HiresWindow v6.0.7

Decision Briefing

Presented by:

Matthew Pyle, EMC

Quick overview – what is HiresWindow?

- In current operations:
  - 4-5 km horizontal spacing
  - no parameterized convection
  - Two models (WRF-ARW and WRF-NMM)
  - Forecasts to 48 h over six different domains.
- Utilized by weather forecasters (NWSFOs, NCEP centers, private industry) needing spatially-detailed information

Outline

- Upgrade elements – what is changing and why
- Parallel testing evaluation
  - QPF skill
  - Convective storm examples
  - Initial spin up of precipitation
  - Surface (2 m / 10 m) fields: verification and an example
  - Upper air stats
- Summary

Upgrade elements

	Current ops	Planned upgrade
Model code version	WRFV3.1+ (early 2010 version)	WRFV3.5 (ARW) Aug 2013 trunk + updates (NMMB)
Horizontal grid spacing	4 km WRF-NMM 5.15 km WRF-ARW	3.0 - 3.6 km NMMB 3.5 - 4.2 km WRF-ARW
Vertical levels	35	40
Microphysics (ARW)	WSM3	WSM6 (includes graupel; more appropriate for sub-10 km grid spacing forecasts)
Microphysics (NMMB)	Ferrier	updated Ferrier (refinements over last 3+ years)
Radiation (NMMB)	GFDL	RRTM (a more realistic parameterization; NAM also making this switch)

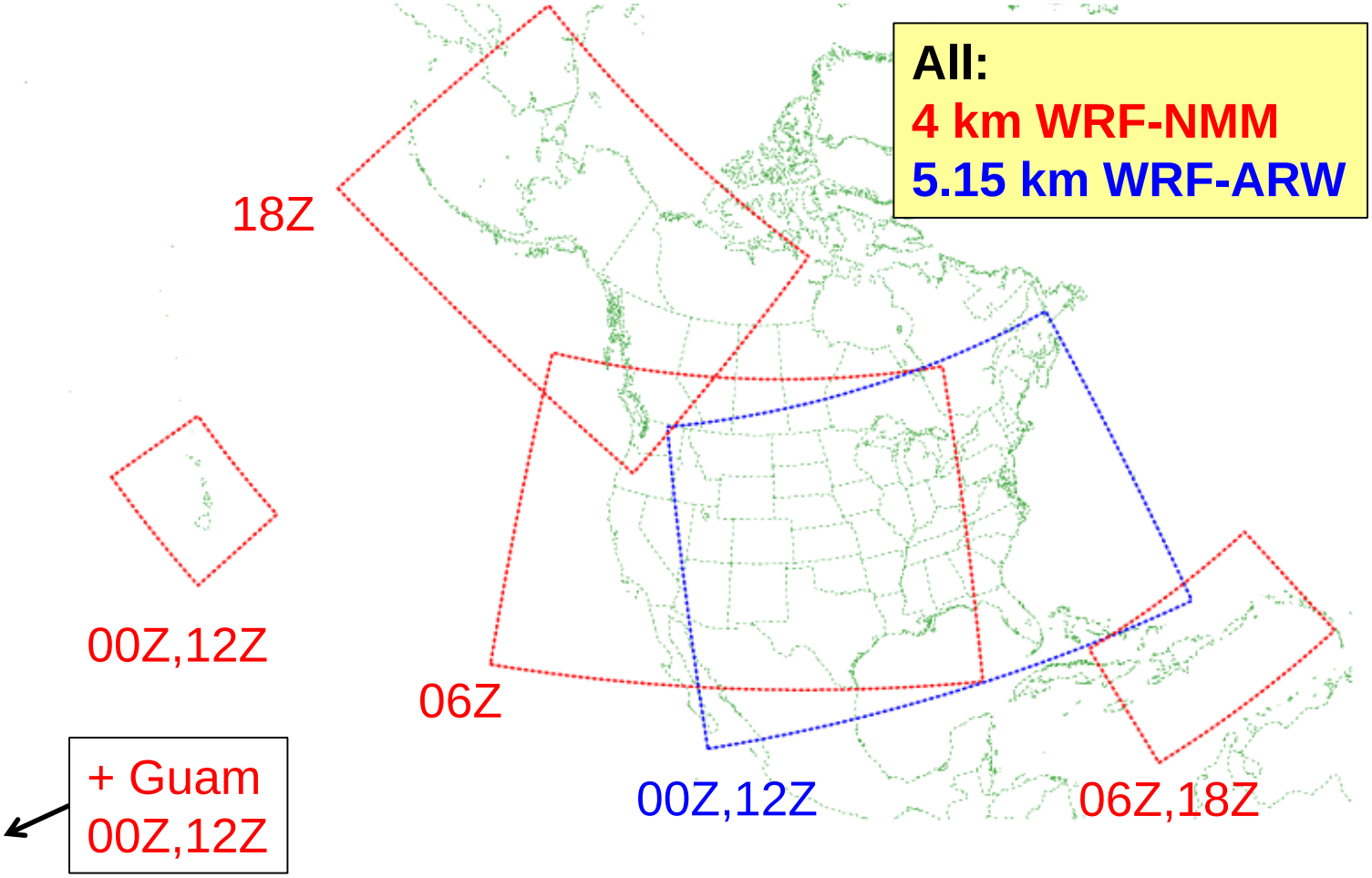
Upgrade elements

Items not covered on preceding table:

- Domain reconfiguration over CONUS: east and west domains replaced by a single full-CONUS domain.
- RAP replaces NAM as initialization source over CONUS – adding to model suite forecast diversity and enhancing short-range guidance.
- GFS replaces NAM for HI & PR domain initializations.
- New output on 2.5-3 km NDFD grids with smartinit downscaling.
- Additional isobaric level output and select new fields for aviation (sim radar VIL) and fire wx (Haines Index).

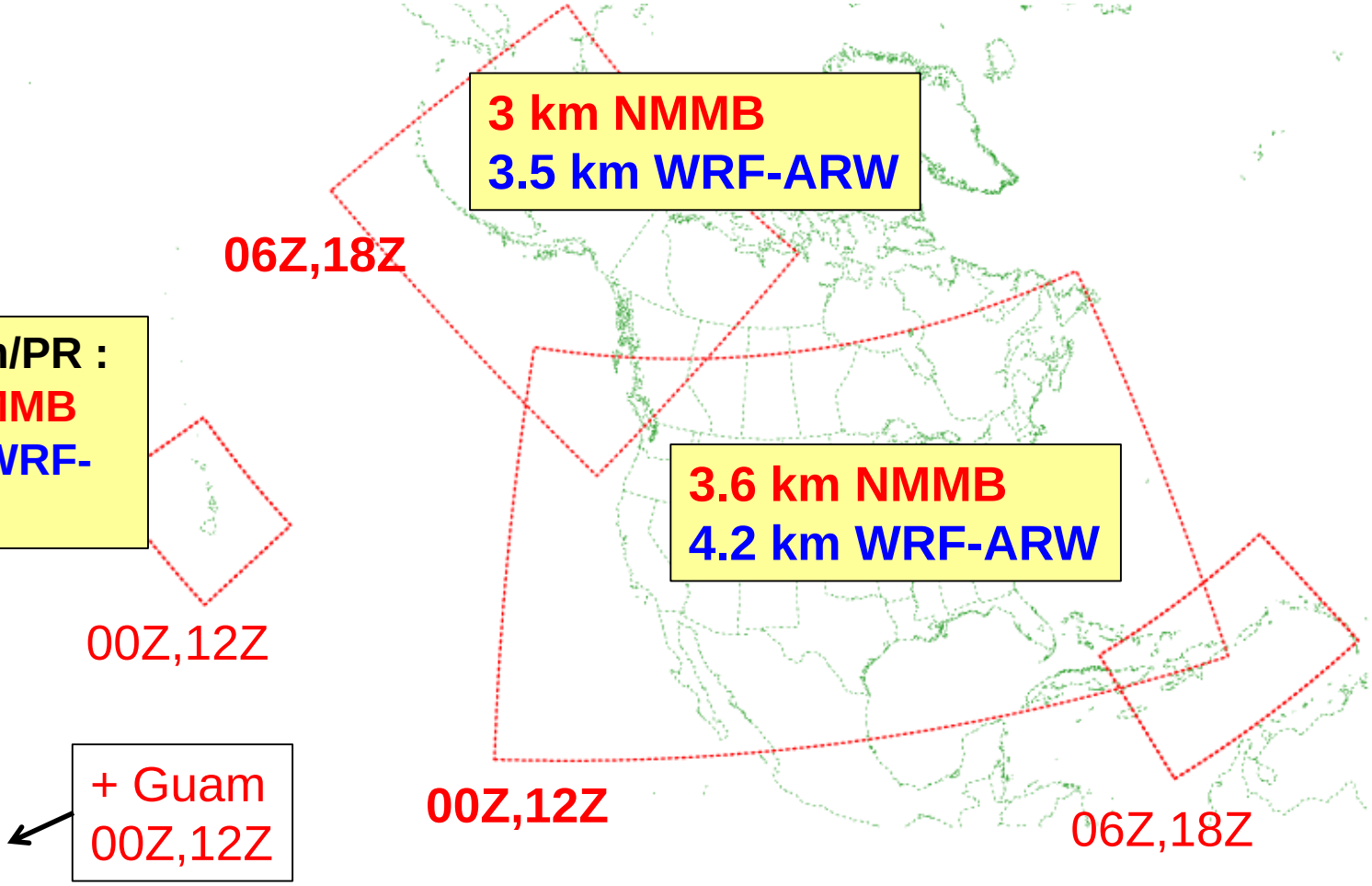
Upgrade elements

Current integration domains and run times



Upgrade elements

Planned integration domains and run times



Upgrade elements

Expected benefits to end users:

- Improved precipitation bias performance
- Enhanced resolution of fine mesoscale features: terrain-driven phenomena and convective storm structures
- Improved near-surface (2 m / 10 m) temperature and wind forecasts
- Twice daily runs of all domains makes dissemination of these products more equitable (currently 1, 2, or 3 runs available per day, varying with location in U.S.)

Upgrade elements

Expected benefits to end users (cont.):

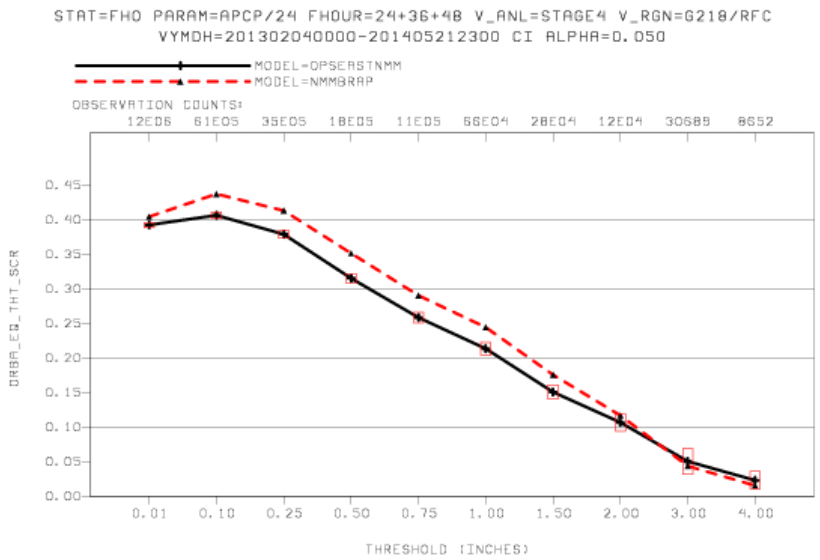
- Producing output directly on grids used by WFOs should enhance product usefulness.
- New products will make HiresW more relevant to high-res ensemble product generation, and for other specialized forecasts (aviation and fire wx).

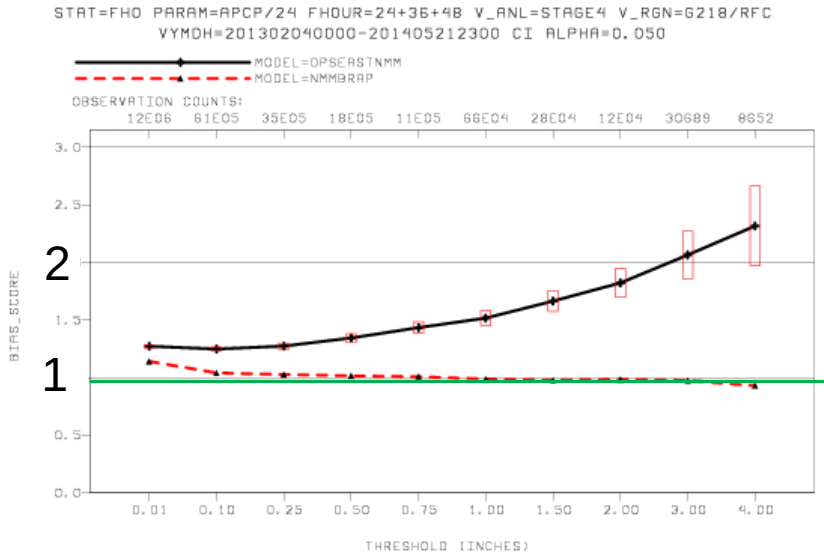
Pre-Implementation Testing

- Retrospective testing:
  - Cool season (Feb 4-28, 2013) (CONUS/AK)
  - Severe wx season (May 2013) (CONUS only)
  - Warm season (June 1-18, 2013) (CONUS/AK)
  - *RAPV1 conditions for CONUS*
- Real-time testing: 12/13/2013 to date, all domains. *RAPV2 conditions for CONUS*.
- ~225 days of testing total for CONUS, ~190 days for AK, ~150 days PR/HI/Guam

CONUS NMMB precipitation – all test cases

Bias Corrected Equitable Threat Score





Bias

24/36/48 h precip verification over eastern CONUS

Feb/May/June 2013 retro
Dec 2013 - May 2014 real time

Ops HiresW WRF-NMM

Para CONUS NMMB

bias=1

CONUS ARW precipitation – all test cases

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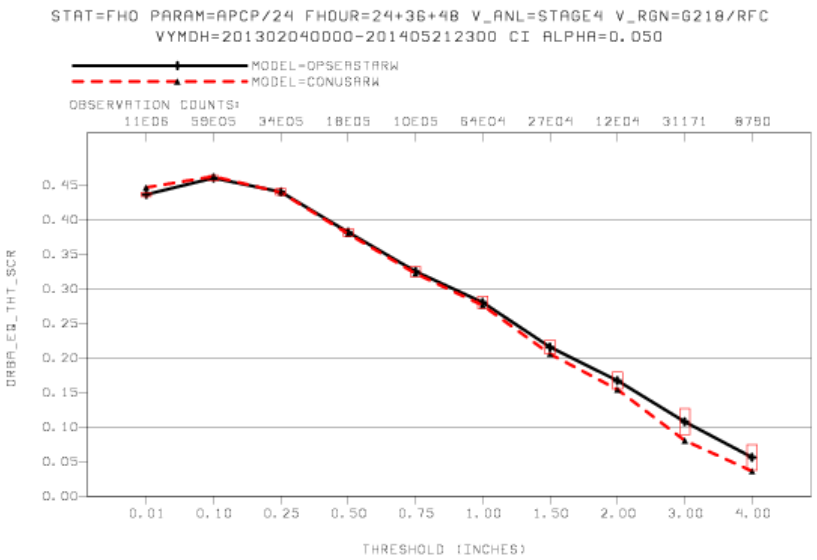
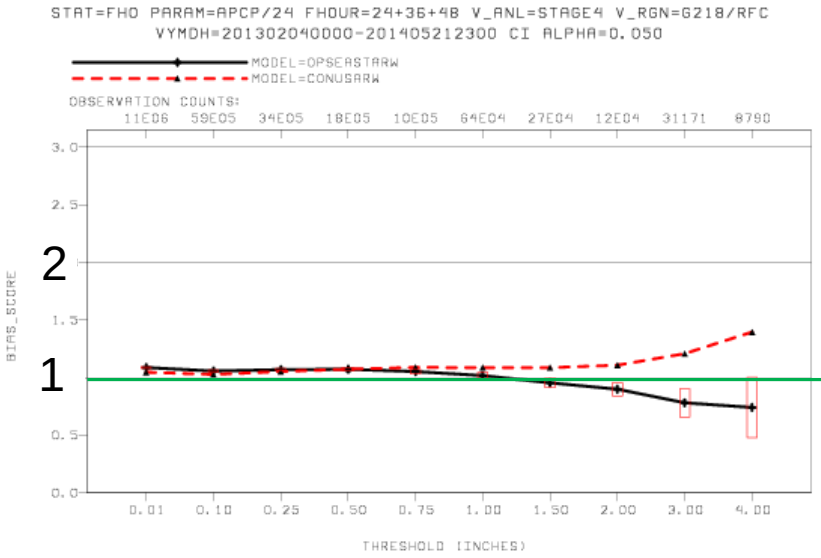


Bias



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CONUS NMMB precipitation – 2013 warm season testing

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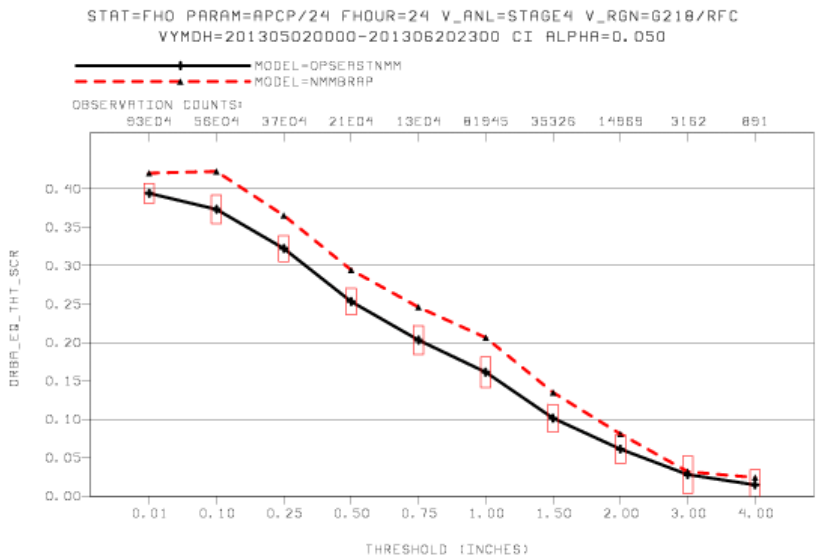

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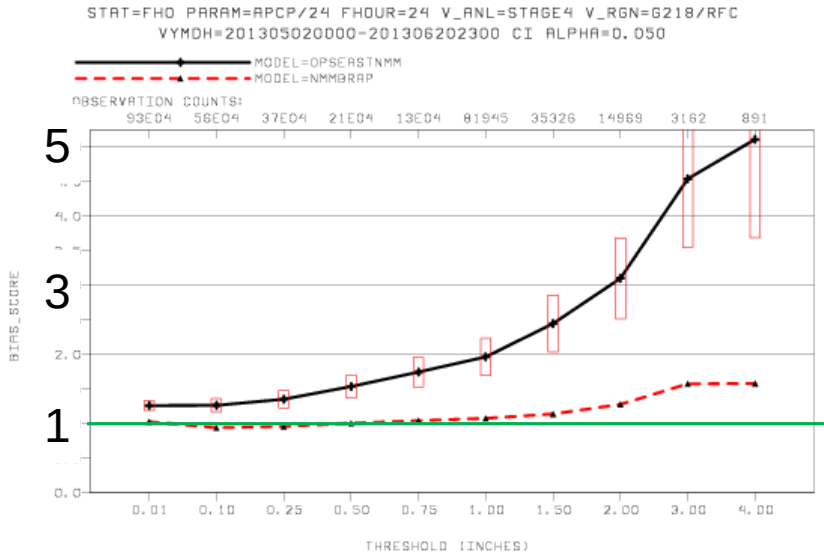

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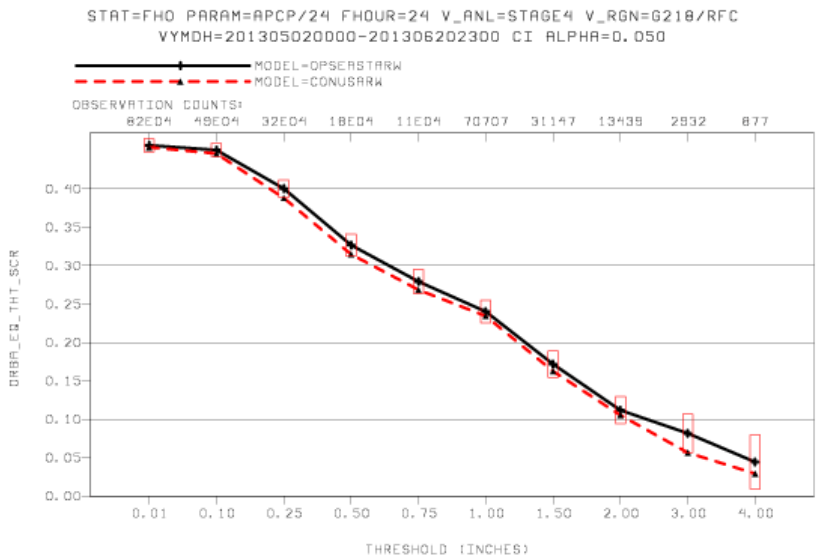
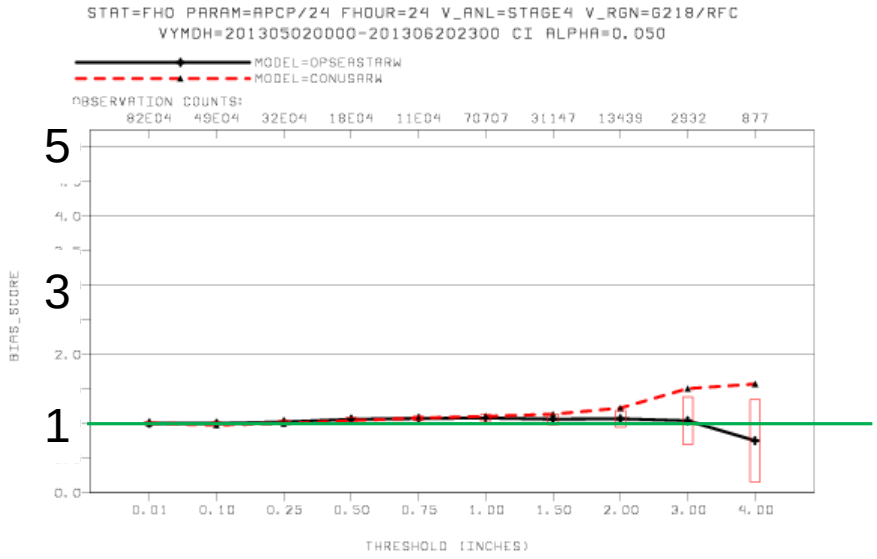


