Development of an Hourly-Updated NAM Forecast System
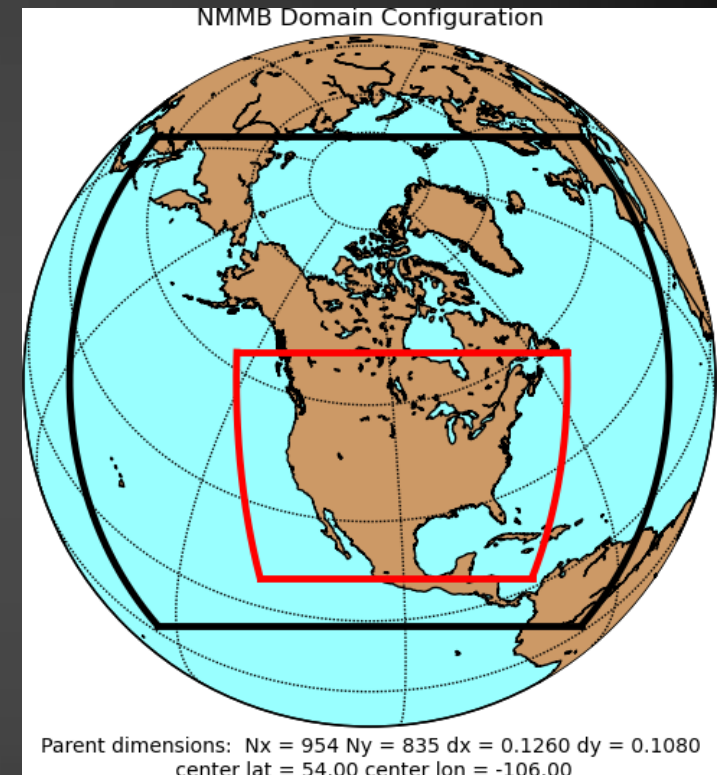
Jacob Carley[ab], Eric Rogers[b], Shun Liu[ab], Brad Ferrier[ab], Eric Aligo[ab],
Matthew Pyle[b], and Geoff DiMego[b]
[a]*IMSG,* [b]*NOAA/NWS/NCEP/EMC*
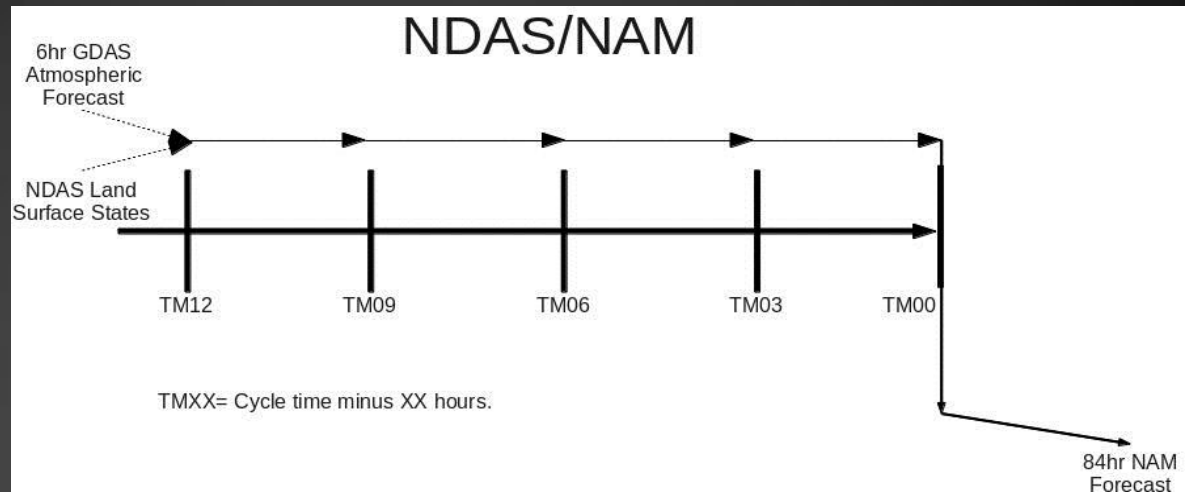*jacob.carley@noaa.gov*

Hourly-Updated NAM Forecast System

- NAM – North American Mesoscale forecast system
  - Runs 4x daily at 00,06,12,18Z
  - Short-range mesoscale NWP system for the U.S.

