# The NCEP Production Suite:
## Recent and Planned Upgrades


**Michelle Mainelli presenting for:**

**Dr. William M. Lapenta**
Director, National Centers for Environmental Prediction
NOAA/National Weather Service
AMS Summer meeting
July 2016, Tuscaloosa AL

# Presentation Outline

- **NWS and Weather Ready Nation**
- **The NCEP Production Suite**
- **Model Upgrades: GFS, RAP/HRRR, HWRF, NWM**
- **Recommended Long Term Plans to Unify Suite**

# NWS Strategic Outcome: Weather-Ready Nation

## NWS Strategic Goals

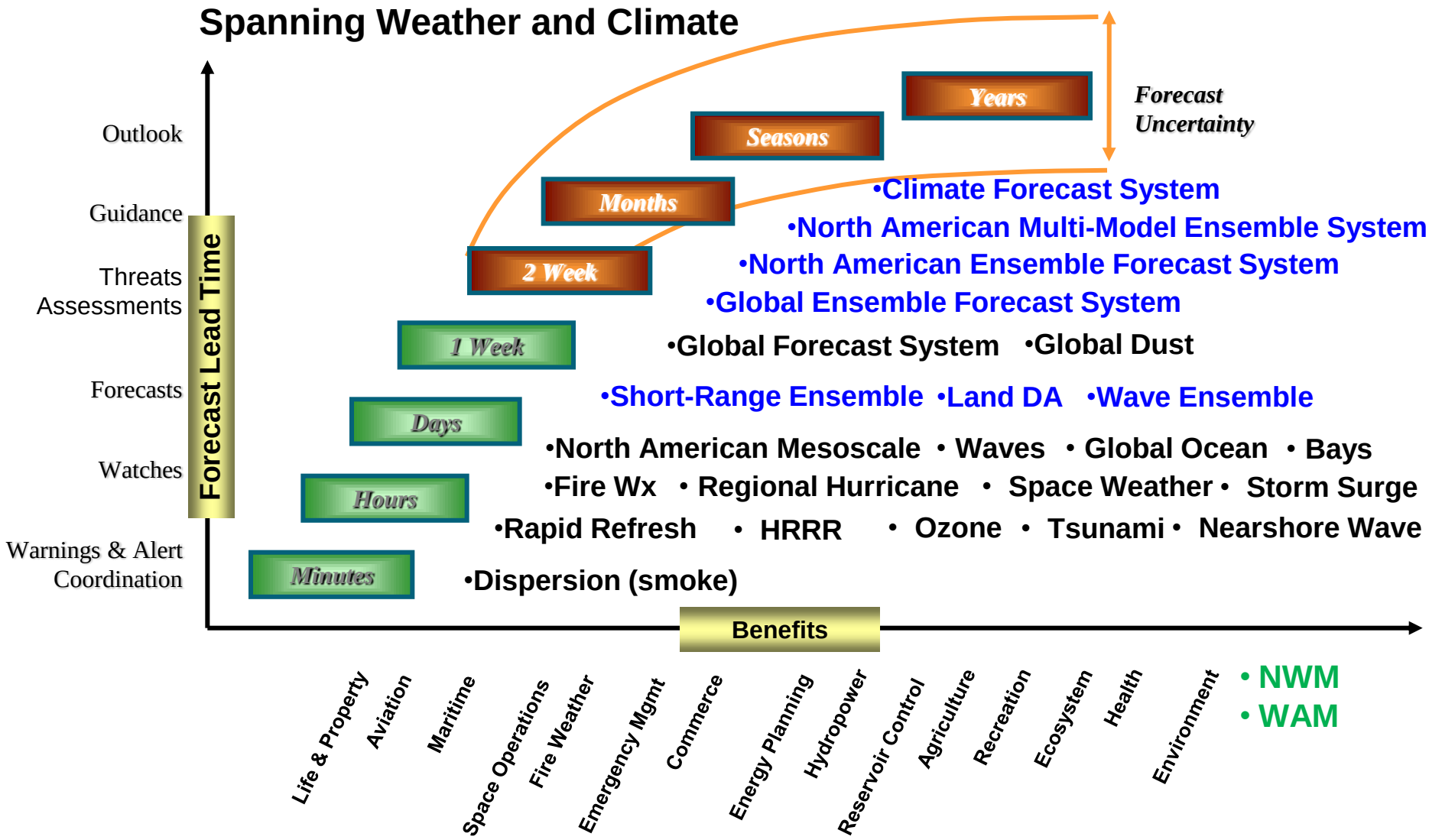
- Improve Weather Impact-Based Decision Support Services
- Improve Water Forecasting Services
- Enhance Climate Services and adapt to climate-related risks
- Improve sector-relevant information in support of economic productivity
- Enable environmental forecast services supporting healthy communities and ecosystems
- Sustain a highly skilled, professional workforce equipped with training, tools, and infrastructure to meet mission


**Operational numerical guidance:**

**Foundational tools to used to improve public safety, quality of life and make business decisions that drive U.S. economic growth**

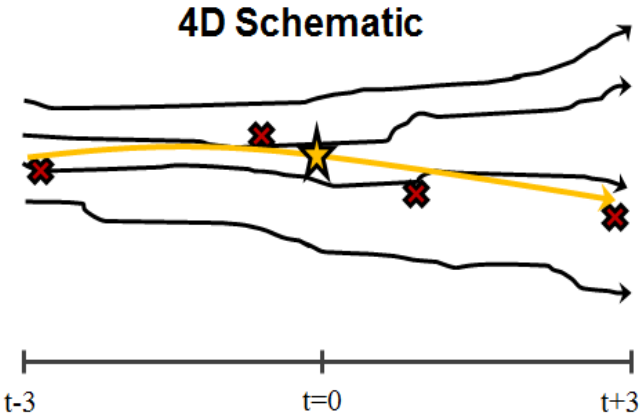
***Prediction is what makes NOAA/NWS unique and indispensable!***