Bias



May/June 2013 retro

24 h forecasts only precip verification over eastern CONUS

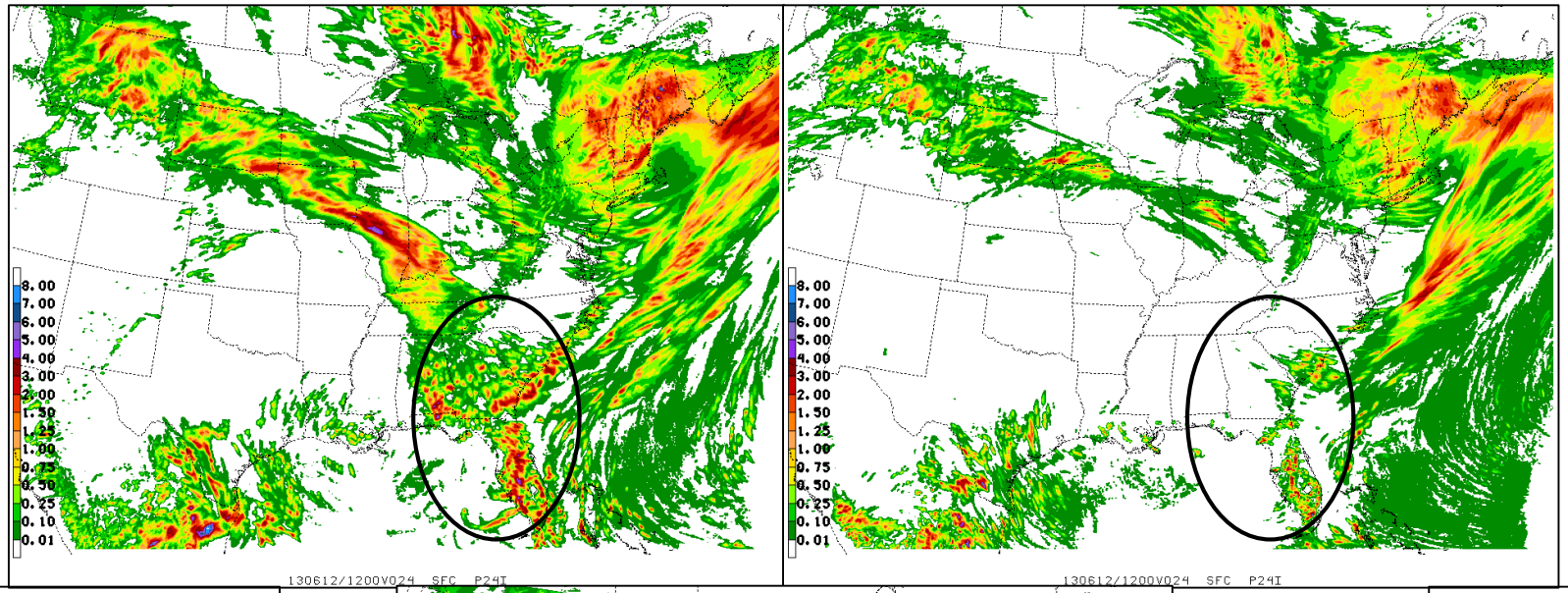
Ops HiresW WRF-ARW

Para CONUS WRF-ARW

bias=1

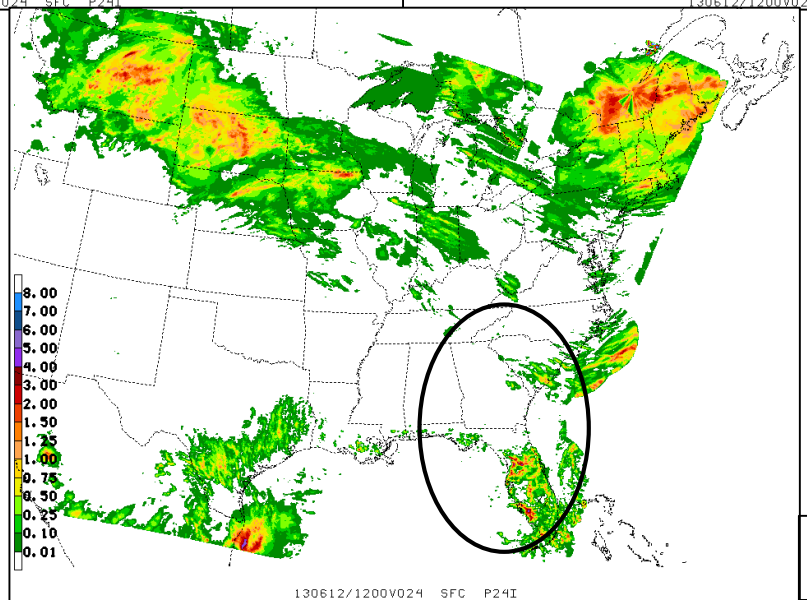
Improvement in precipitation bias

24 h totals ending 12 June 2013, 12Z



Ops WRF-NMM

Para NMMB



Stage 4 analysis

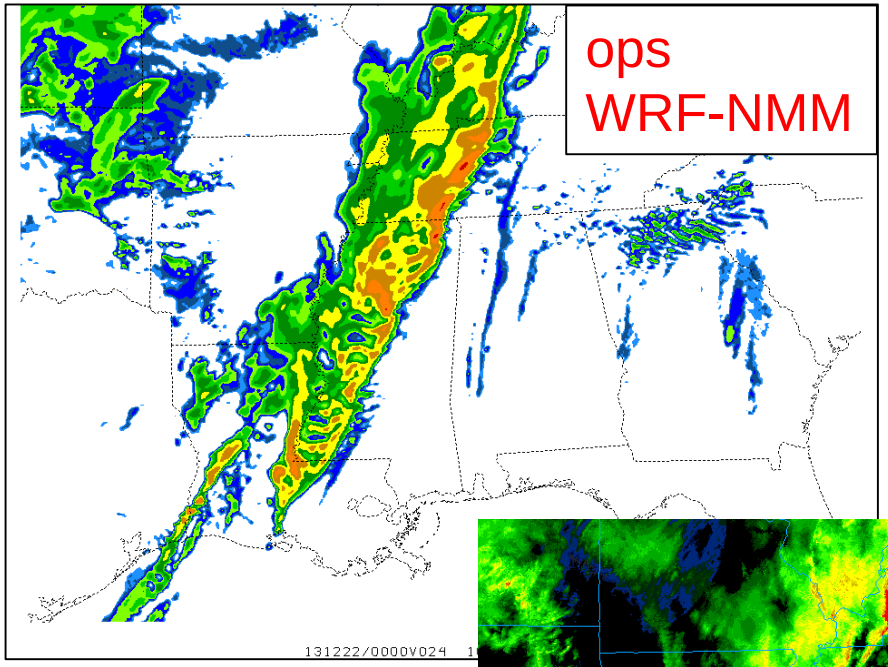
Impacts of upgrade on convective storms

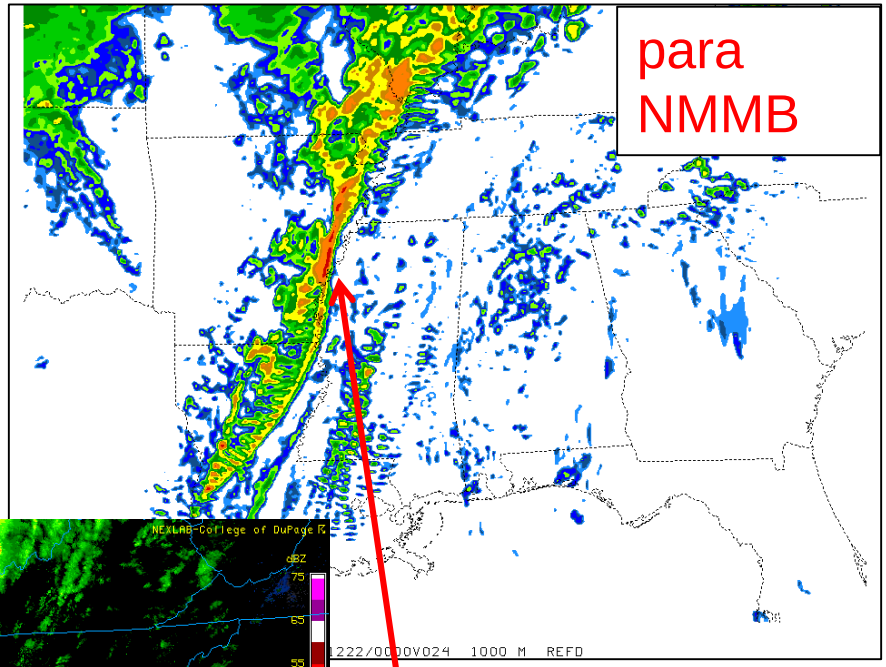
- Qualitative and quantitative impression is that the parallels (both models) tend to produce finer-scale storms, more consistent with radar observations.

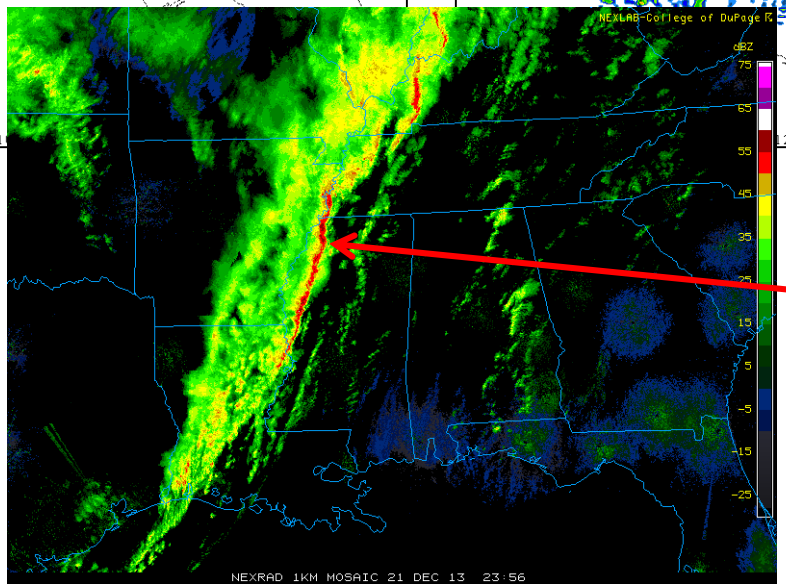
- Also have seen a tendency (more true for WRF-ARW) toward greater apparent convective intensity in the parallels, as measured from a simulated radar reflectivity perspective.

More intense convective signals, more in line with observations

Model and observed 1 km AGL radar, 00Z 22 December 2013



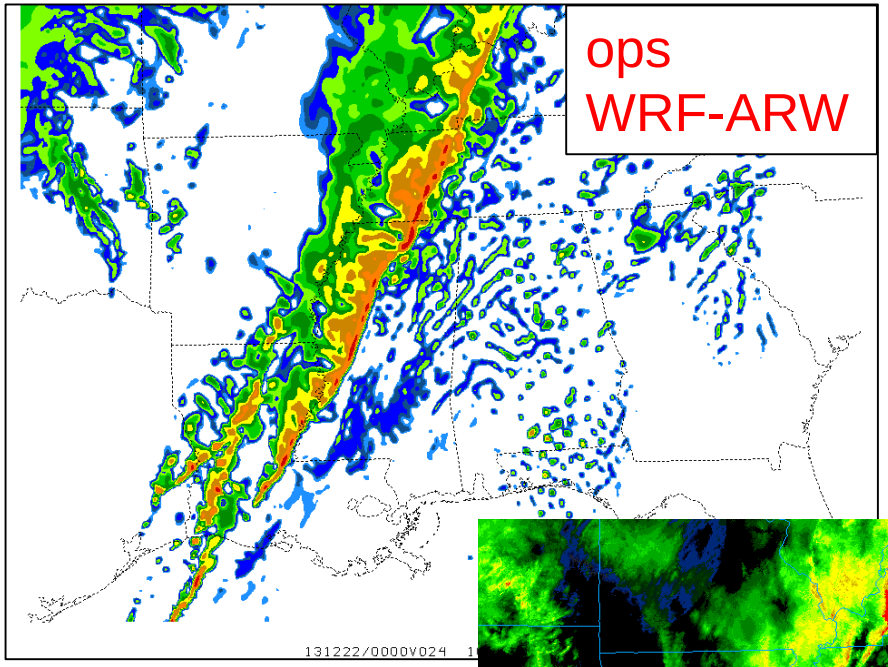


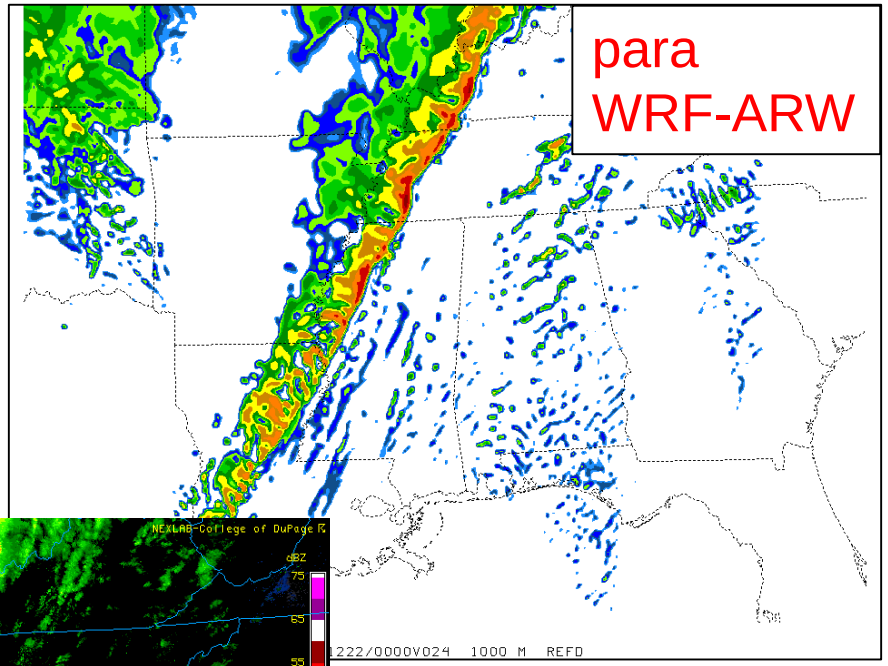


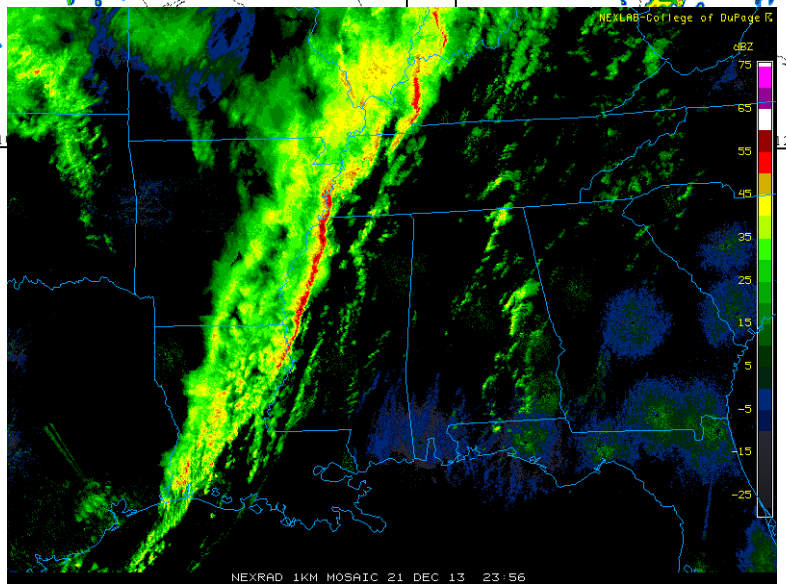
Much sharper and more intense leading edge in para, position also better

More intense convective signals, more in line with observations

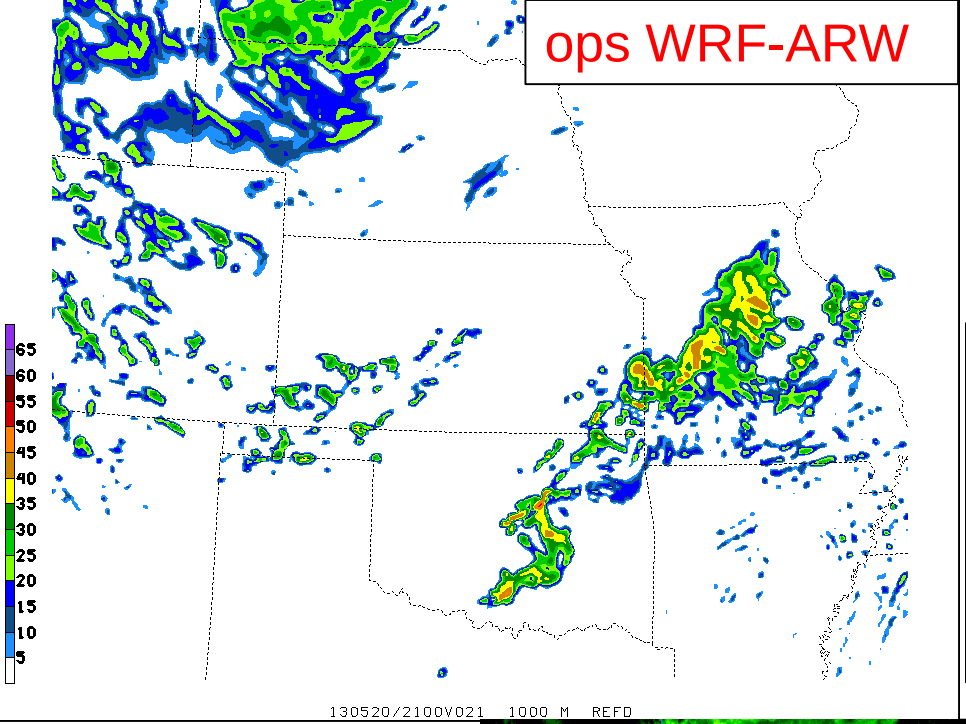
Model and observed 1 km AGL radar, 00Z 22 December 2013

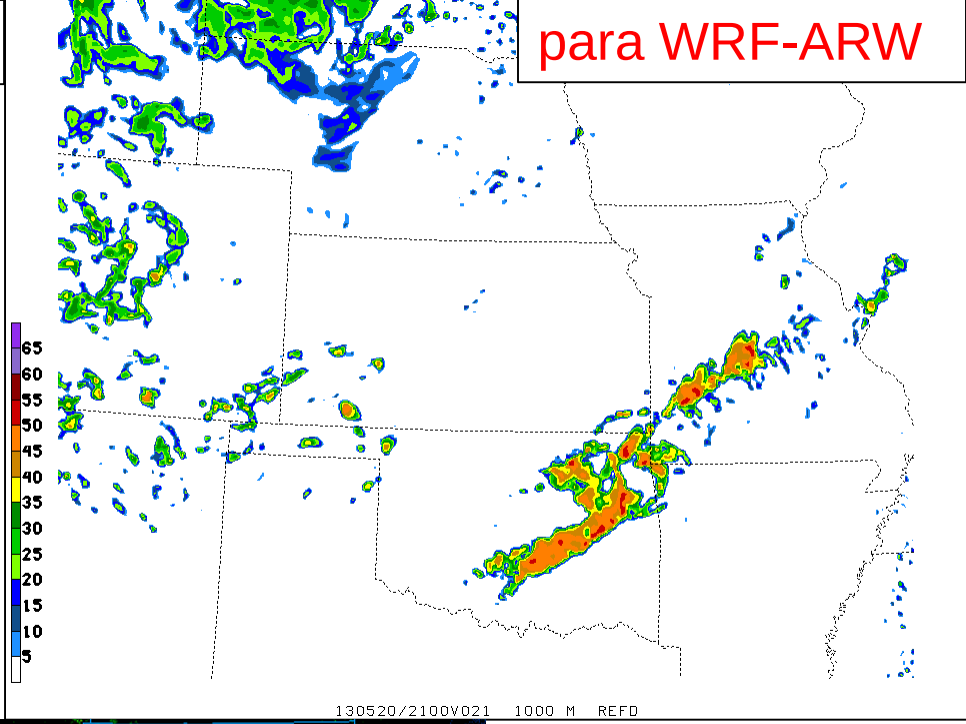






Stronger radar signal (40+ dbZ, yellow/ orange/red) packed in a narrower band in para, more like obs.