- NAM*RR*: NAM Rapid Refresh
  - *Hourly updates*
  - Future North American Rapid Refresh Ensemble system (NARRE)
    - NAMRR + RAP/HRRR Foundation

- Development of *hourly* NAM cycling capabilities on NOAA R&D machine Zeus
  - Part of DOE-funded wind energy projects
    - WFIP/POWER
  - Cycling 12 km NAM *and* 4 (3) km CONUS nest
  - Hybrid ensemble-3DVar via Global Data Assimilaion System's EnKF members
  - Cloud analysis and diabatic digital filter initialization with radar-derived temperature tendencies
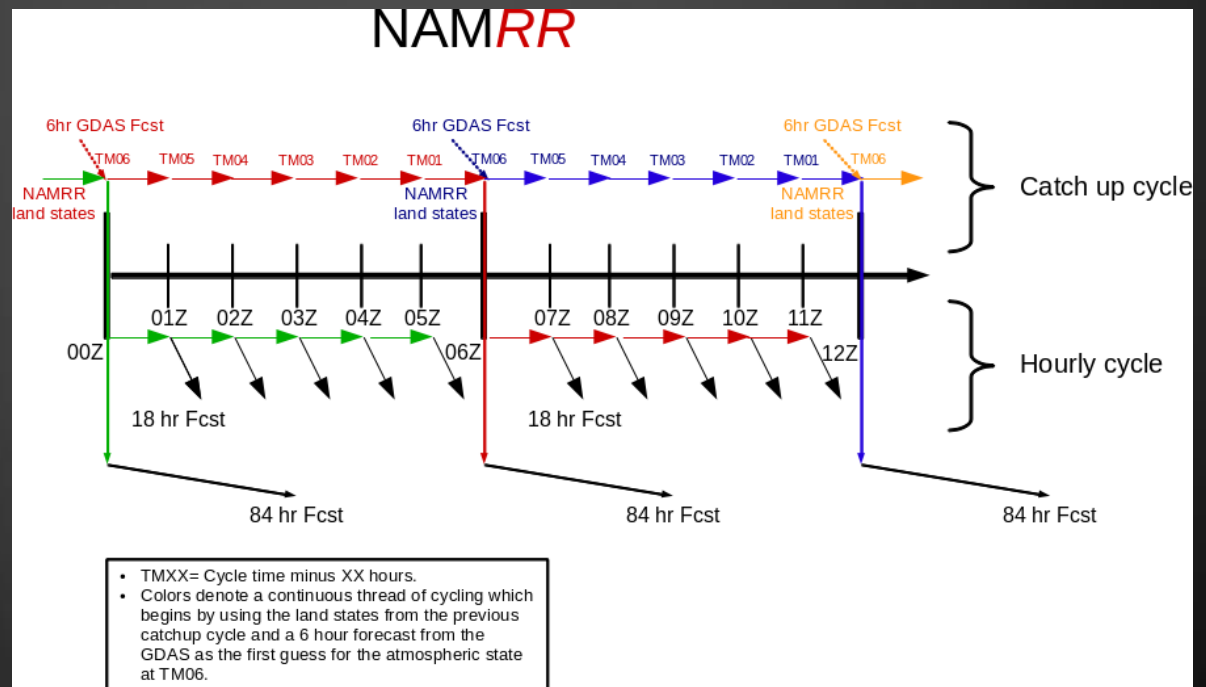

NMMB Domain Configuration

Parent dimensions: Nx = 954 Ny = 835 dx = 0.1260 dy = 0.1080 center lat = 54.00 center lon = -106.00

NAM*RR* Overview

Current, example, NDAS/NAM configuration for a single, arbitrary cycle:

Experimental example NAMRR configuration for 12, hourly cycles:
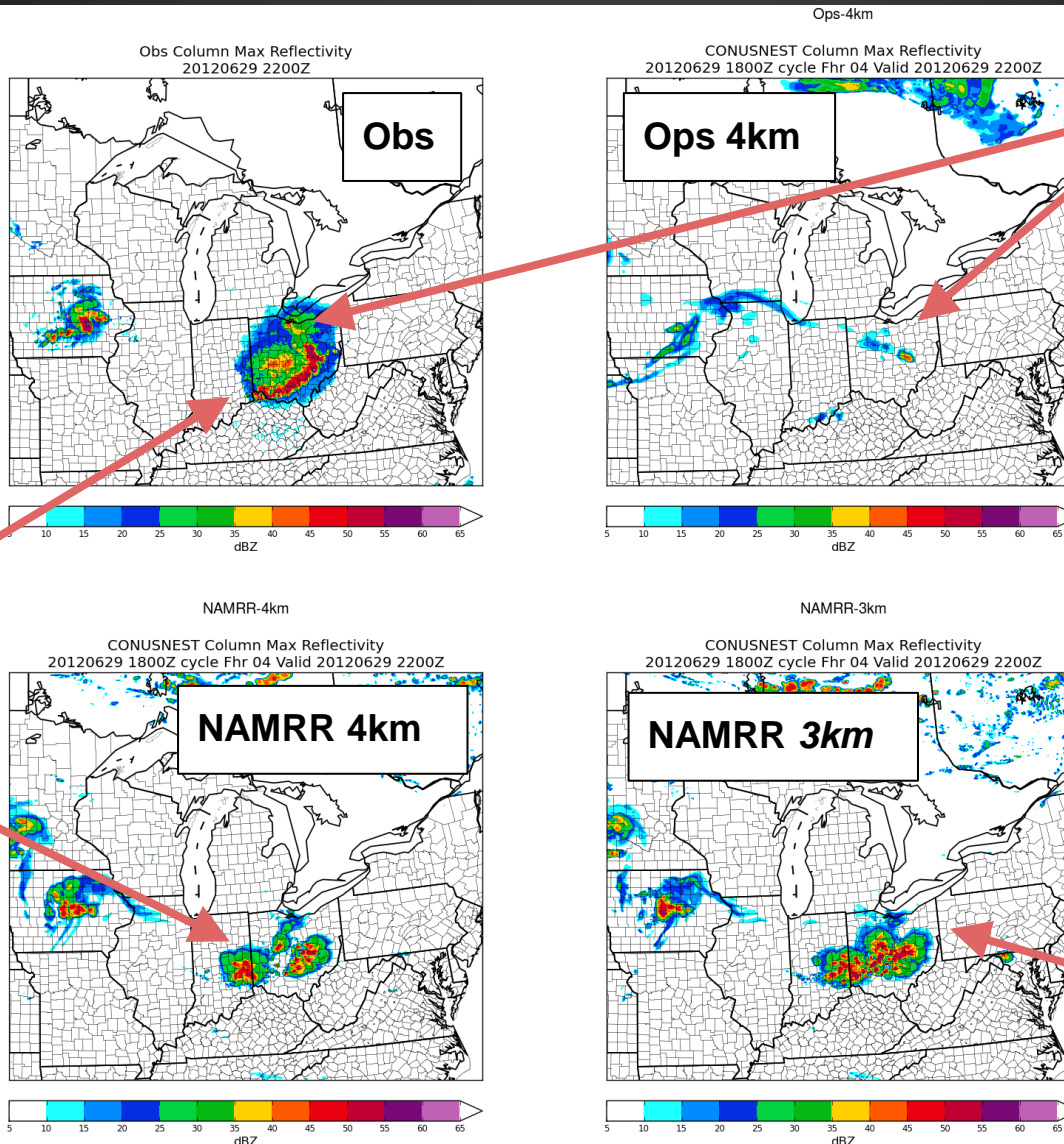
NAM*RR*: Configuration (still testing)

Model	Points	Grid spacing	Digital filter?	Radar Reflect. Initialization?	Vert. levels	Model top	Analysis/ Update frequency	Forecasts per day	Max forecast length
Ops NAM	954x835	12 km	No	No	60	2 hPa	3 hourly	4	84 hours
Ops NAM CONUS nest	1371x 1100	4 km	No	No	60	2 hPa	None	4	60 hours
NAMRR	954x835	12 km	*Yes*	*Yes*	60	2 hPa	*Hourly*	*24*	84 hours
NAMRR CONUS nest	1371x 1100	4 km (3 km)	*Yes*	*Yes*	60	2 hPa	*Hourly*	*24*	60 hours

NAM*RR*: Configuration (still testing)

Model	Param. Conv.?	Radiation (LW/SW)	Microphysics	PBL	LSM	Cycled analysis
Ops NAM	BMJ	GFDL	Ferrier	MYJ	Noah	GSI-3DVar
Ops NAM CONUSnest	BMJ "light"	GFDL	Ferrier	MYJ	Noah	None
NAMRR	BMJ (w/ updates)	*RRTMG*	*Ferrier (w/ updates)*	MYJ	Noah	*GSI hybrid ens-3DVar (global EnkF)*
NAMRR CONUSnest	None	*RRTMG*	*Ferrier (w/ updates)*	MYJ	Noah	*GSI hybrid ens-3DVar (global EnkF)*

June 29-30, 2012 Derecho - NAMRR Test
4 Hour Forecast valid 22 UTC

Obs Column Max Reflectivity
20120629 2200Z

Obs

CONUSNEST Column Max Reflectivity
20120629 1800Z cycle Fhr 04 Valid 20120629 2200Z

Ops 4km

NAMRR-4km
CONUSNEST Column Max Reflectivity
20120629 1800Z cycle Fhr 04 Valid 20120629 2200Z

NAMRR 4km

NAMRR-3km
CONUSNEST Column Max Reflectivity
20120629 1800Z cycle Fhr 04 Valid 20120629 2200Z

NAMRR 3km

Poor 4 hour forecast from Ops NAM 4 km CONUSnest

Much improved 4 hour forecast from NAMRR 4 km CONUSnest

Additional improvement with NAMRR *3 km* CONUSnest
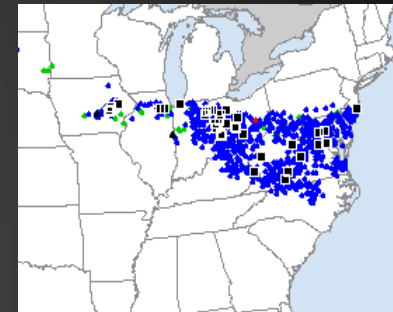
Prelim. Storm Reports from SPC (06/29/2012)

