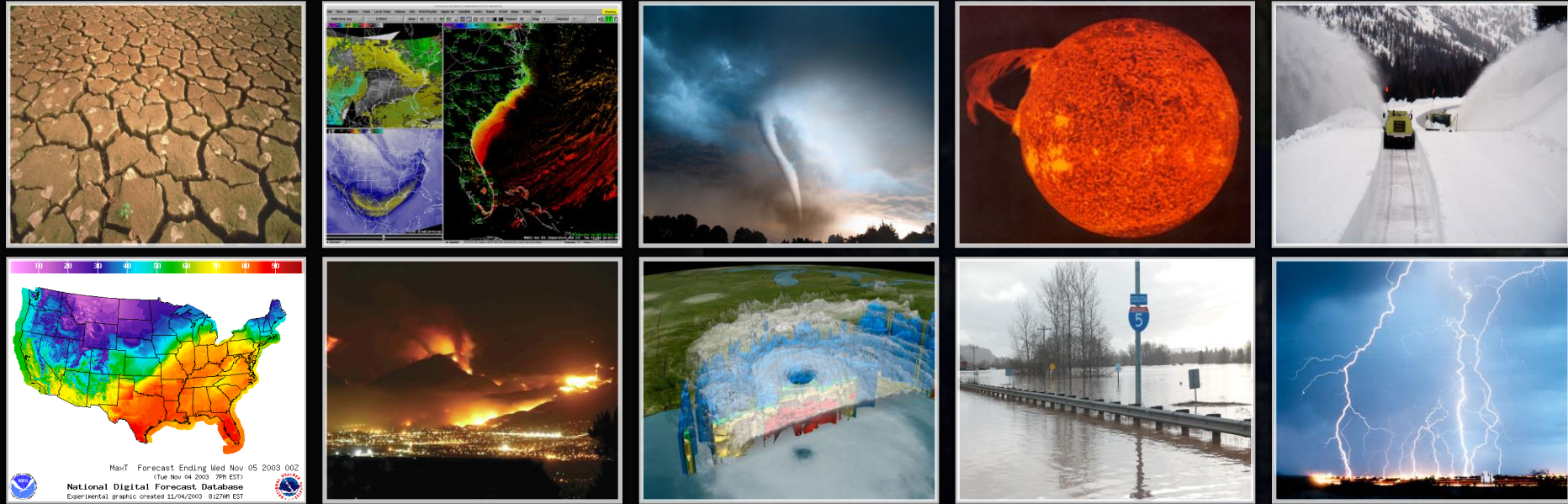


# The NCEP Production Suite: Recent and Planned Upgrades



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



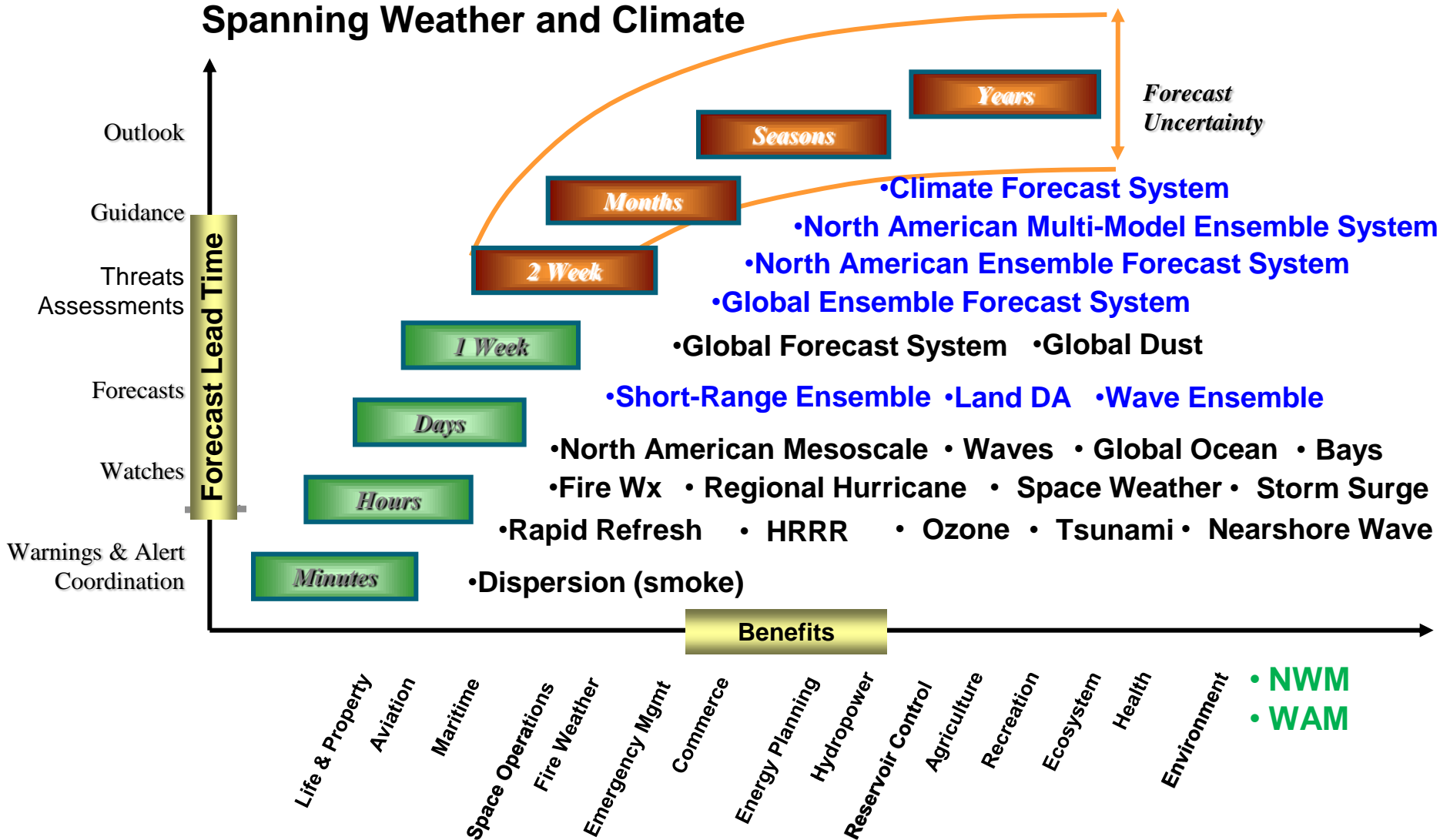
### Operational numerical guidance:

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





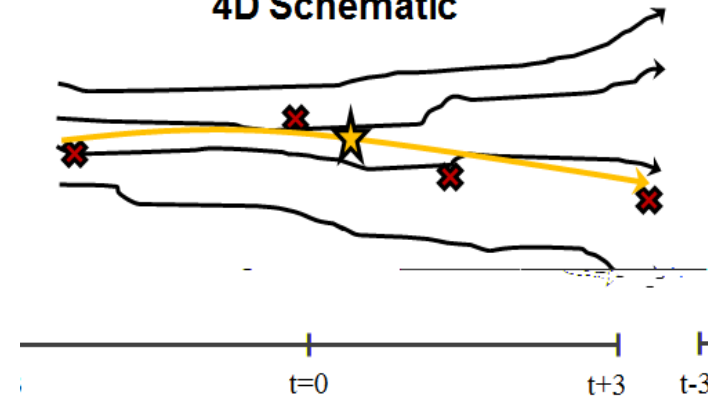


# GFS/GDAS 4D Hybrid En-Var: Implemented May 2016

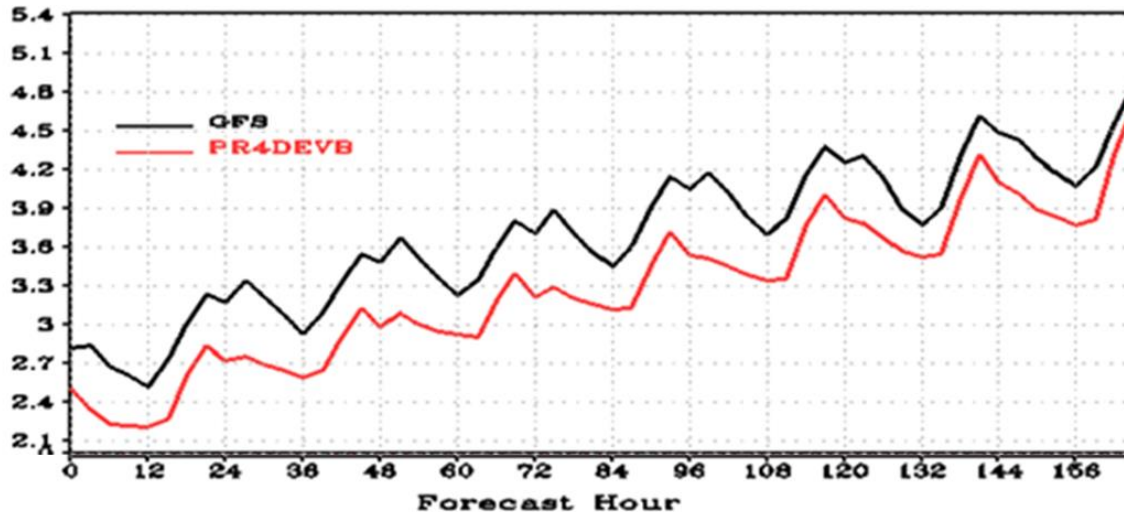


- 4-D Hybrid En-Var:
- All-sky AMSU-A Radiances
- SATWND/Aircraft ob changes
  - AVHRR satellite winds and aircraft moisture data are also assimilated.
- Modified relocation/tracking to allow hourly relocation
- Modified thinning/weight in time