# Seamless Suite of Operational Numerical Guidance Systems

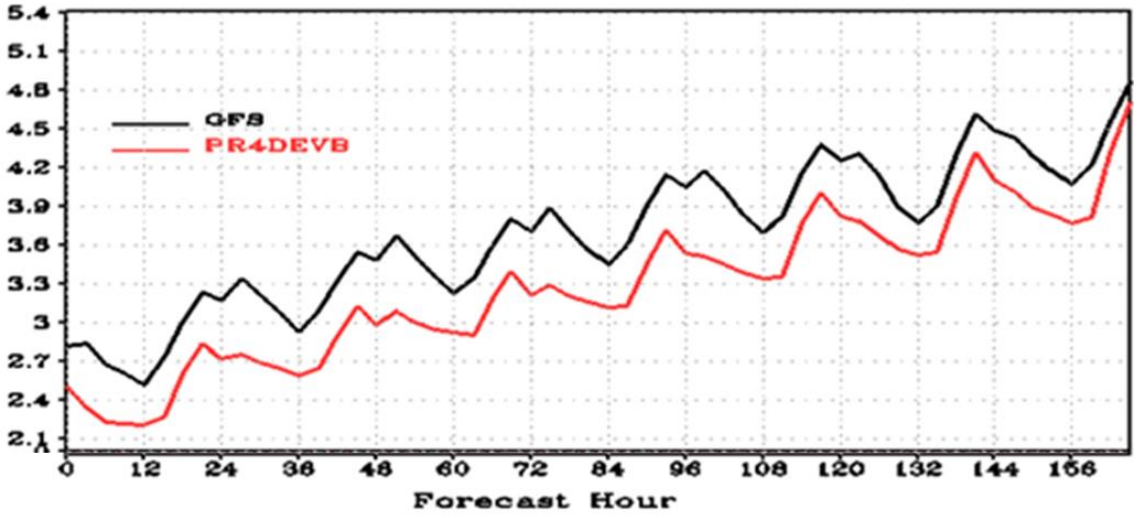


# GFS/GDAS 4D Hybrid En-Var: Implemented May 2016

- **4-D Hybrid En-Var:**
- **All-sky AMSU-A Radiances**
- **SATWND/Aircraft ob changes**
  - AVHRR satellite winds and aircraft moisture data are also assimilated.
- **Modified relocation/tracking to allow hourly relocation**
- **Modified thinning/weight in time**




**2m Dew Point RMSE 00Z Cycles 7 July to 11 Nov 2015**




- Semi-implicit upgrade,
- Convective gravity wave upgrade,
- Tracer adjustment upgrade
- ***Corrections to land surface to reduce summertime warm, dry bias over Great Plains***
- Improved icing probability products and new icing severity product
- ***Hourly output through 120-hr forecast***