June 29-30, 2012 Derecho - 27 Hr Forecast
NAMRR Test with *3 km CONUSnest*

Significant improvement at longer lead times with *3 km* NAMRR relative to Ops

CONUSNEST Column Max Reflectivity
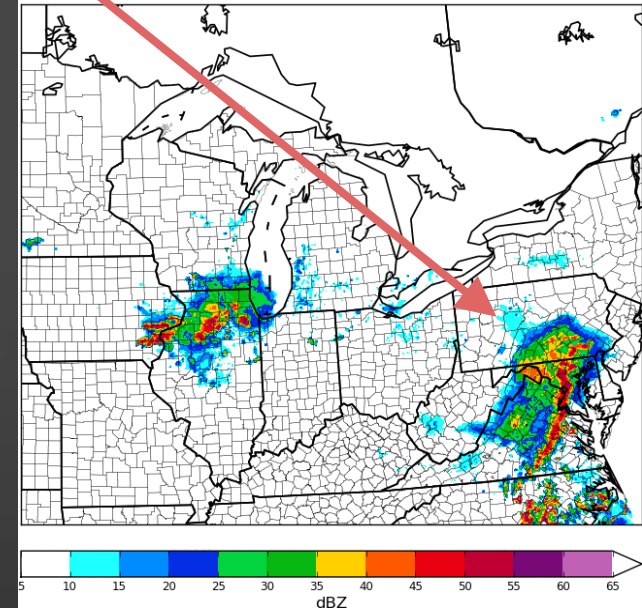20120629 00Z cycle Fhr 27 Valid 20120630 0300Z

dBZ

CONUSNEST Column Max Reflectivity
20120629 00Z cycle Fhr 27 Valid 20120630 0300Z

dBZ

Obs Column Max Reflectivity
20120630 0300Z

dBZ
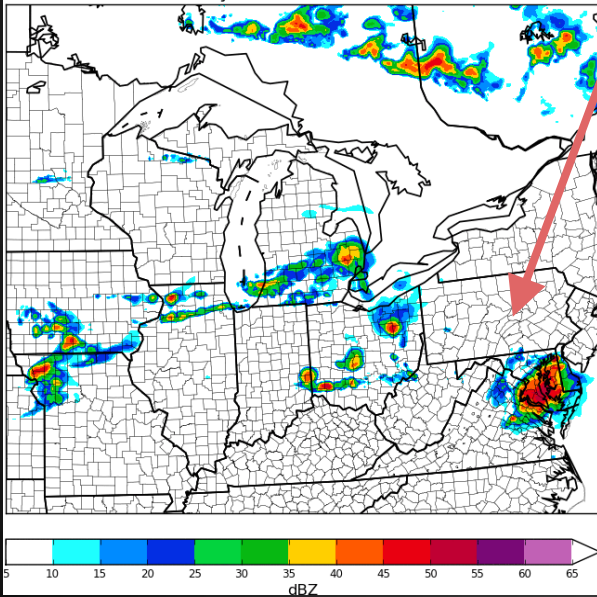
4 km Ops NAM CONUSnest
Fhr=27
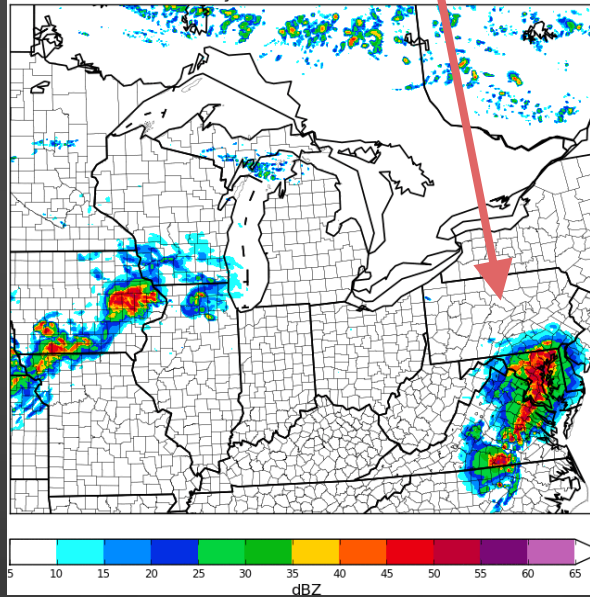
3 km NAMRR CONUSnest
Fhr=27

Observations

Impact of Cloud Analysis on 4 km CONUSnest Reflectivity Forecasts

Verification over CONUS for 2012 Derecho short-term forecasts (dBZ >= 30)