4D Schematic



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



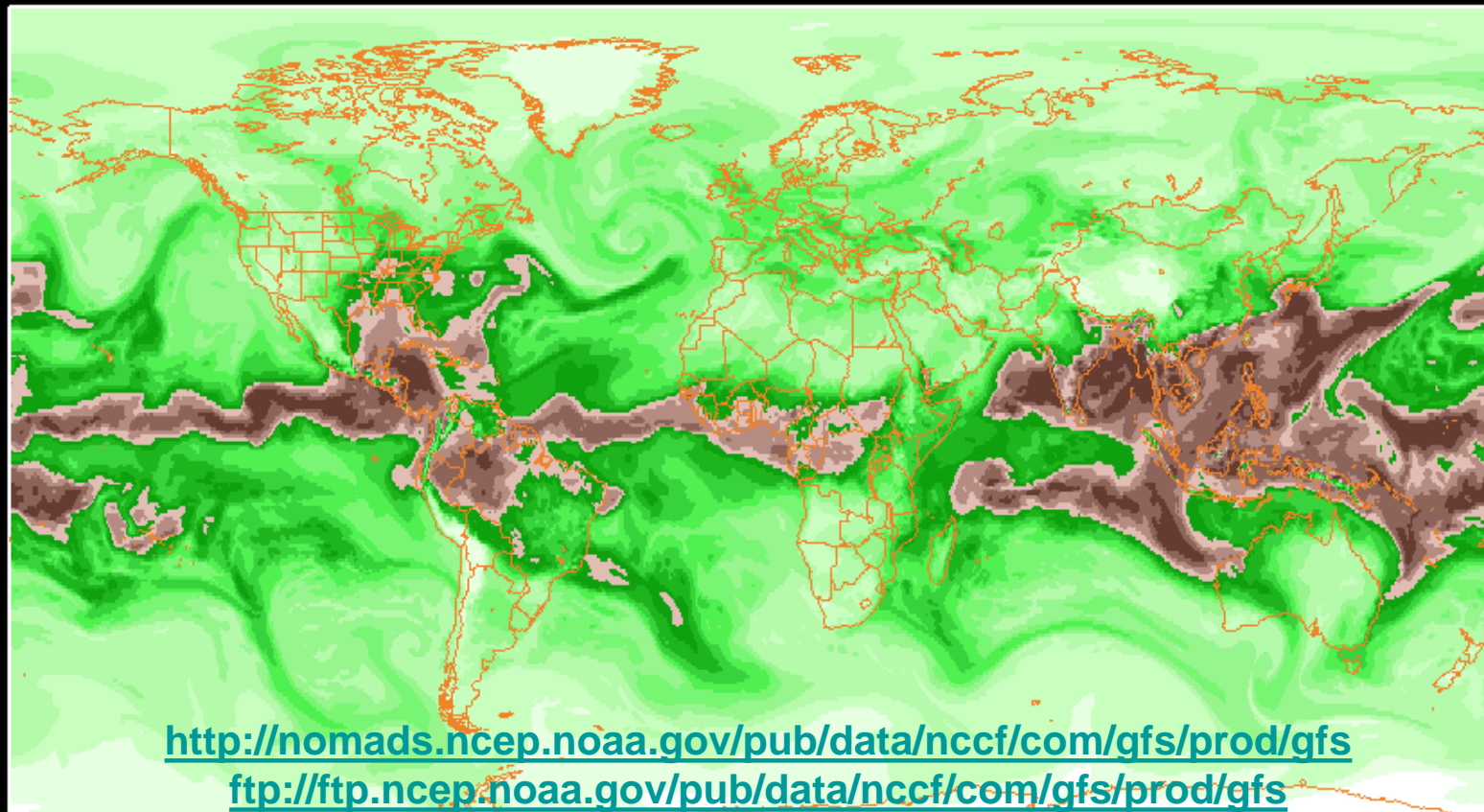
04 June 2016, 12 UTC cycle; Hourly to 120 hours

Fcst Hour

(f001),

0.25° x 0.25°

GFS Colum Precipitable Water (kg/m<sup>2</sup>)



<http://nomads.ncep.noaa.gov/pub/data/nccf/com/gfs/prod/gfs>  
<ftp://ftp.ncep.noaa.gov/pub/data/nccf/com/gfs/prod/gfs>

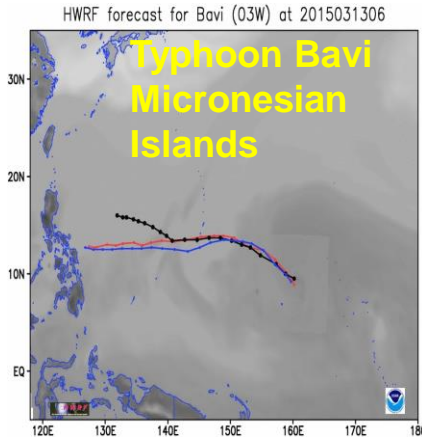
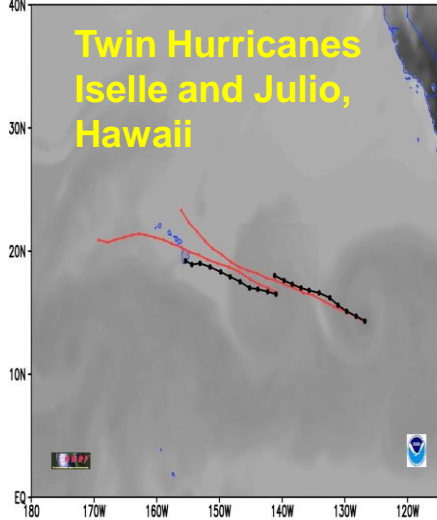