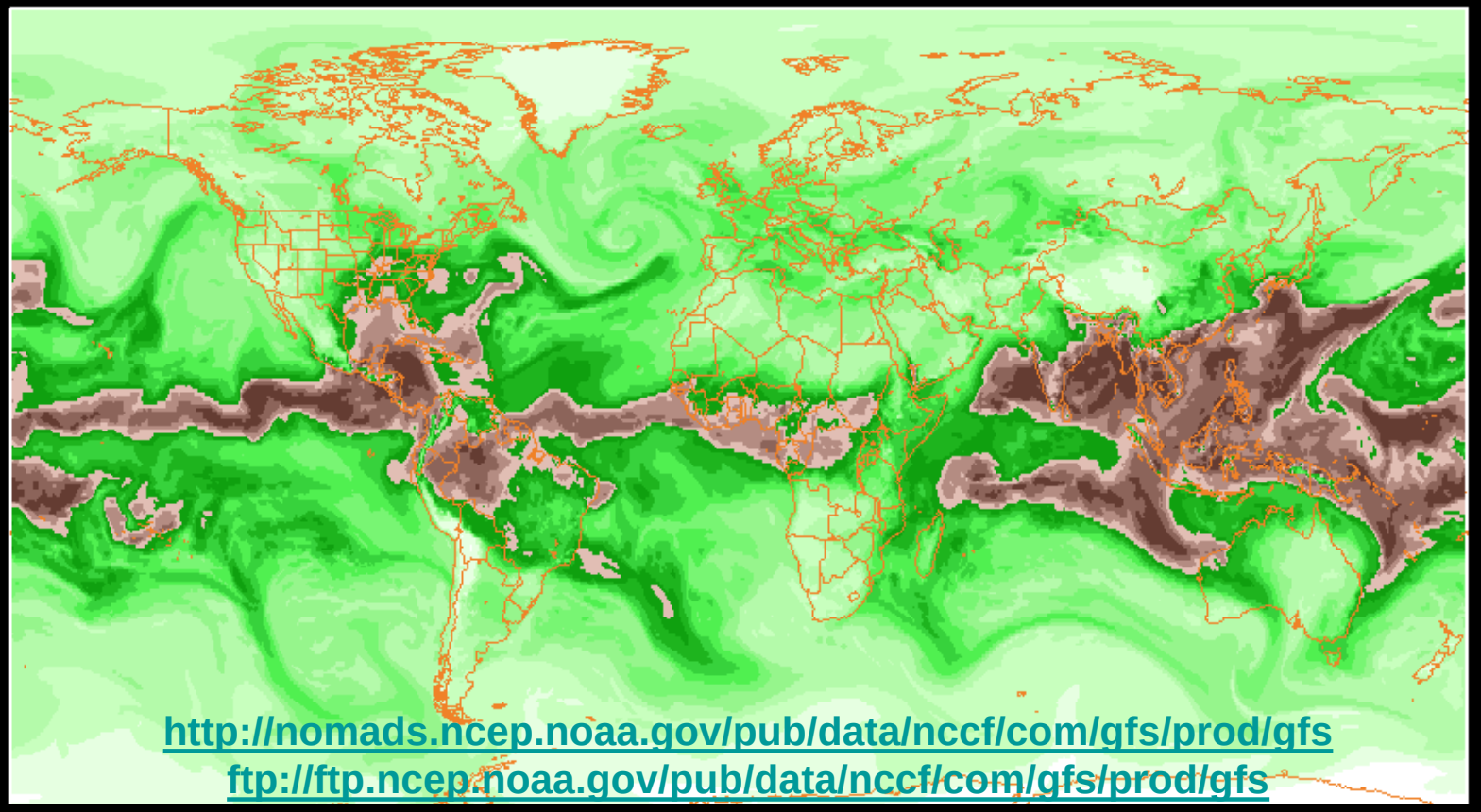
# Hourly GFS Output to Day-5

04 June 2016, 12 UTC cycle; Hourly to 120 hours

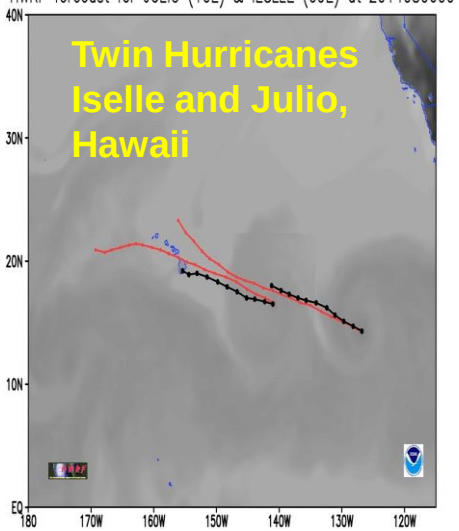
Fcst Hour (f001),

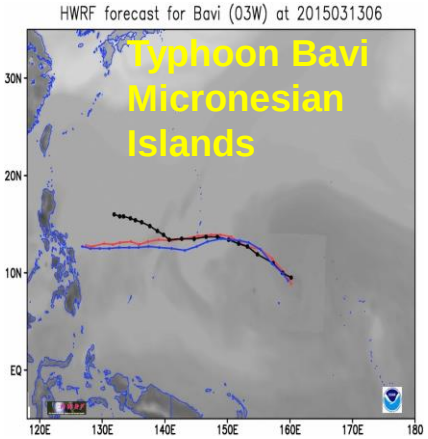
0.25° x 0.25°

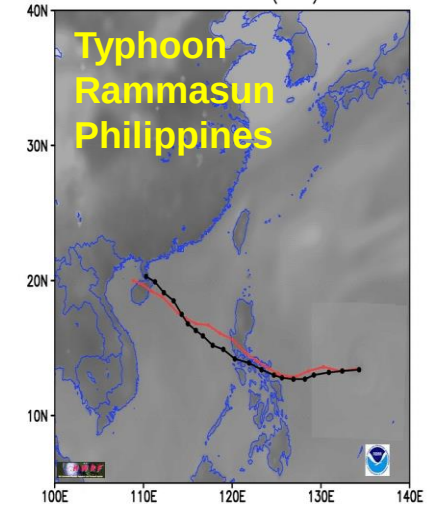
GFS Colum Precipitable Water ($kg/m^2$)