Red = 4 km NAMRR CONUSnest *without* cloud analysis

Blue = 4 km NAMRR CONUSnest *with* cloud analysis

Stats from 30 hourly forecast cycles. Lines falling outside the rectangles are significant at the p=0.05 level
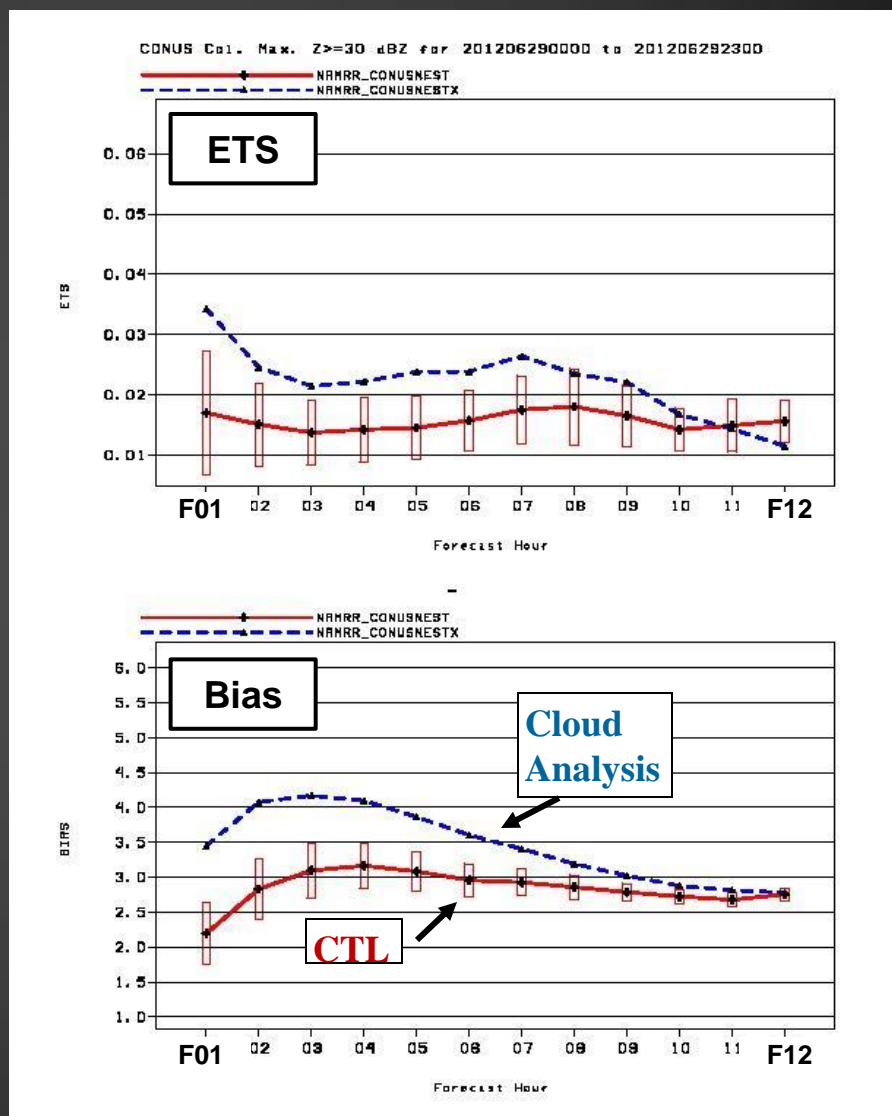
NAMRR Testing of Ferrier-Aligo Microphysics

3 km CONUSNEST forecast column max radar reflectivity from the 20120628 12Z cycle using the repository microphysics (top) and the Ferrier-Aligo microphysics (bottom). On grid 227 (5 km).

NMMB Repository
Ferrier Microphysics
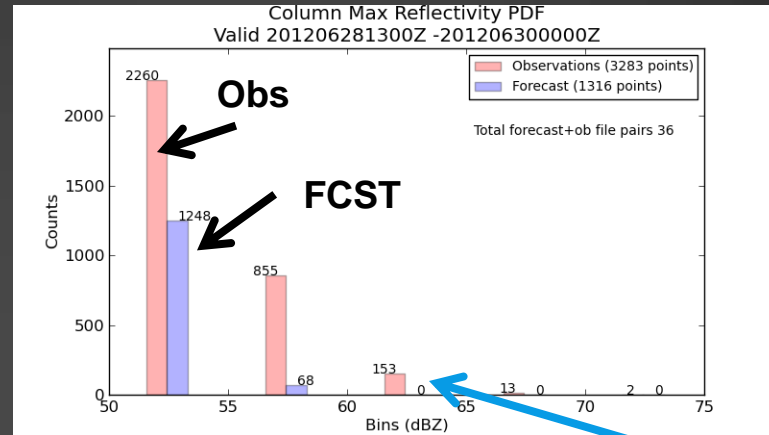
Updated Ferrier-Aligo
Microphysics tested in
NAMRR
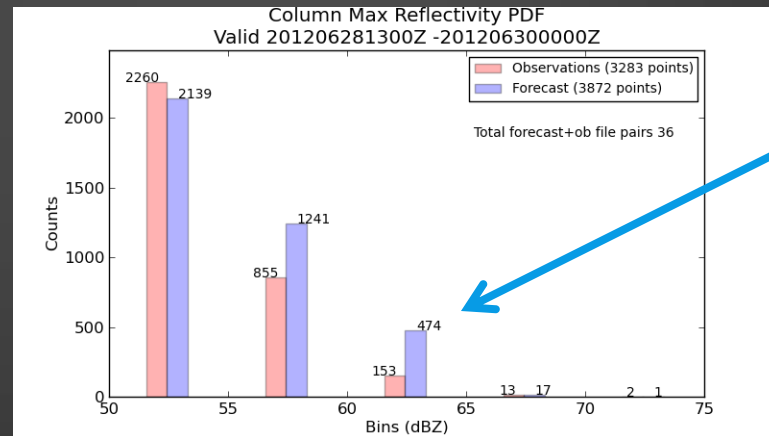
Increased number of forecast reflectivity values >= 50 dBZ. More consistent with observations.

