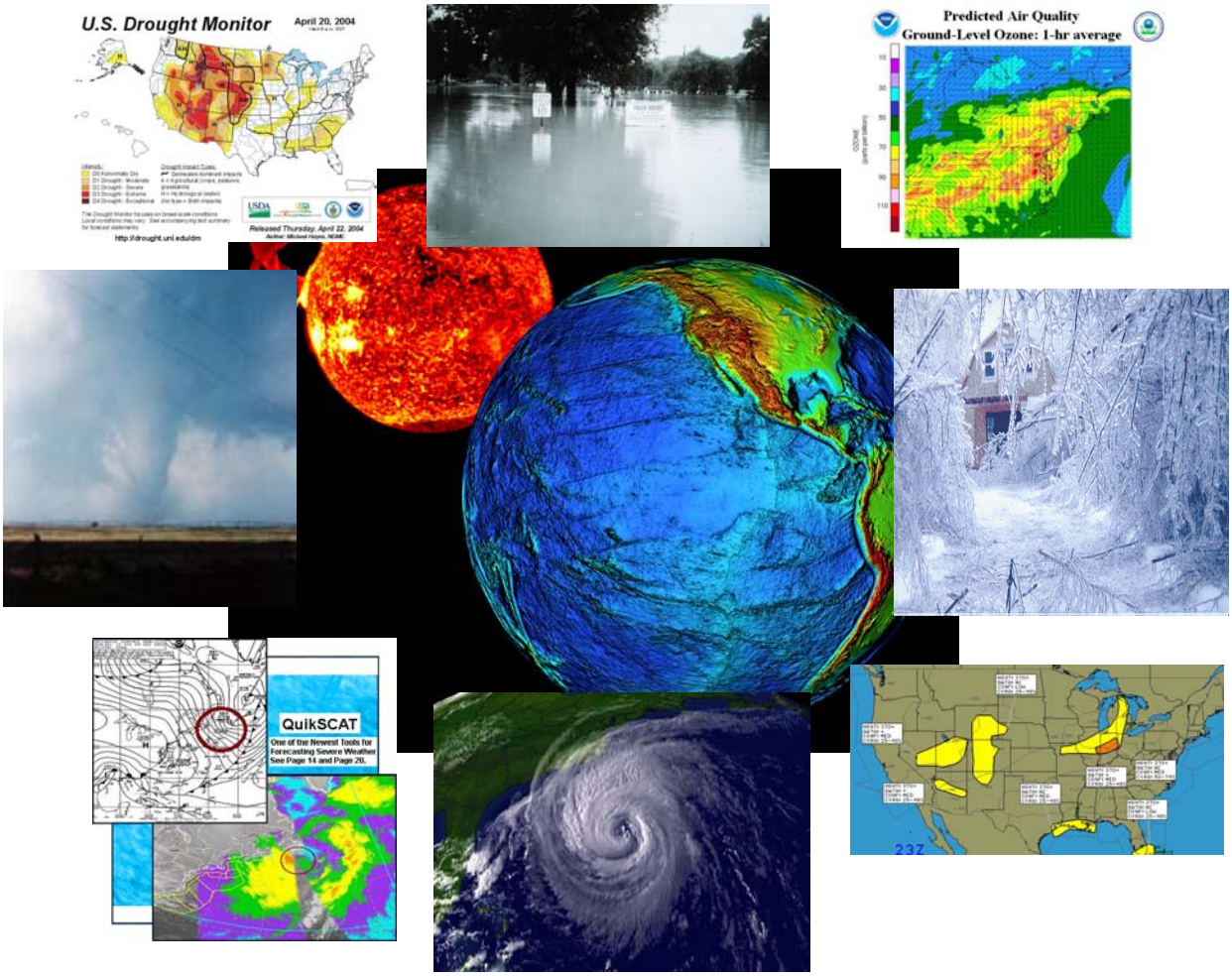
# National Centers for Environmental Prediction

*Biennial Review – 2003/2004*




***Where America's Climate, Weather and Ocean Services Begin***

## DIRECTOR'S MESSAGE

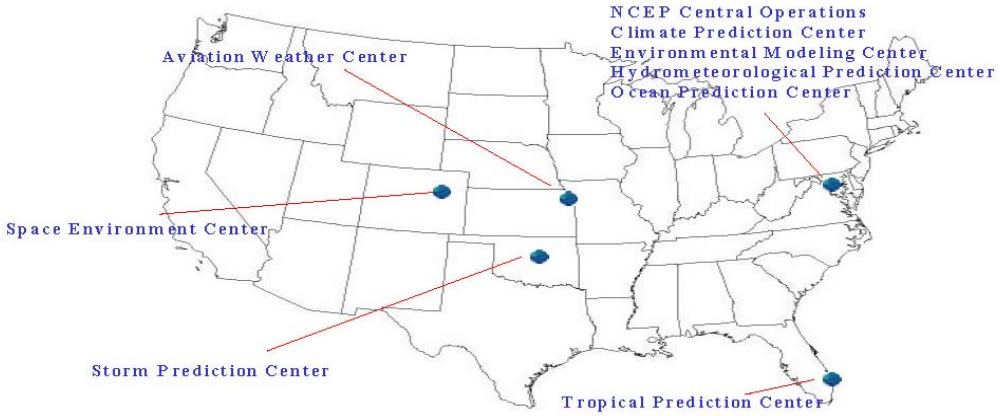
In June 2004, I had the honor to co-chair (with Professor Eugenia Kalnay) the one week celebration of the 50th anniversary of the creation of the Joint Numerical Weather Prediction Unit (1954-1958), which represented the start of the operational development, implementation and use of numerical prediction models for weather forecasts by the National Weather Service, Air Force and the Navy. Anyone who attended this event at the University of Maryland College Park could only be humbled by the accomplishments of the team of scientists and forecast researchers that provided the basis for the model-based forecast process that we rely on today. Today, global and mesoscale models of the atmosphere, ocean, land, cryosphere are used for all of our recent advancements that serve an incredible array of users and related applications from climate to weather forecasts and predictions of extreme events including severe weather outbreaks, hurricanes, rapidly developing ocean storms, snow and ice storms, fire weather events and flood producing rainfall. Furthermore, forecast units including the Navy's Fleet Numerical Meteorology and Oceanography Command (FNMOC), the Air Force Weather Agency (AFWA) and NOAA's National Centers for Environmental Prediction (NCEP) are direct outgrowths of the success of the JNWPU, and based directly on the Science-Service legacy represented by the remarkable achievements in introducing and objective, and theoretical based approach to operational forecasting.

With the 50th Anniversary of the JNWPU as a backdrop, I take sincere pleasure in highlighting for you the many accomplishments achieved over the past several years by the women and men who make up the National Centers for Environmental Prediction (NCEP). These accomplishments build upon our commitment to achieve our mission to deliver science-based products and services extending from the sun to the sea and serve society's needs for accurate analyses and prediction for weather, climate and ocean related events. The many successes contained herein emphasize the exemplary performance and achievements of NCEP and our research and operational partners and demonstrate the advances we have made in our computer infrastructure and operational implementation of climate, weather, land and ocean numerical prediction models. The advances in NCEP's Service Centers are impressive with the number of products increased, the accuracy of these products improved and the real-time accessibility to these products enhanced through multiple, real-time delivery systems, especially those related to the web. Building upon the historical service-science legacy of NOAA's National Weather Service (NWS), these efforts illuminate the critical role that NCEP plays in providing national and global climate, weather, ocean and space weather guidance, forecasts, warnings and analyses to our partners and external user community. As Director, I look forward to the challenges that lie ahead as we attain our vision of "first choice", "first alert", and "preferred partner" based on a collaborative interaction with the broad-based research community, the entire operational NWS field structure, and continued interaction with an increasingly diverse and sophisticated user community.

Dr. Louis W. Uccellini
Director, NCEP

## WHO WE ARE

# NCEP Center Locations




## WHAT WE DO

### *Guidance*

- Fire and Winter Weather Outbreaks
- Weather Forecasts to Day 7
- Quantitative Precipitation Forecasts to Day 5
- CPC Products to Day 14
- Marine, Mesoscale Weather and Model Discussions
- National Tornado/Severe Thunderstorm Report Summaries

### *National/International Products*

- Unified Surface Analyses
- Severe Weather Watches/Outlooks
- Hurricane Forecasts, Watches and Warnings
- Aviation Forecasts and Warnings
- Climate Forecasts
- Marine High Seas Forecasts/Warnings
- Solar Storm Forecasts/Warnings

### *Developmental and Operational Support*

- Data Assimilation
- Global/Regional Models
- Ensemble Forecast System
- High Performance Computing and Information Technology

## WHERE WE ARE GOING

**NCEP Vision**

*America's first choice, first alert and preferred partner for climate, weather and ocean prediction services*

**NCEP's Future is Built Upon**

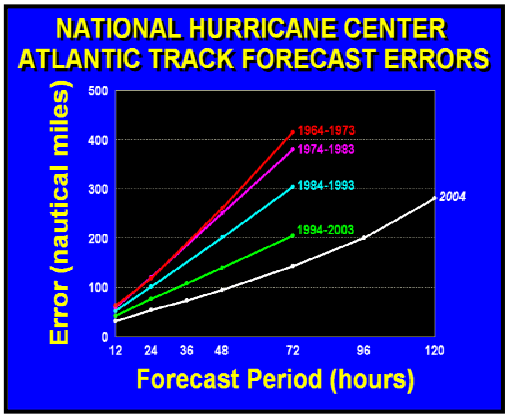
- Linking Climate-Weather-Ocean-Land Forecast Systems
- Producing a Seamless Suite of Products Through a Collaborative Approach
- Extending Predictability of Weather and Climate
- Improving Forecasts of Extreme Events
- Implementing a Unified Model Infrastructure based upon a Community Model Approach
- Addressing Uncertainty in Forecasts through Ensemble Modeling
- Embracing a Collaborative Forecast Approach with the NWS Field Structure

## WHERE WE'VE BEEN

NCEP is on the front lines providing timely and precise information that includes: flooding potential, developing drought conditions, hurricanes, tornadoes, an active fire weather season, and winter storms crossing the country. Highlights of NCEP's exemplary performance to the American people during the period 2003-2004 include:

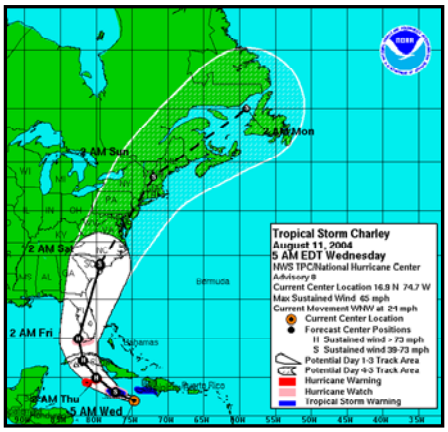
***Record-Breaking Hurricane Track Forecast Accuracy in 2003 and 2004 Seasons*:**

The Tropical Prediction Center/National Hurricane Center (TPC/NHC) 48-hour hurricane track forecast errors in the Atlantic Basin achieved a record-breaking 107 nautical miles during the 2003 Hurricane Season and 94 nautical miles during the 2004 Season which exceeded the Government Performance and Results Act (GPRA) goal for reducing hurricane track forecasting errors. New records were established in 2003 for the average Atlantic track forecast errors at all forecast periods out through 72-hours and each of these records were broken again in 2004. In 2003 for example, a major part of this achievement was the exceptional forecast performance for Hurricane Isabel (48-hour track forecast error of 61 nautical miles). The acceleration in these forecast improvements during the ten year

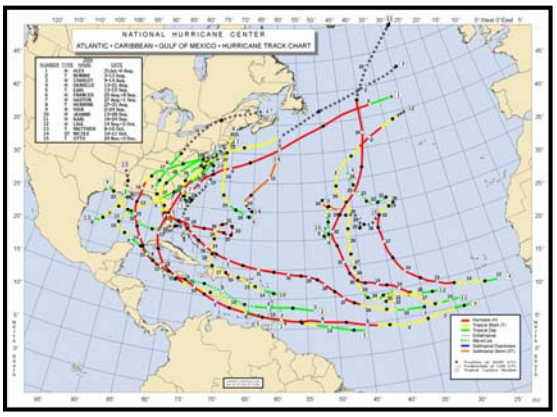


period 1994-2003 is attributable to the concerted efforts of the U.S. Weather Research Program that had the improvement in hurricane track forecasts as its highest priority. The results of this interagency effort were improved observations, global model systems, and mesoscale numerical prediction models developed at GFDL and implemented by NCEP's Environmental Modeling Center and NCEP's Central Operations.