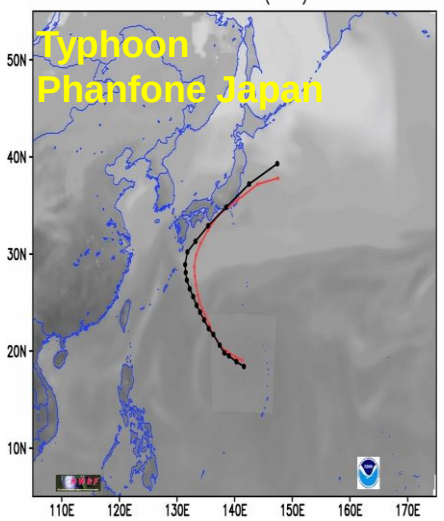


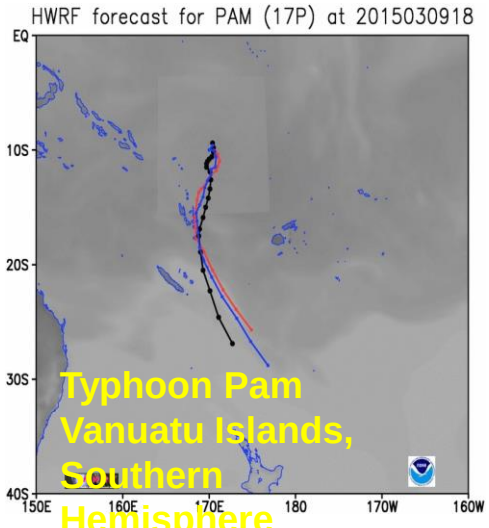

# High-Resolution Forecast Guidance from HWRF for all global Tropical Cyclones: Upgraded July 2016

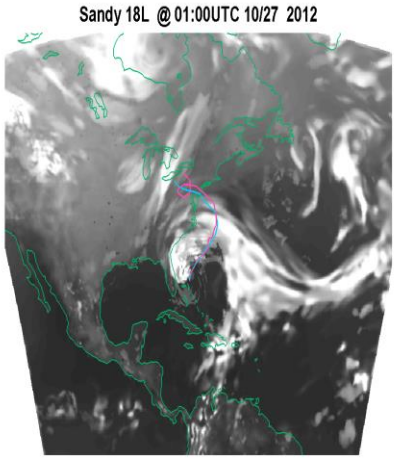


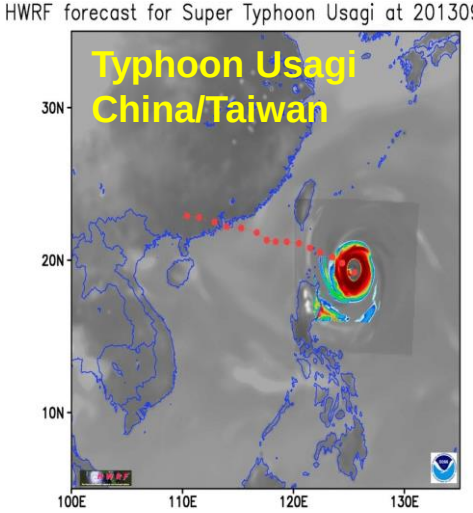



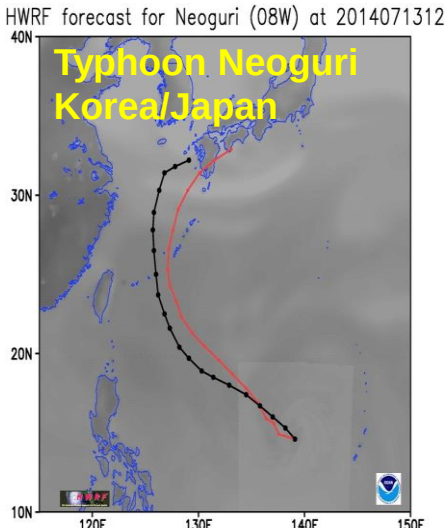




Hurricane Sandy, North Atlantic



# RAP/ HRRR
# Planned Upgrade Aug 2016

**Hourly-Updated weather model guidance for improved decision-making**

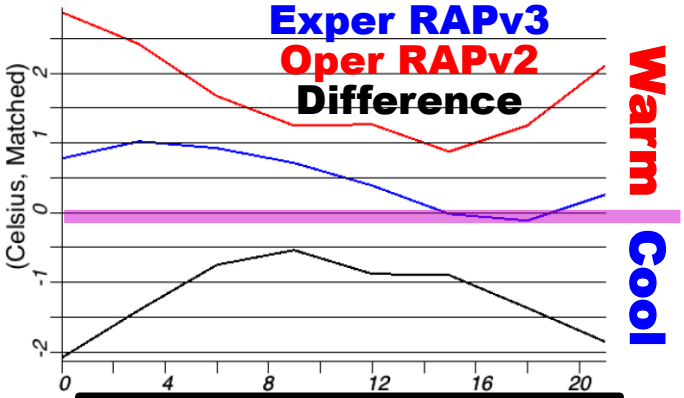
**Forecast Hours:**
**RAPv3 increasing from F18 to F21**

**HRRRv2 increasing from F15 to F18**

**Significant improvements:**
**Better PBL, LSM, Microphysics, data assimilation**

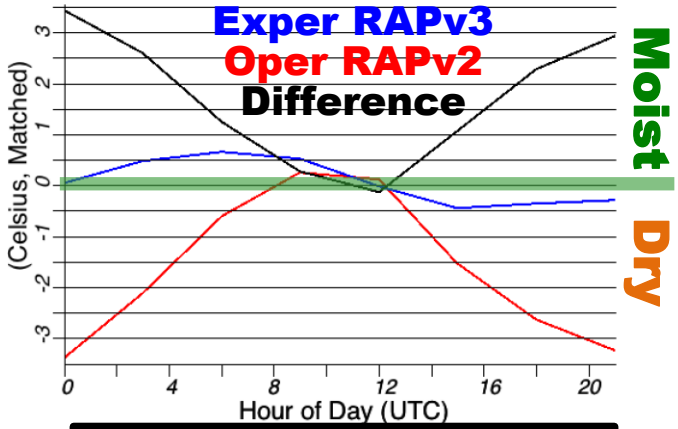
**Benefits:**
**Significantly reduced biases, reduced RMS, Improved convection**