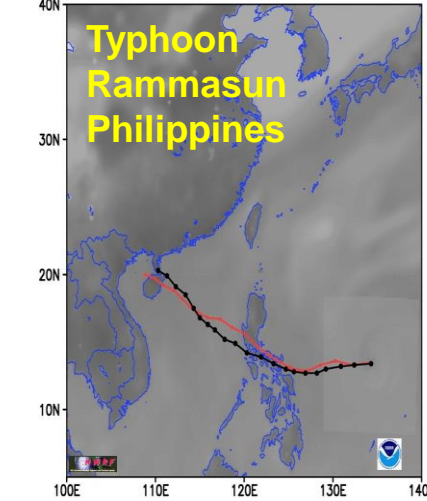
# High-Resolution Forecast Guidance from HWRF for all global Tropical Cyclones: Upgraded July 2016



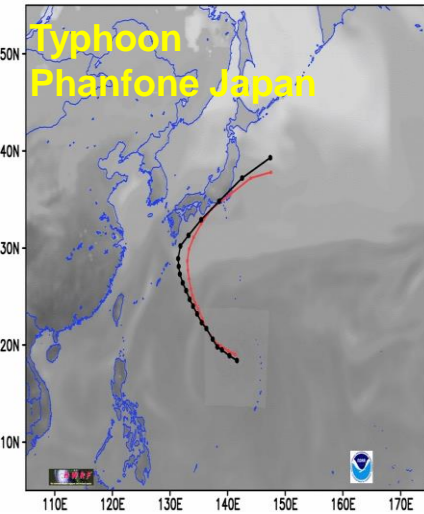
HWRF forecast for JULIO (10E) & IESLLE (09E) at 2014080600



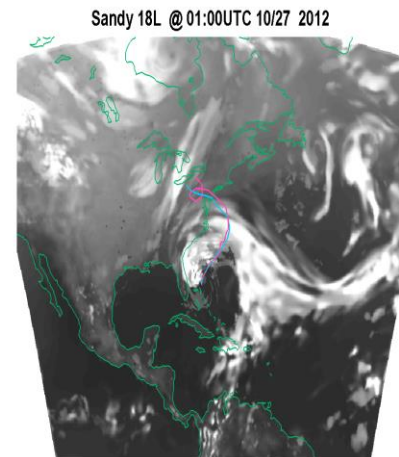
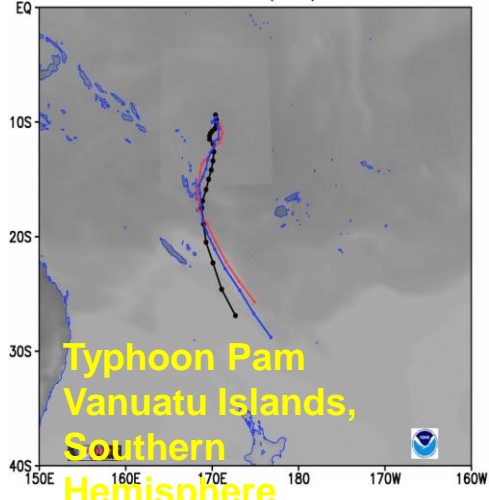
HWRF forecast for Rammasun (09W) at 2014071312