***5 Day Hurricane Forecast a Major Success*:**
In 2003, after two years of rigorous testing, the TPC/NHC's operational hurricane track forecast periods were extended from Day 3 to Days 4 and 5. During the 2003 Hurricane Season, the hurricane track forecast errors at Day 5 were comparable to the previous 10-year average track forecast errors at Day 3. The 5-Day forecasts for the more extreme hurricanes were particularly noteworthy with average track errors of 144 nm for Isabel and 206 nm for Fabian. The increase from 3- to 5-Day forecasts represents the first extension in 40 years.



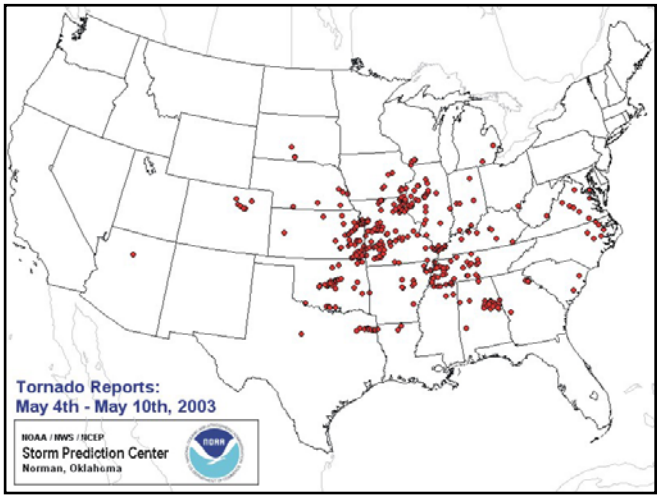

***Very Busy 2004 Atlantic Hurricane Season*:** In 2004, the TPC/NHC's issued nearly 500 tropical cyclone advisories (not counting intermediate advisories) and provided over 2000 media interviews during the 6-week period of peak activity. The TPC/NHC web pages as supported by the NOAA web mirror project received more than 3.5 *billion* hits during August and September, alone. Forecast products contributed to relatively low loss of life in the United States during the most destructive hurricane season on record for this country.




***Presidential Visit to TPC/NHC*:** On September 8, 2004, President George W. Bush, accompanied by FEMA Director Mike Brown, Florida Governor Jeb Bush and Red Cross CEO Marti Evans visited the TPC/NHC. This marked the first ever visit to TPC/NHC by a U.S. President. The President's visit honored TPC/NHC as did his participation in a tropical weather briefing and office tour by TPC/NHC Director Max Mayfield and by graciously greeting and posing for pictures with the forecast staff. The TPC/NHC contributions were further recognized in Congressional Resolutions of commendation by both the U.S. House and Senate, and through support provided by Supplemental Hurricane bills they passed.

White House Photo by Eric Draper.

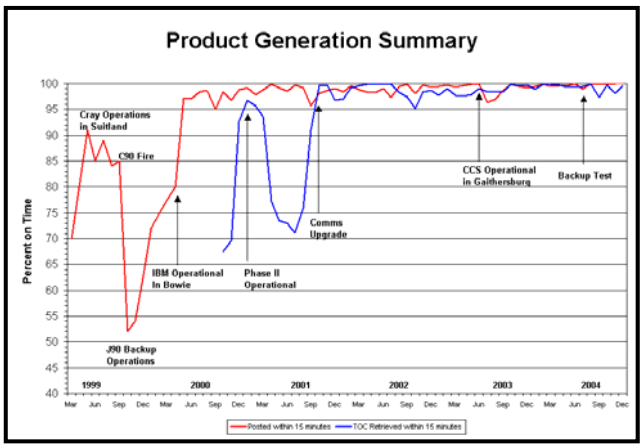
***Record-Breaking 7-Day Tornado Outbreak of the May 4-10, 2003:*** The seven-day period, May 4-10, 2003, featured a Tornado Outbreak that produced a record 393 confirmed tornados across the contiguous United States. This was more than twice the previous seven-day record of 171 tornadoes. Even with the excessive number of tornadoes, the tornado death toll was held to 39. This remarkably low number of fatalities is a direct reflection on the value and quality the watches issued by the Storm Prediction Center(SPC), and the warnings issued by the NWS Weather Forecast Offices (WFOs). During the Outbreak, the SPC issued 87 tornado watches, 36 severe thunderstorm watches, and 235 mesoscale discussions highlighting the severe weather conditions. The average lead time of the tornado watches (the time between when the watch and a tornado fatality occurred) was over 2 hours. The U. S. Department of Commerce (DOC) recognized that SPC products in concert with the warnings issued by the WFOs helped to save a significant number of lives, by presenting the SPC and five WFOs with its Gold Medal (the highest DOC award). The citation read "for providing life-saving services during a record outbreak of tornadoes during the period of May 4-6, 2003."

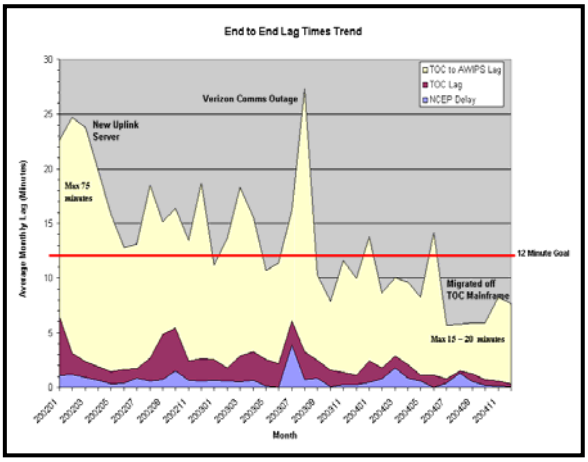


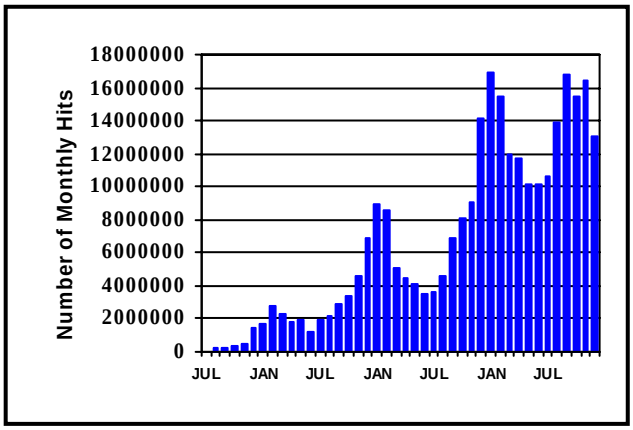

## *Successful Transition of Climate, Weather and Ocean Supercomputer while Achieving Record-Setting On-Time Product Generation Performance.*

In May 2003, NCEP completed a successful transition of its computer operations from

the IBM SP supercomputers located in Bowie Maryland to the new Central Computer System (CCS) located at an IBM facility in Gaithersburg Maryland. Congressional, federal and IBM officials attended a ribbon cutting ceremony, held in June 2003. The CCS, a cluster of IBM Power4 servers, is 2.5 times faster than the IBM SP and will provide the needed computational power for planned model upgrades during the next several years. Making more than 450 trillion calculations per second, the new generation CCS is poised to give the NOAA National Weather Service the ability to improve local, regional and national forecast accuracy, as well as extend watch and warning lead times for potential severe weather such as winter storms, tornadoes, floods and hurricanes. In September 2003, an additional 128 processors were added for climate forecasting upgrades and in October 2004 IBM completed the delivery of a backup system for the CCS. The completion of the conversion, testing and system configuration continues into early 2005. During 2004, while completing the system conversion, testing and system upgrades, a geographically separate backup system with full operational backup capabilities was being installed. During 2003/2004, the on-time product generation summary for NCEP computer systems achieved a record-setting goal of 99.4%, as reflected in the reliability statistics for percent on time. During this same period, the end-to-end product delivery time to Advanced Weather Interactive Processing System (AWIPS) for model guidance products was reduced from an average time of over 20 minutes to well under the 12-minute goal. With the upgraded satellite uplink server provided by the Network Control Facility, the NCEP Central Operations and the NWS Telecommunication Operations Center developed and implemented a new data flow mechanism that bypassed an overwhelmed TOC mainframe-based flow mechanism. This effort has resulted in over 90% of AWIPS products being available well under



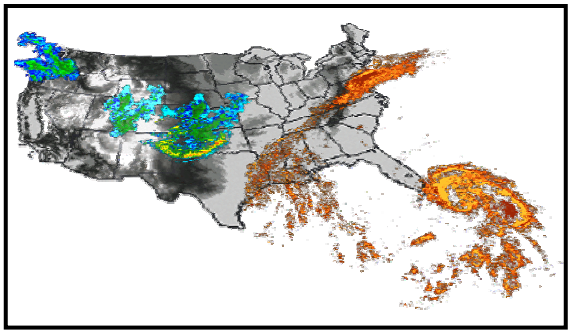



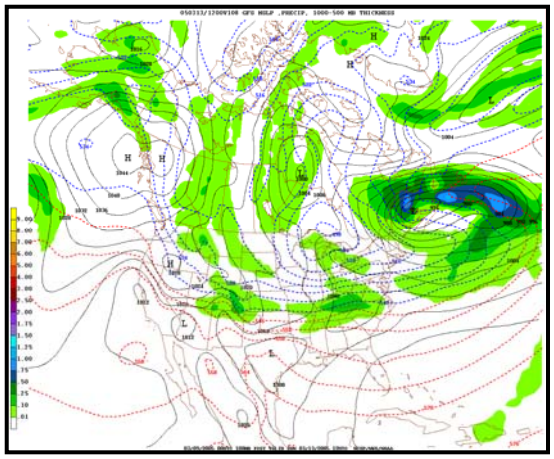
the 12-minute goal, with numerous products available within 60 seconds. This noteworthy decline in delivery time to AWIPS for model guidance products occurred while the volume of the model guidance produced by the CCS increased by about 50%, further illustrating the importance of this technical achievement. Furthermore, the popularity of accessing NCEP model data via the web has steadily increased over the last 3 years with the largest demand occurring during the winter months. The fact that data delivery times were improved to such a great extent while the volume of the data transmitted also increased places in the clear relief the magnitude of this technical achievement.

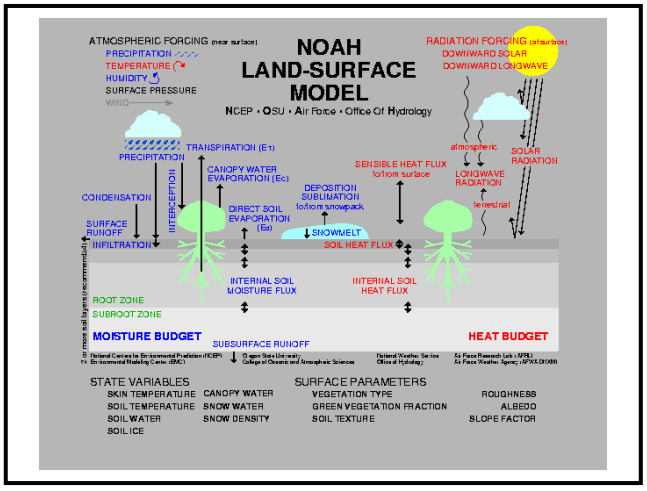
## NUMERICAL GUIDANCE ADVANCES

***NCEP Implements Weather Research and Forecasting (WRF) model for Operational Forecasting*:** In September 2004, NCEP announced the first steps in the operational implementation of the WRF modeling system have been taken. WRF represents multi-organizational partnerships to create the next-generation mesoscale numerical weather prediction (NWP) modeling system for research and operations that will facilitate collaboration within the entire research and operational meteorological community and accelerate the transfer of new scientific breakthroughs from research into operations. The implementation consists of both the Non-hydrostatic Mesoscale Model (NMM) WRF core run with NCEP-supplied physics, and the Advance Research (AR) WRF core (formerly known as the Eulerian Mass core) run with National Center for Atmospheric Research (NCAR)-supplied physics. Both versions of WRF receive initial conditions and lateral boundary conditions interpolated from the 12-km operational Eta model using the WRF Standard Initialization software developed by NOAA's Forecast Systems Laboratory. This implementation is the first step on the way to an implementation of a WRF High Resolution Window mesoscale ensemble, which is scheduled for implementation in FY 2005. These model cores and related physics package will ultimately provide the basis for a multi-model Short Range Ensemble Forecast (SREF) system that will provide a basis for all operational forecasts in the United States, as well as "deterministic" high resolution model runs applied to service areas such as fire weather, aviation, volcanic dispersion and hurricanes. The WRF was tested during the Annual Collaborative Forecast Experiment at the NOAA Hazardous Weather Testbed that is collocated with the Storm Prediction Center and the National Severe Storms Laboratory in Norman Oklahoma (see item under **Partners and Users**). Results from the two month long operational experiment in 2004 strongly suggest that the high resolution WRF can provide beneficial forecast guidance to the severe weather forecaster, as on many days it exhibited improved skill in predicting important characteristics of convective initiation and evolution that helped forecasters delineate areas of potential convective systems with increased lead time.