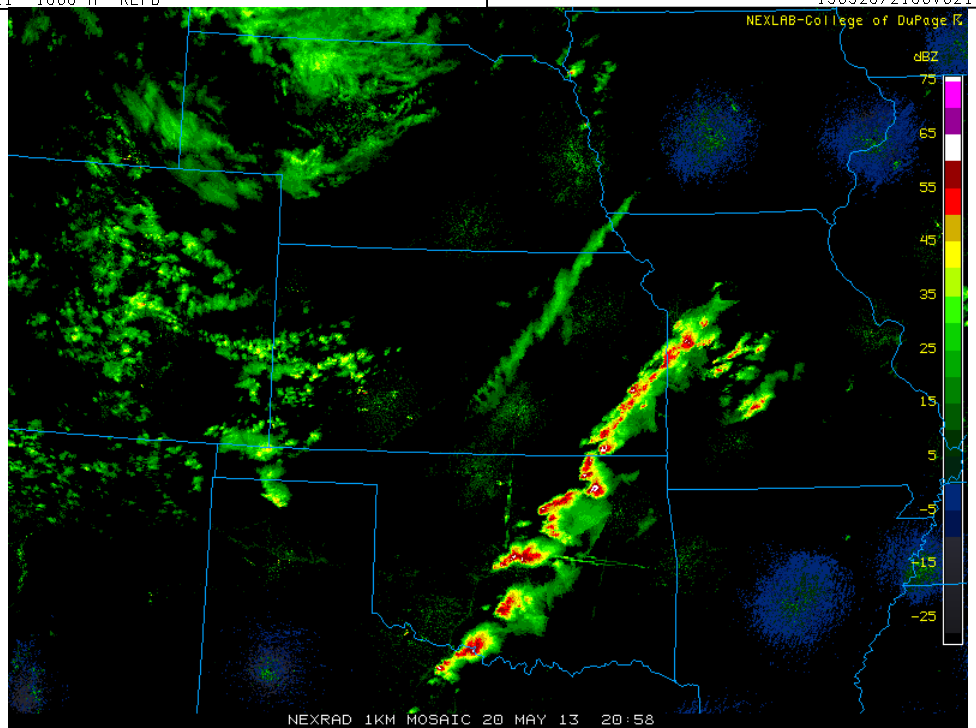




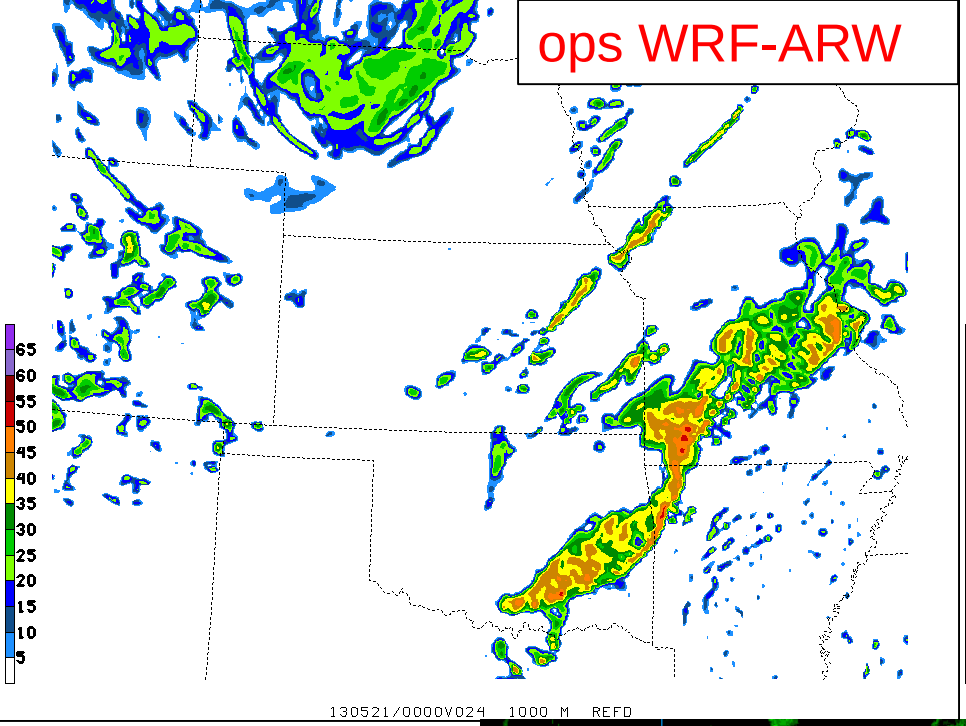
21 h forecast

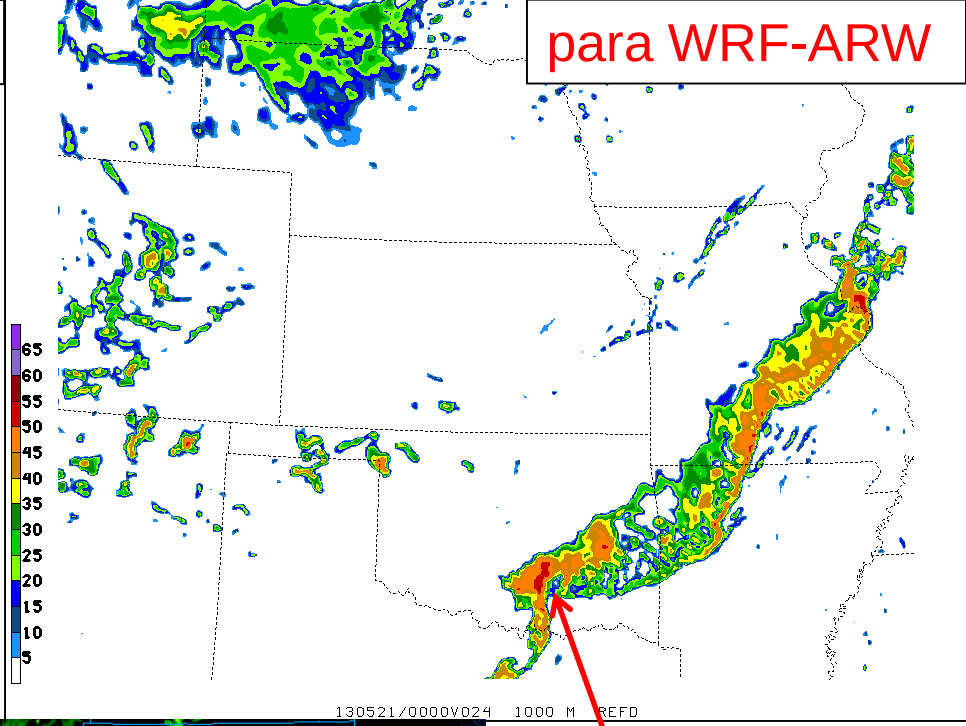
May 20, 2013

21Z



Much sharper convective initiation in para WRF-ARW

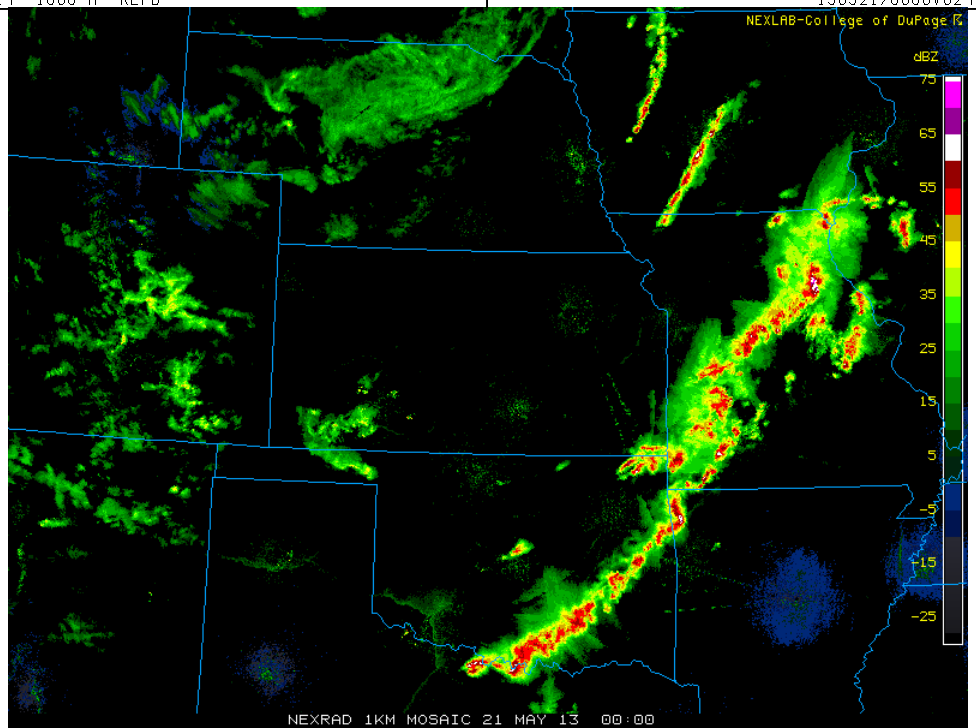




24 h forecast

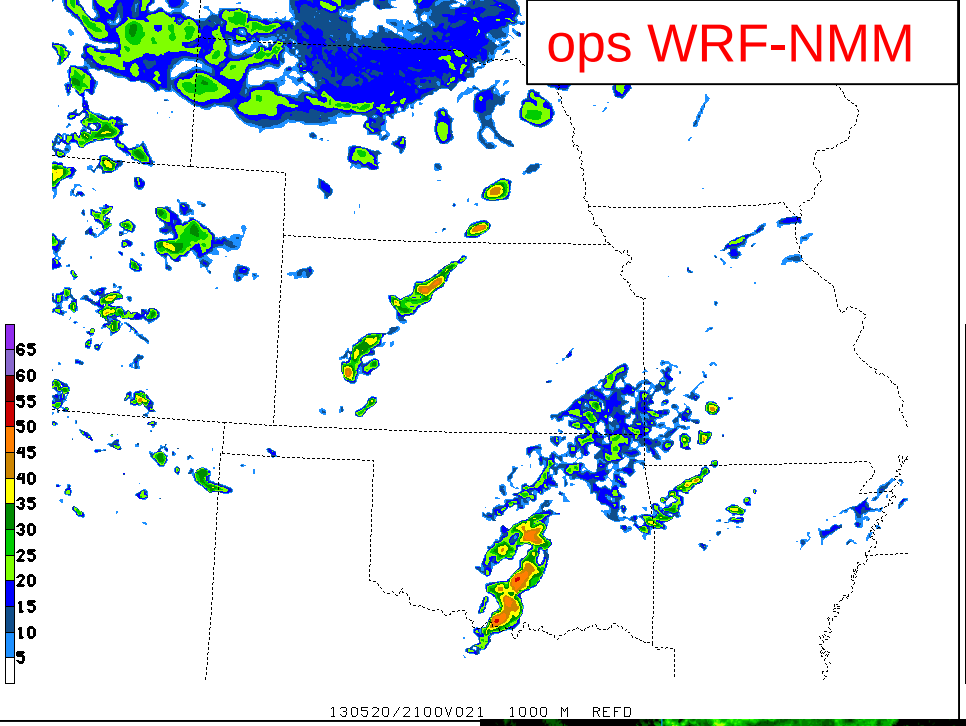
May 21, 2013

00Z

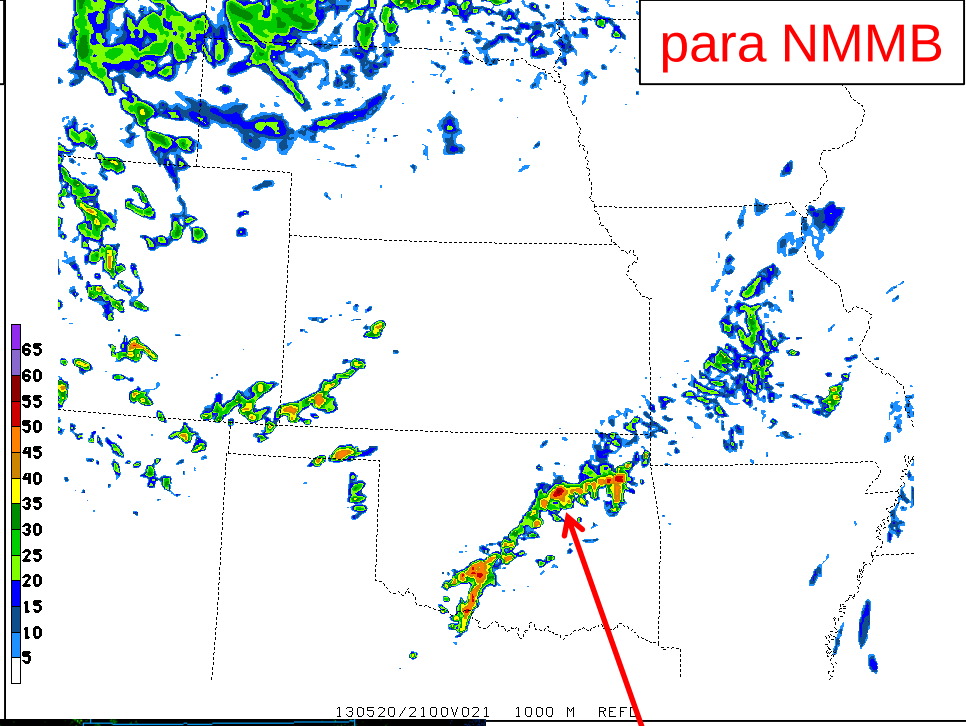


Dramatically more intense over SC Oklahoma

ops WRF-NMM



para NMMB



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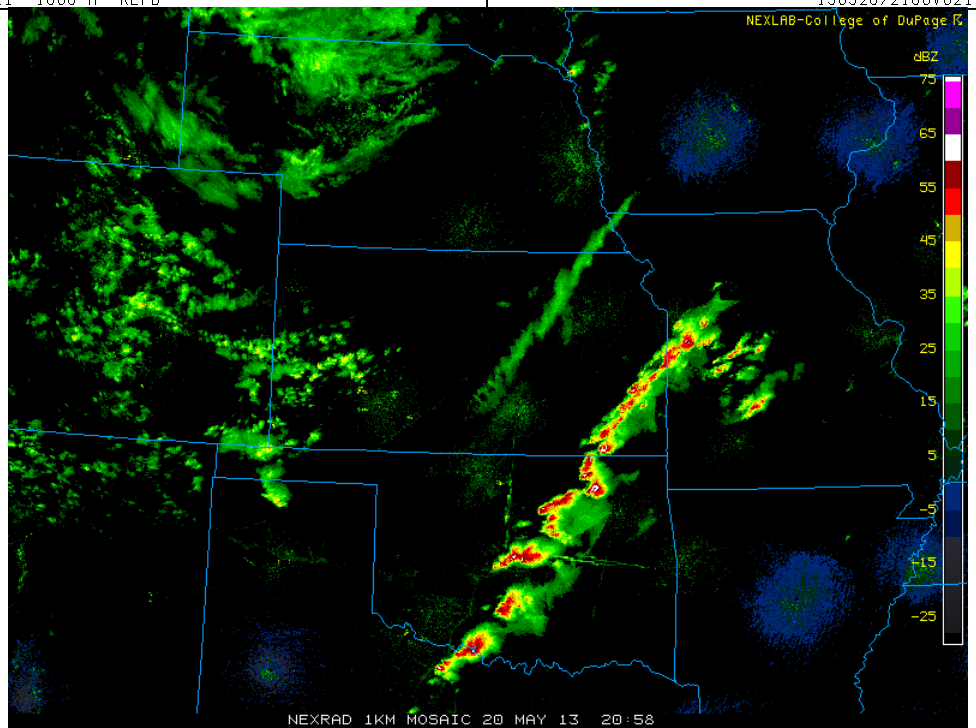
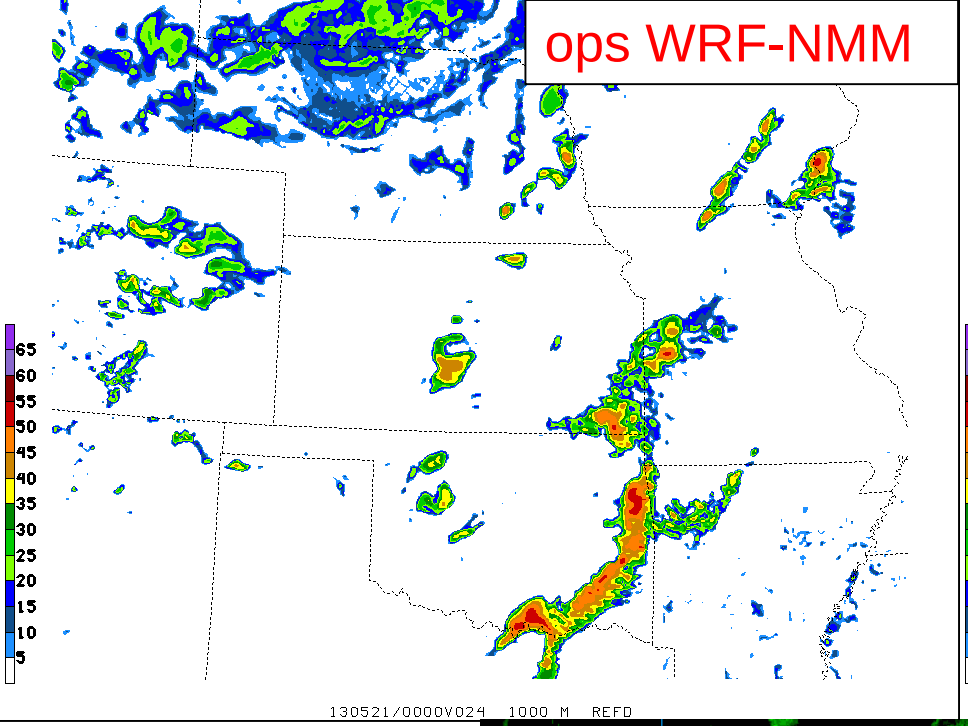
May 20, 2013

21Z

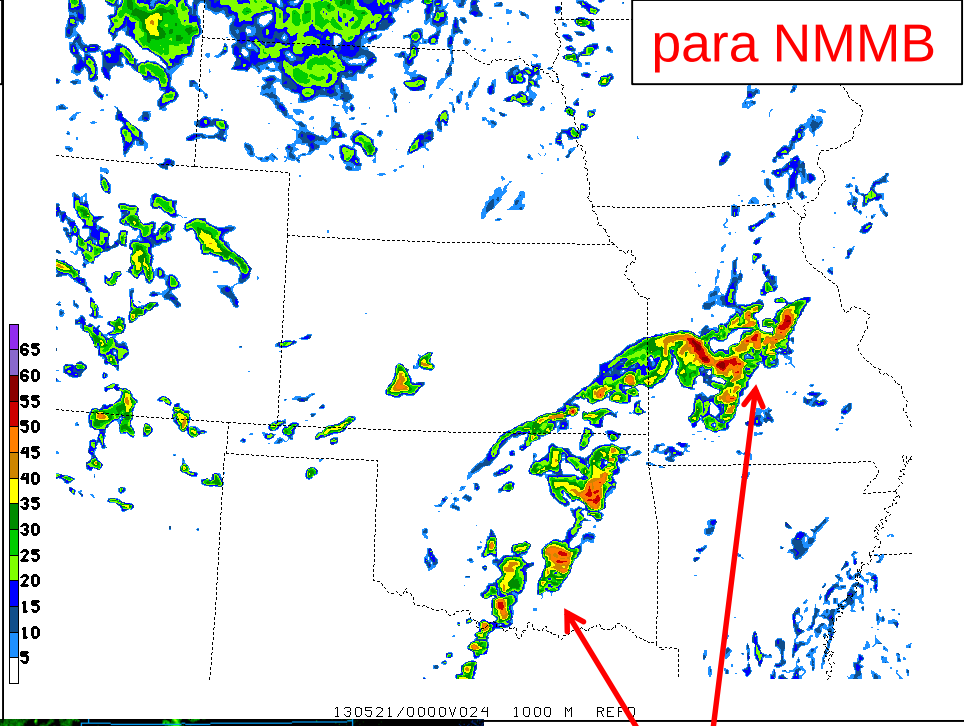


Greater intensity to early cells in para NMMB

ops WRF-NMM



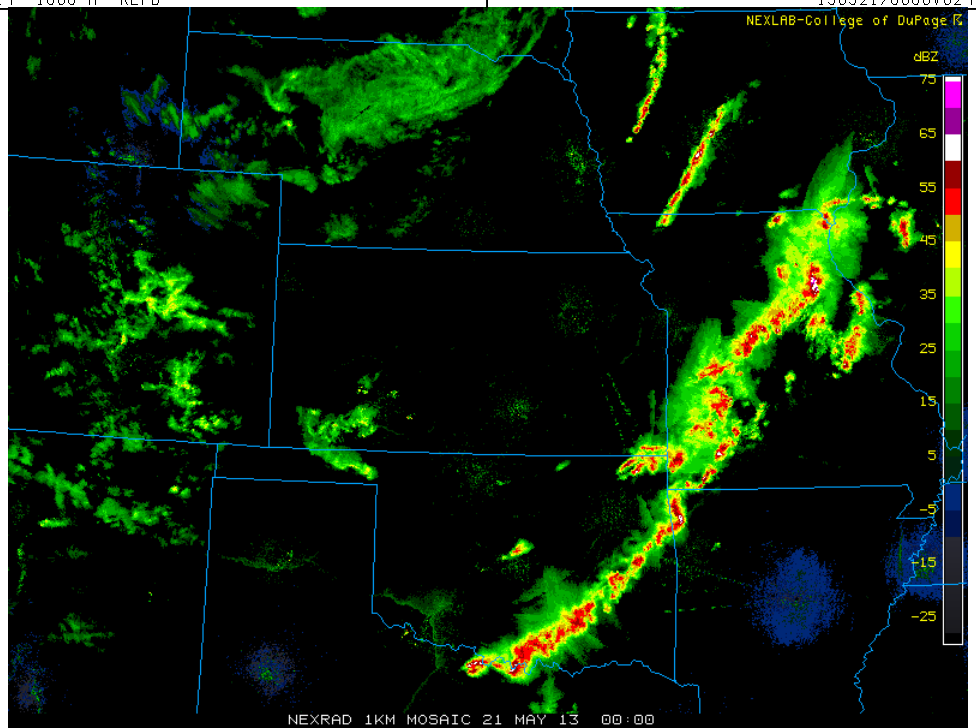
para NMMB



24 h forecast

May 21, 2013

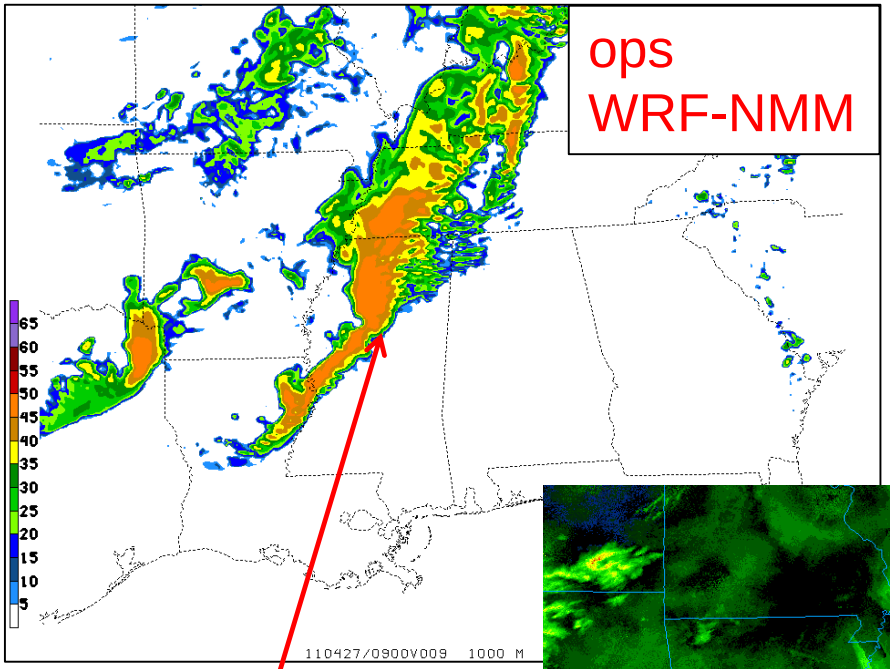
00Z

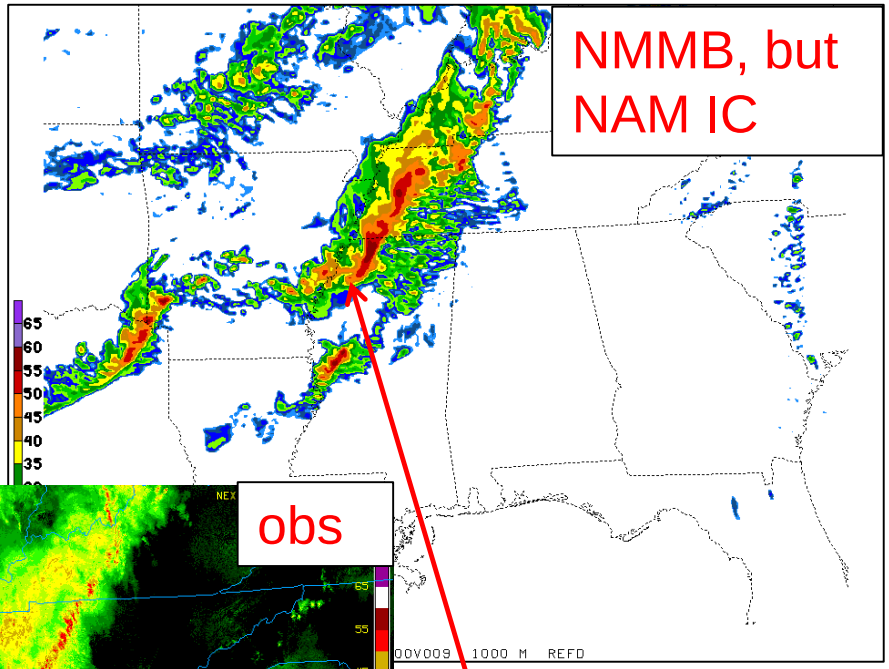


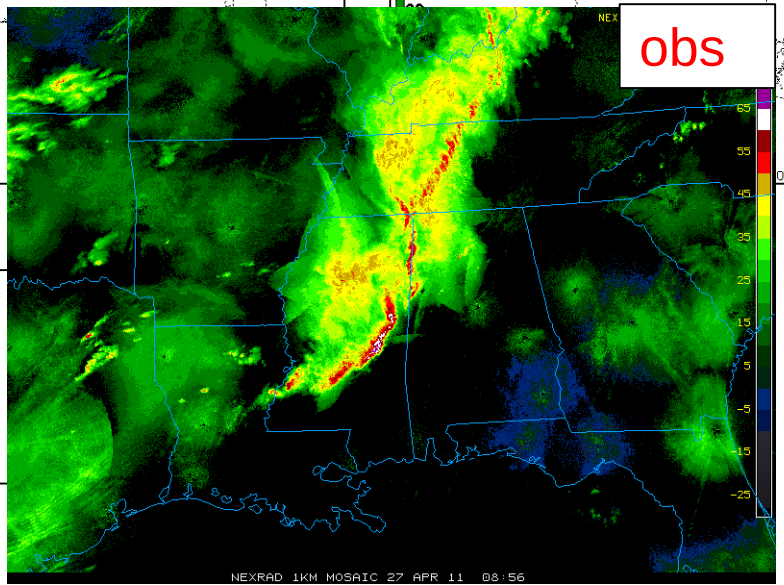
Coverage/ organization in OK underdone in para NMMB, but much improved over MO.

More intense convective signals, more in line with observations

Model and observed 1 km AGL radar, 09Z 27 April 2011





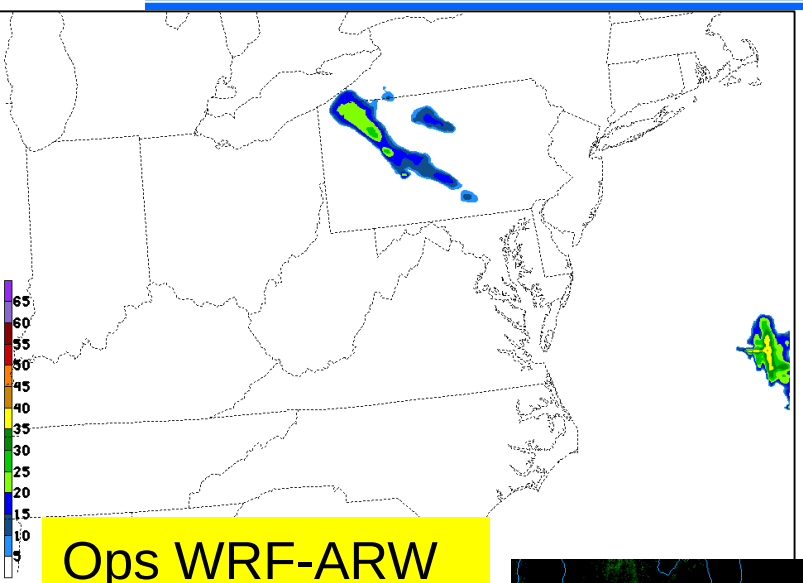


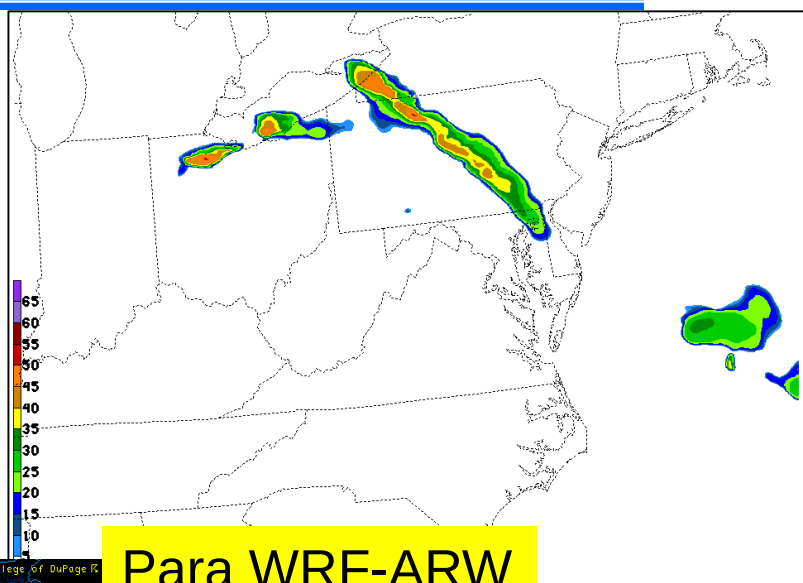
Diffuse convective signals in ops WRF-NMM an SPC complaint

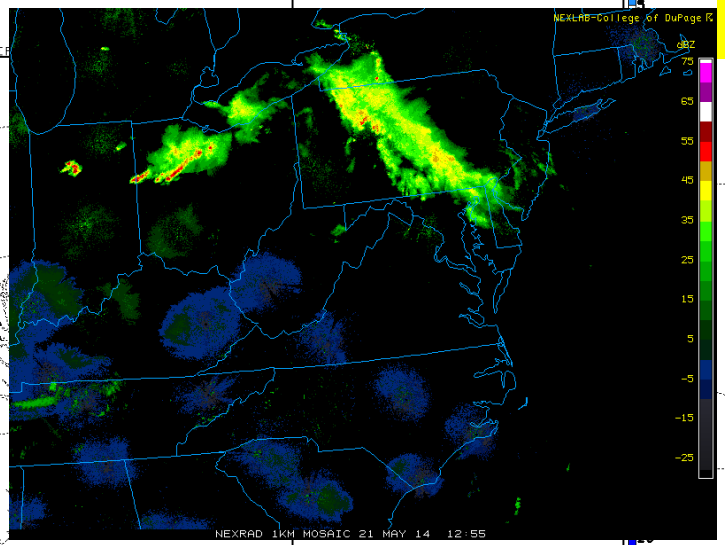
NMMB shows stronger, sharper line

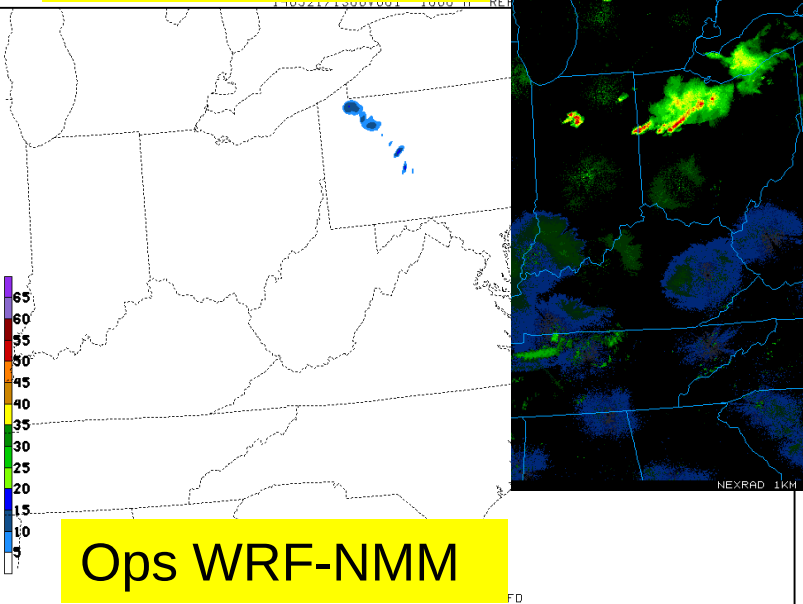
Quicker spinup of precipitation processes over CONUS

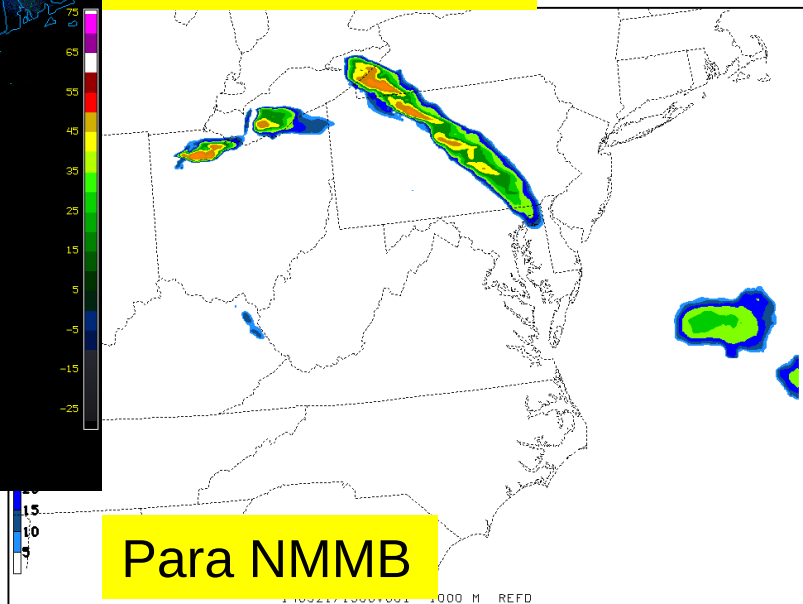
1 h forecasts of 1 km AGL radar, valid 13Z, 21 May 2014









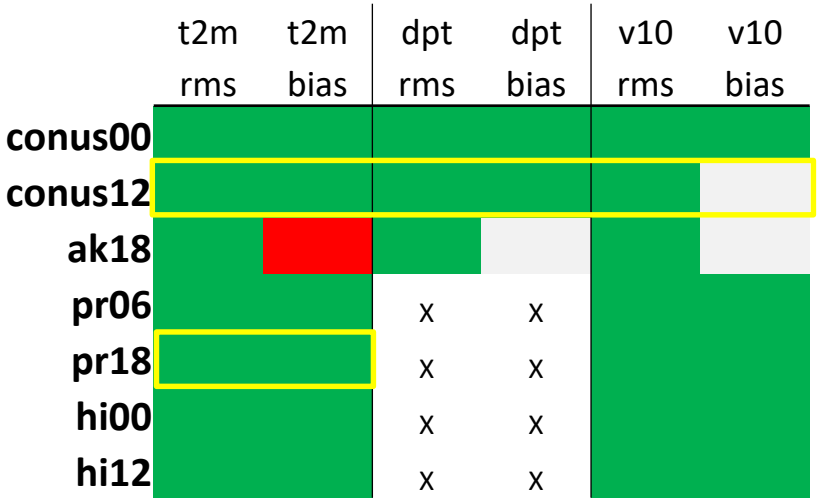


Surface Verification

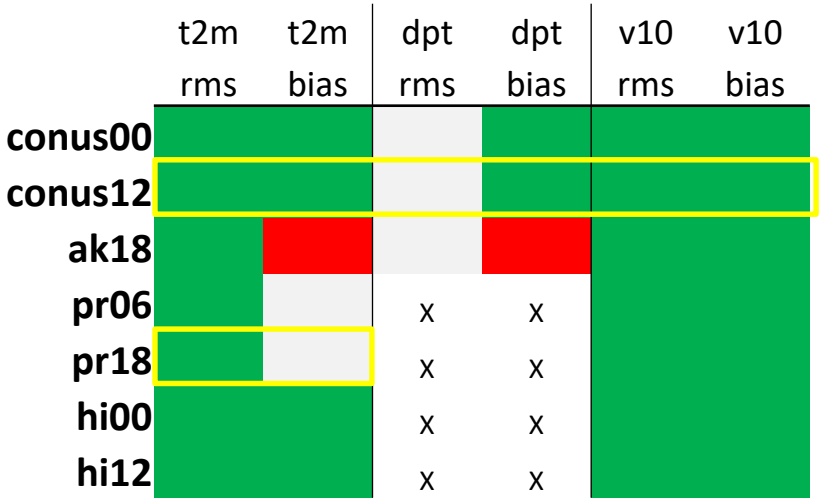
- Combined (warm + cold season) results at 2 m/10 m *almost* uniformly positive
  - Improvements to WRF-ARW 10 m winds the most consistent signal
  - Alaska bucks the trend (slightly)
- The switch to RRTM radiation in NMMB introduced/worsened a 2 m temp cold bias over snow (NAM upgrade has battled this same issue).