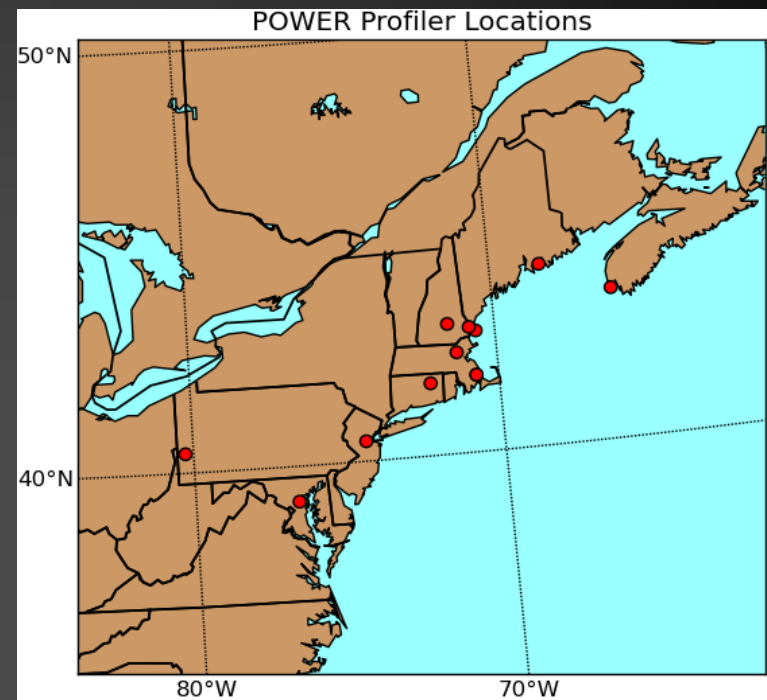NAMRR is playing a role in *current* physics development.

POWER: Position of Offshore Wind Energy Resources

- Collaborative effort with DOE, ESRL/GSD, and ESRL/PSD
  - Provide information about observation networks needed to support offshore wind energy development
- Data denial experiments
  - Summer 2004 New England Air Quality Study deployed ~13 coastal wind profilers and one shipborne Doppler lidar in the New England area
  - POWER uses these pre-existing coastal profiler observations in a set of data-denial experiments with the NAMRR and RAP/HRRR systems
    - Shipborne lidar is used for verification
  - Two periods of study
    - July 10th-17th, 2004
    - August 6th-12th, 2004