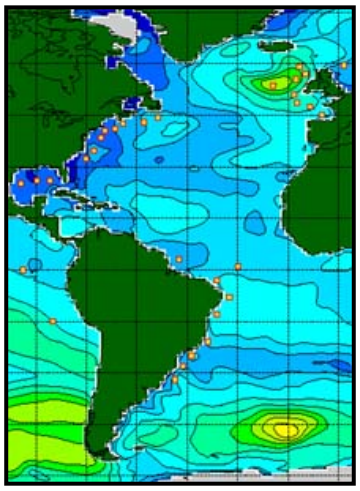


***Global Forecast System Improvements*:** In 2004, improvements were introduced in the Global Forecast System (GFS), a merged version of the Medium Range Forecast (MRF) model and the Aviation (AVN) model that became operational in 2002. The GFS now provides global numerical weather forecasts four times per day out to 16 days with horizontal resolution increased from 75 km to 55 km and the vertical resolution increased from 42 to 64 levels for the first 84 hours of its forecast. This increase resolution and improved physics (modified vertical diffusion, enhanced mountain blocking, sea ice model) has provided more accurate forecasts of large-scale circulation feature and precipitation while improving the depiction of sharp gradients relative to fronts and jet streams. Another upgrade to the GFS included the NOAH



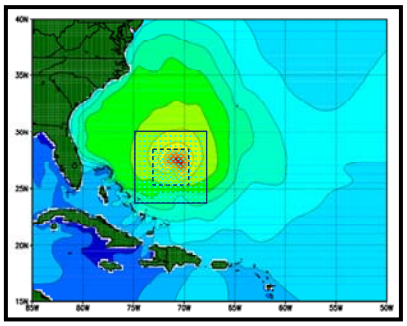



(**N**CEP-**O**SU-**A**ir Force-Office of **H**ydrology) Land Surface Model upgrade incorporates up to 4 soil layers, reduces the early bias in snow pack depletion and improves the treatment of frozen soil, ground flux heat, and energy and water balances at the surface. This trend in increasing horizontal resolution in the GFS will be continued with the implementation of the 35 km resolution model in June 2005.

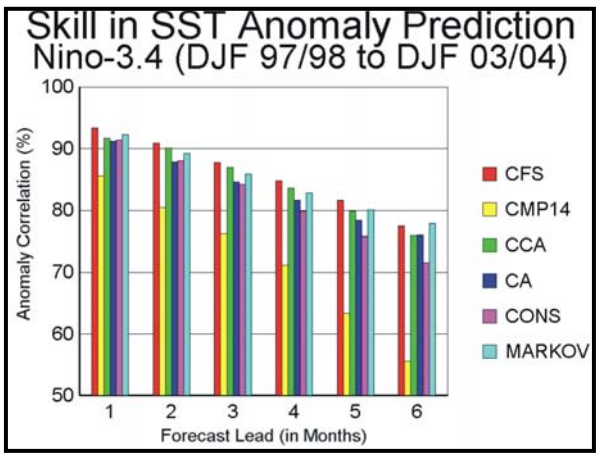


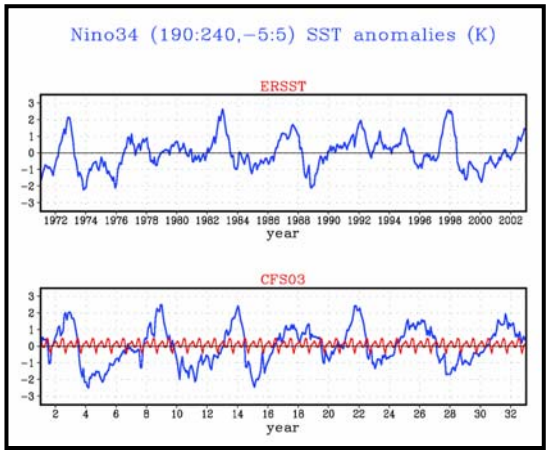
***Improved Accessibility of High-Resolution Operational Wave Products from WAVEWATCH III*:** NOAA's WAVEWATCH III numerical ocean-wave prediction computer model provides important information about potentially dangerous surf conditions resulting from storms hundreds or even thousands of miles away. Improvements to the WAVEWATCH III product suites have been realized through increases in computer power, enhanced access to ocean and atmospheric data and improved physical representation. Improved operational wave products and accessibility to forecasters from the NOAA National Weather Service as well as private sector weather information providers will be used to alert beachgoers,

boaters and others to possible unsafe conditions. Through the 2003/2004 Atlantic Hurricane Seasons, the Environmental Modeling Center (EMC) continues to upgrade the operational hurricane wind wave modeling capabilities by using a Hurricane version of the NOAA WAVEWATCH III at ¼ degree resolution and two-way nesting to provide wind/wave numerical guidance products out to 126 hours. In 2004, excellent short term wave forecast were produced, particularly during Hurricane Ivan.



***Climate Forecast System (CFS) model*:** In August, 2004, NCEP implemented a breakthrough Climate Forecast System (CFS) based on a global coupled atmosphere-ocean model system. The CFS couples the current NCEP forecast system atmospheric spectral Global Forecast System (GFS) model, with a horizontal resolution of approximately 210 km and 64 layers in the vertical, to version 3 of the 40-level Geophysical Fluid Dynamics Laboratory, Modular Ocean Model (MOM3). The CFS is initialized using the NCEP Global Ocean Data Assimilation System (GODAS), which was implemented in September 2003 and is run daily. The CFS is run once each day to generate a 10-month forecast. This new seasonal forecast system unifies the NCEP atmospheric models used for weather forecasts to a global ocean system to make seasonal forecasts. CFS replaced the first NCEP operational coupled seasonal forecast model used for Sea Surface Temperature (SST) prediction. Simulation of El Nino & La Nina events with the CFS (CFS03) and related prediction of the tropical SSTs in Nino 3.4 exceeded the skill of the statistical models (ERSST) for a 30 year period.



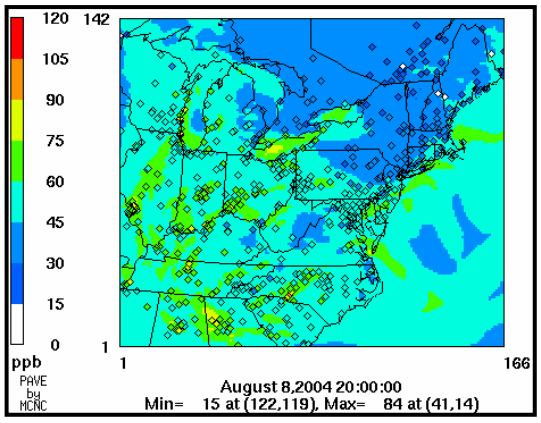



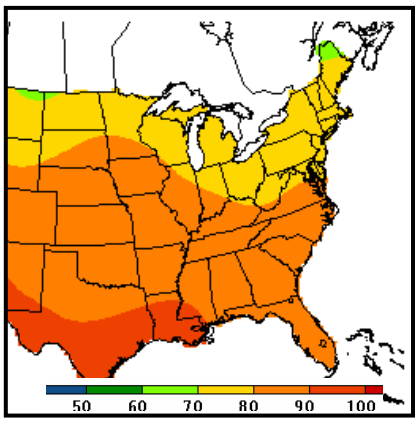

CFS (red) compared to statistical methods. SST anomaly (blue) versus CFS bias (red).

In more than 5000 years of retrospective testing, the CFS forecast skill for tropical SSTs generally exceeds the most advanced statistical models out to at least 6 months. Furthermore, the CFS demonstrates relatively little bias in the Nino 3.4 SSTs (within ± 0.5$^{o}$C) during the course of 30+ year simulations.

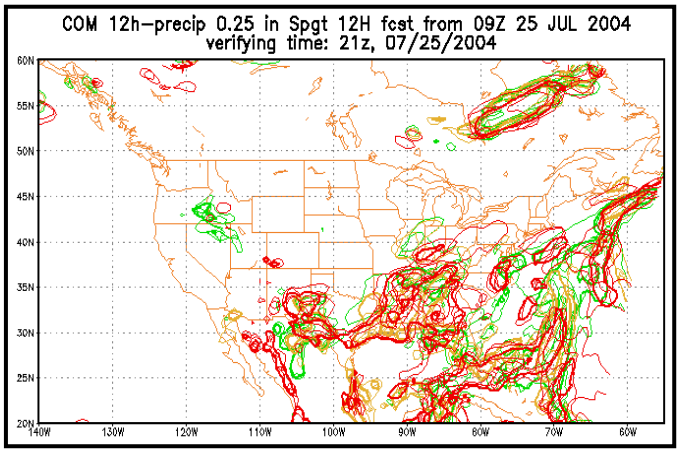
***New Air Quality Forecast Model*:** In September 2004, NCEP implemented an Air Quality Forecast System (AQFS) which will initially forecast ozone concentrations for the Northeast U.S., and runs twice daily (at 06 and 12 UTC) to provide forecasts of ozone out to 48 hours. The AQFS makes use of the 12 km Eta model to provide meteorological predictions that the Environmental Protection Agency Community Multi-scale Air Quality (CMAQ) model uses to produce ozone forecasts.

The AQFS also performs 6 hour cycling and the use of GFS Ozone predictions for improved initial conditions. The CMAQ system includes chemical mechanisms to simulate various air quality constituents including tropospheric ozone, fine particles, toxics, acidic deposition, and visibility degradation. As the continental polar air mass was undergoing modification, the 48 hour maximum 8-Hour Ozone Forecast initialized at 1200 UTC August 7 and valid for 0400 UTC August 8 indicates the model continues to perform well. The warmer temperatures allow for higher ozone values (mean observed up to 48.7 parts per billion) while over New England were cloud cover was significant the forecasted ozone concentration error is over 0.5 parts per billion. The implementation of AQFS is the first step in a decade long NOAA-EPA program to create a National Air Quality Forecast System to provide the U.S. with forecasts of ozone, particulate matter and other pollutants, with enough accuracy and advance notice so action might be taken to prevent or reduce adverse effects. The Hydrometeorological Prediction Center provides daily interpretation of model forecasts to the EPA air quality forecasters. During the ozone season of 2004, the timeliness of issuing forecast at 11:30 and 17:30 UTC for the aforementioned daily runs has been satisfied 100%. As forecast quality is concerned, the forecast has been verified by the Aerometric Information Retrieval Now (AIRNOW) observation network to be 99.50%, 98.00%, 98.70%, and 99.52% accurate in predicting events of EPA standard accedences and non-excedances for the months of June, July, August and September respectively. A mounting challenge is foreseen for extending the forecast capability with equal timeliness and accuracy to cover a larger portion of the nation for longer lead time with finer details of chemical constituent distribution.



***SPC in Collaboration with EMC develops Tailored Ensemble Forecasting Tools*:** The Storm Prediction Center (SPC), in collaboration with the Environmental Modeling Center (EMC) developed forecast tools for hazardous Mesoscale weather based on both the global extended-range and regional short-range operational ensemble forecast system. The global ensemble forecast system has 40 members with a horizontal resolution of approximately 105 km out to 180 hrs and approximately 210 km out to 384 hours, with 28 vertical levels. The global ensemble system produces forecasts four times a day. The Short Range Ensemble Forecast (SREF) system consists of 15 ensemble members from the Eta and the Regional Spectral Model and has a horizontal resolution of 32 km with 60 vertical levels. SREF forecasts are available twice daily. Specialized ensemble-based forecast guidance have been developed and used by forecasters for diverse mission critical forecast problems such as:




- "dry lightning", which ignites almost half of the wildfires in the United States each year,
- probabilistic quantitative precipitation, which is essential input for river flood forecasts,
- damaging tornadoes, winds and hail produced by supercell thunderstorms, and
- winter storm conditions, including the likelihood of significant snow accumulation, ice pellets and freezing rain.