Surface verification summary – all cases

Parallel NMMB vs. Ops WRF-NMM



Parallel vs. Ops WRF-ARW



Parallel better

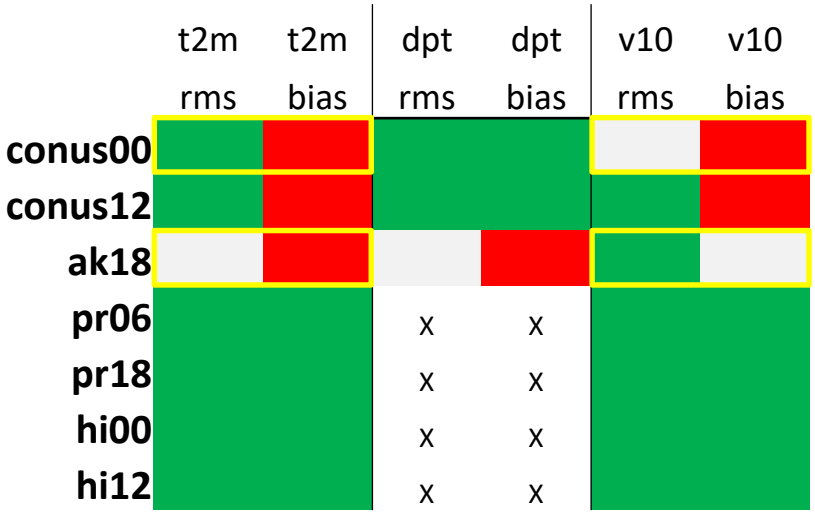
Parallel worse

About equal

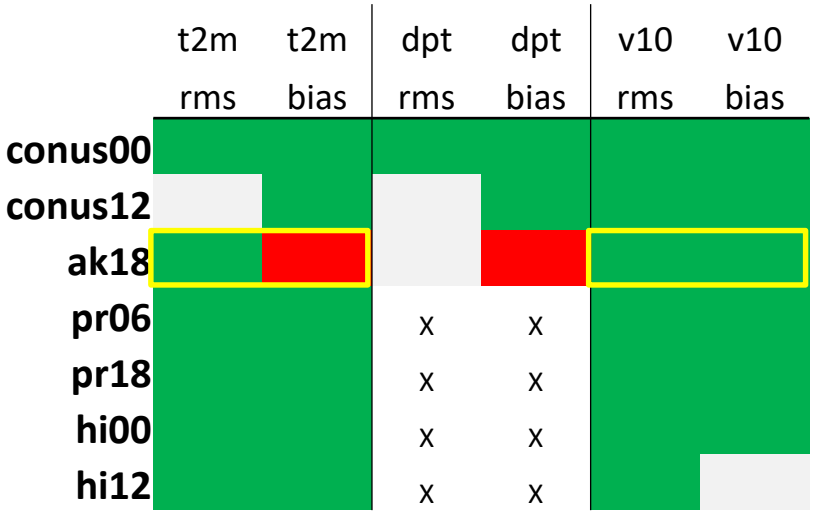
Verif trouble
(insufficient obs?) X

Surface verification summary – cold season (late Dec 2013 – end Feb 2014)

Parallel NMMB vs. Ops WRF-NMM



Parallel vs. Ops WRF-ARW



Parallel better

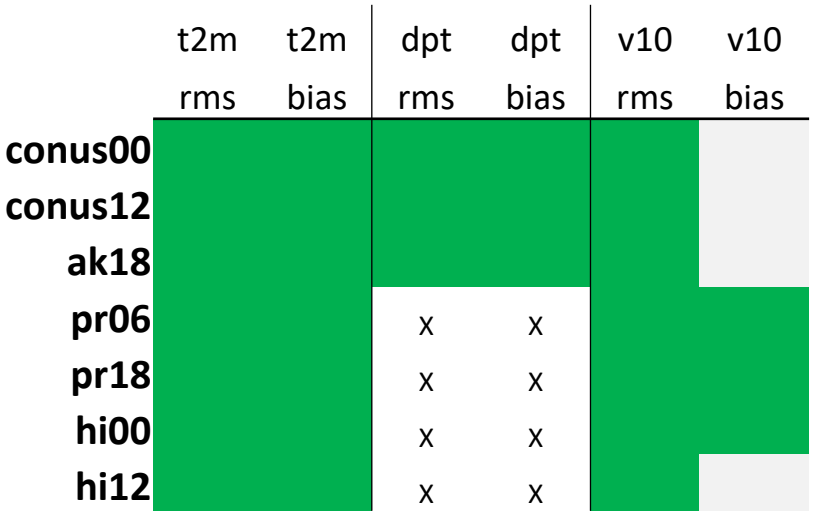
Parallel worse

About equal

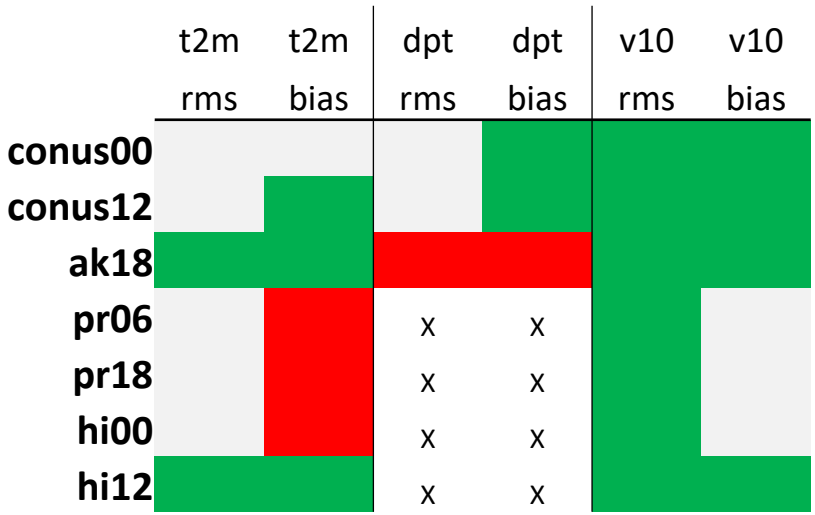
Verif trouble (insufficient obs?) x

Surface verification summary – spring transition season (March – mid-May 2014)

Parallel NMMB vs. Ops WRF-NMM



Parallel vs. Ops WRF-ARW



Parallel better

Parallel worse

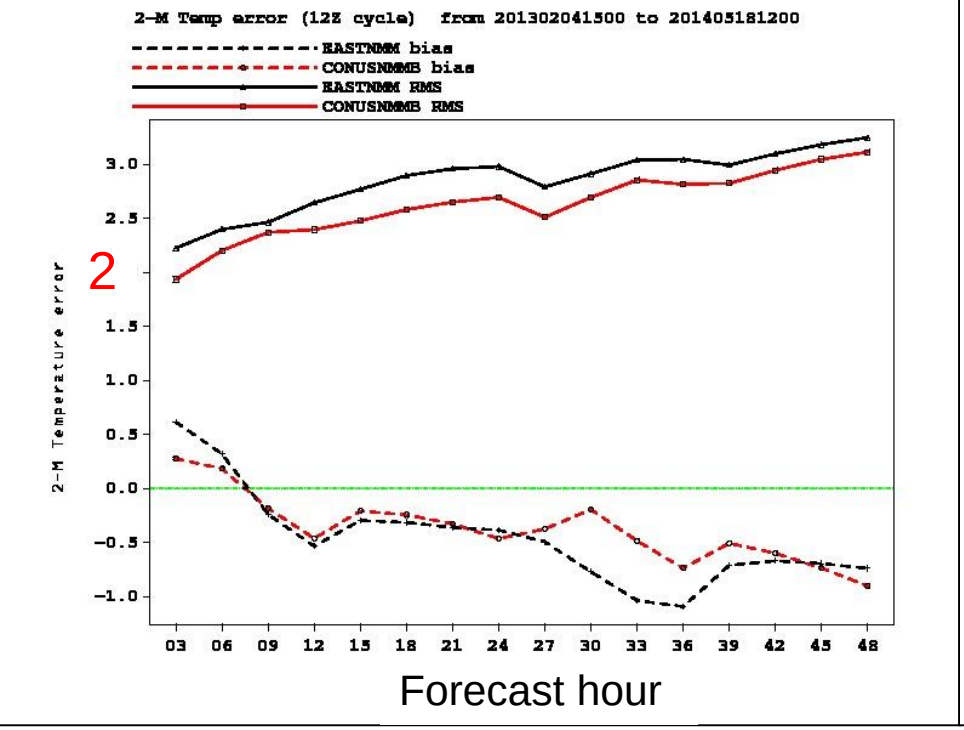
About equal

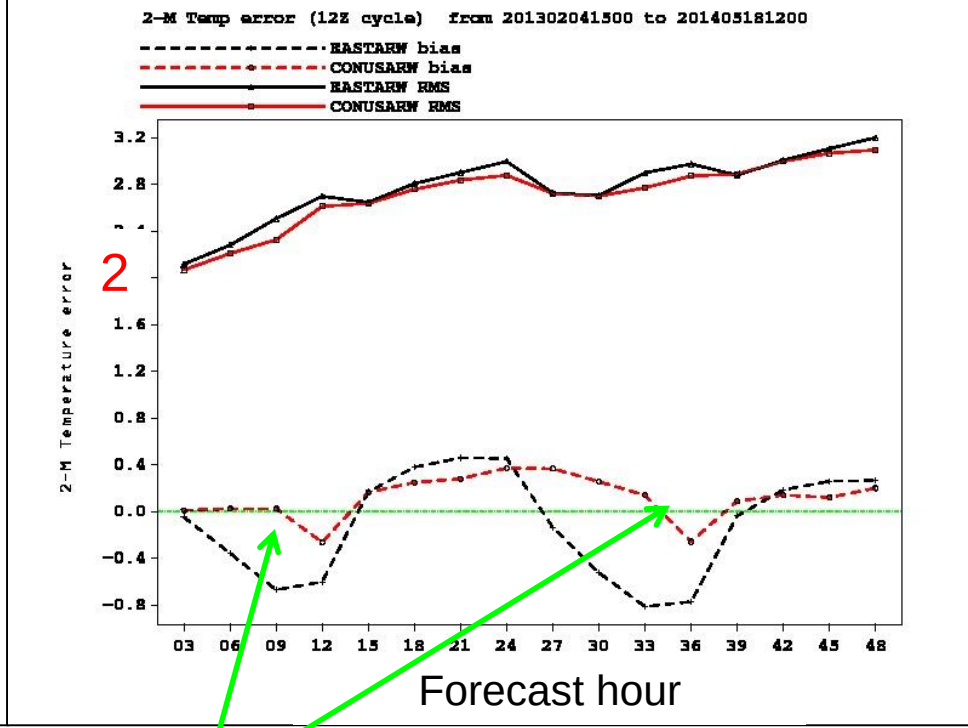
Verif trouble (insufficient obs?) x

eastern CONUS 2 m temp, 12Z cycle

full test period

ops RMS
para RMS
ops bias
para bias





NMM/NMMB

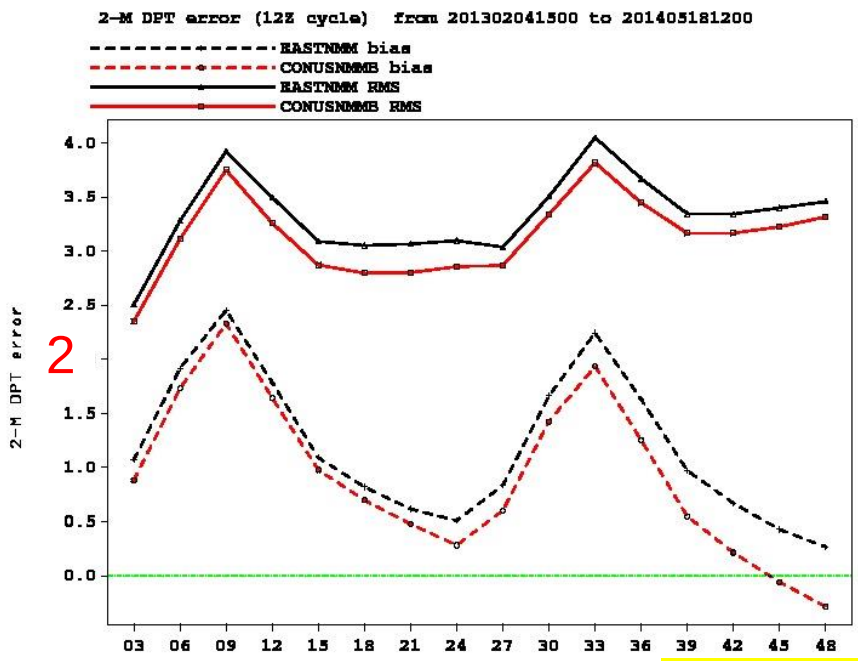
parallel eliminates daytime cool bias

WRF-ARW

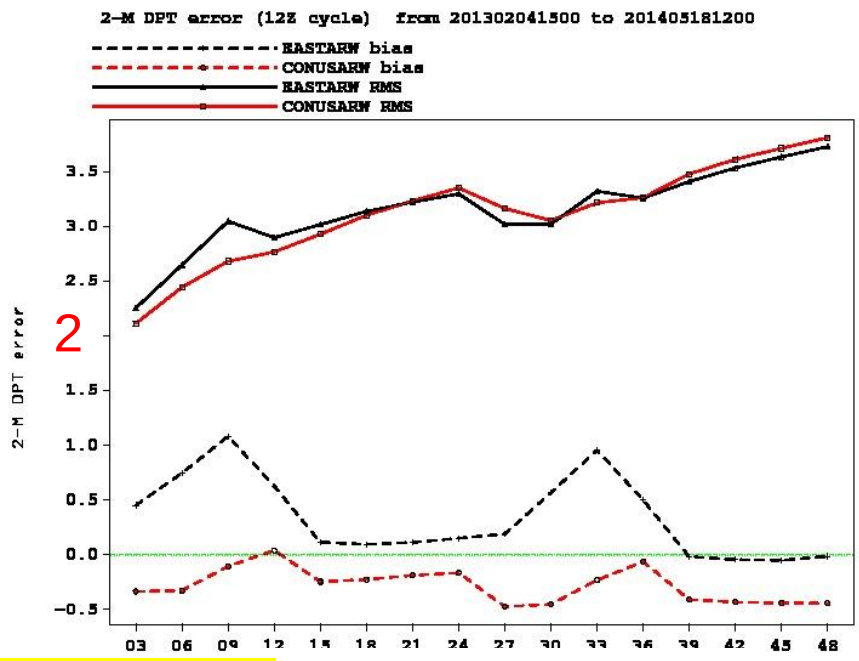
eastern CONUS 2 m Td, 12Z cycle

full test period

ops RMS
para RMS
ops bias
para bias



Forecast hour



Forecast hour

NMM/NMMB

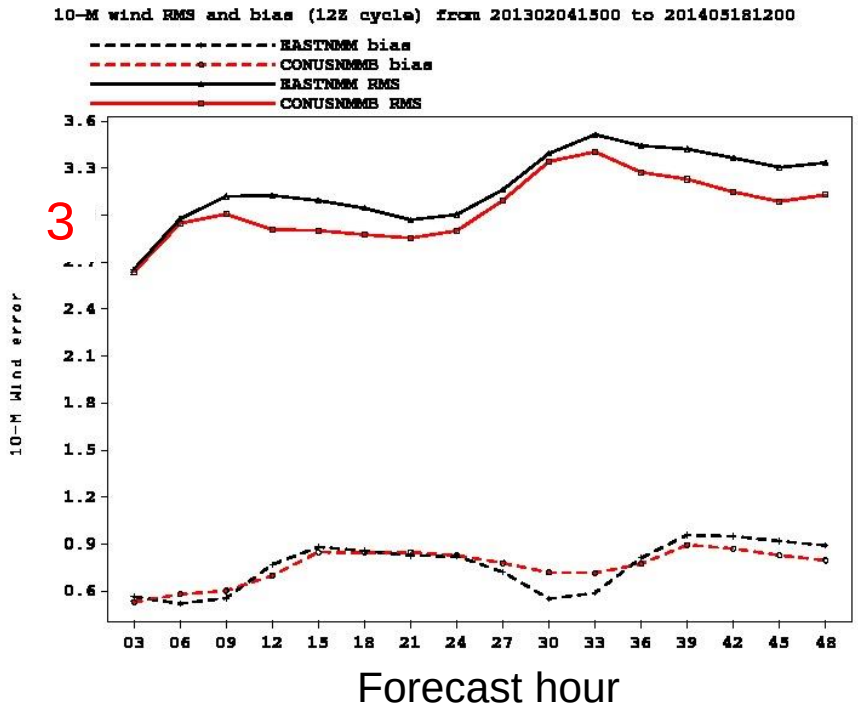
Moist bias reduced in parallel for both models; remains an issue for NMMB

WRF-ARW

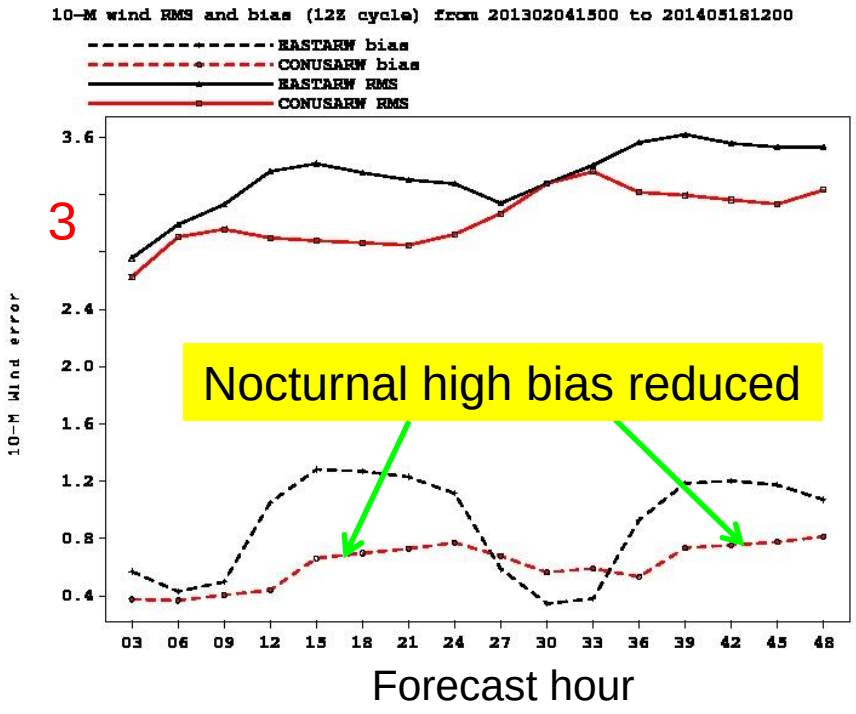
eastern CONUS 10 m wind, 12Z cycle

full test period

ops RMS
para RMS
ops bias
para bias



NMM/NMMB

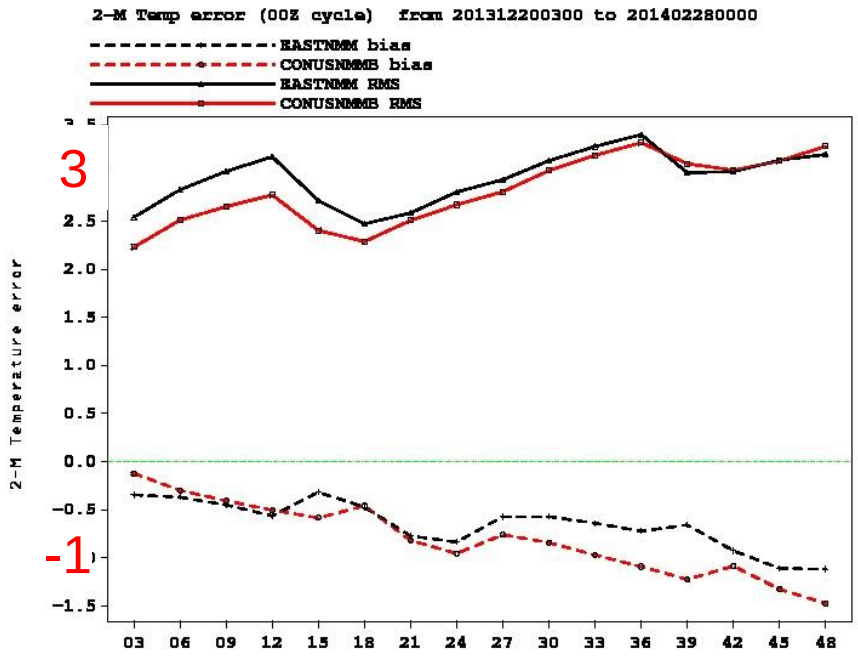


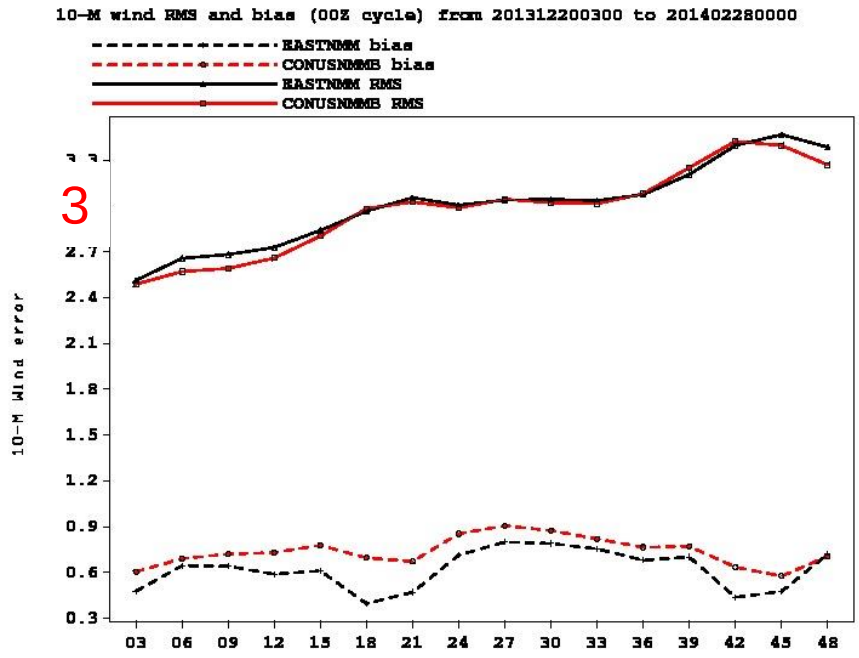
WRF-ARW

eastern CONUS, 00Z cycle

Dec 2013 - Feb 2014 (pure cold season)

ops RMS
para RMS
ops bias
para bias





NMM/NMMB

2 m temp

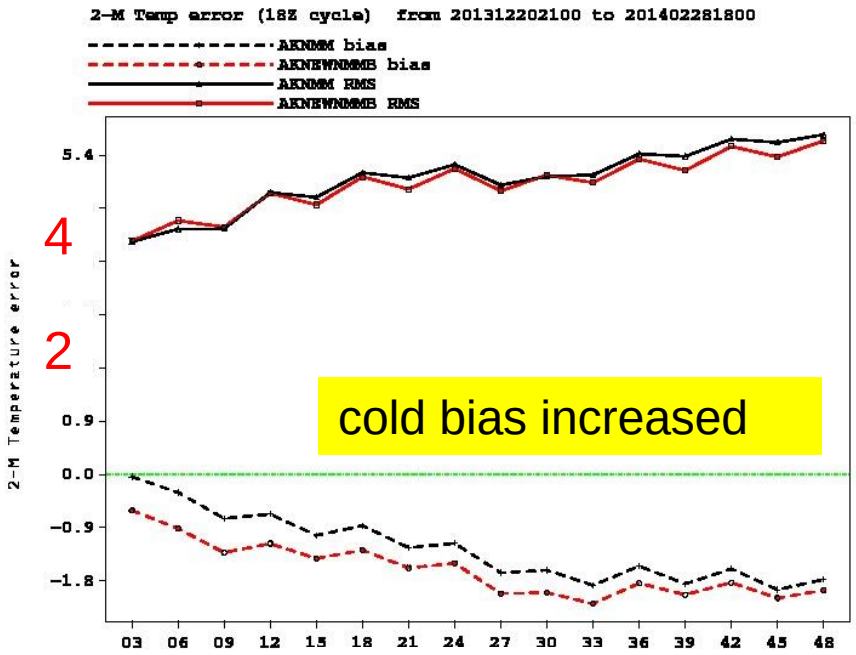
NMM/NMMB

10 m winds

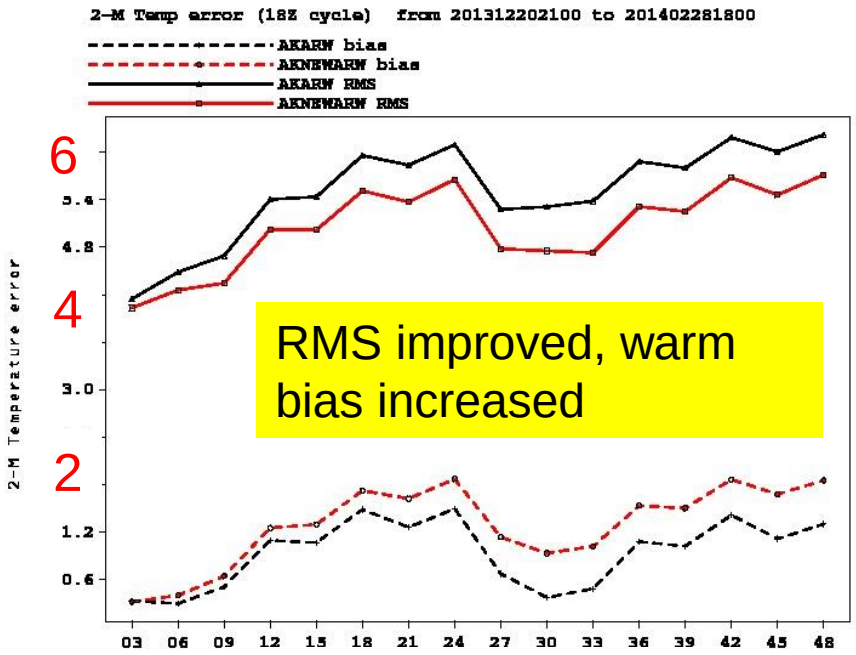
Alaska 2 m temperature, 18Z cycle

Dec 2013 - Feb 2014 (pure cold season)