HWRF forecast for Phanfone (18W) at 2014100112

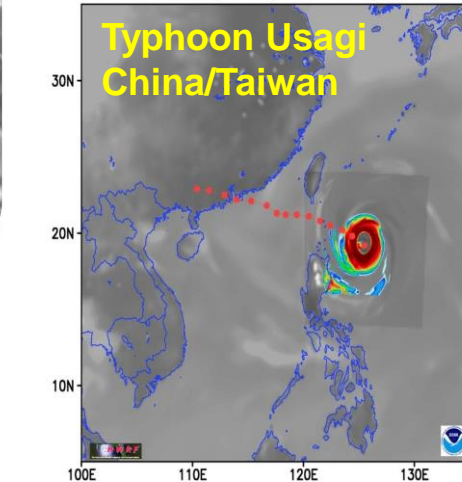


HWRF forecast for PAM (17P) at 2015030918

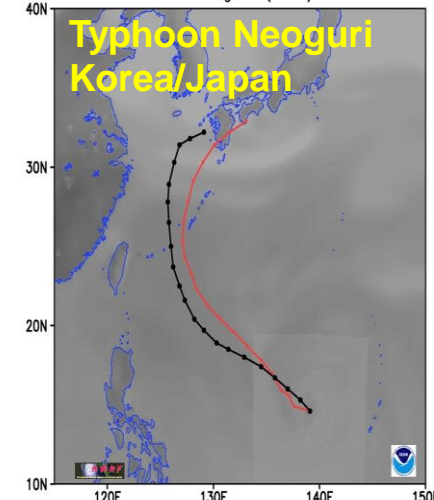


Hurricane Sandy, North Atlantic

HWRF forecast for Super Typhoon Usagi at 2013092000



HWRF forecast for Neoguri (08W) at 2014071312







# RAP/ HRRR



## Planned Upgrade Aug 2016

Hourly-Updated weather model guidance for improved decision-making

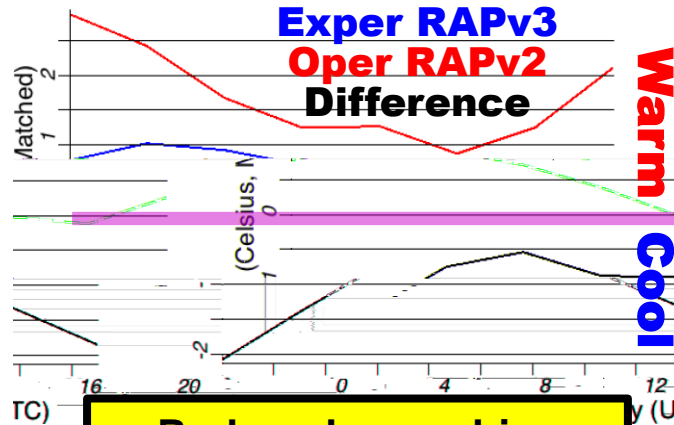
Forecast Hours:  
RAPv3 increasing  
from F18 to F21

HRRRv2 increasing  
from F15 to F18

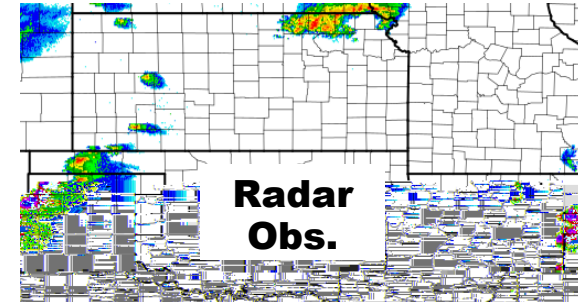
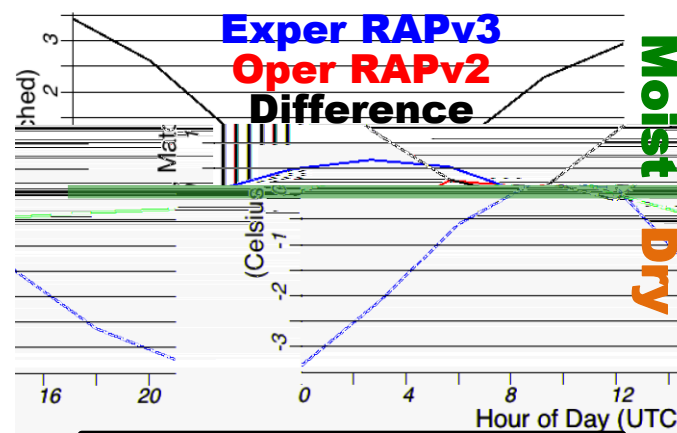
Significant  
improvements:  
Better PBL, LSM,  
Microphysics,  
data assimilation

Benefits:  
Significantly reduced  
biases, reduced RMS,  
Improved convection

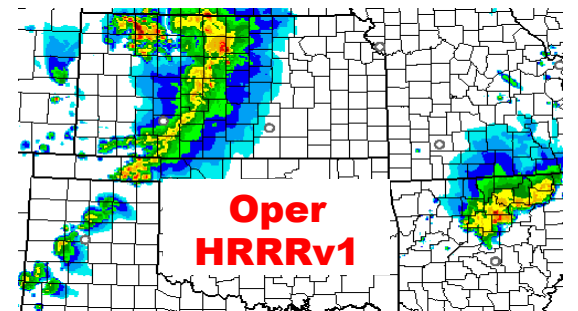
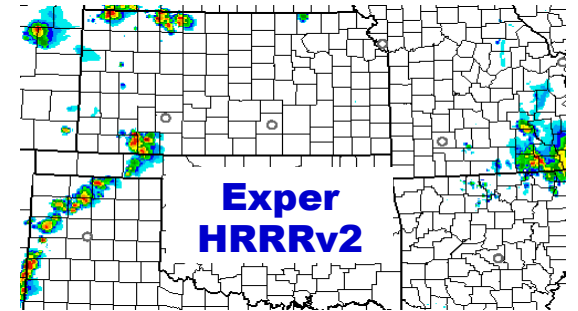
### Jul-Aug 12 hr 2m Temp



### July-Aug 12hr 2m Dewpt



Improved convection  
(reduced over-prediction)



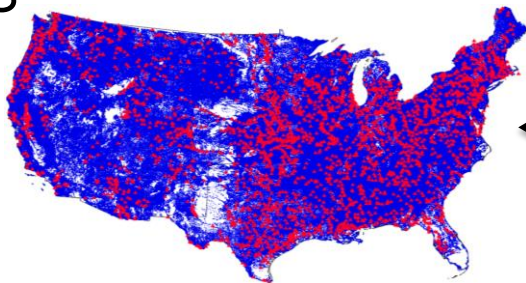




# The National Water Model (NWM) Implementation planned Aug 2016



- 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 rationale?
- 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](mailto:mary.hart@noaa.gov) and ask to be added to the MEG announcement email list