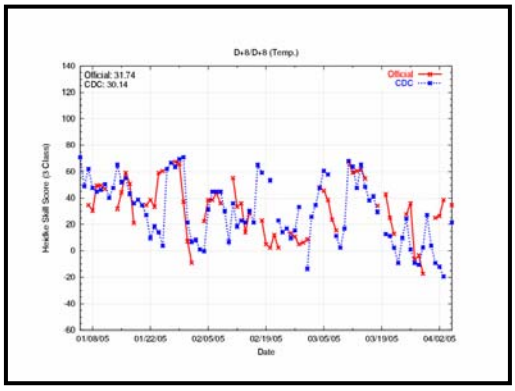
Ensemble products from the SREF, tailored for specialized needs are shared with the broader community in real time through web sites (http://www.spc.noaa.gov/exper/sref) and (http://www.emc.ncep.noaa.gov/mmb/SREF/SREF.html).

***North American Ensemble Forecast System*:** In September 2004, the North American Ensemble Forecast System (NAEFS) was established in an initial operating capability developed by NOAA's National Weather Service, the Meteorological Service of Canada (MSC), and the National Meteorological Service of Mexico (NMSM). The NAEFS involves the exchange and sharing of global ensemble forecasts among the participating countries were these tools (a) provide weather forecast guidance for the 1-14 day period that is of higher quality than the current available operational guidance based on either set of tools alone; and (b) make a set of forecasts that are seamless across the national boundaries between Mexico and the US and the US and Canada. The NAEFS uses a relatively new tool, ensemble forecasting, where a numerical representation of the atmosphere, called a numerical weather prediction model is run multiple times, with slight perturbations in the

initial conditions and the model formulation. The purpose of this approach is to capture all possible weather scenarios. Currently, all software products used in the processing of ensemble data, as well as in the generation of products are shared among the participating organizations, and used consistently at each center. As a result, forecasts issued by the participating National Meteorological Services will be seamless both in time and space. Such an approach can support a probabilistic forecast suite, allowing users to better prepare for extreme weather events by providing early warnings.

Signing of the documents at the Inauguration Ceremony for the North American Ensemble Forecast System. Seated are Marc Denis Everell, Assistant Deputy Minister, Meteorological Service of Canada (MSC), General David L. Johnson, Director of US National Weather Service, and Michel Rosengaus, Head of National Meteorological Service of Mexico (NMSM). Standing are Michel Beland of MSC, Stephen Lord, Louis Uccellini and Zoltan Toth of NCEP, and Rene Lobato-Sanchez of NMSM.

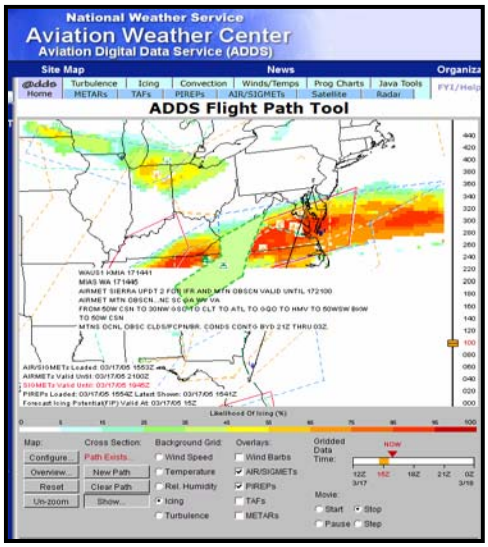
***New GFDL Hurricane Model*:** In 2003, NCEP implemented the upgraded Geophysical Fluid Dynamics Laboratory Hurricane Model which is one of several computer simulations used to guide NWS forecasters in forecasting the behavior of hurricanes. The model upgrade includes an increase in vertical resolution from 18 to 42 levels and improvements to the way in which convection (an important part of hurricane formation) and the lowest layer of the atmosphere are modeled.



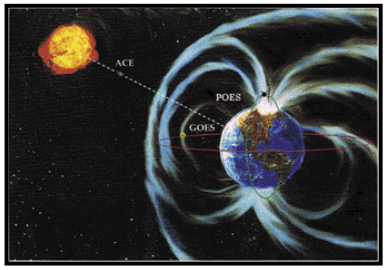

***Climate Diagnostic Center Ensemble Week-2 Forecast System*:** In September 2004, the Environmental Modeling Center, NCEP Central Operations and the Climate Prediction Center (CPC) implemented NOAA's Climate Diagnostic Center (CDC) Calibrated Ensemble Week-2 Forecast System. CDC scientists Thomas Hamill and Jeffrey Whitaker developed and tested an ensemble probability calibration scheme for extended range (6-10 day and week 2) forecasts of surface

temperature and precipitation by using a 1998 version of the NCEP Global Forecast System (GFS) model and ran a set of daily ensembles containing 15 members for 23 years. Then, they calibrated the forecast probabilities with the observed frequencies of these variables. The calibrated forecasts are statistically more reliable and their probabilities better-calibrated than comparable forecasts from the current GFS ensemble in the week-2 time frame and CPC's official forecasts. CPC actively uses the new technique in their 6-10 day and week-2 forecast operations and routinely monitors the U.S. average skill of 6-10 day and week-2 temperature and precipitation with the Heidke skill score, the measure of categorical skill traditionally used for these forecasts.

***Aviation Digital Data Service:*** The Aviation Weather Center commissioned the Aviation Digital Data Service (ADDS) as an operational service to the aviation community on September 30, 2003. ADDS makes available to the aviation community digital and graphical analyses, forecasts and observations of meteorological variables and its extremely popular with the aviation community. ADDS is a joint effort of NOAA Forecast Systems Laboratory (FSL), NCAR Research Applications Program (RAP), and the National Centers for Environmental Prediction (NCEP) Aviation Weather Center.




## SPACE ENVIRONMENT CENTER TRANSFERRED TO NOAA's NATIONAL WEATHER SERVICE



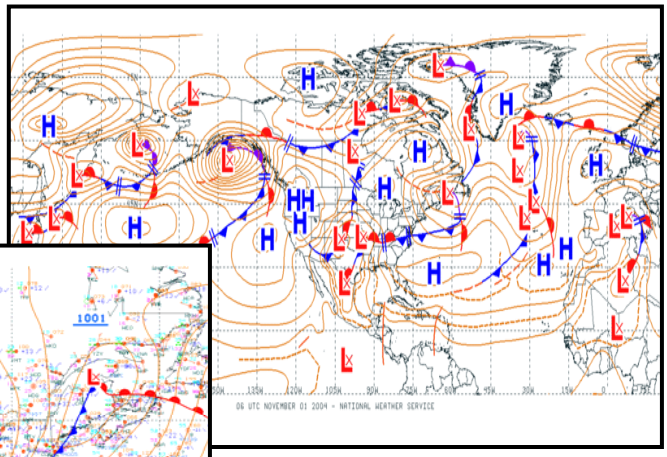

In January 2005, the Space Environment Center (SEC) was officially transferred from NOAA Research to NOAA National Weather Service (NWS). NOAA recognized SEC as a necessary component of the NWS's operational prediction mission by adding the space weather center to NCEP's array of service centers. SEC will strengthen the mission of the NWS by supporting its efforts for protection of life and property and the enhancement of the national economy from climate and weather hazards. Space weather affects people and equipment on Earth, as well as those traveling in airplanes and those working in space. SEC continues its mission, started 40 years ago, to provide operational forecasts, warnings and watches of the effects of solar disturbances and related space weather events to the American public and to perform applied

research. The addition of SEC to NCEP will help foster a seamless suite of operational products from *the Sun to the Sea*. Already there is an accelerated effort between the SEC, the Aviation Weather Center in Kansas City, and officials in Alaska to link Space Weather Advisories to aviation products required by commercial and general aviation within the polar regions.

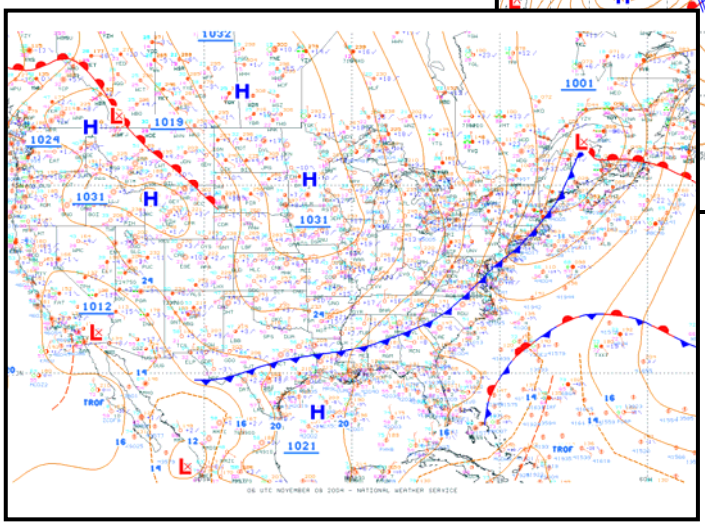
## PRODUCTS AND SERVICES

***Unified Surface Analysis*:** In June 2004, NCEP took the lead in creating a unified National Weather Service surface weather analysis based on a collaborative approach with the Hydrometeorological Prediction Center (HPC), the Ocean Prediction Center (OPC), the Tropical Prediction Center (TPC) and the Pacific Region's Honolulu Weather Forecast Office. The collaborative approach provides a seamless analysis, eliminating overlap and duplication among the various centers and is issued every six hours, serving marine, aviation, and other user groups as well as the general public. The unified surface analysis encompasses North America and the North Atlantic and North Pacific Ocean basins. The implementation of this analysis improved not only the product, but also introduced efficiencies by eliminating the need for individual centers to reanalyze in overlapping areas. Furthermore, given the overall quality of the unified surface analysis, the Alaskan Region no longer produces surface analysis over the North Pacific, but uses this analysis instead.

Unified Surface Analysis

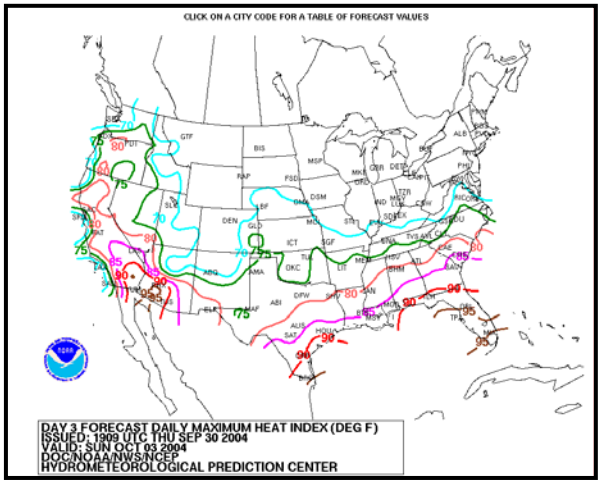


Analysis provided for
Continental United States

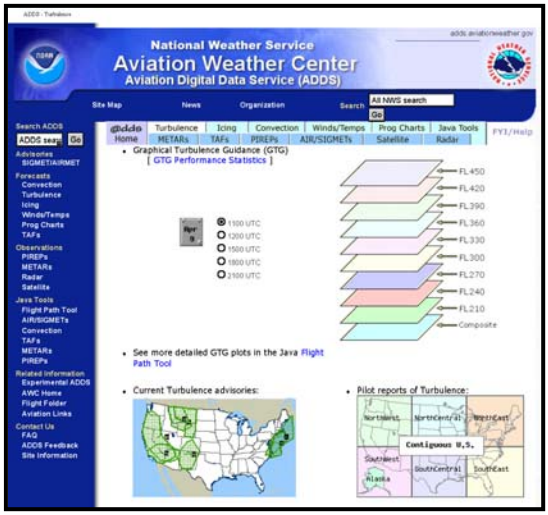


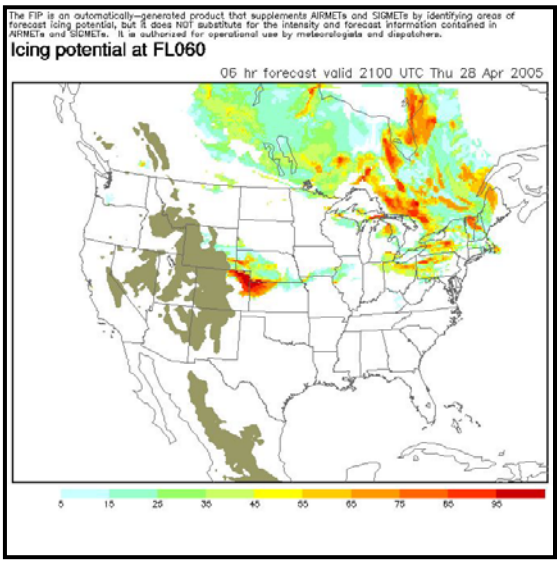
***HPC begins issuance of Heat Index Probability Forecasts*:** In 2003, HPC expanded on the issuance of the mean heat index products containing daily maximum, daily minimum and daily mean heat indexes for days 3 through 7 during the period from May 1 through September 30. The mean heat index product was initiated in 2002. These products are based on an ensemble of model and manual forecasts. There are two types of forecast products shown on the HPC heat index forecast web page: 1) deterministic forecasts of actual forecast mean heat index values based on the HPC's medium range maximum and minimum temperature forecasts coupled with GFS ensemble derived dew point temperatures and 2) probabilistic forecasts of mean heat index values exceeding certain threshold values.