ops RMS
para RMS
ops bias
para bias



NMM/NMMB

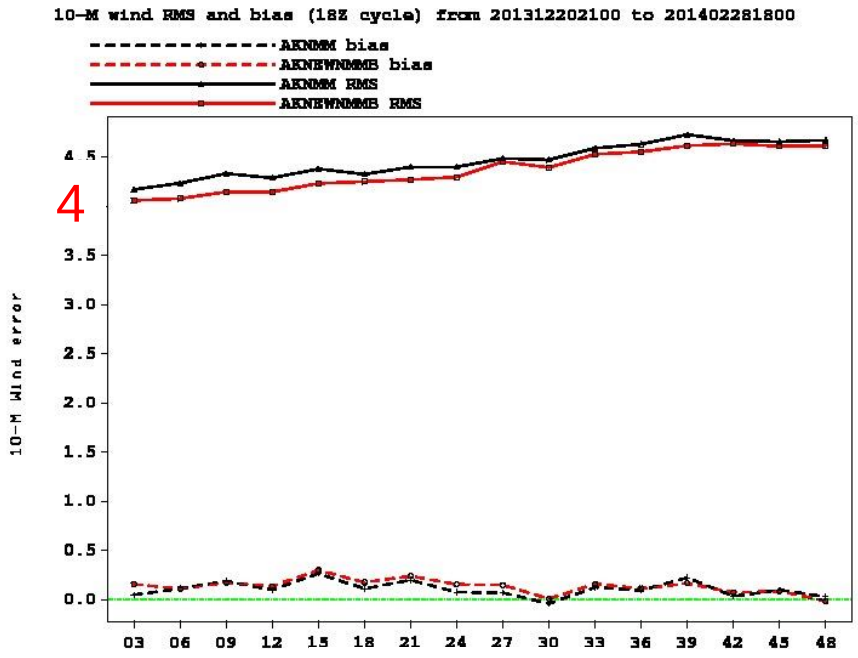


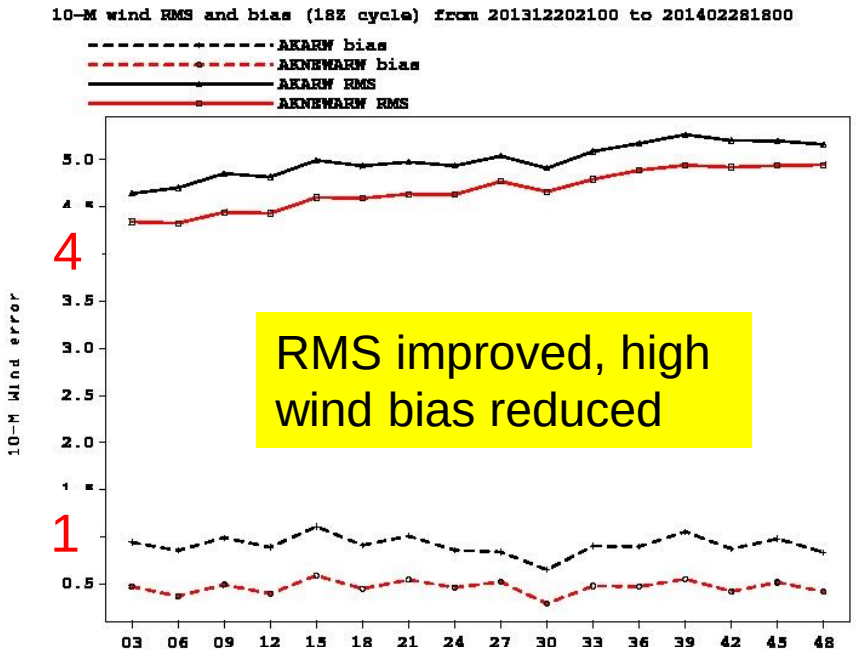
WRF-ARW

Alaska 10 m wind, 18Z cycle

Dec 2013 - Feb 2014 (pure cold season)

ops RMS
para RMS
ops bias
para bias





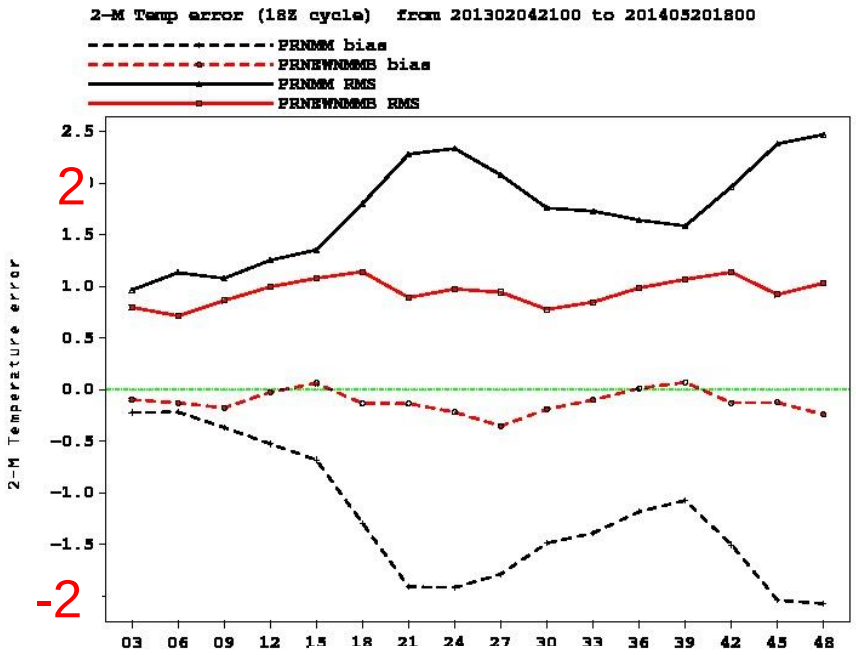
NMM/NMMB

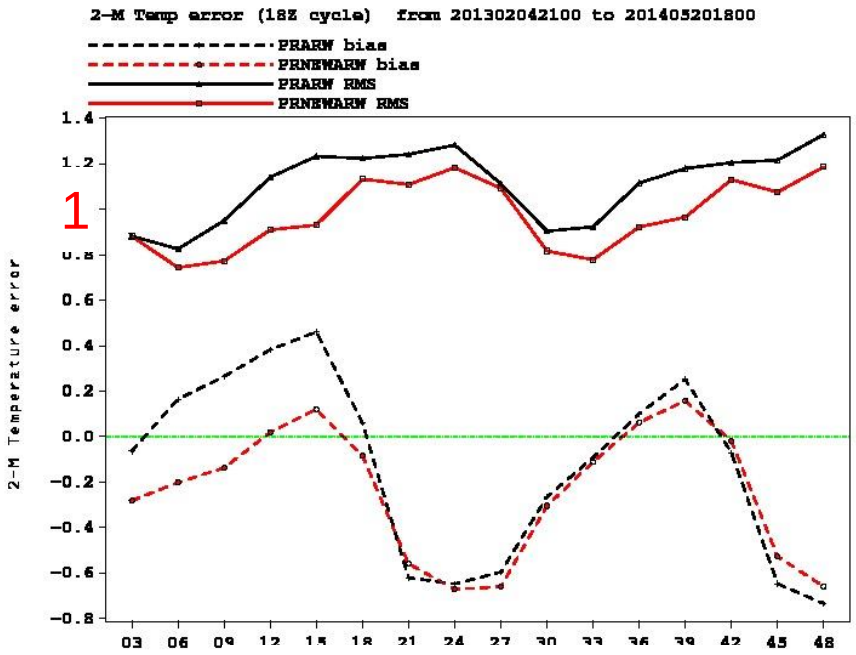
WRF-ARW

Puerto Rico 2 m temp, 18Z cycle

full test period

ops RMS
para RMS
ops bias
para bias





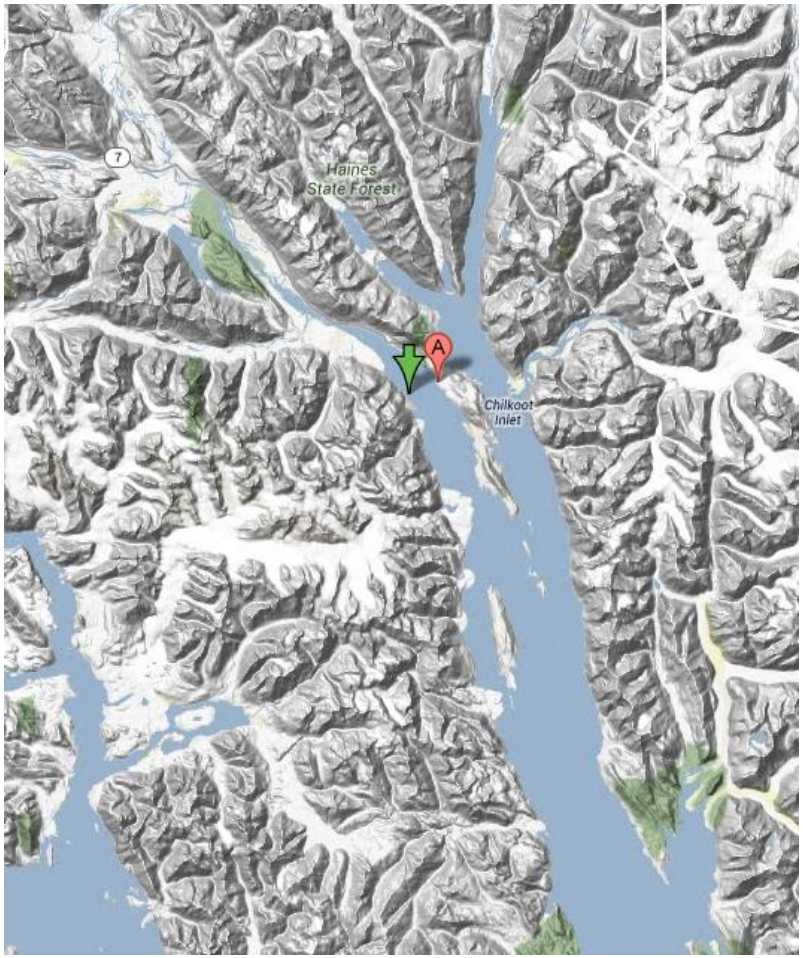
NMM/NMMB

WRF-ARW

Impact of model and grid resolution on near-surface temps and winds

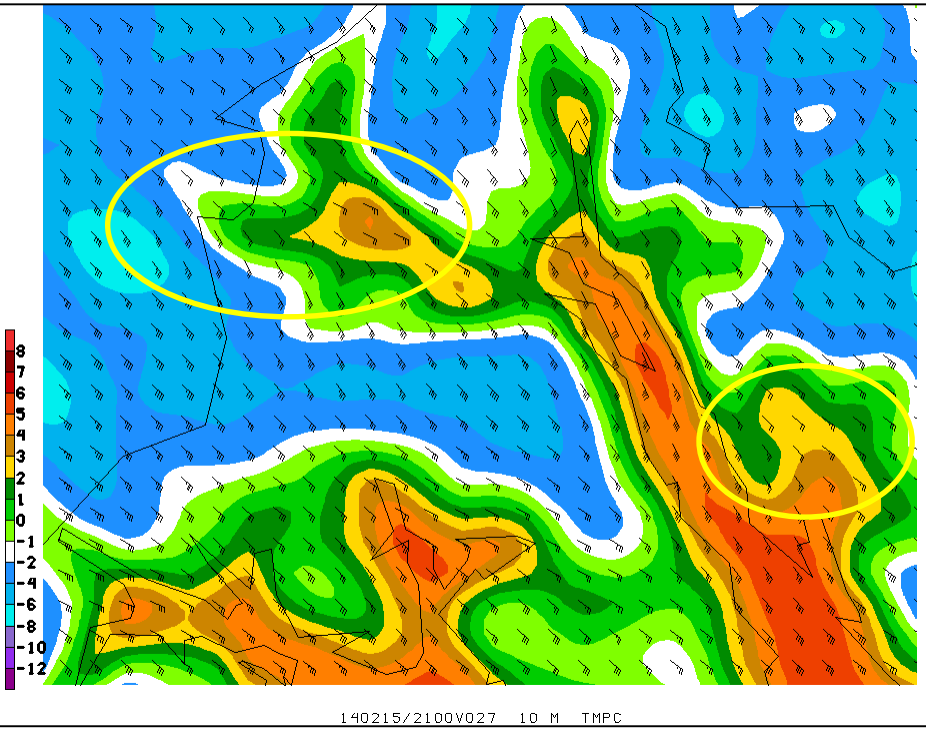
Region of focus in Skagway/Haines region of SE Alaska

- narrow channels and valleys, rugged topography

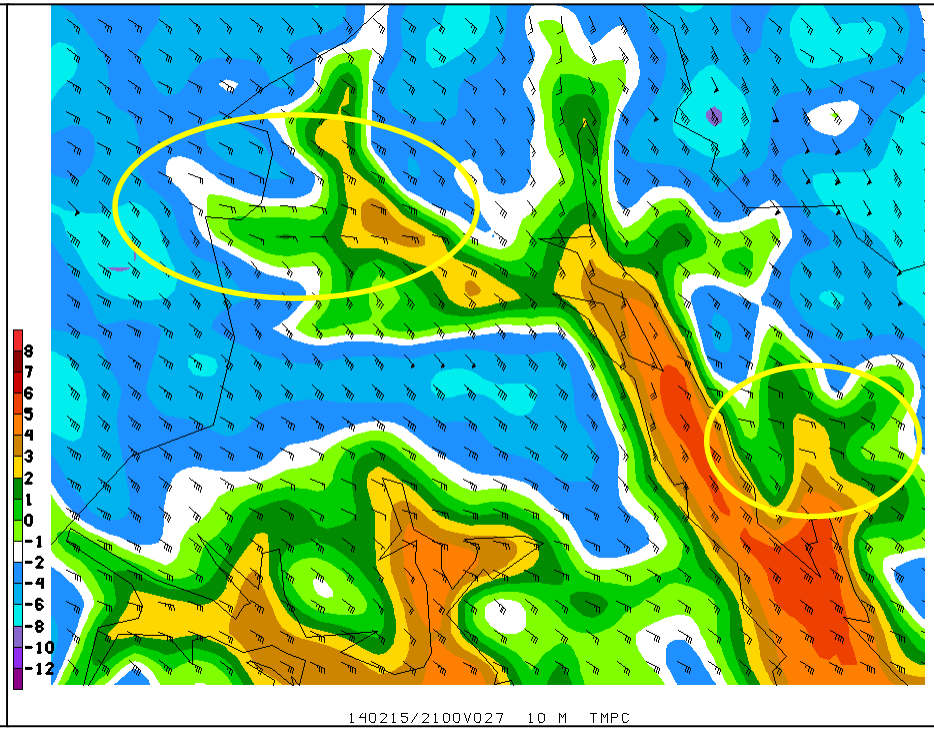


Impact of model and grid resolution on near-surface temps and winds

27 h forecast valid 21Z on 15 Feb 2014



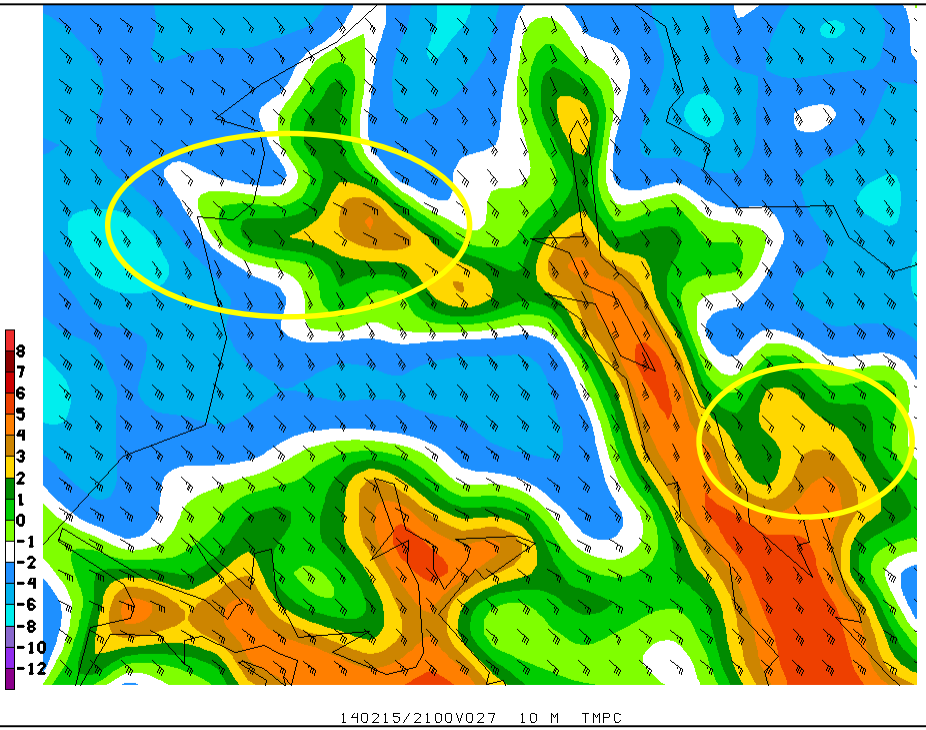
Ops WRF-ARW (5.15 km)
5 km output grid



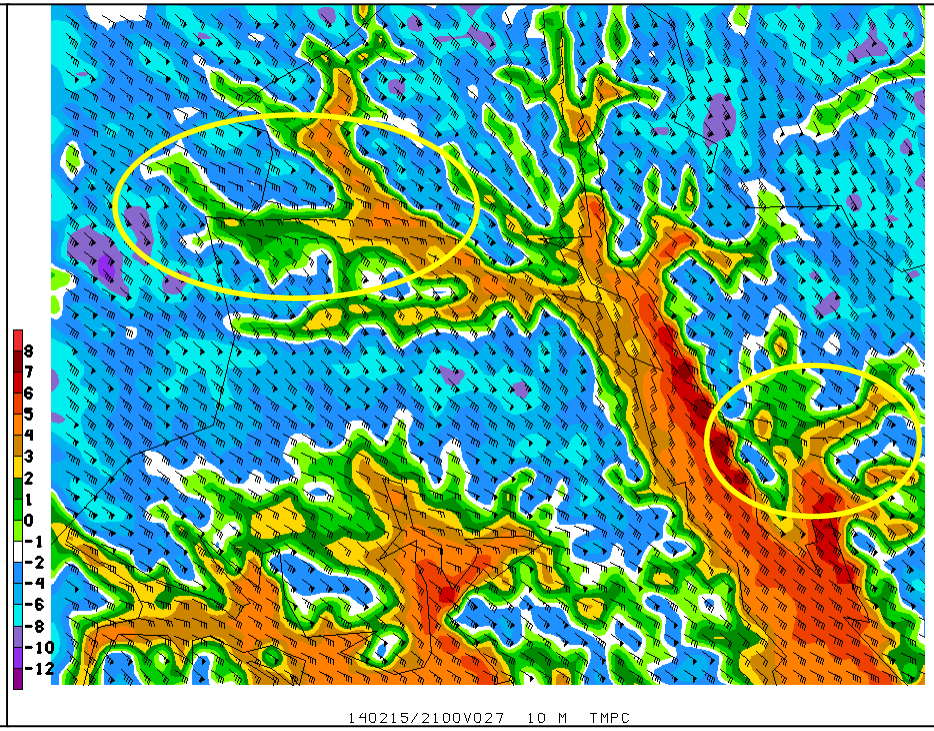
Para WRF-ARW (3.5 km)
5 km output grid

Impact of model and grid resolution on near-surface temps and winds

27 h forecast valid 21Z on 15 Feb 2014



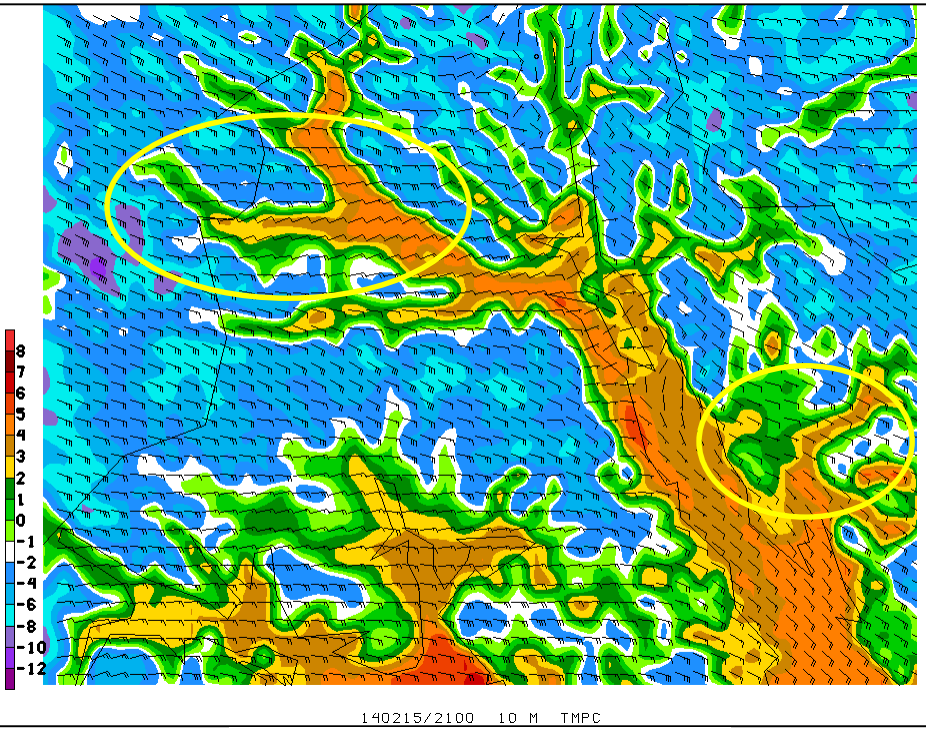
Ops WRF-ARW (5.15 km)
5 km output grid



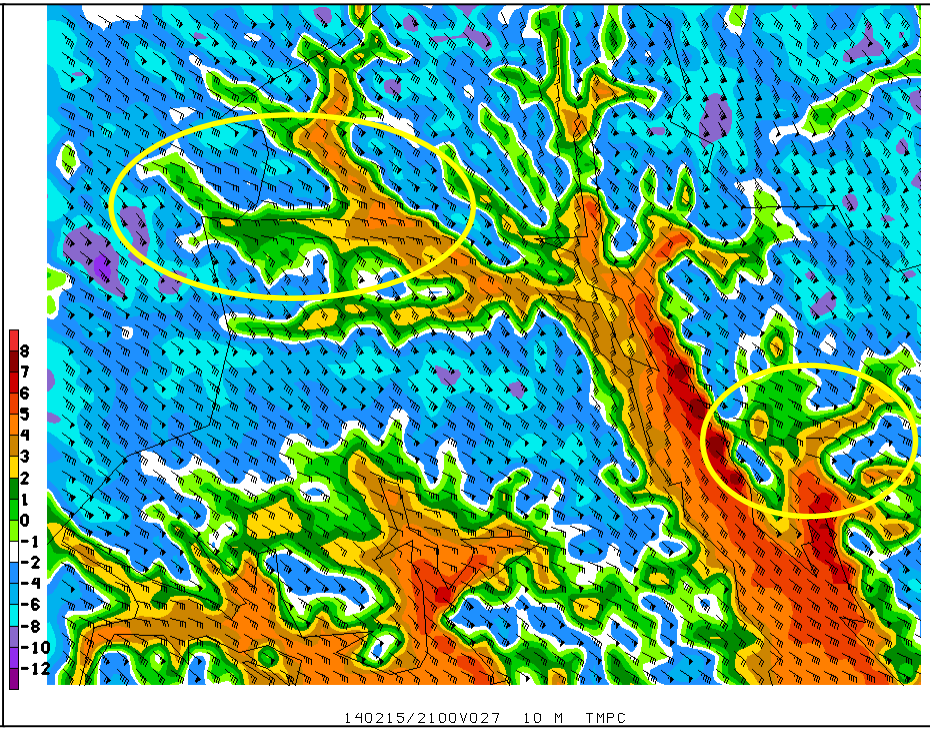
Para WRF-ARW (3.5 km)
new 3 km NDFD output grid
(smartinit downscaling)

Impact of model and grid resolution on near-surface temps and winds

27 h forecast valid 21Z on 15 Feb 2014

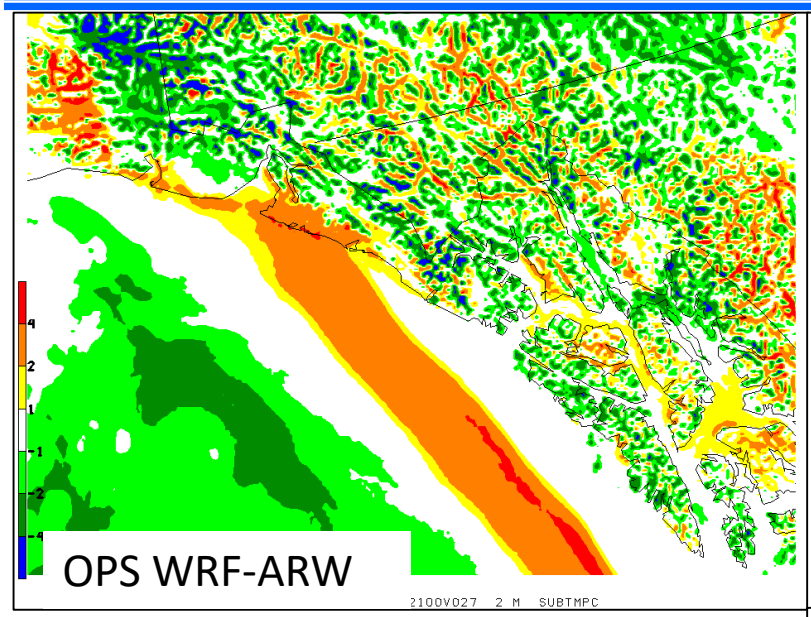


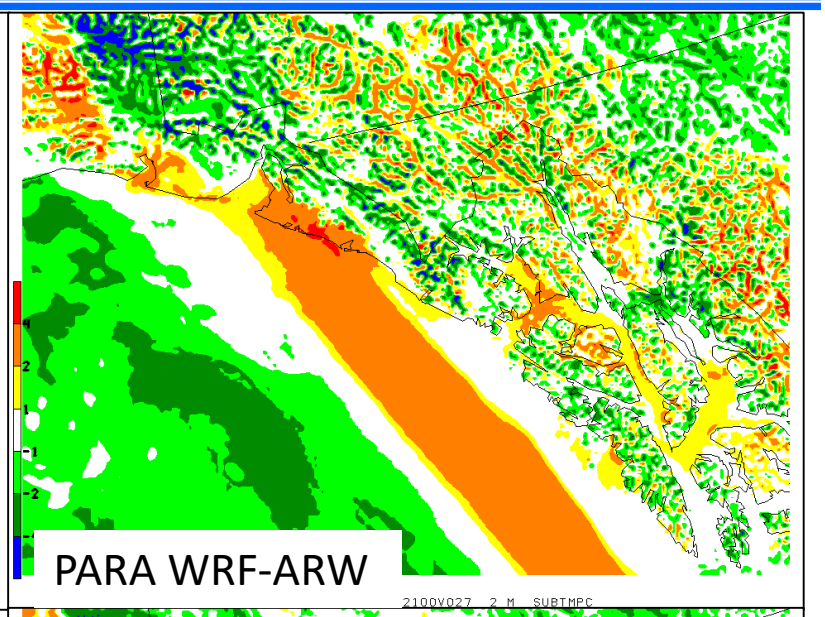
3 km NDFD analysis

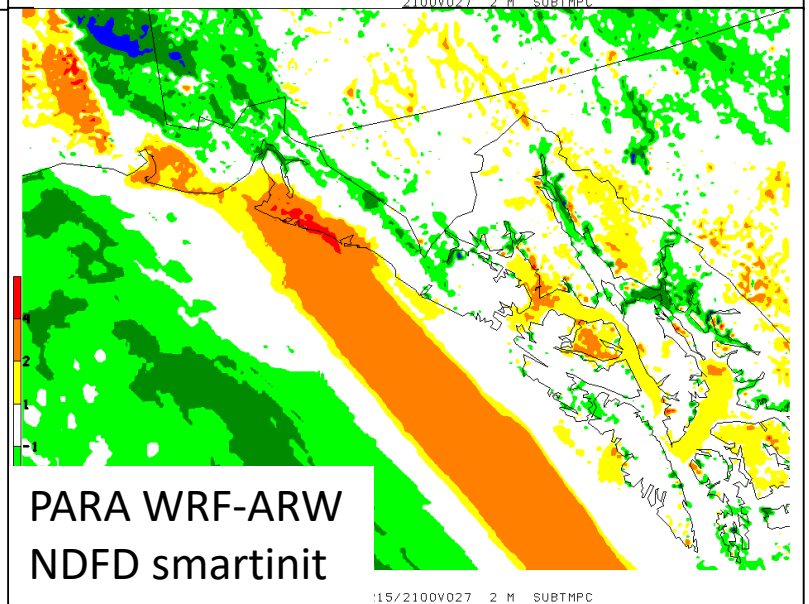


Para WRF-ARW (3.5 km)
new 3 km NDFD output grid
(smartinit downscaling)