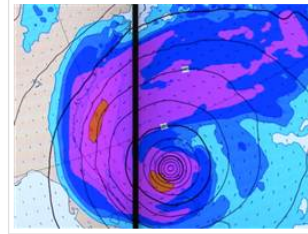




# Hurricane Sandy (2012) Raises Public Awareness of Modeling.....



<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

### AT A GLANCE

Tue	Wed	Thu
54   70	53   75	58   78
Fri	Sat	Sun
20% 60   81	30% 63   80	20% 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 European GFS model, in high impact storms affecting Snowquester - has raised the question: is good? Guest contributor Richard Rood

As early as 1995, the weather

October 28, 2012, 8:17 PM

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

Article Comments (34)

Tweet 255

Email Print

Facebook Twitter Google+ LinkedIn

### COMMENTARY

By Kerry Emanuel



## Cliff Mass Weather Blog

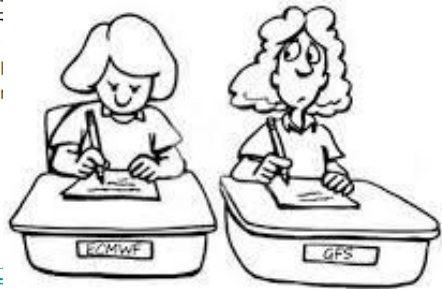
Monday, February 11, 2013

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

It happened again.

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

### WEATHER DATA PROCESSING CENTER



[http://www.washingtonpost.com/f0feafdd1394\\_blog.html](http://www.washingtonpost.com/f0feafdd1394_blog.html)