**Jul-Aug 12 hr 2m Temp**

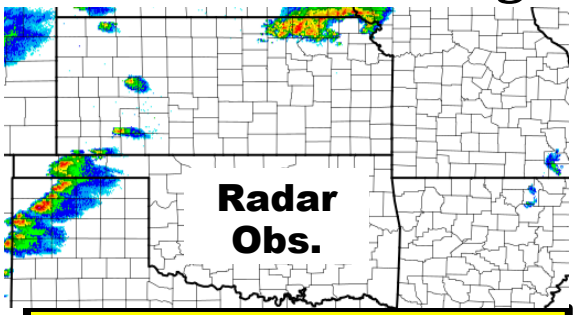



**Reduced warm bias**

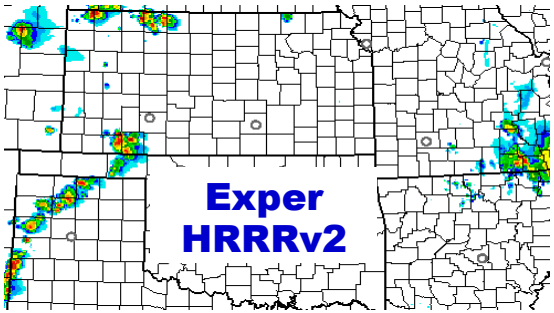
**July-Aug 12hr 2m Dewpt**

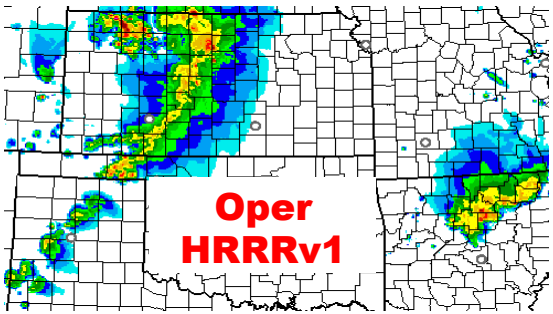



**Reduced dry bias**



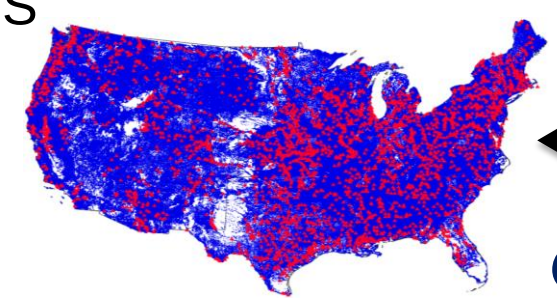

**Improved convection**
(reduced over-prediction)



# The National Water Model (NWM) Implementation planned Aug 2016

- NWM hydrologic model scheduled for operational implementation in August
  - A collaborative research-to-operations effort between OWP, NCAR and NCEP
  - Will provide high resolution forecast information for rivers/streams at 2.7 million locations, complementing the ~4,000 NWS core river forecast locations now available and providing first-ever coverage for many areas of the United States
  - Output also includes key water resource components such as soil states, snow pack, and energy fluxes on 1km CONUS+ grid
  - Will help forecasters better predict floods/droughts, supports FEMA's flood response mission
- Uncoupled NWM will use atmospheric model data, observations as forcing
  - Hourly NWM analyses driven by hourly MRMS, assimilate streamflow from USGS gauges
  - Hourly Deterministic NWM forecasts driven by HRRR to 15 hours
  - Once daily deterministic NWM forecasts driven by GFS to 10 days
  - Once daily ensemble NWM forecasts driven by CFS out to 30 days (output comes out all day)
- Dissemination via public NWC website, feed for RFC CHPS systems, and NOMADS



Current NWS river forecast points (red)
NWM forecast points (blue)

OWP | Office of Water Prediction

# Feedback: Model Requirements and Pre-Implementation Assessments


- **Requirements definition**
  - Identified as a weakness by NCEP stakeholders
  - incomplete requirements may create false expectations
  - NWS needs an improved process—is portfolio management the answer?

- **Stakeholders--- need earlier access to information**
  - What changes are being made?
  - What's the rational?
  - What characteristics of the tool will change?
  - Stakeholder calibration methods need time and access to pre-implementation data in order to adapt (i.e., GEFS FY15 Upgrade)
  - 30-day NCO parallel insufficient for customer assessment


**IMPROVE COMMUNICATION BETWEEN MODEL DEVELOPERS AND STAKEHOLDERS**

# EMC Model Evaluation Group (MEG)

***Goal: Enhance communication between EMC and its customers!***

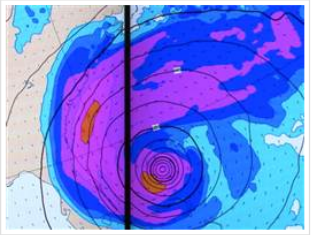
- **Daily examination of model performance:**
- **Evaluations of EMC development parallels and associated experiments**
- **MEG presentations have directly led to model corrections/enhancements**
- **Provides critical feedback to EMC modelers**
- **Keeps customers "in the loop" regarding model changes and issues**
- **Provides streamlined feedback addressing their model concerns**
- **Can rapidly generate critical case studies (i.e. 2012 Mid-Atlantic derecho, 2015 PHL-NYC snow forecast bust, 2016 Houston floods)**

**Weekly webinars Thursday at 11:30 EDT – open to all model customers**

**Topics announced in advance – contact mary.hart@noaa.gov and ask to be added to the MEG announcement email list**

# Hurricane Sandy (2012) Raises Public Awareness of Modeling……

http://www.nbcnews.com/video/nightly-news/51108647#51108647

Nightly News | March 08, 2013

## European weather forecasts superior to US models

The predictions from European computer models, which have 10 times the computing ability of the National Weather Service, have increasingly become more accurate than our models with the starkest example being Hurricane Sandy. NBC's Al Roker reports.

Share This:

## Capital Weather Gang

The inside scoop on weather in the D.C. area and beyond

The Washington Post Weather website | Jump to CWG's Latest Full Forecast | Outside now? Radar, temps and more: Weather Wall

Follow us on Twitter (@capitalweather) | Become a fan on Facebook | RSS

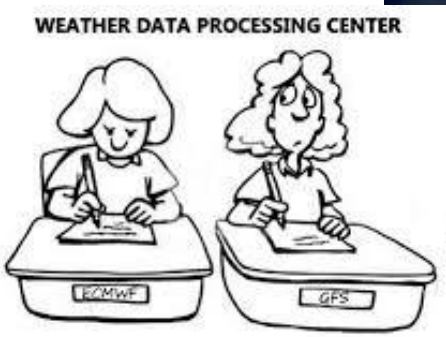
## Cliff Mass Weather Blog

Monday, February 11, 2013

### The U.S. Weather Prediction Computer Gap

**It happened again.**

A major storm hit the northeast U.S
the European Center for Medium F
illustrate, take a look at the 120-hr
models valid at 4 PM PST Friday, I
solid lines, isobars, lines of constar




http://www.washingtonpost.c
f0feafdd1394_blog.html

AT A GLANCE

| Tue | Wed | Thu |
|---|---|---|
| --- | --- | --- |
| 54 \| 70 | 53 \| 75 | 58 \| 78 |
| Fri | Sat | Sun |
| 20% | 30% | 20% |
| 60 \| 81 | 63 \| 80 | 62 \| 77 |