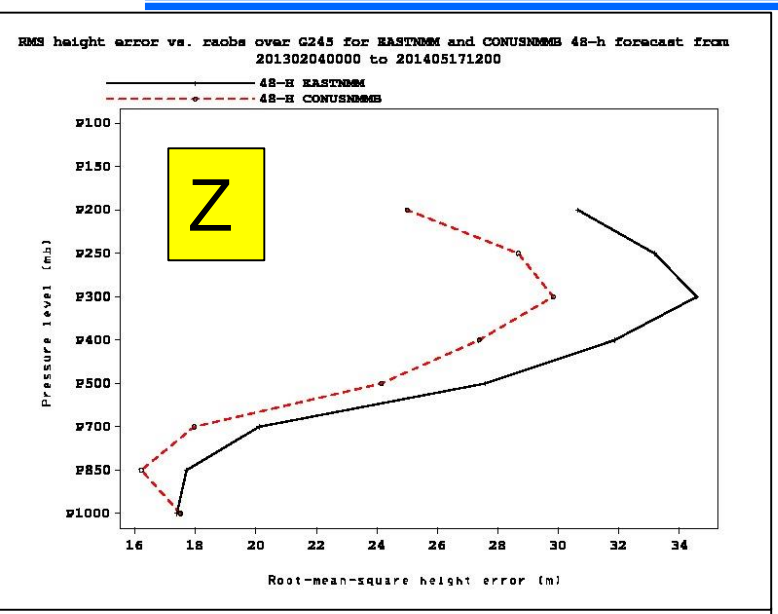
2 m temp diffs (model - 3 km RTMA analysis)
15 Feb 2014, 21Z







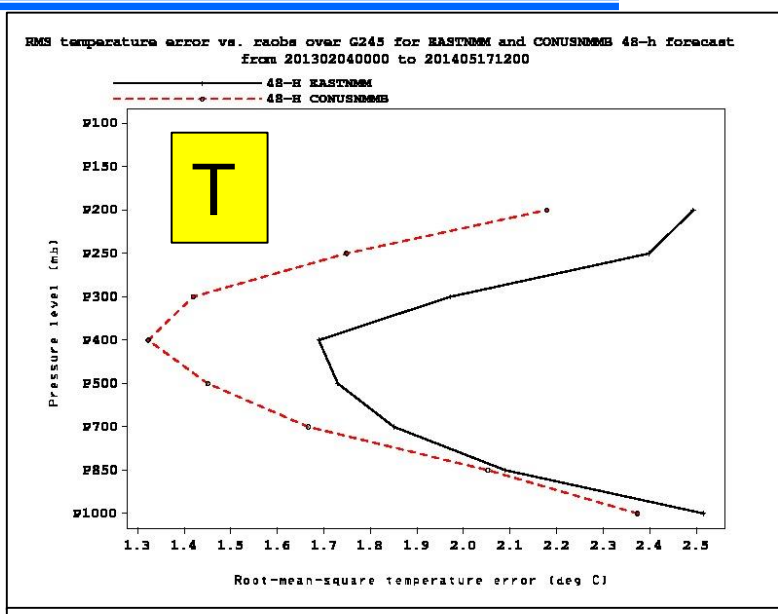
RMS errors at 48 h for eastern CONUS – WRF-NMM / NMMB (12Z cycles only)

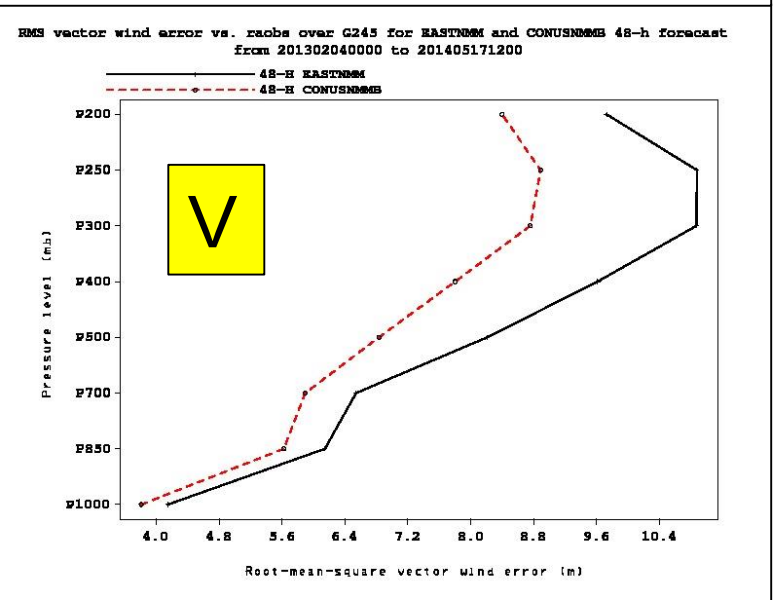


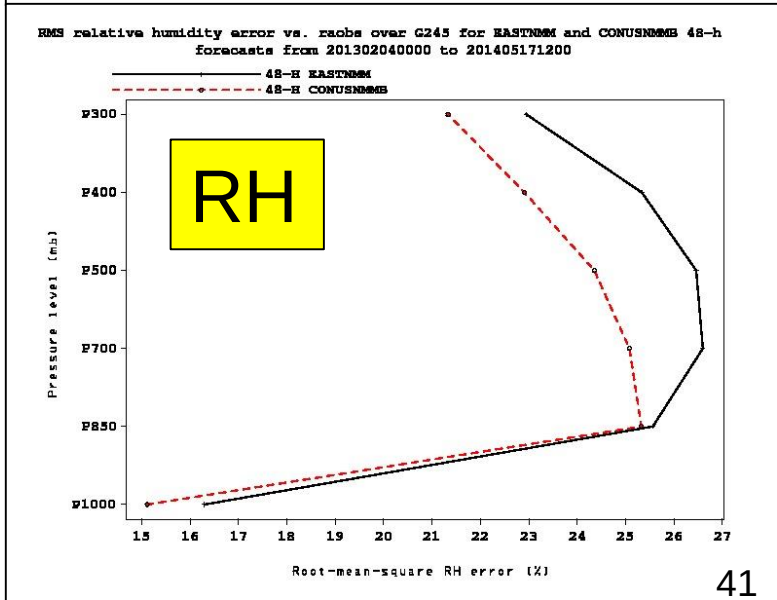
All test runs

OPS NMM

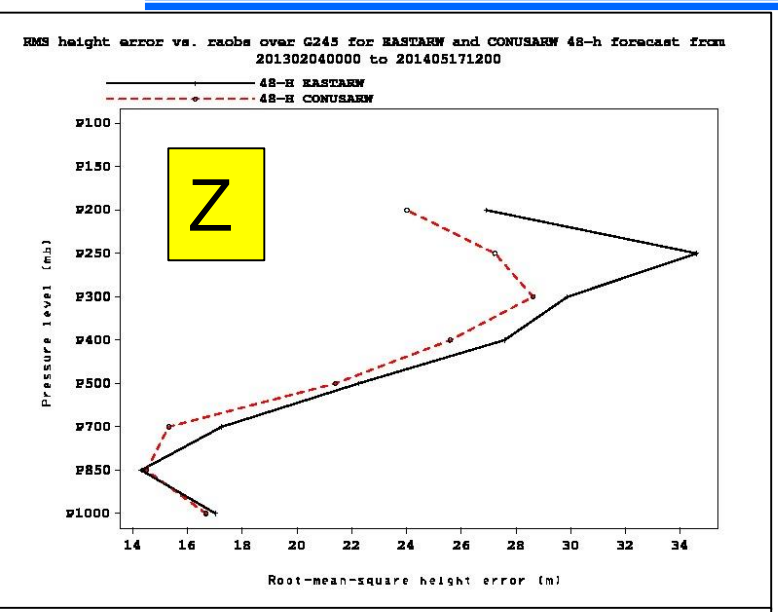
PARA NMMB







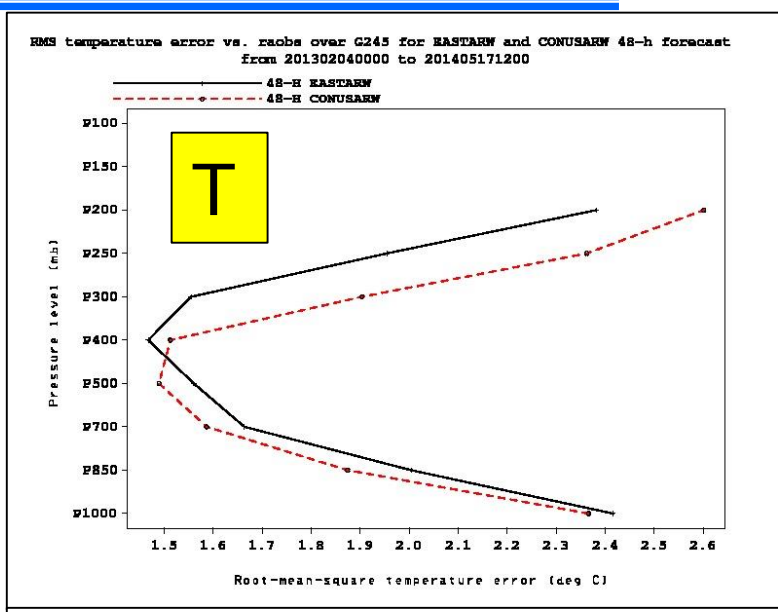
RMS errors at 48 h for eastern CONUS – WRF-ARW (12Z cycles only)

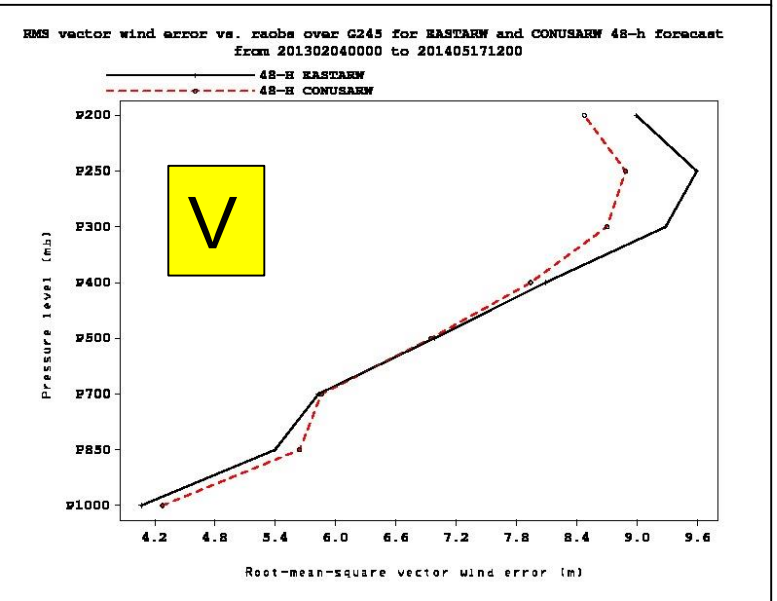


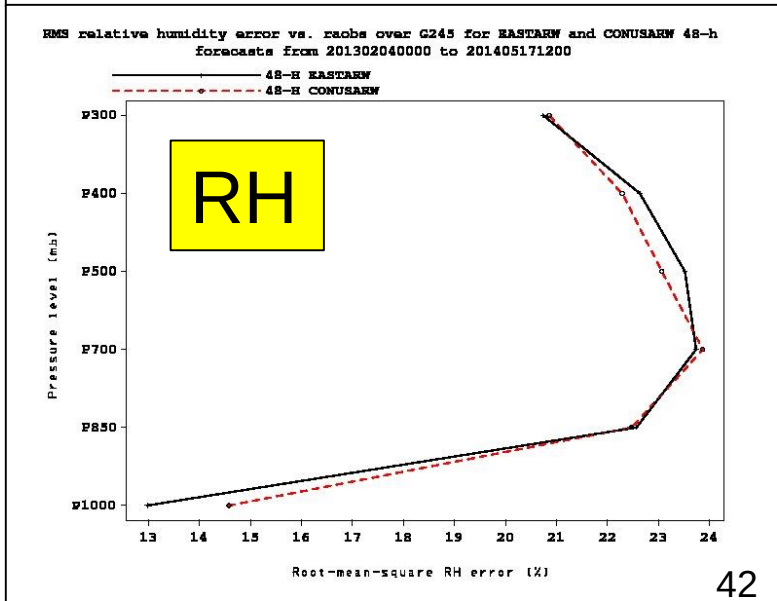
All test runs

OPS ARW

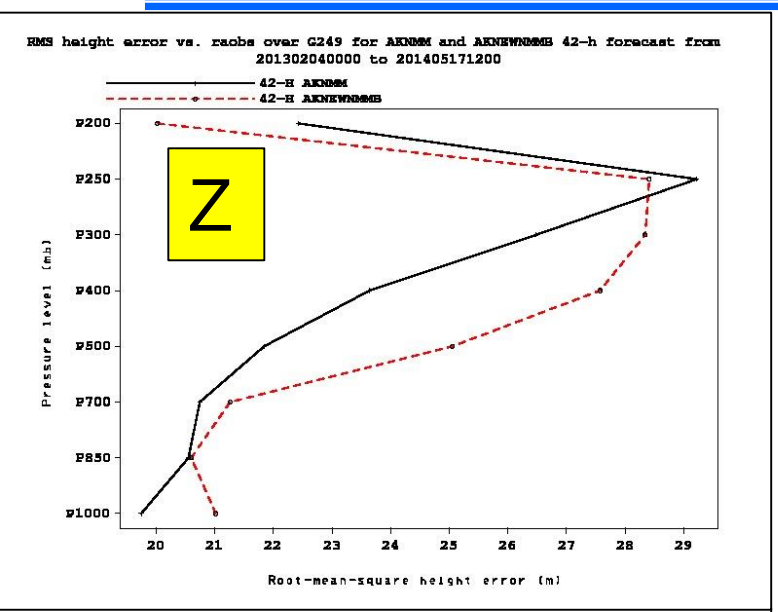
PARA ARW







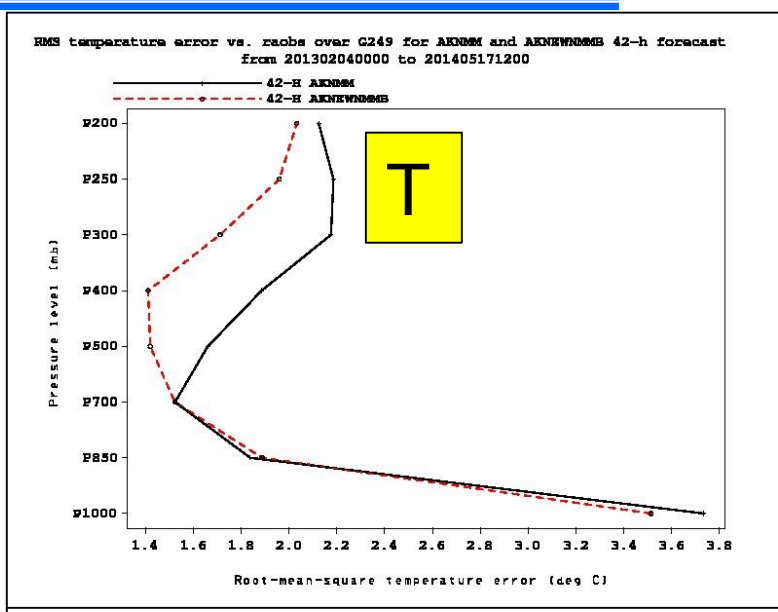
RMS errors at 42 h for AK - WRF-NMM / NMMB (18Z cycles only)

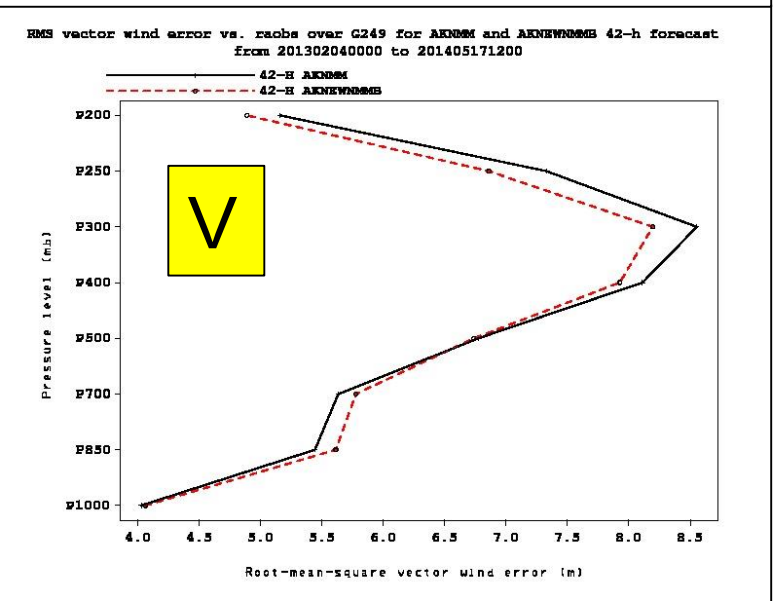


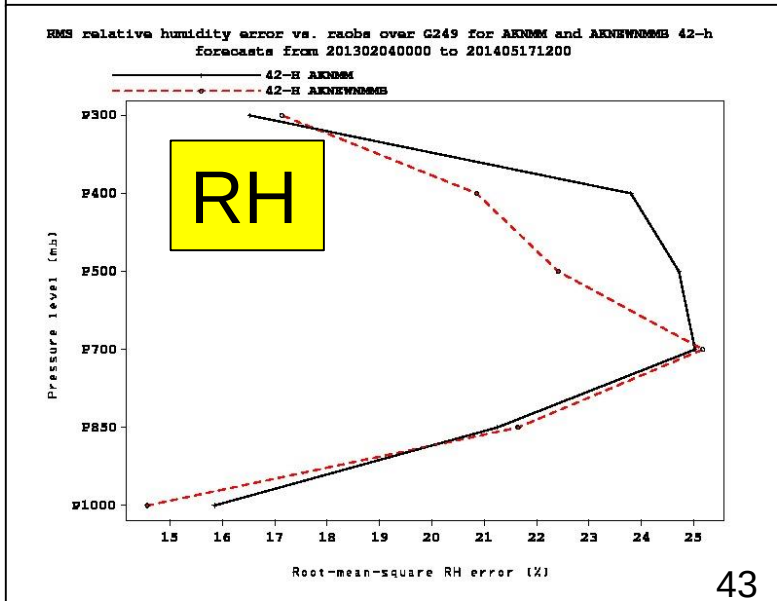
All test runs

OPS NMM

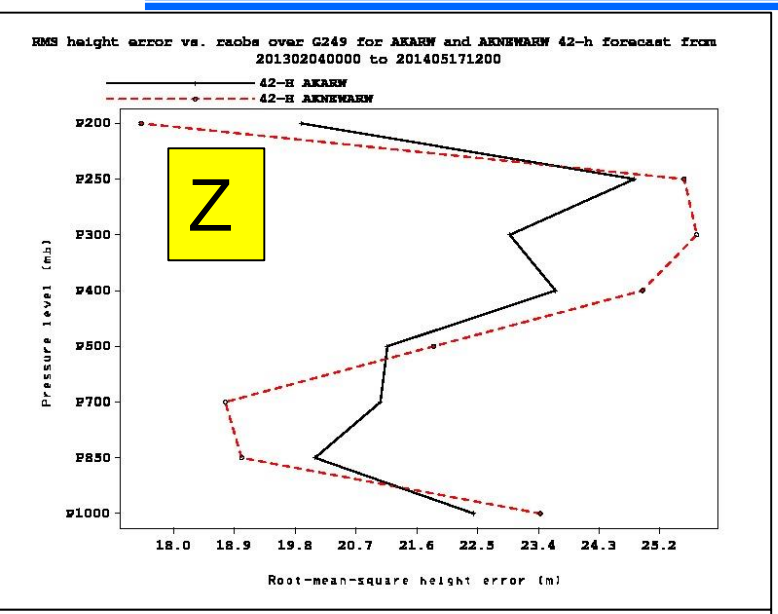
PARA NMMB







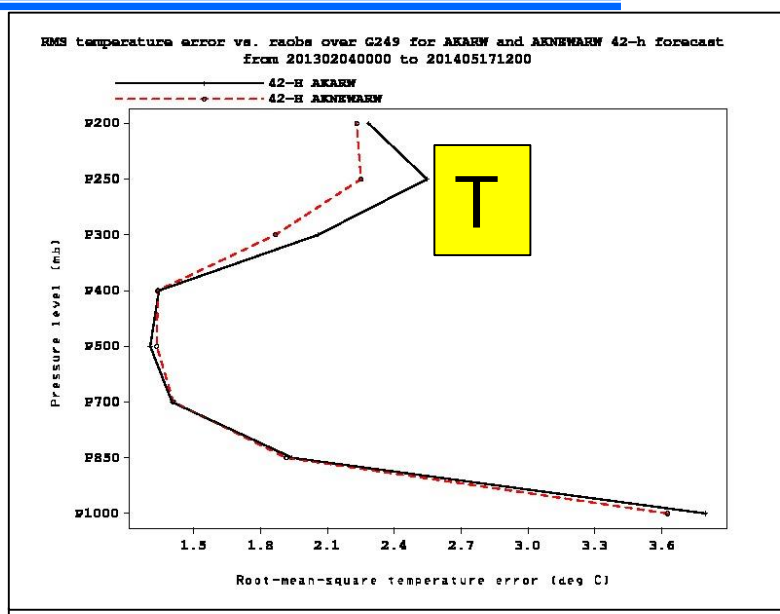
RMS errors at 42 h for AK - WRF-ARW (18Z cycles only)

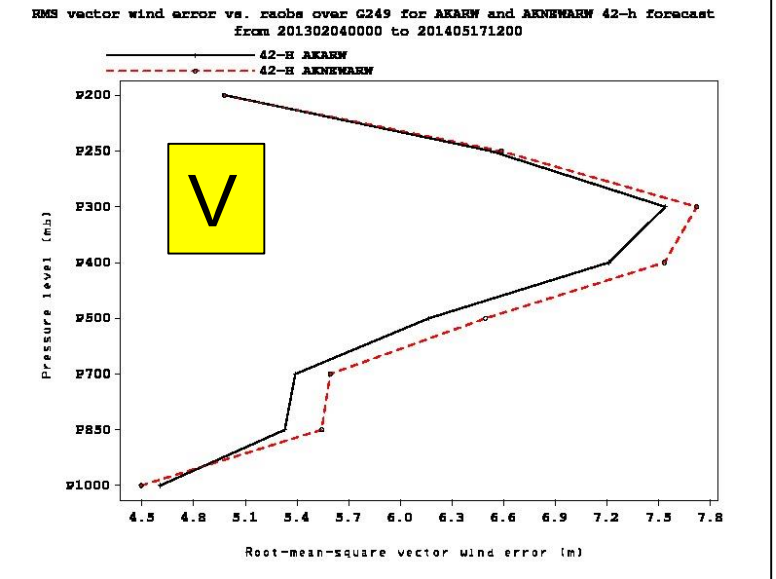


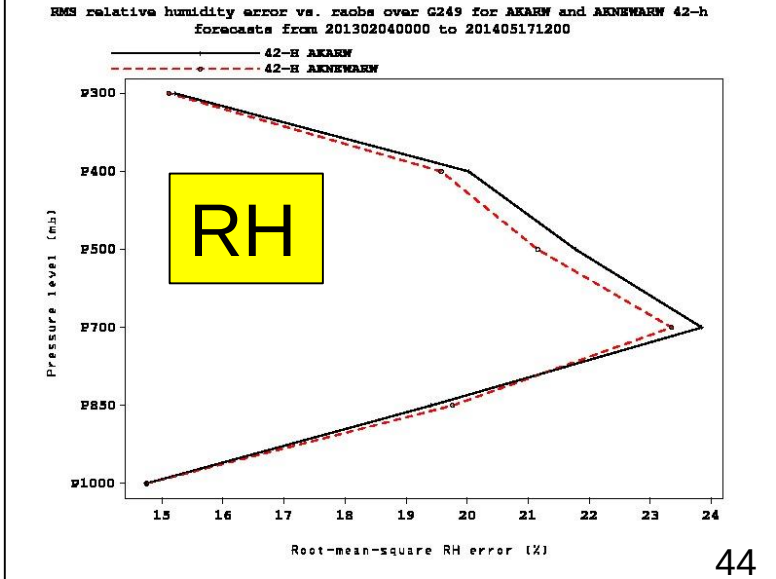
All test runs

OPS ARW

PARA ARW





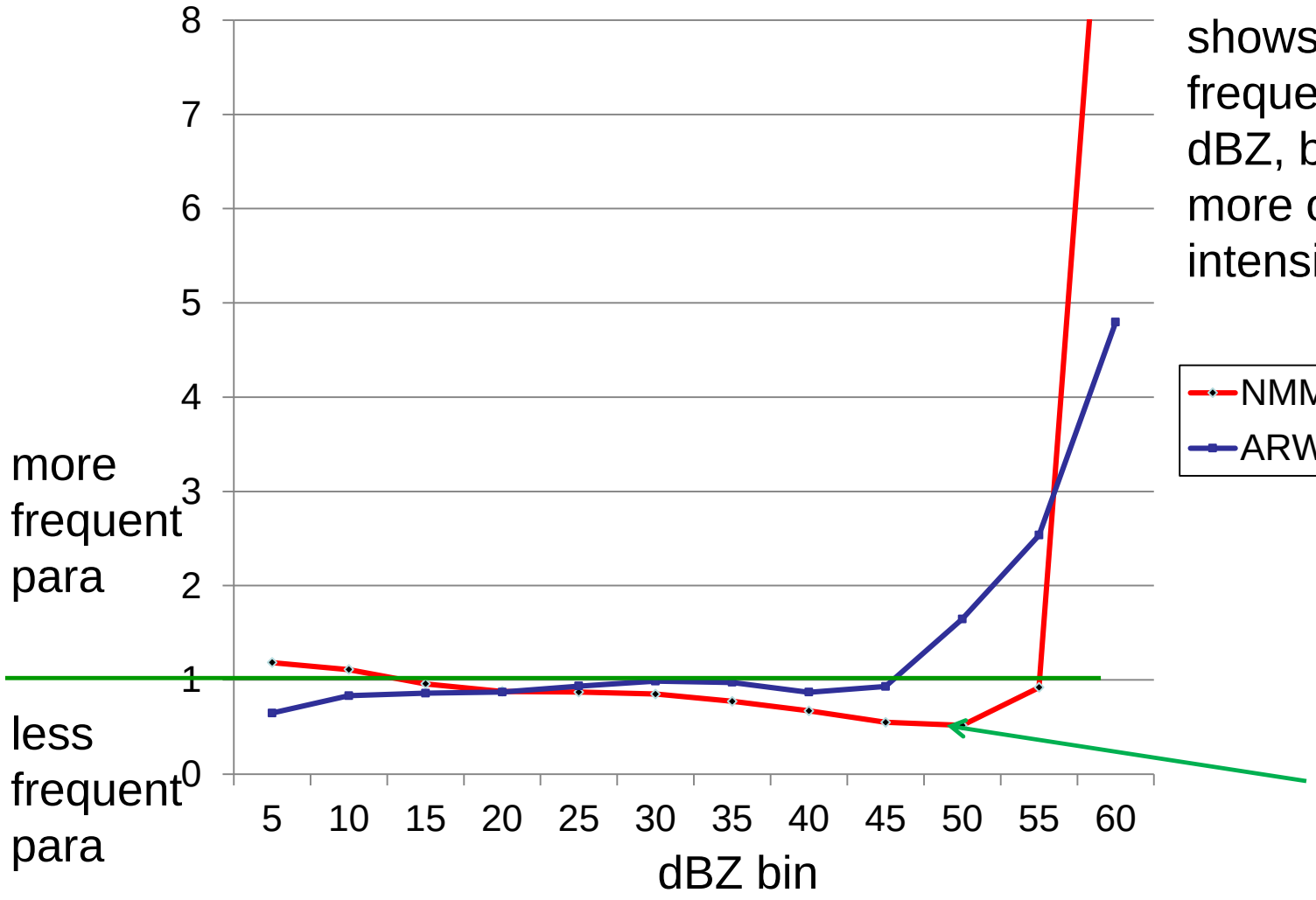


Summary

- The parallel HiresW system improves upon the relative weak spots in each of the constituent models:
  - The NMMB improves precipitation forecasts (especially bias) over the current WRF-NMM based system.
  - The parallel WRF-ARW improves on surface forecasts in general and dramatically reduces a high bias in 10 m wind speed.
- The resolution increase and microphysics upgrades will enhance HiresW severe weather forecasts.
- Additional products and output grids will make HiresW guidance more useful to various groups in the research and operational weather communities.