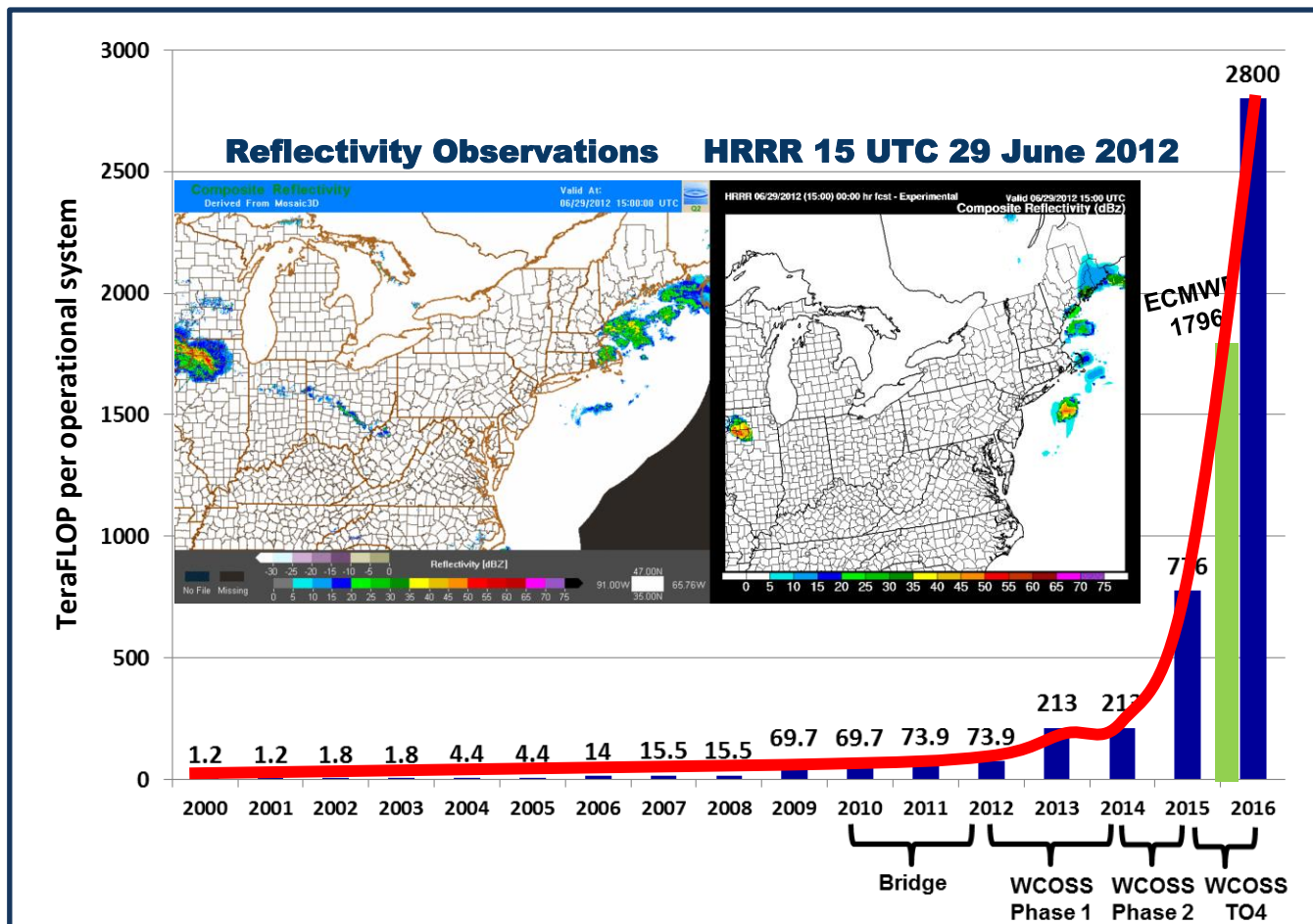




# Computer Upgrade Now in Place!



Increased HPC capacity to 2.8 petaFLOPs  
(for primary and backup, respectively—for a total of 5.6 PF)  
Accepted for Operations: November 30<sup>th</sup>, 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
		UCACN; Weather Company
Peter	Neilley	
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](http://www.ncep.noaa.gov/director/ucar_reports/ucacn_20151207/UMAC_Final_Report_20151207-v14.pdf)



# UMAC Preliminary Findings and Recommendations



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

---



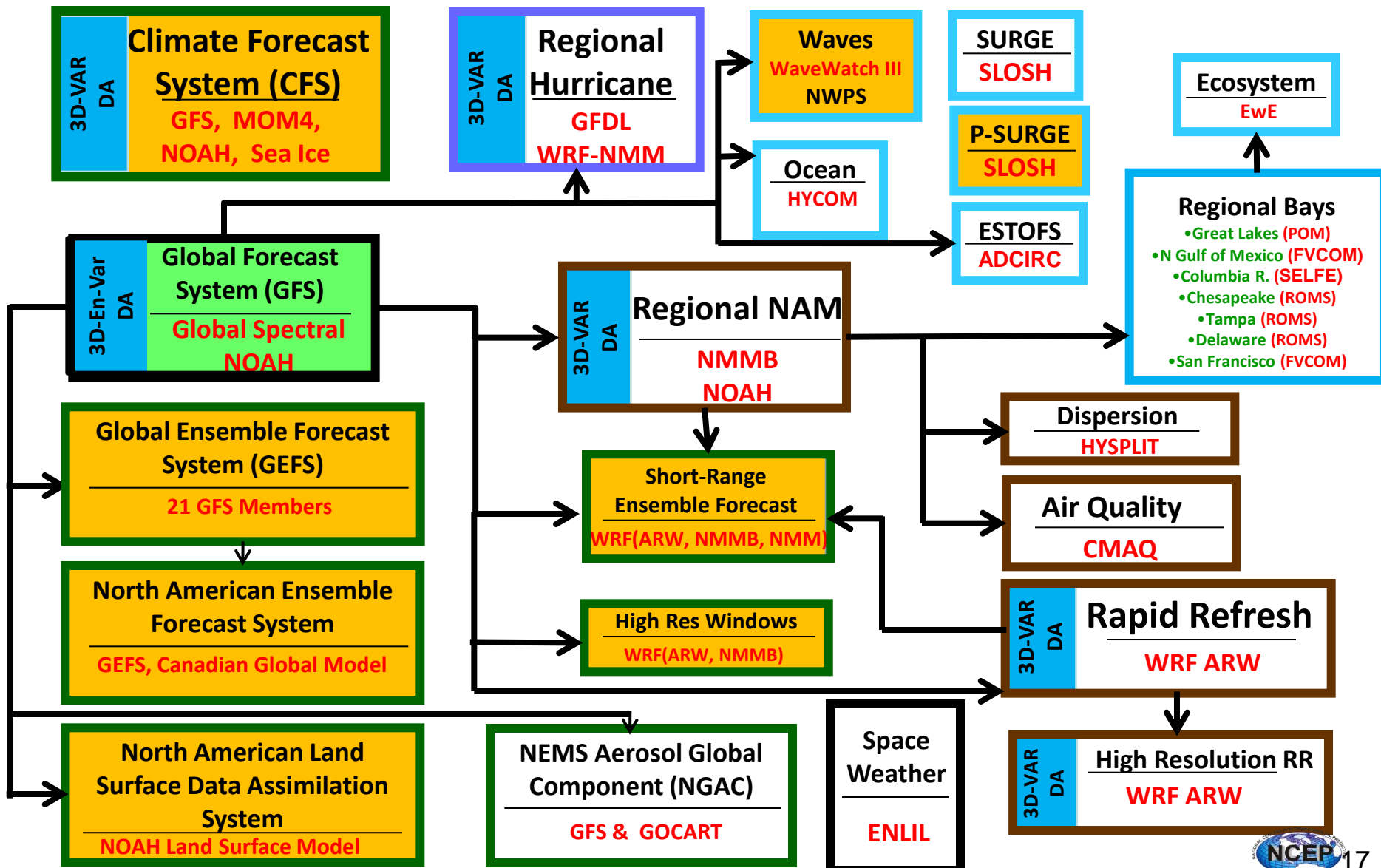
- **Reduce complexity** of the NCEP Production Suite.
- A **unified, collaborative strategy** for model development across NOAA is needed.
- Leverage the **capabilities of the external community**
- Continue to **enhance High Performance Computing** capabilities.
- Execute strategic and implementation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