***SPC issues a new graphical product that depicts the location of developing hazardous mesoscale weather systems*:** Each year, the Storm Prediction Center (SPC) issues about 2,500 mesoscale discussions for winter weather, heavy rain and/or non-severe thunderstorms. Each mesoscale discussion is a technical discussion of the on-going weather conditions in a particular region of the country. Responding to its customer feedback on the need for its users to know where the areas of concern for hazardous weather is at a glance, the SPC developed and overview graphic or coded text product for transmission that depicts the location of all active mesoscale discussions.



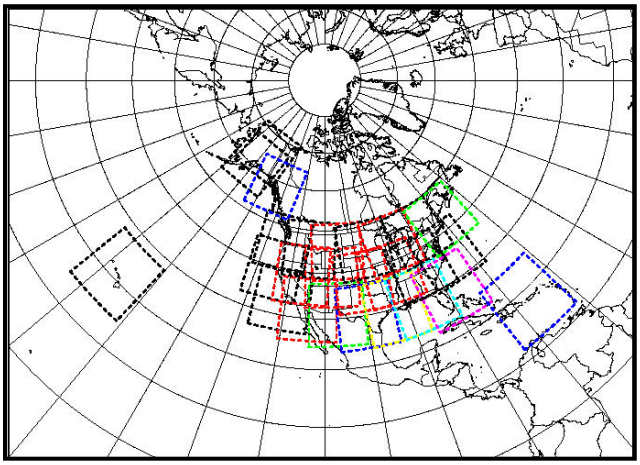

***New Aviation Weather Product Predicts Turbulence*:** In March 2003, the Aviation Weather Center introduced the Graphical Turbulence Guidance (GTG) product into its operational product stream. The GTG is an automatically-generated turbulence product that predicts the location and intensity of atmospheric turbulence over the continental United States. The GTG produces an analysis of current turbulence every hour and 12-hour forecasts every 3 hours for 9 flight levels. The GTG was developed by the National Center for Atmospheric Research Turbulence Product Development Team, sponsored by the Federal Aviation Administration's (FAA's) Aviation Weather Research Program, and implemented by the AWC.



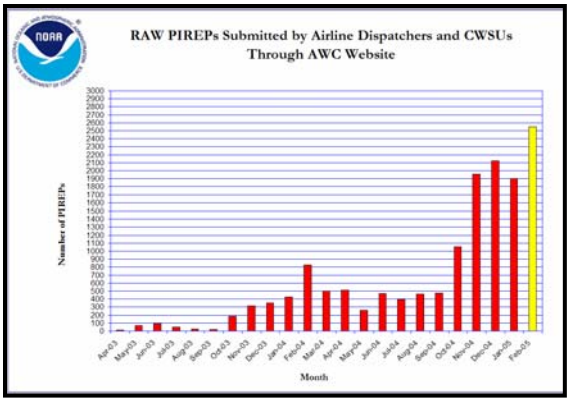



***New Aviation Weather Product Aids Icing Condition Forecasts*:** The AWC began transmitting Forecast Icing Potential (FIP) products in January 2004 to help meteorologists and flight dispatchers advise pilots of in-flight icing. The product is now available through the AWC's Aviation Digital Data Service, known in the aviation community as ADDS (http://adds.aviationweather.gov). The FIP, an automatically generated forecast of aircraft icing potential, will help flight dispatchers plan safer, alternative routes for pilots and will help meteorologists provide more accurate advisories for in-flight icing conditions.

***Improved NWS Fire Weather Program*:** NCEP implemented an 8 km Non-Hydrostatic Meso-Scale Model (NMM) to provide real-time weather guidance with better detail than was previously available to Weather Forecast Office Incident Meteorologists, who provide on-site meteorological support during wildfire suppression. The 8 km NMM runs on demand in one of 26 areas of coverage, each about 900 km square, an area the size of several states. Based on information provided in the coordination calls, the Fire Center will specify locations for which the model should be run. The model covers the continental United States, Hawaii, Alaska, and Puerto Rico.

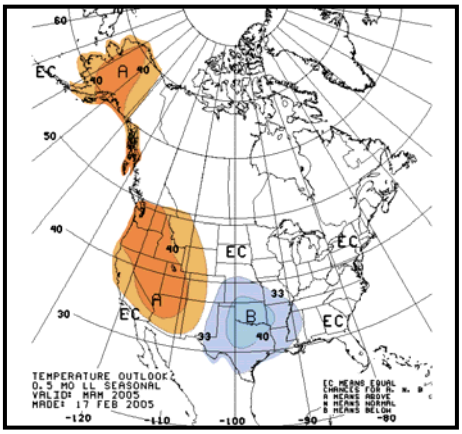


***Web interface for Airline Dispatcher Pilot Reports:*** Airline dispatchers and the Aviation Weather Center have worked together the last few years to enhance the collection of critical weather data that will help improve air travel safety through more accurate forecasting. The NOAA Weather Service's Aviation Weather Center in Kansas City, Mo., led the charge with a simple change: allow airline dispatchers to file their pilot reports

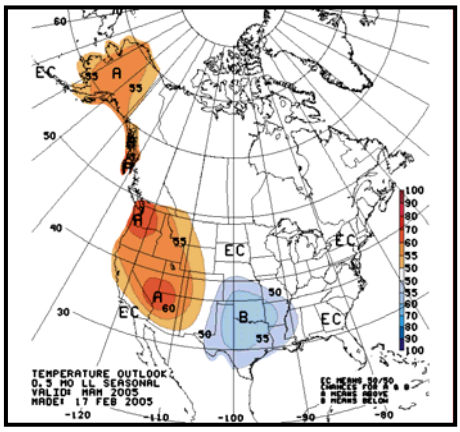


(colloquially called PIREPs) through the Internet for relay into the FAA's weather information system. Since beginning in 2003, the number of pilot reports collected in this manner has risen into the thousands, and consists of almost 10% of all pilot reports received.

***CPC introduces additional, experimental U.S. Seasonal Outlook format*:** In 2003, the Climate Prediction Center introduced a new, experimental U.S. Seasonal Outlook format designed to be easier for

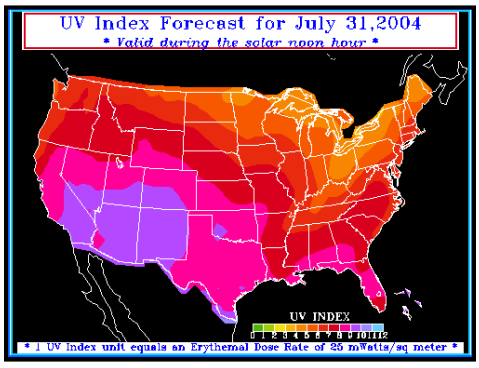



"Three-class" format



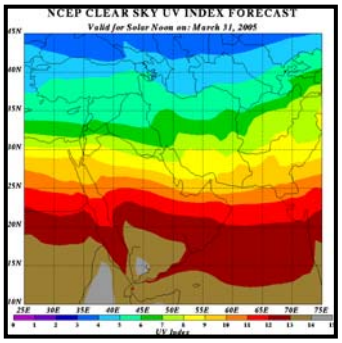

Modified "two-class" format

customers to use. The re-designed format is based on user feedback and uses a "two-class" system representing above and below-normal categories only (i.e., the near-normal category is eliminated). The CPC's U.S. Seasonal Outlooks attempt to predict, using probabilities, whether the average temperature and precipitation will be above or below normal over given time periods and geographic regions. The Seasonal Outlooks provide insight into long term expected trends or anomalies, such as drier/wetter or cooler/warmer than normal conditions for a season in a particular region. The U.S. Seasonal Outlooks offer enormous potential for social and economic benefits, and represent NCEP's continuing efforts to achieve a seamless suite of products over weather and climate scales. These products aid in the management of water resources, fires, agriculture, and energy, as well as benefit industries involved in transportation, manufacturing, retail business, recreation, emergency management, and health.

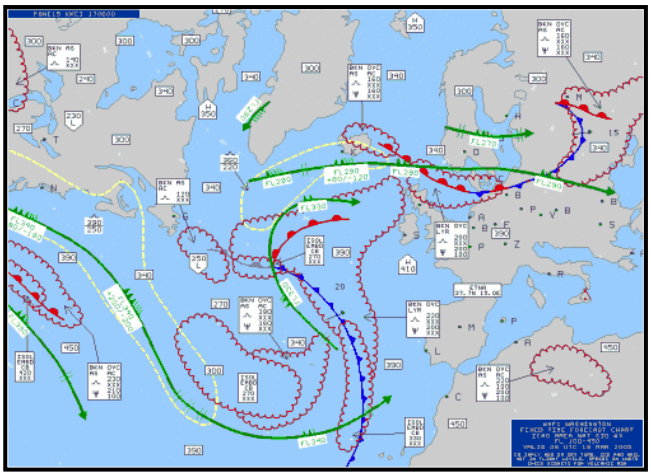



***New Global Ultraviolet Index*:** In May 2004, NCEP and the Environmental Protection Agency announced the new Global Ultraviolet Index, which replaces the existing UV reporting methods in the United States. The Global Solar UV Index developed by the World Health Organization, the United Nations Environment Program and other international organizations is a set of guidelines designed to better help people understand which precautions to take to protect themselves from

different levels of UV radiation. The global UV index is automatically produced for clear sky conditions from the Global Forecast System (GFS) model total ozone output, and informs users when the suns rays will be strongest so they can take action to protect themselves. For the U.S., the index is further modified using cloudiness from NGM Model Output Statistics (MOS). The National Weather Service and Environmental Protection Agency adopted the Global Solar UV Index and are collectively producing daily UV forecasts for 58 major metropolitan areas, as well as for other global regions as requested by other agencies, such as UV Index forecasts for southwest asia.

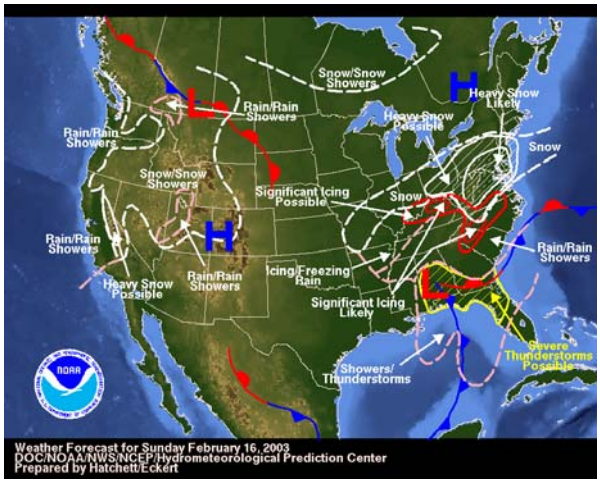



***Aviation Weather Center enhances international aviation forecast capabilities*:** In two ways the Aviation Weather Center improved its service to the international aviation community. First, the Aviation Weather Center fulfilled a request from the International Civil Aviation Organization by providing a North Atlantic mid-level aviation forecast product. The production of this product would not have been possible without the improvement in efficiencies to the NCEP workstation software. Second, the AWC is now capable of backing up its partner in the World Area Forecast system, the United Kingdom's Meteorological Office.