Backup Slides

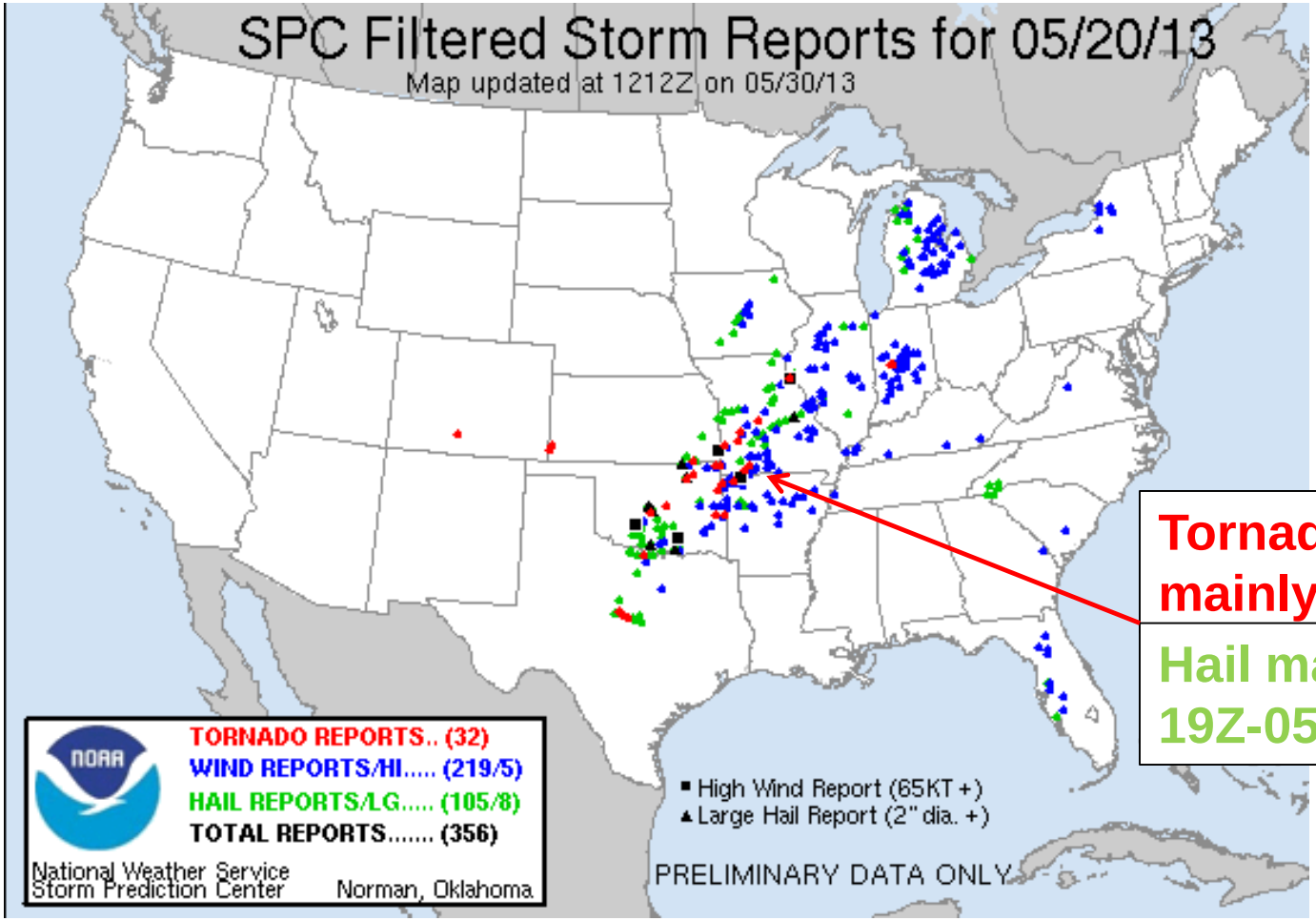
Reflectivity count ratios (para/ops)
May-June 2013 cases



Para WRF-ARW shows greater frequency of 45+ dBZ, both have more of 55-60 dBZ intensities

Much less coverage of 35-50 dBZ in para NMMB

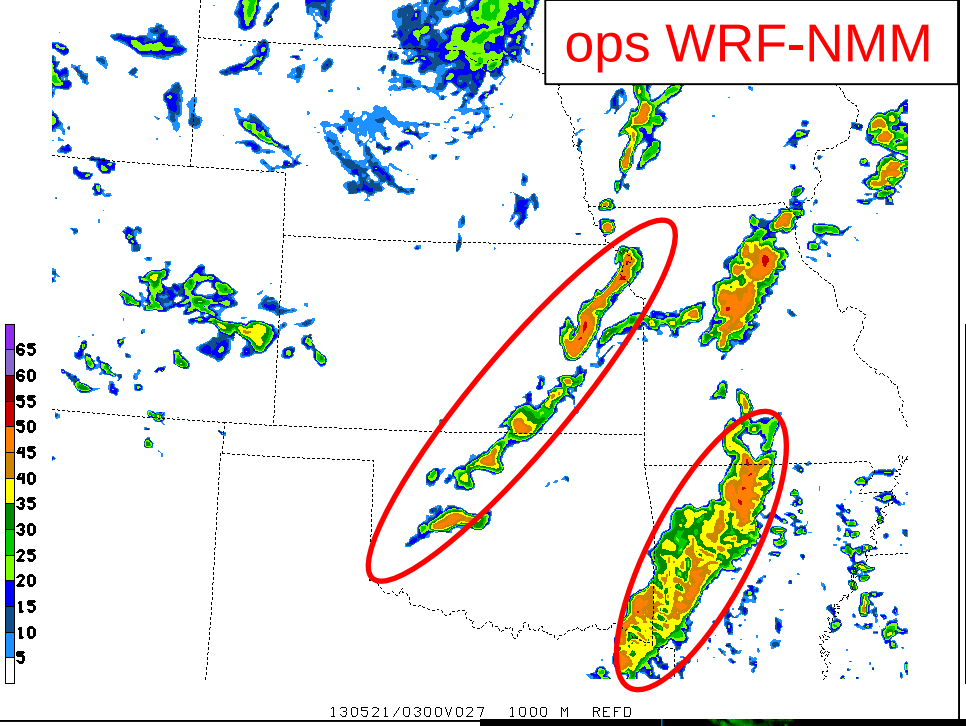
May 20-21, 2013 severe weather



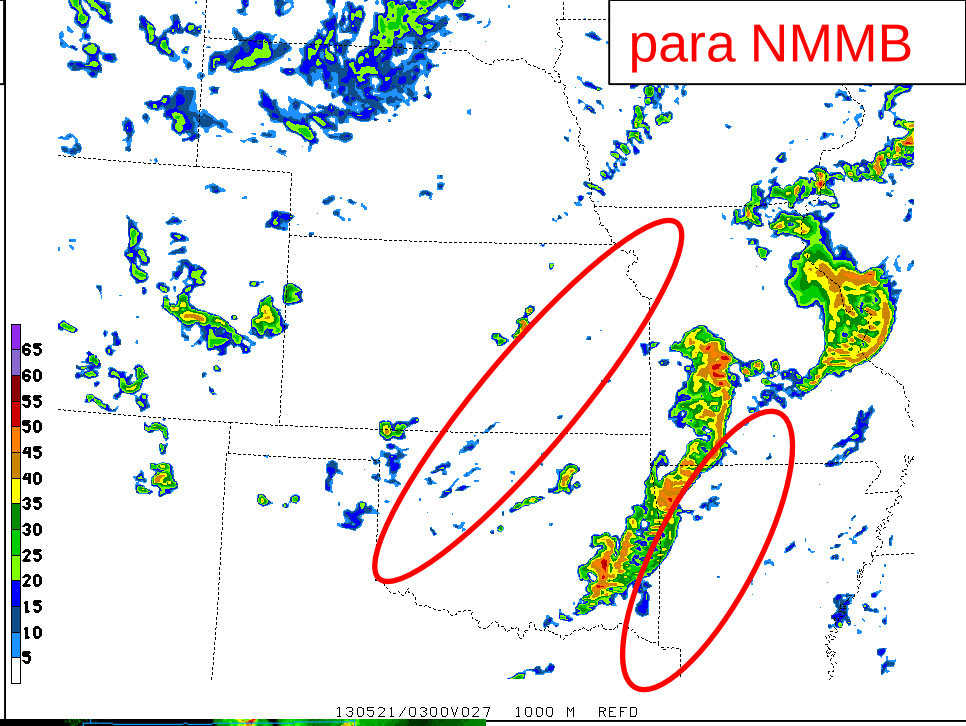
Tornadoes mainly 20Z -

Hail mainly 19Z-05Z

ops WRF-NMM



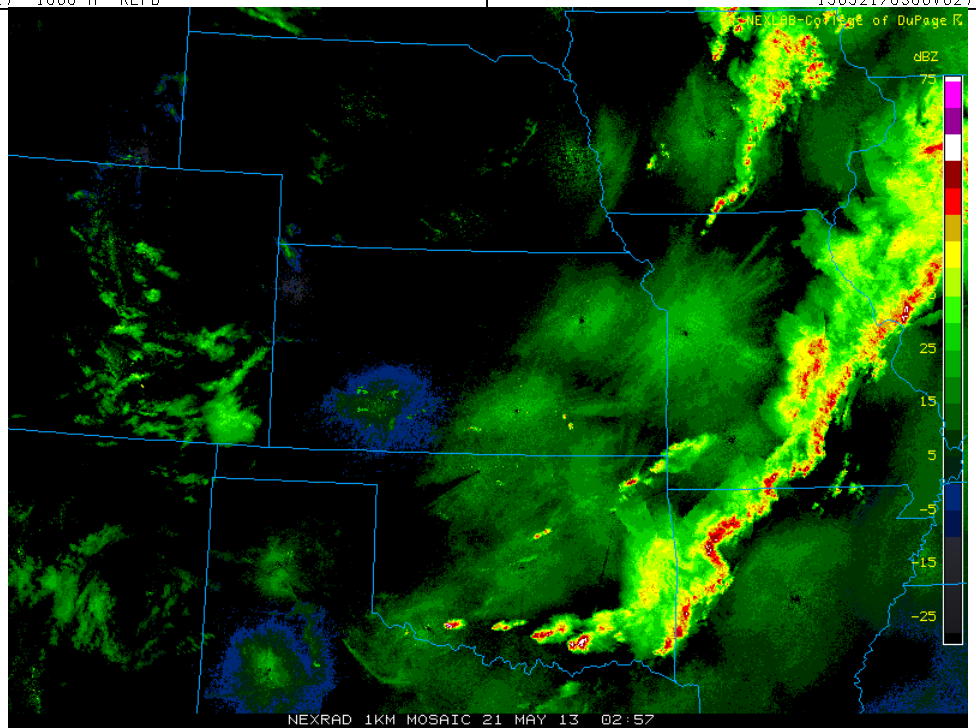
para NMMB



27 h forecast

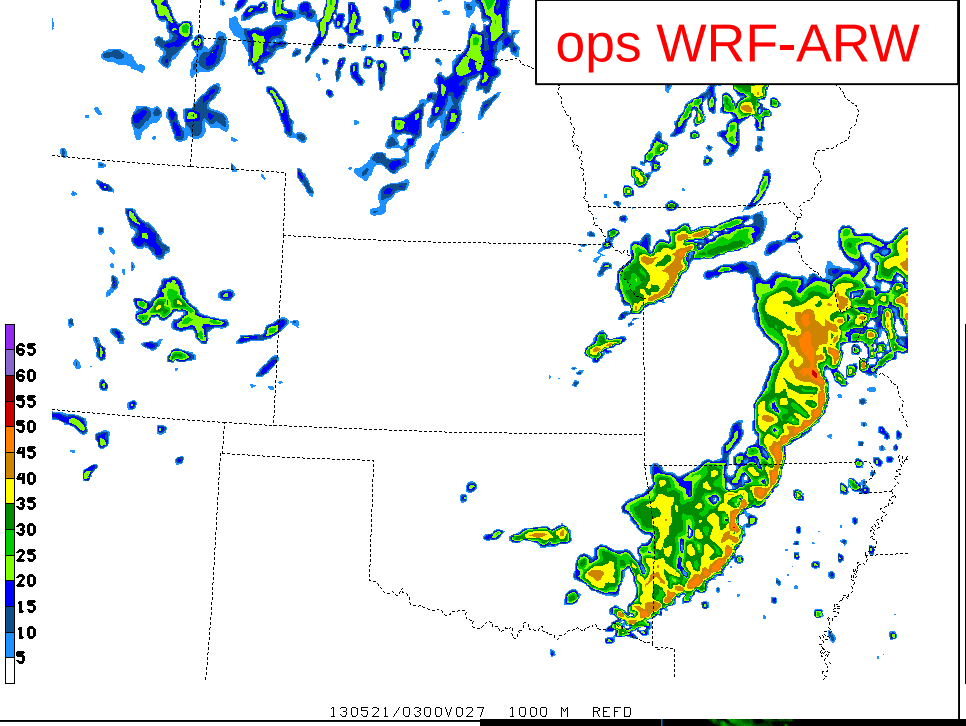
May 21, 2013

03Z

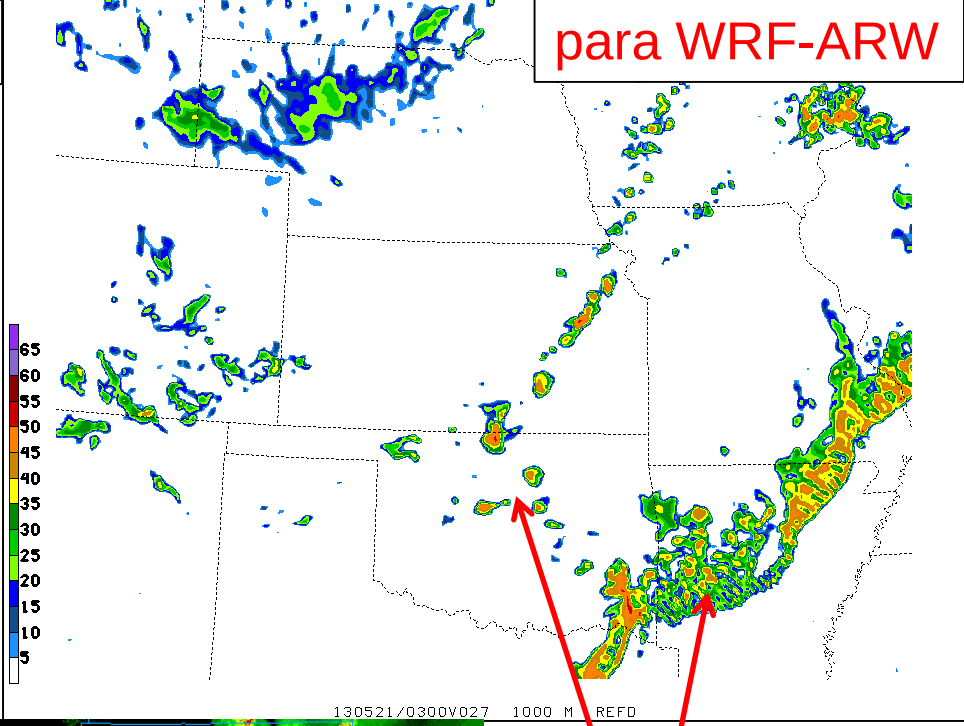


para NMMB slower moving line into MO/AR (bad), but cuts down convective activity KS/OK (good).

ops WRF-ARW



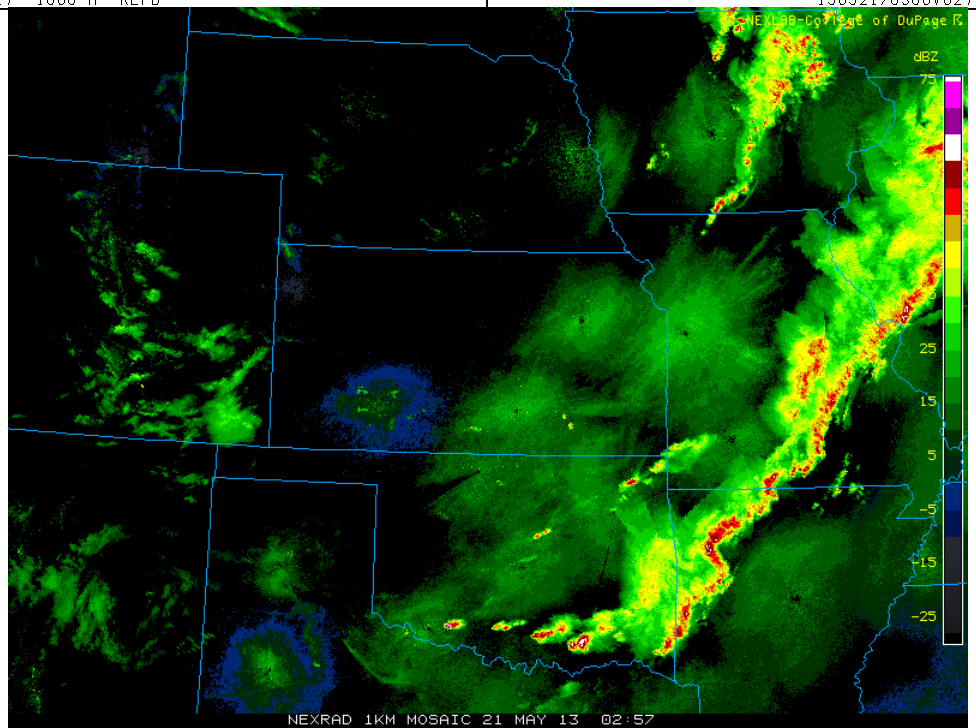
para WRF-ARW



27 h forecast

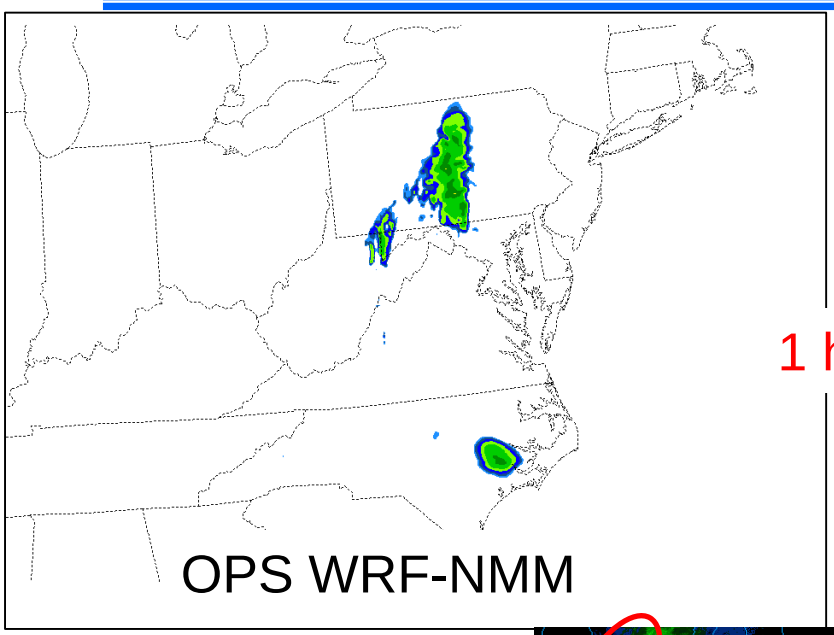
May 21, 2013

03Z



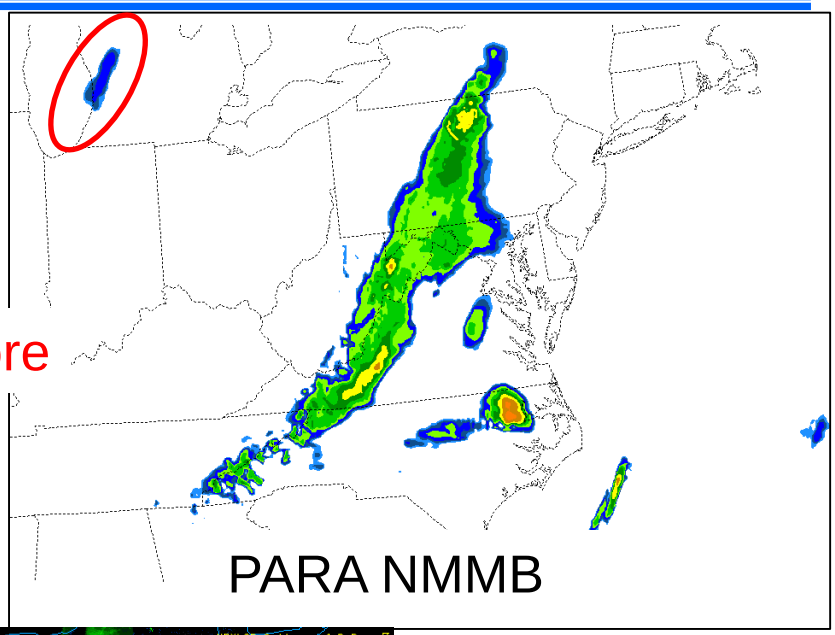
para WRF-ARW overactive in lee of main line, overly muted in AR.