NOAA *Ron Brown* ship tracks (August, 2004)
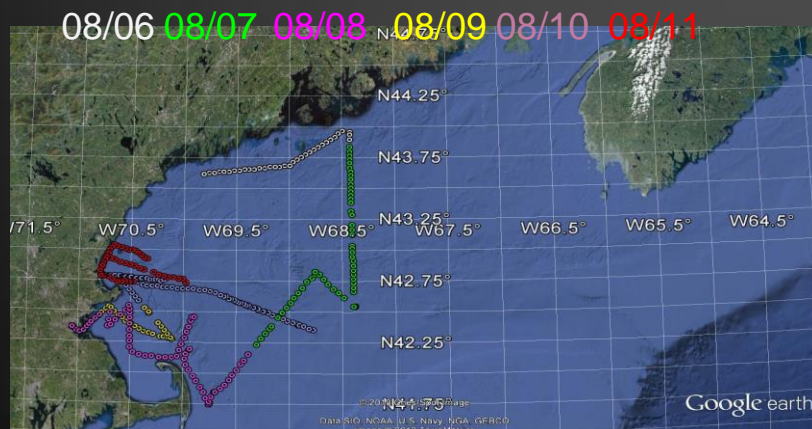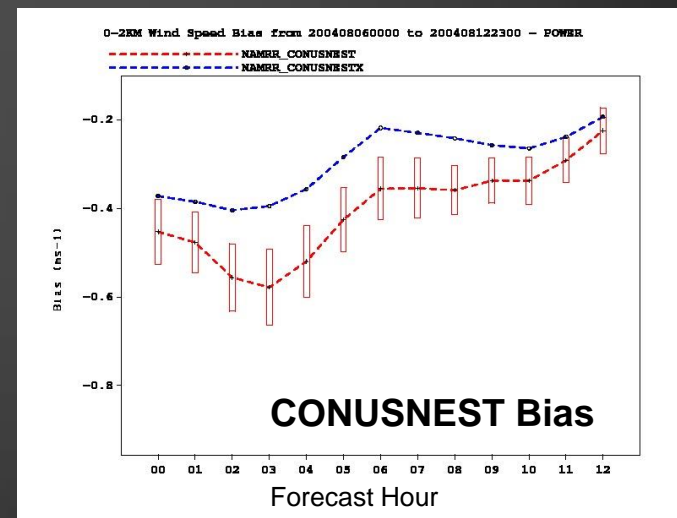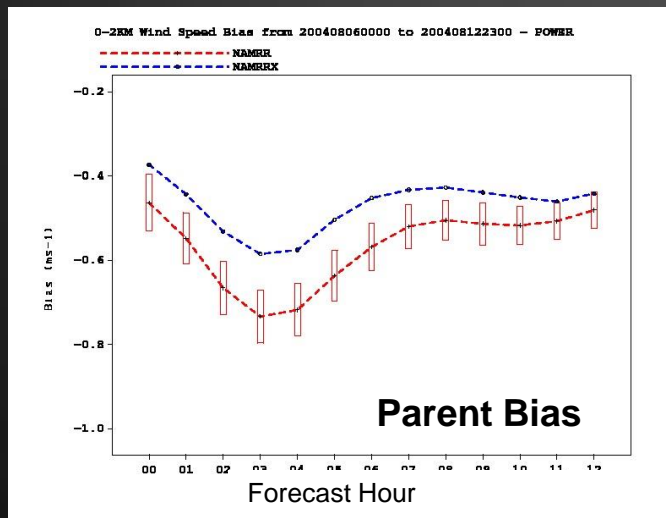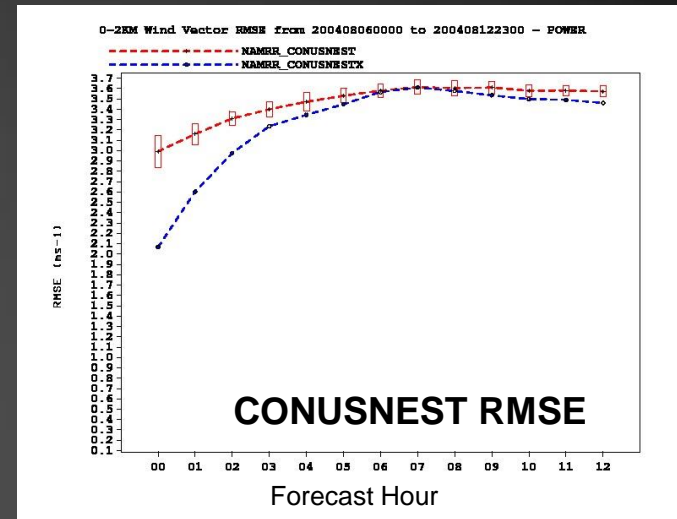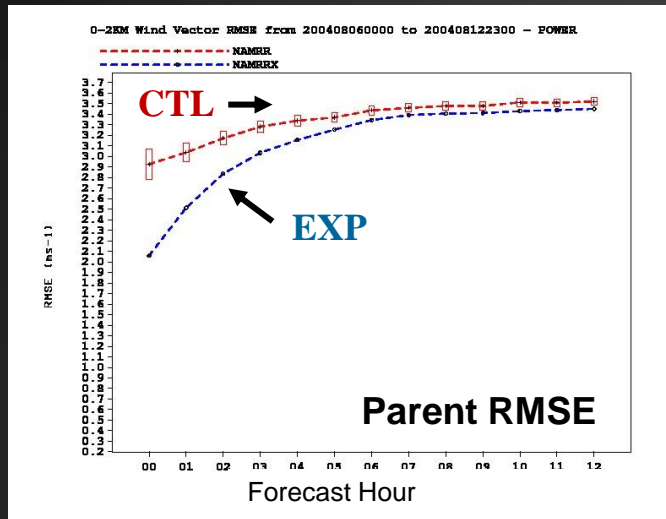

Courtesy of Yelena Pichugina

NOAA *Ron Brown*
http://oceanexplorer.noaa.gov/technology/vessels/ronbrown/ronbrown.html

August 6th-12th, 2004
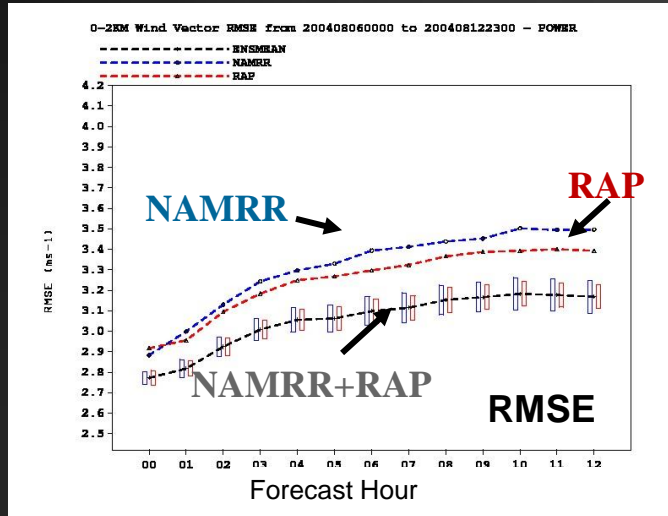## 0-2km AGL vs. POWER profilers