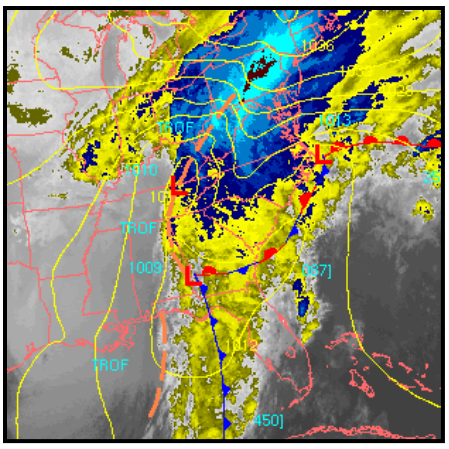


## MAJOR WEATHER EVENTS

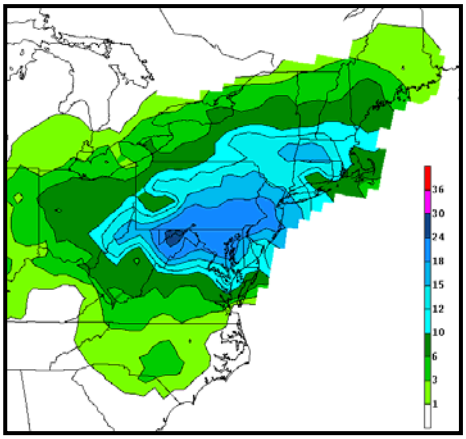
***The 2003 Presidents Day Snowstorm*:** February 16, 2003 — Cold temperatures and a mixed bag of wintry precipitation blanketed the eastern U.S. as a large-scale weather system coming out of the southern Plains wreaked havoc on the 2003 Valentine's Day and Presidents' Day holiday weekend. The weather system tracked through the central plains and the southeastern states through the weekend and reformed off the Carolinas on Sunday. A mix of snow, sleet and freezing rain spread across the Ohio Valley and Mid-Atlantic States through Saturday. Record breaking snowfall was reported in the Mid-Atlantic States as the cold



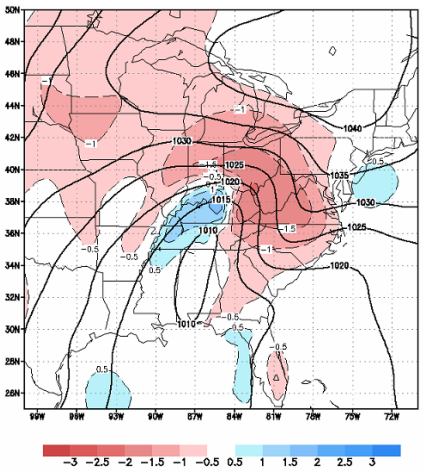
air moved in from the north early Saturday and all-day Sunday. A significant period of sleet and freezing rain developed in southern Virginia and the western Carolinas Saturday, and farther south the following day.



Satellite image at 0015 UTC Feb 17, 2003

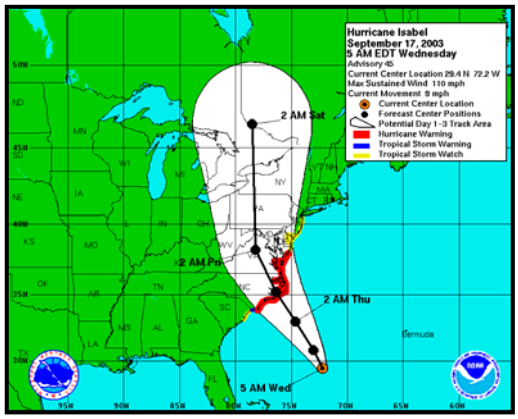



Total observed snowfall (in inches)




The developing storm system and associated heavy precipitation were predicted up to 5 days in advance by the GFS and was predicted by the ETA operational model in the 1 to 3 day range. Impacts on the GFS from inclusion of the dropsonde observations obtained during the Winter Storm Reconnaissance missions over the Pacific Ocean basin resulted in a 13% improvement in the Root Mean Square forecast error for surface pressure at the 60 hour forecast period as depicted at 1200 UTC Feb 16, 2003 with the surface pressure verification. Here red indicates forecast improvement and blue indicates forecast degradation.

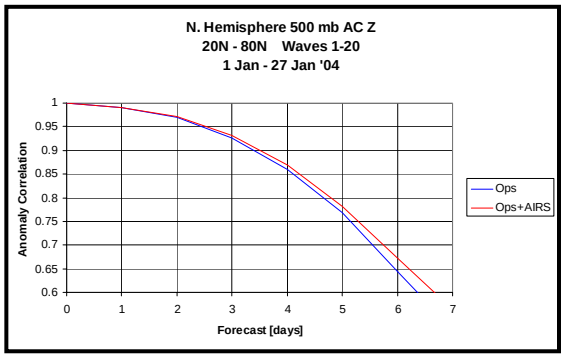
***Hurricane Isabel*:** Hurricane Isabel was a long-lived Cape Verde hurricane that reached Category 5 status on the Saffir-Simpson Hurricane Scale. It made landfall near Drum Inlet on the Outer Banks of North Carolina as a Category 2 hurricane. Isabel was one of the most significant tropical cyclones to affect portions of northeastern North Carolina and east-central Virginia since Hurricane Hazel in 1954 and the Chesapeake-Potomac Hurricane of 1933. Isabel caused widespread wind and



storm surge damage in coastal North Carolina and southeastern Virginia. Storm surge damage also occurred along Chesapeake Bay and the associated river estuaries, while wind damage occurred over portions of the remaining area from southern Virginia northward to New York.

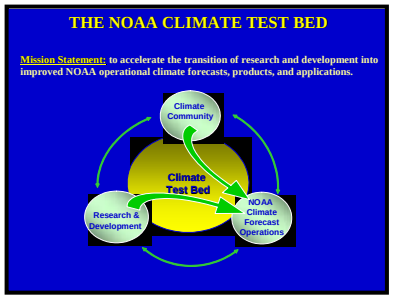
## PARTNERS AND USERS

***Joint Center for Satellite Data Assimilation (JCSDA)***: NCEP's commitment to increasing the use of satellite data for numerical modeling suites and recognition of the need to use those which will be available from future satellite sensors were factors that resulted in the formation of the Joint Center for Satellite Data Assimilation (JCSDA). The amount of satellite data available for operational numerical prediction models has increased dramatically to greater than 125 million observations per day, and now represents over 97% of all data used in the operational numerical weather prediction model system. Through close collaboration between several NOAA line offices (NESDIS, OAR, NWS), NASA Goddard Modeling and Assimilation Office, and DOD Air Force Weather Agency and Naval Research Laboratory-Monterey, the JCSDA is designed to accelerate and improve the quantitative use of research and operational satellite data in weather and climate prediction models. The amount of satellite data available for operational numerical prediction models is projected to increase by a factor of a thousand within the next decade. By coordinating the efforts of the participating agencies in order to define priorities, share resources, and avoid redundant efforts, the JCSDA is preparing to take advantage of the new observations that will be provided by Meteostat Operational (METOP), National Polar-orbiting Operational Environmental Satellite System (NPOESS), and Geostationary Operational Environmental Satellite-R (GOES-R) during this period. The JCSDA develops and distributes state of the art infrastructure to support satellite data assimilation. The JCSDA also conducts impact studies that evaluate the benefit of current satellite observations and techniques for incorporating them into numerical weather prediction models, or which help anticipate how observations from future sensors may be used most fruitfully. The optimal assimilation of atmospheric wind vectors (AMV's) derived from Moderate Resolution Imaging Spectrometer (MODIS) image sequences over the polar regions has been shown to improve the anomaly correlation coefficient (ACC) of forecasts in the Global Forecast System (GFS) significantly compared to control forecasts made without MODIS AMV. Perhaps most significant recent work has been the demonstration of the capability of Atmospheric Infrared Sounder (AIRS) data to improve global weather forecasting. These preliminary results have an immediate significance in that the AIRS data will be incorporated in the next upgrade of the Forecast System Suite at NCEP in June 2005.



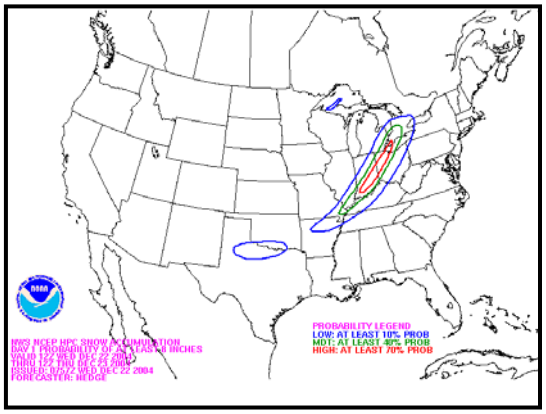

***Creation of the NOAA Climate Test Bed*:** During 2004, NOAA began developing a Climate Test Bed (CTB) to accelerate the transfer of research to development into improved operational climate forecasts. The CTB will routinely serve as a conduit

between the operational, academic and research communities and this facility is initially located at NCEP. The CTB personnel and staff will include scientists from NCEP and from other NOAA and non-NOAA organizations participating in the CTB. The mission of the NOAA CTB is to accelerate the transition of research and development into improved NOAA operational climate forecasts, products, and applications.

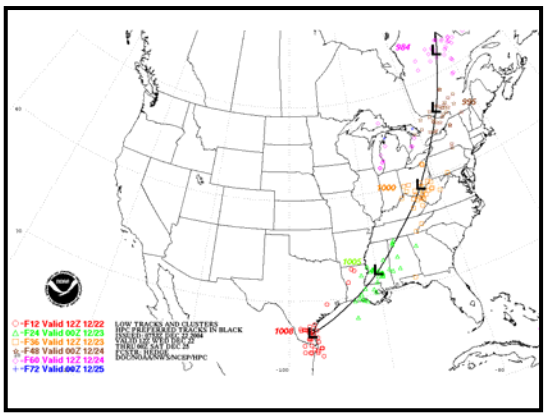



***Collaborative Convective Forecast Product adds Canadian Partner.*** The participation of the Meteorological Service of Canada began with the fourth season of the Collaborative Convective Forecast Product (CCFP) issued by AWC. The CCFP represents a collaborative forecast effort among meteorologists from the AWC, commercial airlines, Center Weather Service Units, and now Canada. The CCFP is a staple in the strategic planning of air traffic across the United States, and consists of 2, 4, and 6-hour forecasts of thunderstorm coverage with indications of growth potential and probability of occurrence. Forecasts are issued every two hours, 24-hours a day, 7-days a week.

***Winter Weather Experiment Culminates Third Season with Implementation of NWS Winter Weather Desk*:** In September 2004, the Winter Weather Experiment (WWE), a



Day 1 Snow Accumulation Probability.


Track of low pressure system.

three season collaborative effort between NOAA's NCEP Hydrometeorological Prediction Center (HPC) and Weather Forecast Offices (WFOs) in the Eastern, Central, Southern and Western Regions, culminated with the implementation of the NOAA Winter Weather Desk (WWD). The WWD operates from September 15 – May 15 each winter season. Because of WWE findings, the WWD now operationally provides winter weather guidance both internally to the WFOs and users external to NOAA. The HPC provides winter weather based guidance products to the WFOs through the application of short-range and global model ensemble output. HPC issued guidance products (graphics of 24 hour freezing rain and combined snow/sleet accumulations out to 3 days in the future) are collaborated upon internally within NOAA using chat room technology. The collaborative process culminates in a NOAA issued deterministic and probabilistic winter weather product suite to its users. The probabilistic suite supplements WFO

deterministic forecasts by conveying forecast uncertainty out to 3 days in the future for 24 hour accumulations meeting and exceeding a quarter inch of freezing rain, and 24 hour combined accumulations of snow and sleet meeting and exceeding 4 inch, 8 inch, and 12 inch thresholds. This collaborative process between the HPC and the WFOs results in a product suite providing positive impact on the public through improved guidance, and more consistent and accurate Winter Storm watches and warnings delivered by NOAA.

***SPC hosts National Severe Weather Workshop*:** Each year, the Storm Prediction Center hosts the National Severe Weather Workshop held in Norman, OK. Severe weather experts team up with the emergency management community, the media, and academia to discuss their latest research findings, forecasting techniques, emergency preparedness activities, and applications. Among the speakers in 2003, was Congressman Tom Cole from the State of Oklahoma and in 2004, the Governor for the State of Oklahoma the Honorable Brad Henry was one of a host of featured speakers. Each year the overall attendance is more than 500 people.