Posted at 11:24 AM ET, 03/08/2013

### To be the best in weather forecasting: Why Europe is beating the U.S.

*By Richard B. Rood**

*The superior performance of the Europe GFS model, in high impact storms affec Snowquester - has raised the question: good? Guest contributor Richard Rood*

As early as 1995, the weather

October 29, 2012, 8:17 PM

## Why America Has Fallen Behind the World in Storm Forecasting

Article | Comments (34)

Tweet 255

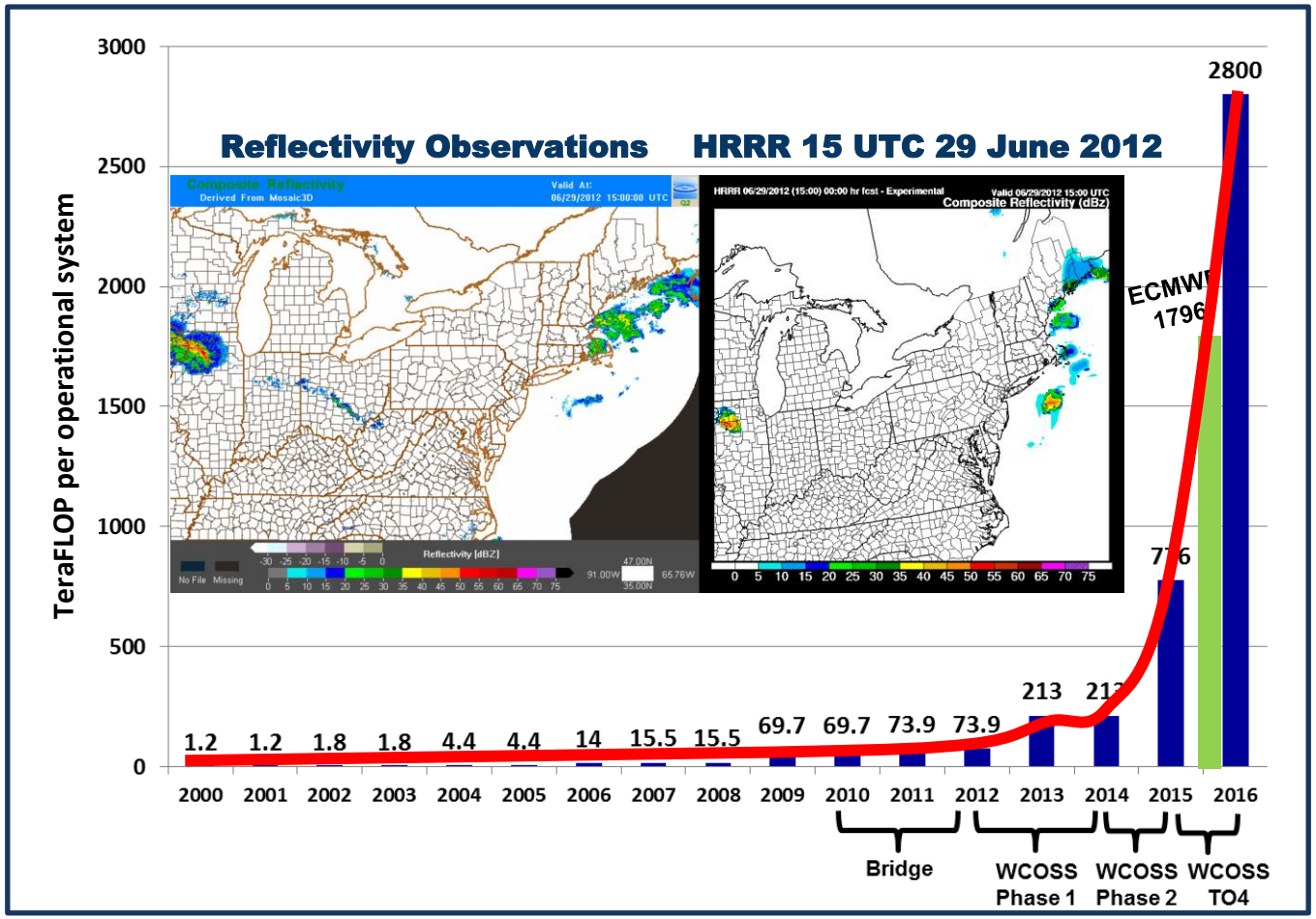
Email | Print

COMMENTARY

By Kerry Emanuel

# Computer Upgrade Now in Place!

**Increased HPC capacity to 2.8 petaFLOPs**
***(for primary and backup, respectively–for a total of 5.6 PF)***
**Accepted for Operations: November 30th, 2015**



# External Review Committee for NCEP Modeling Suite

| First | Last | Affiliation |
|---|---|---|
| Christa | Peters-Lidard | NASA/GSFC |
| Alan | Blumberg | UCACN; Stevens Tech |
| Andy | Brown | Met Office |
| Cliff | Mass | U Washington |
| Ricky | Rood | U Michigan |
| Tom | Hamill | NOAA/ESRL |
| Chris | Bretherton | U Washington |
| Brian | Colle | Stony Brook |
| Jim | Doyle | NRL, Monterey |
| Ben | Kirtman | U Miami |
| Anke | Kamrath | NCAR |
| Eric | Chassignet | FSU, Director, COAPS |
| Peter | Neilley | UCACN; Weather Company |
| Fred | Carr | UCACN; U Oklahoma |
| Jim | Kinter | UCACN; COLA/GMU |
| Bill | Kuo | UCACN; DTC; NCAR |
| Gilbert | Brunet | UCACN; Met Office |
| Tsengdar | Lee | UCACN; NASA HQ |