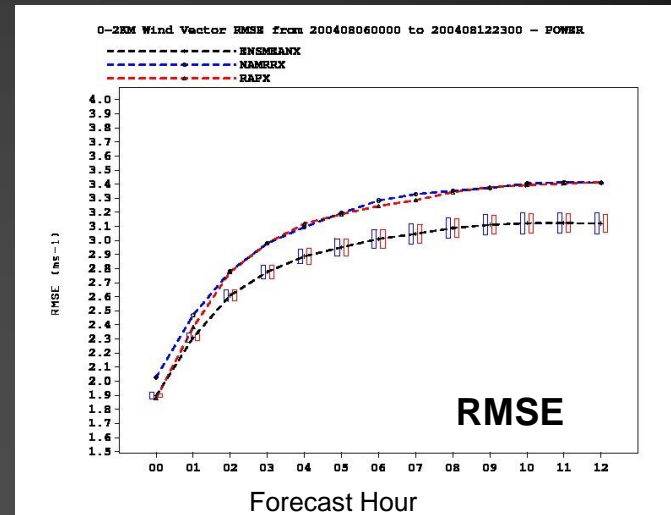**12km NAMRR Parent**

4km NAMRR CONUSnest

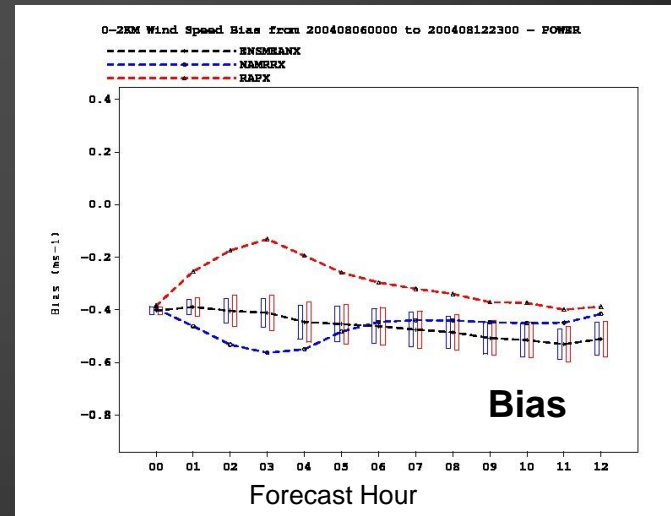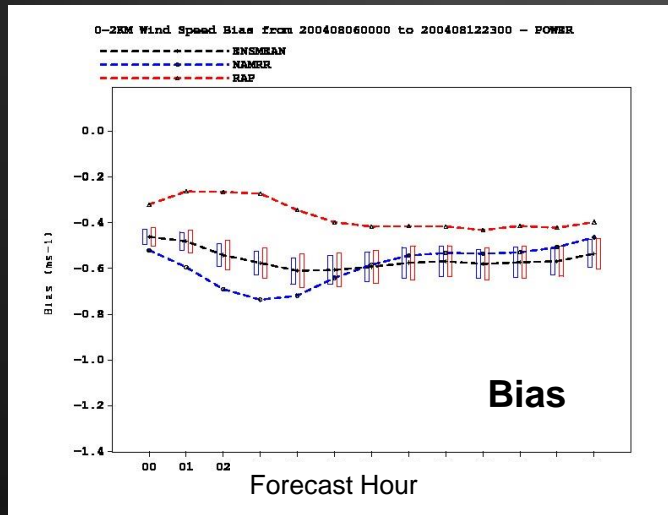# August 6th-12th, 2004
0-2km AGL vs. POWER profilers

ENSMEAN vs. NAMRR vs. RAP

Without Profiler Obs Assimilated

With Profiler Obs Assimilated

All Verification was conducted on grid 218

Ongoing and Future Work

- NAMRR retrospective tests for comaparison with upcoming NAM bundle
- Use of verification methods applicable for higher resolutions
- Optimization (always improving)

Long(er) Term

- Extend NAMRR from current 2 domains to all 6 operational NAM domains
- Test combination of regional ensemble members + global EnKF members for background error computation in hybrid ensemble-3DVar analysis
- Test + evaluate in collaborative R2O settings?
  - WPC-HMT Flash Flood and Winter Weather Experiments, SPC Spring Experiment?
- Planned for WCOSS Phase II (Petaflop): 2016-2018?
- Hybrid 4DEnVar

Questions?

NMMB Domain Configuration

Parent dimensions: Nx = 954 Ny = 835 dx = 0.1260 dy = 0.1080
center lat = 54.00 center lon = -106.00