***SPC hosts Annual Collaborative Forecast Experiment*:** The annual Storm Prediction Center (SPC) Spring Program is a collaborative forecast experiment hosted by the SPC and the National Severe Storms Forecast Laboratory in the NOAA Hazardous Weather Testbed. In 2004, major partners included the Environmental Modeling Center, the National Center for Atmospheric Research, and the University of Oklahoma Center for the Analysis and Prediction of Storms. In addition, numerous scientists and forecasters from other Universities, NOAA entities, the Department of Defense, Meteorology Canada, and the private sector participated. The goal of the Spring Program is to use disciplined synergy to transition promising new meteorological insights and technologies into advances in forecasting hazardous mesoscale weather. This is accomplished by: 1) educating forecasters on the scientific basis of newly emerging tools and to familiarize them with the latest research related to severe weather forecasting, 2) educating researchers on operational forecast needs and potential constraints of operational real-world forecasting, 3) refining and optimizing emerging forecast tools for rapid integration into NWS forecast operations, and 4) motivating future collaborative and individual research relevant to forecast improvement. An important aspect of the Spring Program is that it provides a unique forum where operational forecasters, model developers, research scientists, and university faculty can work together on scientific issues of mutual interest. As such, the benefits are often readily apparent to the participants. Several excerpts from the numerous comments received during and after visitor's participation include:

> "*This week was probably the single most valuable week that I have had in years because it really helped adjust my perspective on how operational forecasters work…"*
>
> *"I think these activities are unique in the weather forecasting community at present. A valuable aspect is the cross-fertilization between research and operations…"*

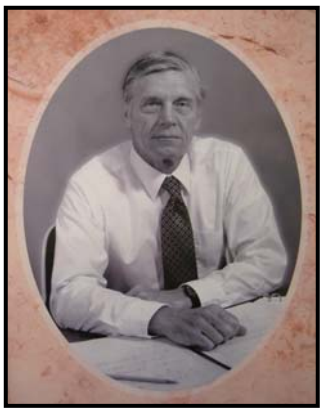
***Real-time evaluation of EPA's Community Model for Air Quality*:** In August 2003, NCEP began the real-time implementation, testing and evaluation of the EPA's Community Multiscale Air Quality (CMAQ) modeling system. The initial implementation of the CMAQ system provides once-per-day forecasts of ozone concentration over the northeastern quarter of the continental United States. For this test, forecasts from this model will be made available to a group of states. The primary goals of the CMAQ are to improve 1) the environmental management community's ability to evaluate the impact of air quality management practices for multiple pollutants at multiple scales and 2) the ability of scientists to better probe, understand, and simulate chemical and physical interactions in the atmosphere.

***NCEP cosponsors Symposium on the 50th Anniversary of Operational Numerical Weather Prediction*:** NCEP, along with the Air Force Weather Agency (AFWA) and the Navy's Fleet Numerical Meteorology and Oceanography Center (FNMOC), cosponsored a "Symposium on the 50th Anniversary of Operational Numerical Weather Prediction", held 14-17 June 2004 at the Inn and Conference Center at the University of Maryland in College Park, Maryland. The origins of NCEP, AFWA, and FNMOC can all be traced back to the first numerical weather prediction (NWP) efforts started in the United States with the Joint Numerical Weather Prediction Unit (JNWPU), which was staffed by members of the U.S. Weather Bureau, the U.S. Air Force and the U.S. Navy. Over 260 attendees enjoyed the historical overview sessions along with other sessions covering the evolution of forecast models, the evolution of supercomputers and data assimilation methods; numerical weather prediction from the perspective of forecasters, long-range forecasting; and the future of NWP.

Fred Shuman
2nd Director of NMC

Eugenia Kalnay past Director of NCEP's EMC and Norman Phillips model pioneer.

The week long symposium which was capped by a ceremonial luncheon honoring Dr. George P. Cressman during which a testimonial to Dr. Cressman's pioneering leadership was presented to his wife and the testimonial is reprinted below in its entirety.



*"Dr. George P. Cressman was one of the early leaders in numerical weather prediction. A PhD student under C-G. Rossby at the University of Chicago, he was well suited by inclination and education for a leadership role. As a civilian consultant for the Air Weather Service at Andrews Air Force Base in the early 1950s, Dr. Cressman was involved in the planning that led to the establishment of the Joint Numerical Weather Prediction Unit, sponsored by the Weather Bureau, Air Force, and the Navy, in 1954. He was the JNWPU's first director, and led the unit until 1958."*

*"Dr. Cressman was a hands-on leader, actively involved in the many aspects of bringing numerical weather prediction to operational status. His most lasting contribution was the "objective analysis", a technique to transfer atmospheric measurements at irregularly-spaced observation stations to the regularly-spaced points of the computational grid on which the prediction equations are integrated. Automating this step was an essential element of the operation, and required careful attention to meteorological science, mathematical principles, numerical analysis, computational requirements, and a certain engineering-like skill to "make things work". His method was based on an idea developed earlier by Pall Bergthorsson and Bo Doos. The Cressman analysis was widely used for many years in operations and research around the world."*

*"In 1958, the JNWPU was transformed into separate centers to serve the Air Force, Navy, and civilian requirements. Dr. Cressman became the first Director of the National Meteorological Center, one of the forerunners of today's National Centers for Environmental Prediction. He served in that capacity until 1964 when he moved to the Headquarters of the Weather Bureau, becoming Chief of the Weather Bureau on September 1, 1965. During his tenure he supervised the transformation of the Weather Bureau to the National Weather Service, following the creation of the National Oceanic and Atmospheric Administration in 1970. He served as Director of the NWS until his retirement in 1978."*

*"His presence in these important positions provided leadership and support that was crucial to the birth, adolescence, and maturing of operational numerical weather prediction."*

## COMMUNITY OUTREACH

NCEP's success is dependent on an active outreach and education program. Outreach efforts are essential in order to increase awareness and understanding of how NCEP's forecasts are made, what value they provide to users and why NCEP is where climate, weather and ocean services begin.

***Student Programs*:** NCEP continued to ensure the inflow of new talent into the organization by enlarging and strengthening educational relationships. During the 2003-2004 period, NCEP hired a total of 19 students through NOAA student programs which included five students representing the NOAA Student Educational Experience Program (SEEP). In addition, NCEP expanded its relationship with Minority Serving Institutes to include Howard University, Clark Atlanta University, Lincoln University, Jackson State, and University of Puerto Rico at Mayaguez. These students worked throughout the year at our different Centers. The remaining 14 students worked for NCEP during the summer months. The programs that provided the students were: the Oak Ridge Institute for Science and Education, the GoFHAS program out of Howard University, volunteers, and the NOAA Educational Partnership Program (EPP). The Hydrometeorological Prediction Center/Ocean Prediction Center hosted the Howard University Weather Camp and gave numerous tours of our facility. In Norman, OK, the Storm Prediction Center has partnered with the Norman Public schools to develop a job shadow program. These programs allow students to participate in a day long personal experience that includes an overview of NOAA's National Weather Service, computer workstation training, and a 2 hour shadowing of an operational SPC forecaster. The program is part of a national initiative to provide students the opportunity to observe the knowledge and skills used at various work places. The Storm Prediction Center also participates in a specific student program called "Research Experience for Undergraduates." This mentoring program is funded by the National Science Foundation through the auspices of the National Severe Storms Laboratory.

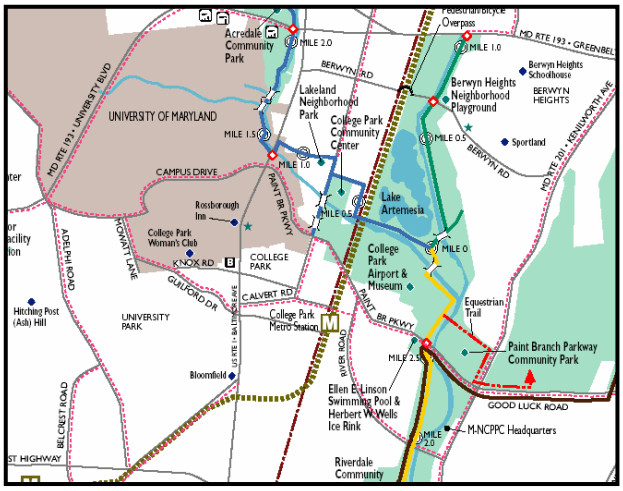
***Gulf Coast Hurricane Awareness Tour*:** In May 2004, the Tropical Prediction Center conducted it's annual Hurricane Awareness Tour with NOAA's Aircraft Operations Center aircrew onboard a WP-3D "Orion" aircraft in an educational outreach effort designed to increase hurricane awareness. The week long Gulf Coast Hurricane Awareness tour visited five cites beginning with an opening season press conference in Houston Texas, announcing the Presidential Proclamation for National Hurricane Preparedness Week and the NOAA Atlantic Hurricane Season Outlook.

***Caribbean Hurricane Awareness Tour*:** In May 2004, the Tropical Prediction Center completed a six day Caribbean Hurricane Awareness Tour with the U.S. Air Force Reserve Commands 53rd Weather Reconnaissance Squadron's WC-130J "Hercules" aircraft supporting the WMO Regional Association-IV hurricane education and outreach objectives through briefings, media interviews and public access to the technology of hurricane forecasting. While more than 15,000 people actually visited the aircraft during

the six day tour, the print and electronic media covering the events spread the hurricane preparedness message more broadly to local, regional and national audiences in Mexico, Dominica, Martinique, Guadeloupe, and Puerto Rico.

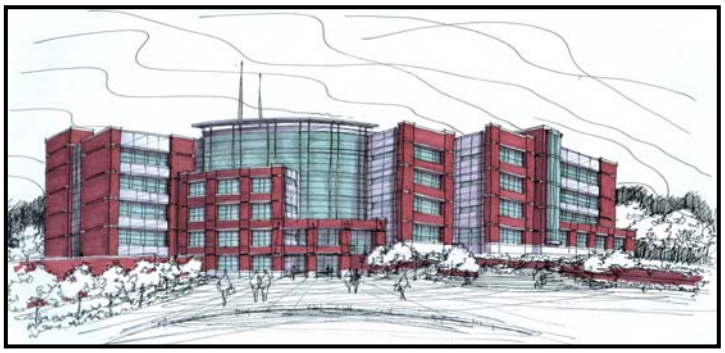
***The American Meteorological Society's DataStreme Atmosphere Project migrates web-based application graphics with the help of N-AWIPS***: The NCEP Central Operations (NCO) completed the migration of the AMS's DataStreme Atmosphere web-based application graphics from the Cooperative Program for Operational Meteorology, Education and Training (COMET) database platform to GEMPAK graphics, using NCEP's N-AWIPS application software. The DataStreme Atmosphere Project is conducted by the AMS, in cooperation with the NWS and the State University of New York at Brockport. This distance learning graduate course is offered to K-12 teachers and provides meteorology principles and real-time environmental data that have classroom applications.

## INFRASTRUCTURE




***NOAA Center for Weather and Climate Prediction*:** Funding was provided in the FY 2004 Presidential Budget to begin the process leading to the start of construction of the new NOAA Center for Weather and Climate Prediction (NCWCP) in College Park, Maryland. On October 14, 2004 a celebration of the launch of the University of Maryland's Enterprise Campus was held at the University's M Square Property located at River Road and Rivertech Center. The new center will be a world-class, state-of-the-art facility, which will deliver national and global climate, weather and ocean guidance, forecasts, warnings and analyses to its partners and the user community; accelerate the use of existing and new satellite data in numerical prediction models and forecast operations; and improve air quality forecasts and enhance dispersion modeling and predicting volcanic ash distributions for aviation forecasts. The NCWCP location with an academic environment is planned to enhance synergistic interaction with the larger research community and strengthen the science service linkage that is a basis for advancing NOAA forecast capabilities. Construction of the new NCWCP building is expected to be completed by early 2008.

***New Facility for Storm Prediction Center*:** Construction of the National Weather Center in Norman, OK began in July 2003 on the University of Oklahoma (OU) South Campus. This building will house NCEP's Storm Prediction Center, along with NOAA's National Severe Storms Laboratory, Warning Decision Training Branch, the Norman NOAA's NWS Forecast Office and parts of NOAA's Radar Operations Center. It will also house meteorological components of the University of Oklahoma. Scheduled completion is expected in 2006.



***Operational Backups and efficiency result from Ocean Prediction Center and Tropical Prediction Center's Synergy Plan*:** The Ocean Prediction Center (OPC) and the Tropical Prediction Center (TPC) completed the first year of their multi-year synergy plan. The plan is designed to achieve more efficient operations at both centers, to provide trained forecast staff familiarity with the operations of both Centers, and to implement new ocean products and services. This will ensure that an effective back up can be implemented in the event one of the Centers becomes non-operational. The back up capability was addressed by the exchange of operational forecasters (three from each Center) to train on the other Center's procedures. The training of the forecast staff began February 2004 with a mutual exchange of OPC and TPC forecasters. The exchange continued through September 2004. An outcome from this exchange is the strengthened relationship between forecasters and management at both Centers. Each trainee prepared a trip report that included a list of possible efficiencies and issues/recommendations. Nearly all the trainees stated that the N-AWIPS model file structure needed to be standardized. Technical specialists from both Centers worked on this project for several months and by the end of the 2004 calendar year the project was complete. In addition, a four member team was created comprising managers and union stewards at both Centers. The charter states that the team was tasked to develop proposals for cross training between the Centers, and modifying workflows and schedules to enhance operational efficiencies. This effort by the team found that by splitting the production of the 48 hour wave period/swell direction forecast chart between the Centers, with one Center preparing the 0000 UTC chart and the other the 1200 UTC chart, will cut the overall production time. A test will be conducted in the spring of 2005 and it is anticipated that production time will be cut nearly in half and that this will produce a unified product between the tropical and extratropical ocean forecast regions.