# Complexity???

## What Complexity?

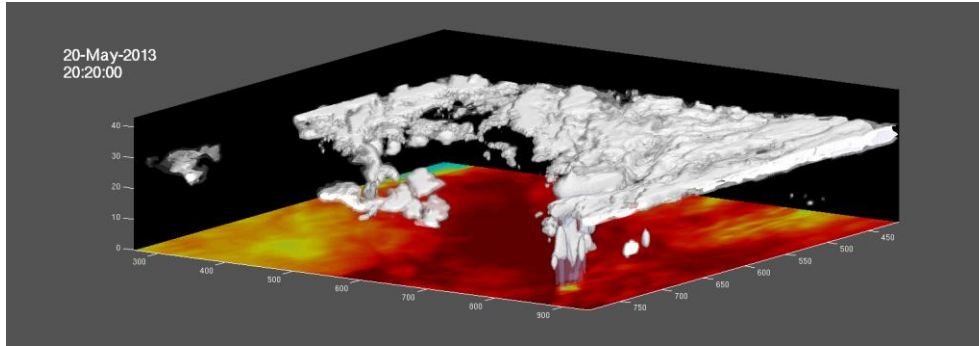




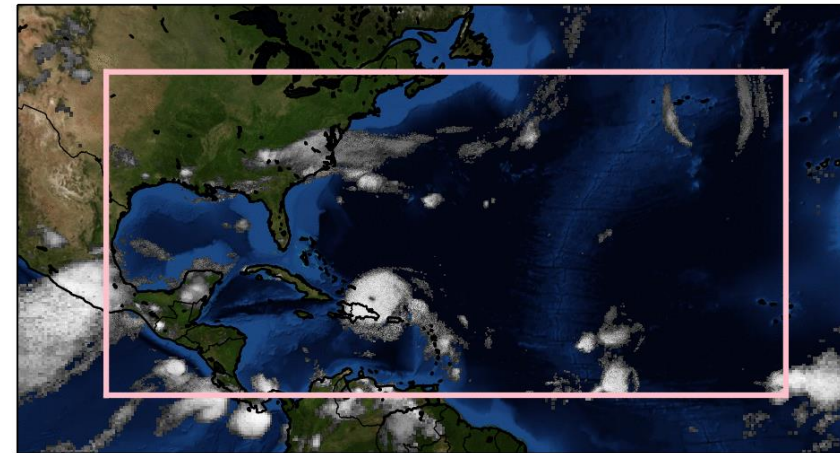
# Next Generation Global Prediction System Path to Unified Weather and Climate Guidance?



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



2005-09-01 01:30:00



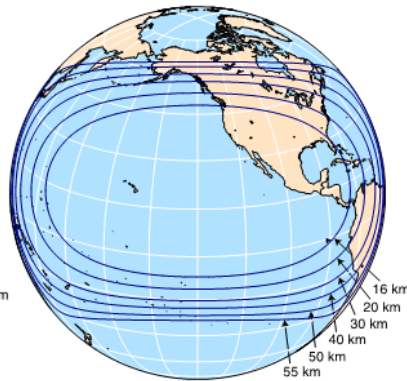
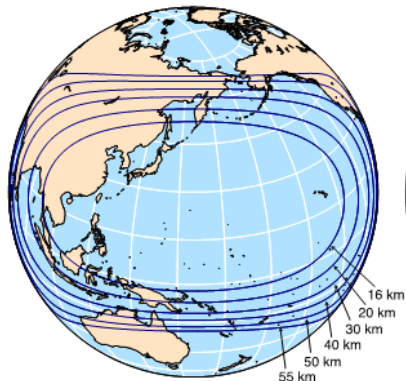
MPAS-Atmosphere 2013-2014-2015  
Tropical Cyclone Forecast Experiments

daily 10-day forecasts during the NH tropical cyclone season

Western Pacific basin mesh

Eastern Pacific basin mesh

Atlantic basin mesh



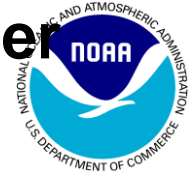
## NGGPS

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





# Overall Assessment & NNGPS Program Manager Recommendation to NWS AA



*The FV3 core represents the lowest risk, lowest cost alternative for the new NNGPS 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
- **NNGPS 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 NNGPS  
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](mailto:Rebecca.Cosgrove@noaa.gov)**

**EMC Model Evaluation Group:**

**[mary.hart@noaa.gov](mailto:mary.hart@noaa.gov)**

**Model Suite Review Report:**

**[http://www.ncep.noaa.gov/director/ucar\\_reports/ucacn\\_20151207/UMAC\\_Final\\_Report\\_20151207-v14.pdf](http://www.ncep.noaa.gov/director/ucar_reports/ucacn_20151207/UMAC_Final_Report_20151207-v14.pdf)**