA R&D computer in Boulder Colorado will be used as will the new R&D computer at Oak Ridge National Laboratory. These facilities, however, have a completely difference operating system and architecture than NCEP's operational computer. Thus, addition testing on NCEP's computer will be required to ensure a reliable implementation. Of course, this additional testing cannot occur until NCEP's operational computer upgrade.

Annex A

Management control processes.

All projects are subject to the following management control processes.

1. Annual Operating Plan review
   AOP review begins the process of defining work to be done each year. Work may be continuation of current development, or new projects may be defined. Estimated resources for project are compiled and compared with available resources.
2. Bi-weekly team meetings
   Bi-weekly team meetings are held to ensure coordination with team members, to address scientific issues that impact system performance, to request and ensure adequate computational resources and planning, and to provide interim review of scientific results
3. Bi-weekly Branch meetings
   Branch meetings are held to review project progress and performance. Decisions are made to advance work to pre-implementation status, continue testing or abandon or suspend development
4. Quarterly project reviews
   Quarterly project reviews are held to monitor progress on major implementation projects, modify priorities among competing projects for computational resources, and to keep upper level management informed on scientific progress and implementation schedules
5. Annual operating review
   Annual operating review assesses overall progress for complete set of projects.

Acronyms for Systems Comprising the NCEP Operational Production System

Abbreviation	Name	Description
GFS	Global Forecast System	Global forecast model
GDAS	Global Data Assimilation System	Provides the best description of the atmospheric state based on all available observations
GENS	Global Ensemble System	Multi-member global forecast system providing probabilistic guidance
NAM	North American Mesoscale forecast model	High resolution regional forecast model covering North America
RDAS	Regional Data Assimilation System	Provides best description of the atmospheric state based on all available observations over the North American domain
SREF	Short-Range Ensemble Forecast system	Multi-member regional forecast system providing probabilistic guidance
HRW	High Resolution Window	High resolution nested runs for severe weather

Abbreviation	Name	Description
RAP	Rapid Refresh	Hourly analysis and short forecast to support domestic Aviation and Severe Weather
RTMA	Real-Time Mesoscale Analysis	Hourly analysis of weather elements (temperature, wind, dewpoint) for NWS Forecast Office weather monitoring
RTOFS	Real-Time Ocean Forecast System	Daily ocean analyses and forecasts
WAV	Wave Model	Ocean surface wave forecasts for daily and hurricane applications
WAVENS	Wave Ensemble System	Provides probabilistic guidance for ocean surface waves
SSTA	Sea Surface Temperature Analysis	Provides real-time sea surface temperature globally
SIC	Sea Ice Analysis	Provides real-time sea ice analysis
MARVIS	Marine Visibility	Real-time product for marine visibility
VESICE	Vessel Icing	Real-time product for vessel icing
AQFS	Regional Air Quality Forecast System	Ozone and particulate matter analysis and forecast over the North American domain
HUR	Hurricane Forecast System	Provides guidance on hurricane track and intensity for North Atlantic and East Pacific basins from Hurricane WRF and GFDL Hurricane Model
VOLC	Volcanic Ash Prediction System	Predicts volcanic ash concentration for specific on-call services whenever eruption occurs
HYS	HYSPLIT	Homeland Security application for dangerous chemical or nuclear dispersion
GOCART	GOCART	NASA Goddard Chemistry Aerosol Radiation and Transport model provides global distribution of aerosols and chemical constituents
CFS	Climate Forecast System	Global coupled atmosphere-ocean-land forecasts for seasonal and interannual missions
GLDAS	Global Land Data Assimilation System	Global data assimilation for land surface states; primary component of drought monitoring; operational in 2011
NLDAS	National Land Data Assimilation System	Data assimilation at higher resolution for the North American domain; primary component of drought monitoring; operational in 2011