## GLOBAL LEADERSHIP

NCEP serves as a catalyst to improve weather, climate, water, land surface and space weather prediction services worldwide by taking the lead in coordination, cooperation

and collaborative efforts related to integrating global and regional modeling activities while focusing on technology transfer and training. Key activities include:

***U.S. Weather Research Program***: NCEP continues to support the U. S. Weather Research Program through a variety of activities including the Joint Hurricane Testbed (JHT) located at the Tropical Prediction Center and the Hydrometeorological Testbed (HT) located at the Hydrometeorological Prediction Center. These testbeds are created to facilitate the rapid and smooth transfer of new technology, research results, and observational advances of the USWRP. Eight JHT projects have been accepted for operational implementation during 2003-04 (six in 2003 and two more in 2004), representing a transition success rate of 73% (8 out of 11) among the JHT projects completed thus far. The implemented projects have made demonstrable and quantifiable contributions to operations. For example, a combination of JHT-funded and other upgrades resulted in a 35% improvement in three-day Global Forecast System (GFS) hurricane track forecasts compared to the pre-JHT period of 1995-99. Further, JHT-funded upgrades to the GFDL hurricane model have contributed to GFDL track errors in 2003 that were about 15% less than in 2002 and about 30% less than in 2001. The GFS and GFDL models were in both 2003 and 2004 the two most skillful dynamical models for track forecasting available to TPC. These advances enabled TPC to establish both in 2003 and 2004 new records for track forecast accuracy. During 2004, JHT-funded upgrades to the Statistical Hurricane Intensity Prediction Scheme (SHIPS model) were responsible for improved intensity forecast guidance throughout the five-day forecast period. The JHT-upgraded GFDL model in 2004 had intensity forecast skill in the Atlantic basin at all time periods out to 72 hours, with skill comparable to the SHIPS model at 24 and 36 hours. Testing and evaluation continued in 2004 on twelve additional currently active JHT projects that will conclude in 2005. A new JHT announcement of opportunity was also published in 2004, and reviews of the submitted proposals were completed near the end of the year; selection and funding of new projects from among these proposals will occur during spring 2005.

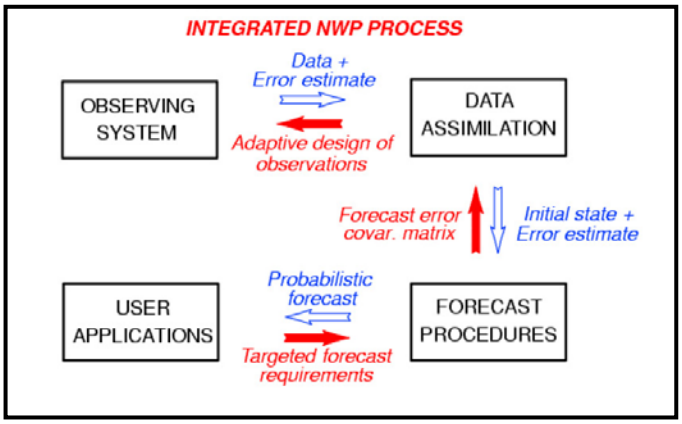
***World Meteorological Organization sponsored training*:** The Tropical Prediction Center hosted three meteorologists from the World Meteorological Organization's Regional Association for a month each during the 2004 Hurricane Season. The meteorologists gained training in tropical cyclone forecasting as well as assisted in the coordination of watches and warnings through the region.

***SPC Forecaster Exchange Program*:** The Storm Prediction Center has had a forecaster exchange program for the past seven years with the Meteorological Service of Canada's (MSC) Prairie Storm Prediction Center in Winnipeg, Manitoba. The program consists of having working level forecasters make extended working visits to the exchange partner's facility. During the visits, the forecasters share meteorological concepts, forecast techniques, and ideas on coordination. This program has proven to be so successful that in 2002 it was expanded to include the MSC Forecast Centers in Toronto, and again in 2004 to include Montreal.

***International Desks*:** Each year, NCEP under the auspices of the United Nations/World Meteorological Organization and the US State Department, provides training to more than 10 meteorologists at its International Desks. Well over a hundred forecasters from South America, Saudi Arabia, Africa, and the Caribbean have been trained on the operational application of numerical weather model output for the preparation and issuance of weather forecasts for their particular regions. The time sensitive products prepared by the visiting meteorologists are available through the World Wide Web, and also disseminated via the Global Telecommunications System. These forecasts are used by climatologists, meteorologists, the aviation community and the general public. They have assisted in the saving of lives, have had a positive economic impact, and have had a favorable impact on resource and personnel protection. The training at the NCEP International Desks provides a solid foundation for these meteorologists to build on, and prepares them with the scientific knowledge to become leaders in their country's meteorological service.

***North American Monsoon Experiment*:** In July/August 2004, the Climate Prediction Center led an international team of scientists from the U.S., Mexico, and Central America in developing plans aimed at determining the limits of predictability of warm season precipitation over North America. The North American Monsoon Experiment (NAME) aims to improve long-range precipitation forecasts during the North American monsoon season of June through September and is fostering a two-way exchange of information, technology and training between NOAA's National Weather Service and Mexico's Servicio Meteorologico Nacional. The eight year NAME program has set far-reaching goals in operational climate forecasting, principally emphasizing time scales ranging from seasonal-to-interannual, to gain a better understanding of 1) the key components of the North American monsoon system and its variability, 2) the role of this system in global water cycle. Additionally, the Tropical Prediction Center's Hurricane Specialists, Storm Prediction Center forecasters and Hydrometeorological Prediction Center's forecasters participated daily in the conference calls discussing NCEP's model trends, expected thunderstorm activity over western Mexico, Qualitative Precipitation Forecast (QPF) and medium range outlooks and issuing graphical 24-hour QPF products for the NAME domain.

***THe Observing system Research and Predictability EXperiment (THORPEX)*:** The mission of THe Observing system Research and Predictability Experiment (THORPEX) is to accelerate improvements in the accuracy of 1 to 14 day weather forecasts for the benefit of society and the economy. To improve the prediction of the location, lead-time and intensity of severe thunderstorms, tornadoes and winter storms requires increases in forecast accuracy for all time scales from 1-day to 2-weeks. THORPEX will extend the limit of predictability from the current seven days to two weeks and double the rate of improvements in forecast skills over the next decade. THORPEX will fundamentally and significantly improve all aspects of global and regional atmospheric predictability in the 1-14 day range by concentrating on improvements in predictions of the most societal relevant parameters of wind, temperature, and precipitation. THORPEX research topics include: global-to-regional influences on the evolution and predictability of weather systems; global observing system design and demonstration; targeting and assimilation of




observations; societal, economic and environmental benefits of improved forecasts. As the Numerical Weather Prediction (NWP) based weather forecasting must be considered as an end-to-end, integrated process. To this end, the proposed integrated NWP process includes the four main components with a two-way interaction, facilitating the feedback of requirement-related information for the different components of the NWP process. The improved predictability will be valuable to many service sectors, including energy, commerce and transportation, and tourism industries that require high accuracy in temperature information, cloud cover, humidity and other basic meteorological variables.

## NCEP CULTURE/RESOURCES

Promoting organizational excellence through employee recognition contributes to the NCEP mission by highlighting our most important asset, our employees. Notable accomplishments, awards and distinctions received by NCEP employees during the last several years include:

*2004*

Storm Prediction Center – DOC Gold Medal – along with several other Weather Forecast Offices received the DOC Gold Medal for providing life saving services during a record outbreak of tornadoes during the period May 4-10, 2003

Tropical Prediction Center – DOC Gold Medal – along with several other Weather Forecast Offices received the DOC Gold Medal for outstanding customer service, while enduring personal hardships, before, during, and after Hurricane Isabel

Hydrometeorological Prediction Center and Ocean Prediction Center – DOC Bronze Medal – among the recipient Regions, Centers and Offices for outstanding customer service, and providing expertise and leadership to decision makers before, during and after Hurricane Isabel in September 2003

James Franklin – Tropical Prediction Center – DOC Gold Medal – shared with NOAA's Hurricane Research Division's Mike Black for development and novel use of GPS

dropwindsondes to improve accuracy of NOAA hurricane analyses and advance the science of hurricane forecasting

Geoff DiMego – Environmental Modeling Center – NOAA Administrator's Awards – Directing the development and implementation of the NCEP Eta model and 3D-Var data assimilation system

Joe Schaefer – Storm Prediction Center – Citation from the Governor of the State of Oklahoma for “his leadership”

Curt J. Janota – NCEP Central Operations – National Isaac Cline Award for Engineering, Electronics, or Facilities

Gerald D. Bell – Climate Prediction Center – National Isaac Cline Award for Leadership

Edwin Danaher – Hydrometeorological Prediction Center – NOAA Diversity Spectrum Award for Managers for significant contributions to the NOAA Diversity Initiative

Steve Corfidi – Storm Prediction Center – elected Fellow of the AMS

Storm Prediction Center – Oklahoma State Legislature Proclamation for service to the State of Oklahoma and the Nation

Max Mayfield – Tropical Prediction Center – Richard Hagemeyer Award – for his contributions to our Nation’s Hurricane Warning Program

Regional recipients of the Isaac Cline Award were:

Gerald D. Bell – Climate prediction Center (CPC) – Meteorology

Michel Davison – Hydrometeorological Prediction Center (HPC) – Leadership

Curt Janota – Ocean Prediction Center – Engineering, Electronics or Facilities

Local recipients of the Isaac Cline Award were:

David Michaud – NCEP Central Operations (NCO) – Leadership

Paul Fike – Aviation Weather Center (AWC) – Leadership

Jonathan Slemmer – Aviation Weather Center (AWC) – Meteorology

Daniel Brown – Tropical Prediction Center (TPC) – Meteorology

Christopher Bailey – Hydrometeorological Prediction Center (HPC) – Meteorology

*2003*

Vernon E. Kousky and Raymond W. Higgins – DOC Silver Medal – Group award for providing critical services in support of fire suppression

Joe Schaefer – AMS Franklin W. Reicheldorfer Award – for enduring contributions to the improvement of severe weather forecasts and especially their dissemination and verification

Tropical Prediction Center – Offshore Energy Center's Hall of Fame as a Technology Pioneer

Mike Bladwin – Storm Prediction Center – AMS Weather and Forecasting Editors Award

John Hart – Storm Prediction Center – National Isaac Cline Award for Hydrometeorology

Joe Schaefer – Storm Prediction Center – Presidential Rank Award for Meritorious Service

Regional recipients of the Isaac Cline Award were:

> HPC's Winter Weather Team - Peter Manousos, Bruce Sullivan, Chris Hedge, Bob Oravec, and Dan Petersen

*2002*

Carmeyia Gillis – NCEP Office of the Director – NOAA Administrator's Award – Public Affairs

Aviation Weather Center – FAA's Excellence in Aviation Award along with the local Research Laboratory and University

Rich Tinker and Douglas Lecomte – Special Recognition Awards from the Metropolitan Washington Council of Governments for their support of drought monitoring efforts

**NATIONAL CENTERS FOR ENVIRONMENTAL PREDICTION**

Louis W. Uccellini
Director, NCEP
www.ncep.noaa.gov

Kevin Cooley
Director, NCEP Central Operations
www.nco.ncep.noaa.gov

Stephen Lord
Director, Environmental Modeling Center
www.emc.ncep.noaa.gov

Jack May
Director, Aviation Weather Center
www.aviationweather.gov

Jim Laver
Director, Climate Prediction Center
www.cpc.ncep.noaa.gov

James Hoke
Director, Hydrometeorological Prediction Center
Director, Ocean Prediction Center
www.hpc.ncep.noaa.gov and www.opc.ncep.noaa.gov

Ernest Hildner
Director, Space Environment Center
www.sec.noaa.gov

Joseph Schaefer
Director, Storm Prediction Center
www.spc.ncep.noaa.gov

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