- Meeting 4-7 August 2015 in College Park
- 90 Participants across the community
- Preliminary findings and recommendations briefed to NOAA leadership
- Report published December 2015:

http://www.ncep.noaa.gov/director/ucar_reports/ucacn_20151207/UMAC_Final_Report_20151207-v14.pdf

# UMAC Preliminary Findings and Recommendations

UMAC UCACN Model Advisory Committee

Date: 20150807

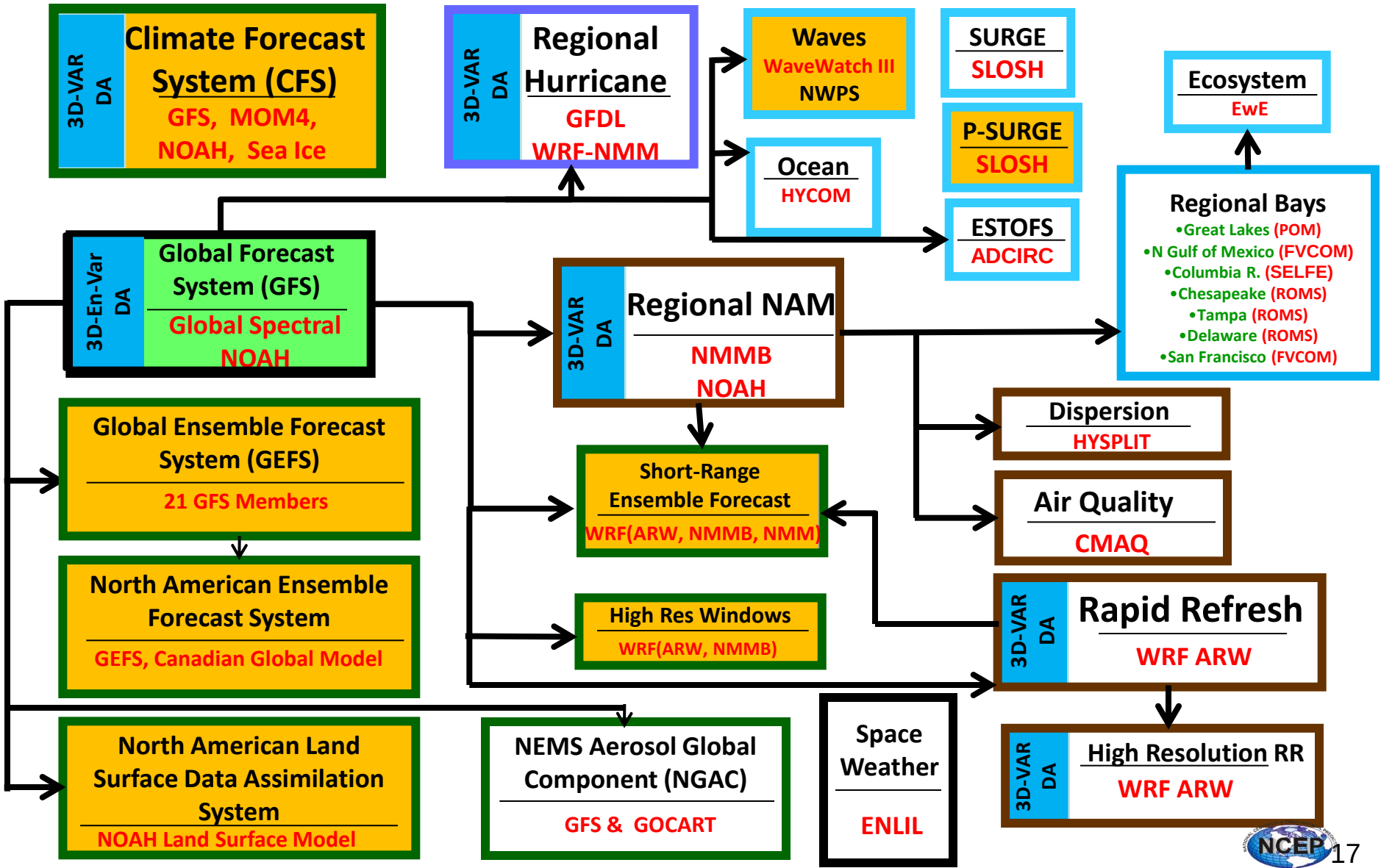
## *Key Finding*

*U.S. Environmental Prediction now has the potential to rapidly progress to world leadership. This requires a new level of organization and the use of evidence-driven decision making.*

# UMAC Overarching Recommendations

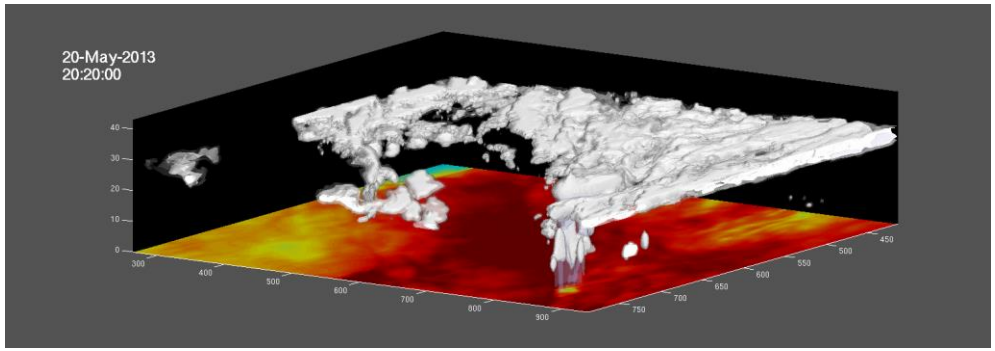
- **Reduce complexity of the NCEP Production Suite.**
- **A unified, collaborative strategy for model development across NOAA is needed.**
- **Leverage the capabilities of the external community**
- **Continue to enhance High Performance Computing capabilities.**
- **Execute strategic and implementation plans based on stakeholder requirements.**

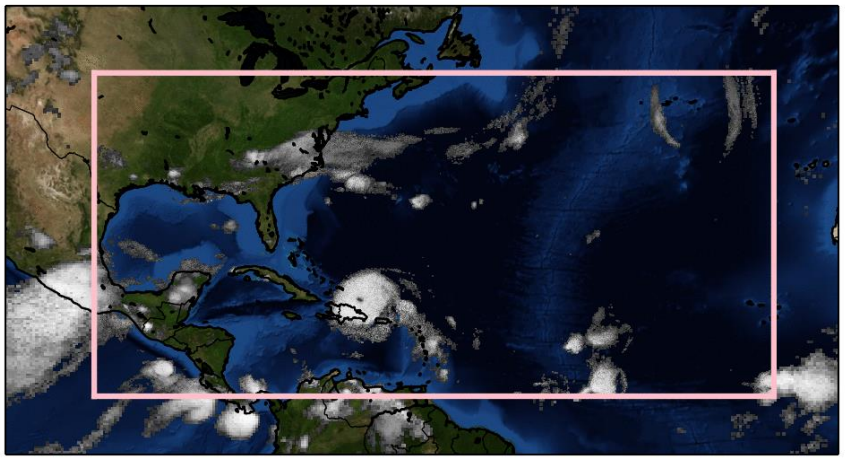
# Complexity???
# *What Complexity?*



# Next Generation Global Prediction System Path to Unified Weather and Climate Guidance?

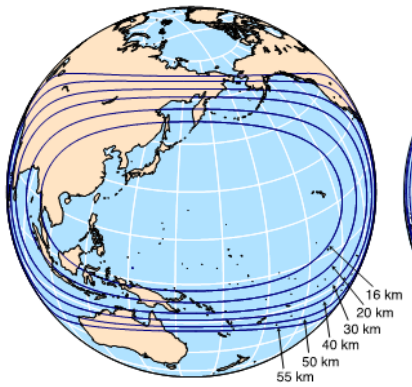
High-resolution nested grid simulations using HiRAM and Finite Volume 3 (FV3)



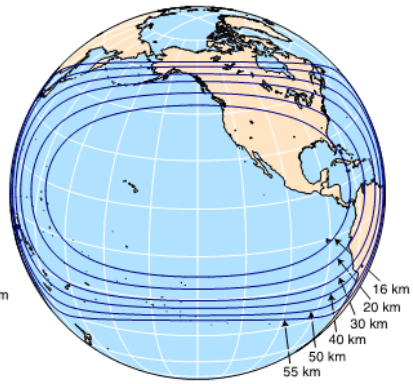




MPAS-Atmosphere 2013-2014-2015
Tropical Cyclone Forecast Experiments
daily 10-day forecasts during the NH tropical cyclone season

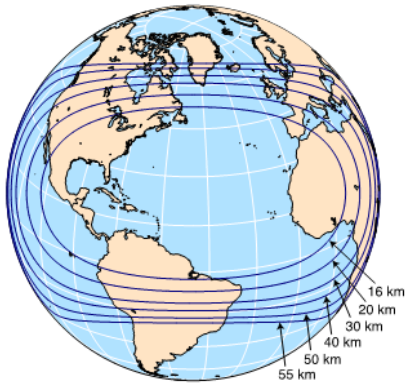
Western Pacific basin mesh




Eastern Pacific basin mesh




Atlantic basin mesh




## NGGPS

***Seamless solutions for tropical weather and climate in a unified global-to-local-scale modeling framework***

# Overall Assessment & NGGPS Program Manager Recommendation to NWS AA

***The FV3 core represents the lowest risk, lowest cost alternative for the new NGGPS atmospheric model***

- **Compared to the MPAS, FV3:**
  - **Meets all technical needs**
  - **Less expensive to implement**
  - **Higher readiness for implementation**
  - **Significantly better technical and computational performance**
  - **Lower risk**

- **NGGPS strategy has always been to find and implement the best global model (not the best convective scale model, although nothing in results precludes eventual global/convective-scale unification based on FV3)**

**Recommendation:** **Select GFDL FV3 and proceed to NGGPS Phase 3 dynamic core integration and implementation**

# Important Links to NCEP Model Data

**NOAA Operational Model Archive and Distribution System (NOMADS):**

http://nomads.ncep.noaa.gov/pub/data/nccf/com/

**NCEP FTP Server:**

ftp://ftp.ncep.noaa.gov/pub/data/nccf/com

**NCEP Model, Analysis and Guidance WEB Page:**

http://mag.ncep.noaa.gov/

**Questions About Model Data:**

Rebecca.Cosgrove@noaa.gov

**EMC Model Evaluation Group:**

mary.hart@noaa.gov

**Model Suite Review Report:**

http://www.ncep.noaa.gov/director/ucar_reports/ucacn_20151207/UMAC_Final_Report_20151207-v14.pdf