Quicker spinup of precipitation processes over CONUS

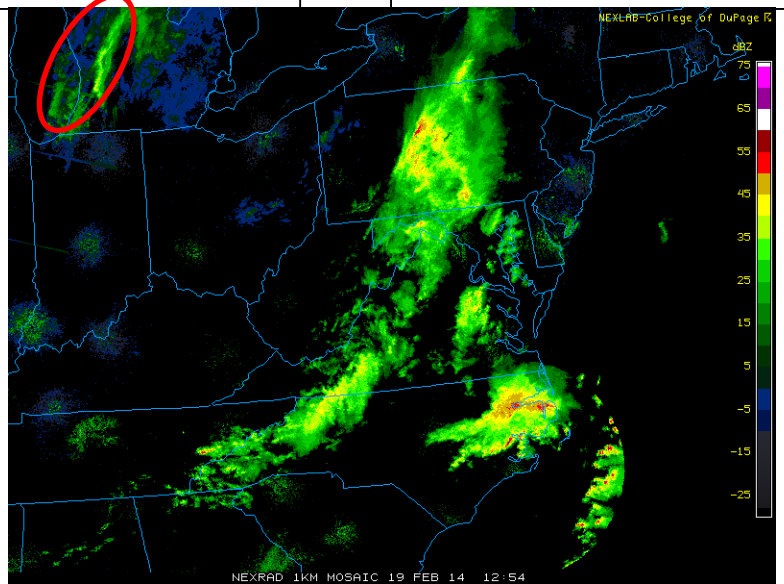


OPS WRF-NMM

1 h fore

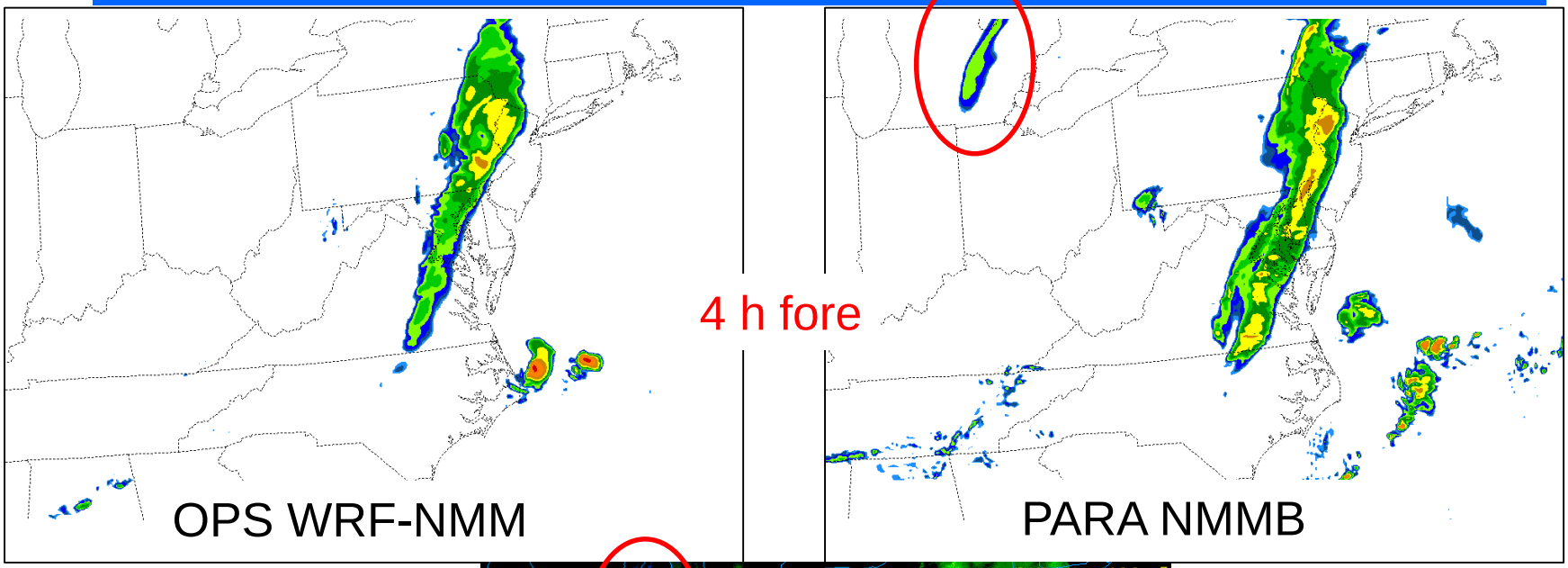


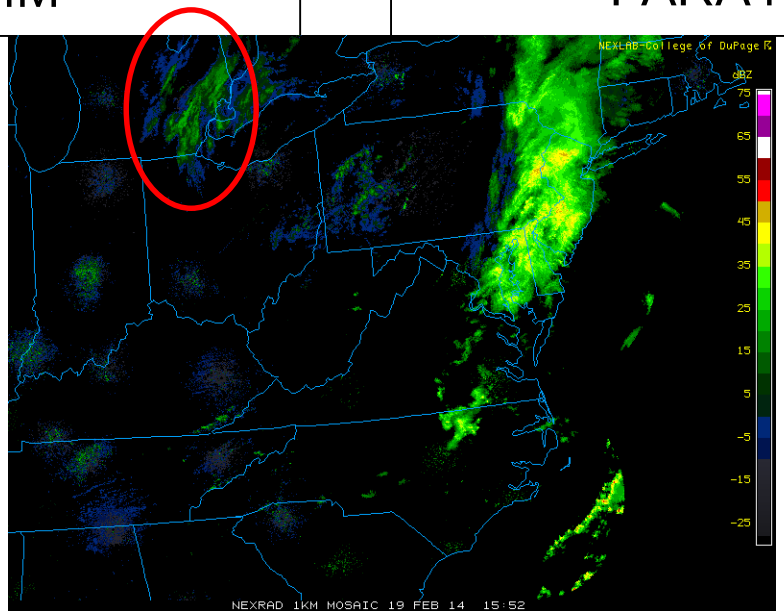
PARA NMMB



Model and observed 1 km AGL radar, 13Z 19 Feb 2014

Quicker spinup of precipitation processes over CONUS



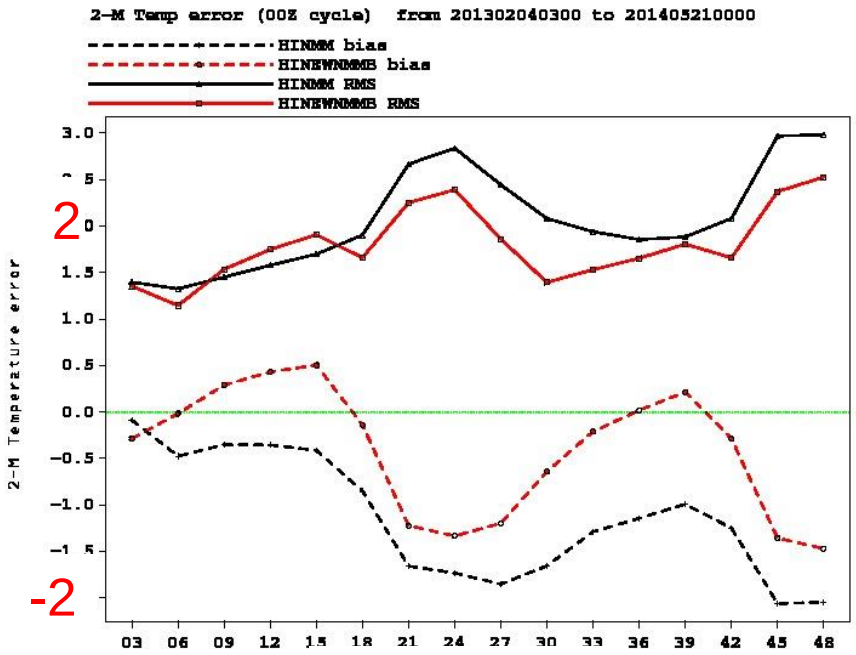


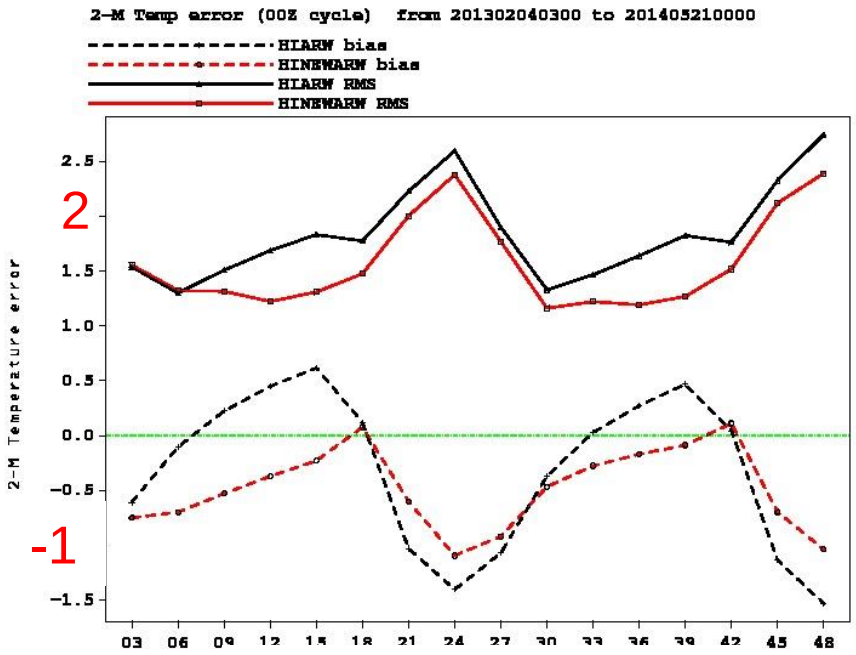
Model and observed
1 km AGL radar, 16Z
19 Feb 2014

Hawaii 2 m temp, 00Z cycle

full test period

ops RMS
para RMS
ops bias
para bias





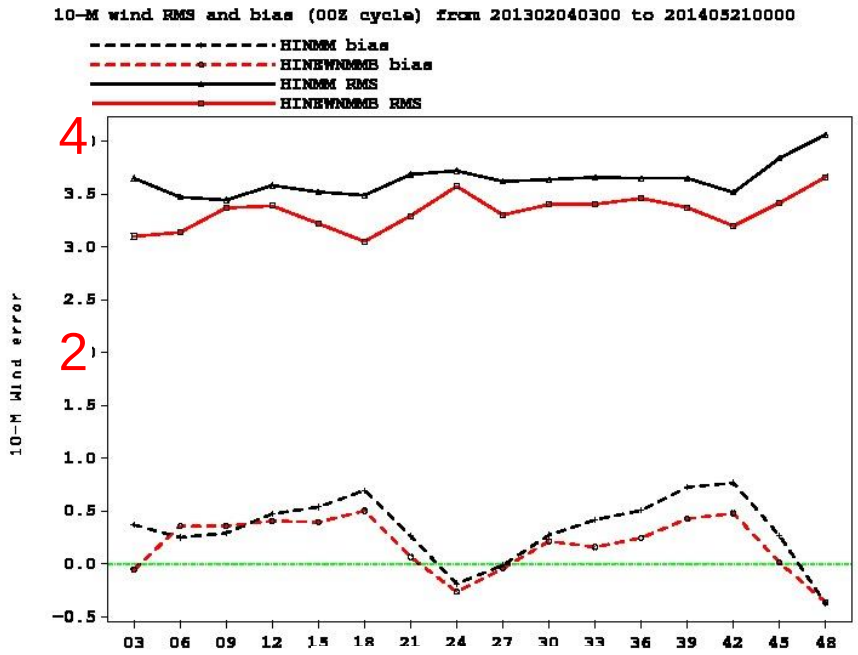
NMM/NMMB

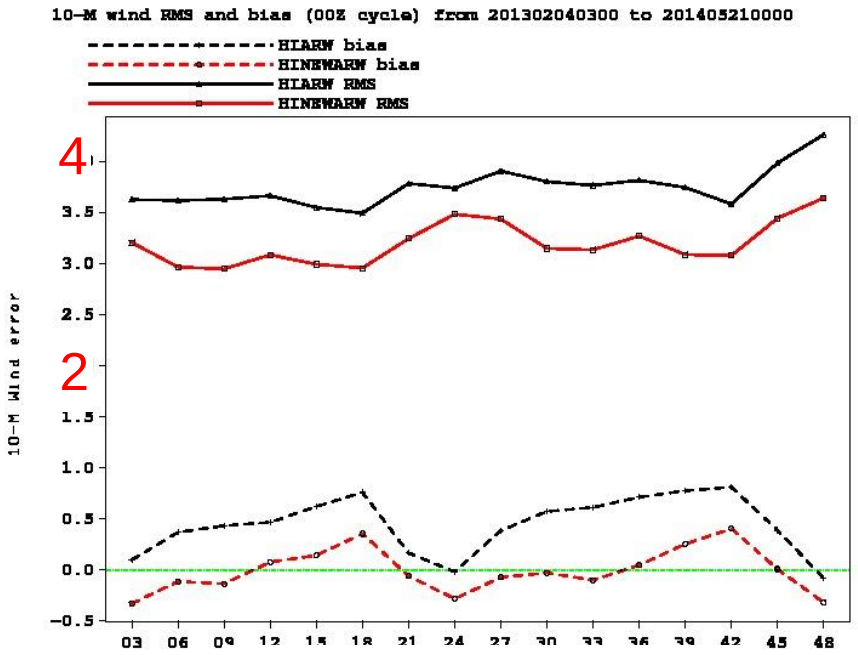
WRF-ARW

Hawaii 10 m winds, 00Z cycle

full test period

ops RMS
para RMS
ops bias
para bias





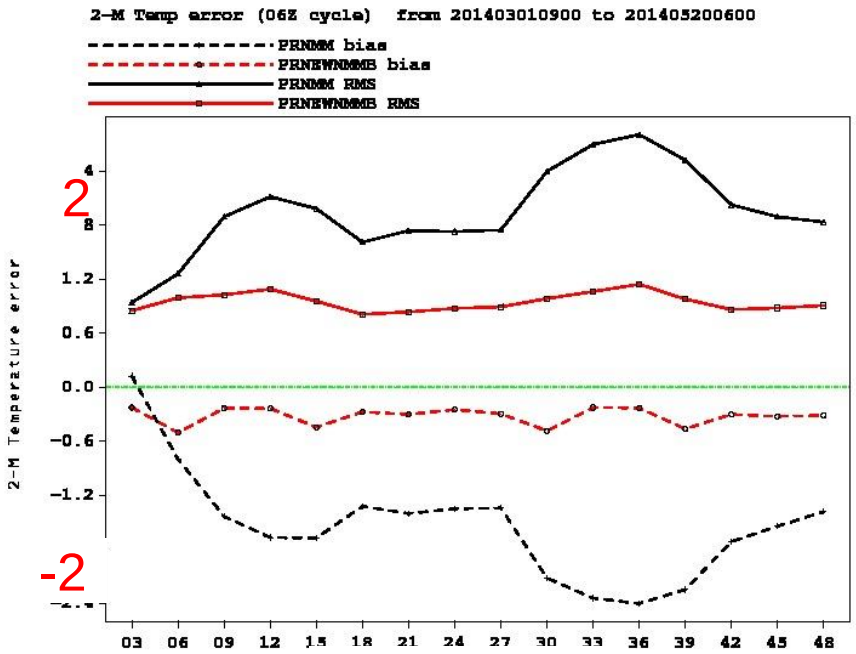
NMM/NMMB

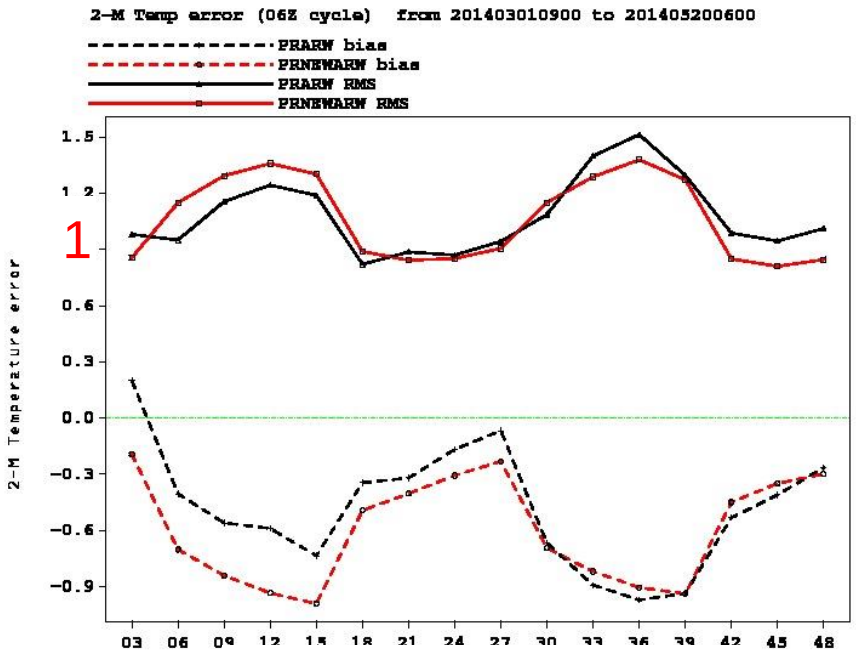
WRF-ARW

Puerto Rico 2 m temps, 06Z cycle

Mar-May 2014 (spring)

ops RMS
para RMS
ops bias
para bias





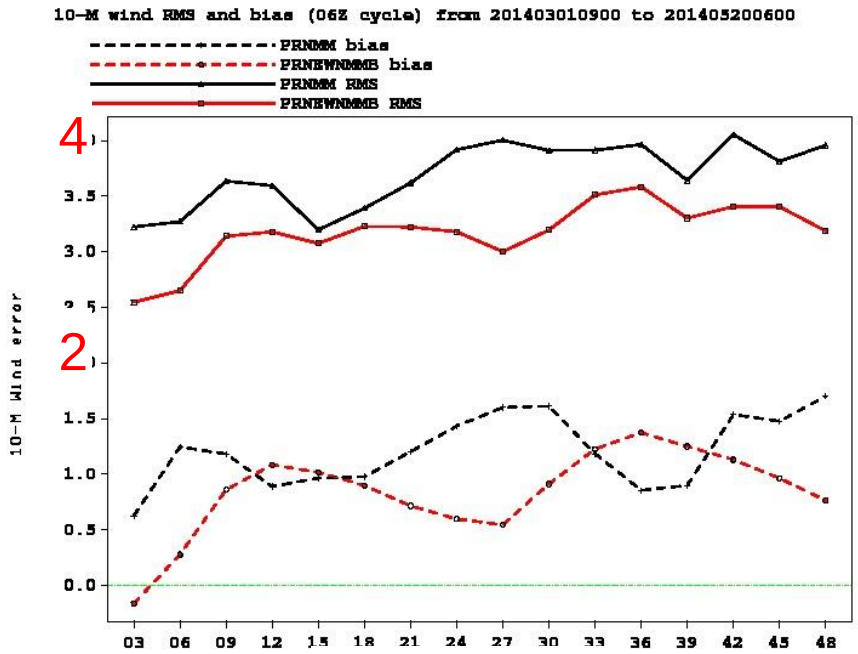
NMM/NMMB

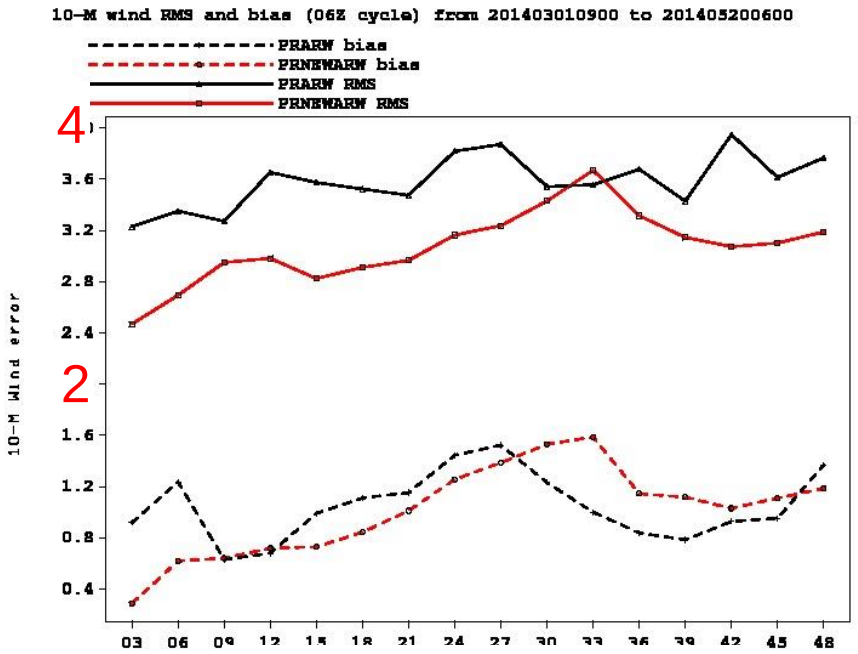
WRF-ARW

Puerto Rico 10 m winds, 06Z cycle

Mar-May 2014 (spring)

ops RMS
para RMS
ops bias
para bias

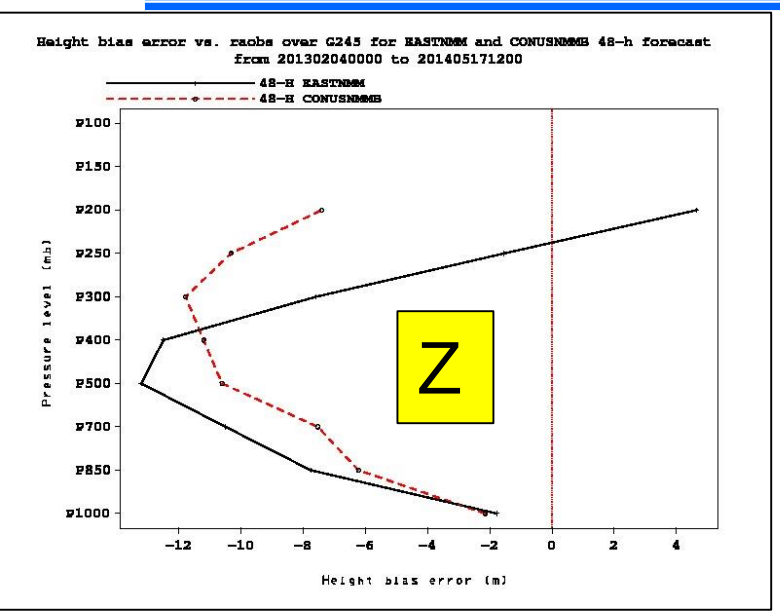




NMM/NMMB

WRF-ARW

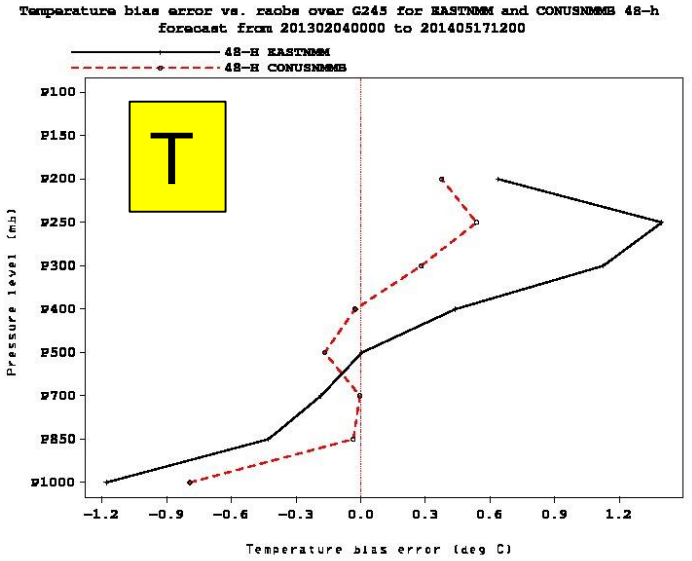
Bias errors at 48 h for eastern CONUS – WRF-NMM / NMMB (12Z cycles only)

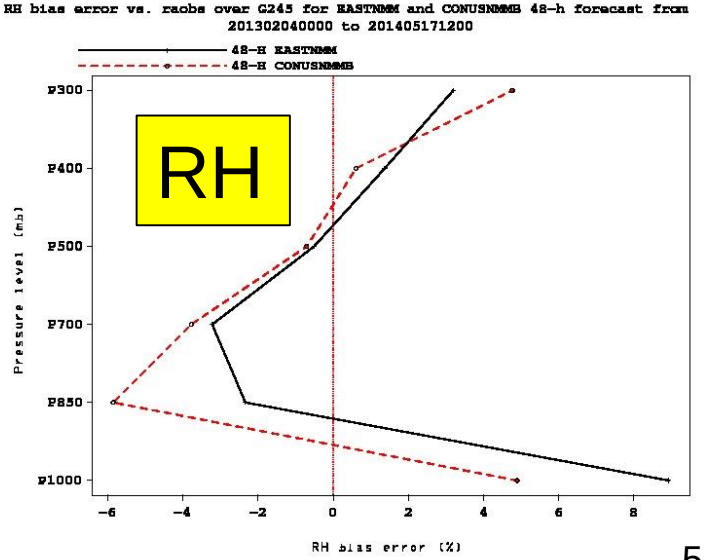


All test runs

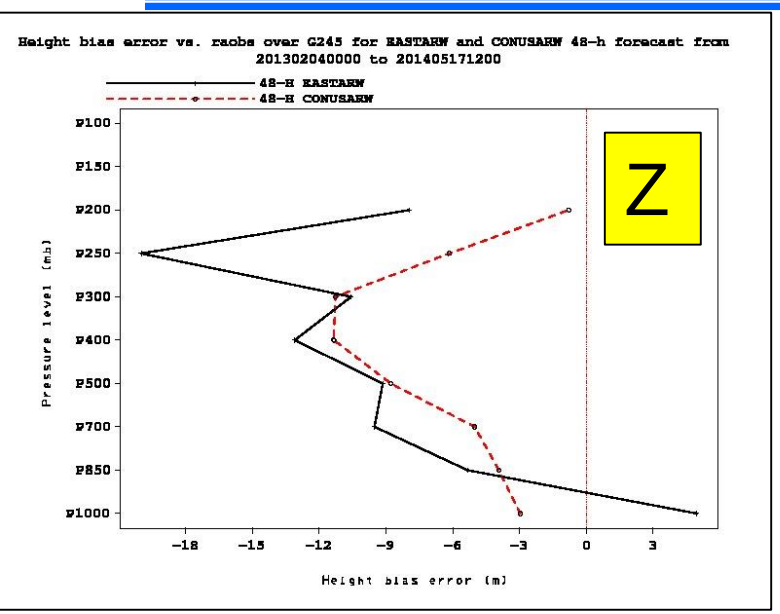
OPS NMM

PARA NMMB





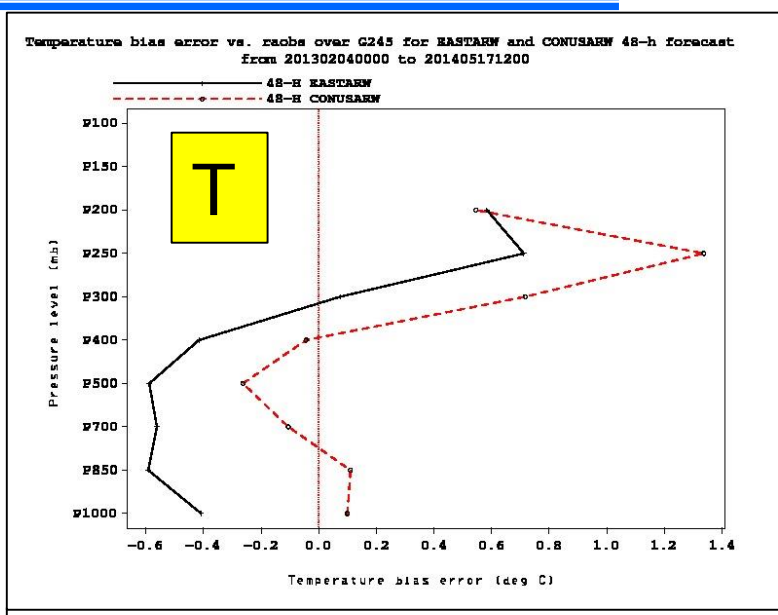
Bias errors at 48 h for eastern CONUS – WRF-ARW (12Z cycles only)

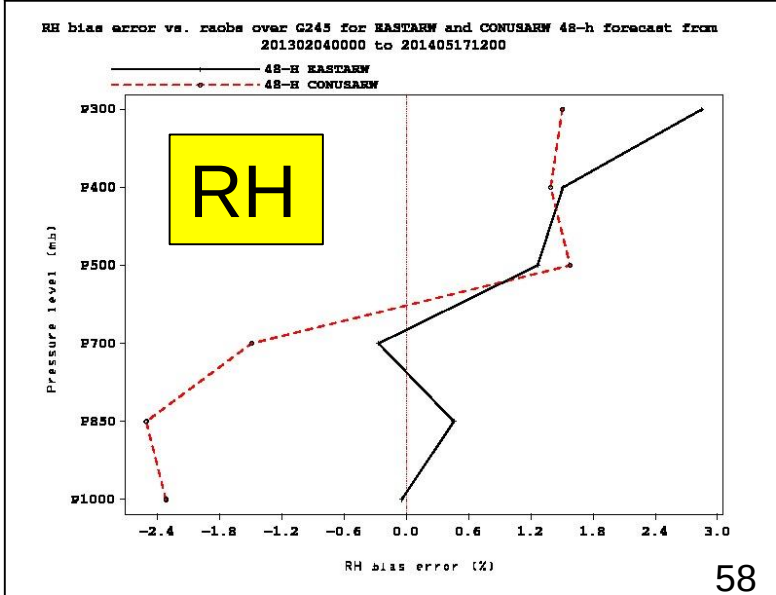


All test runs

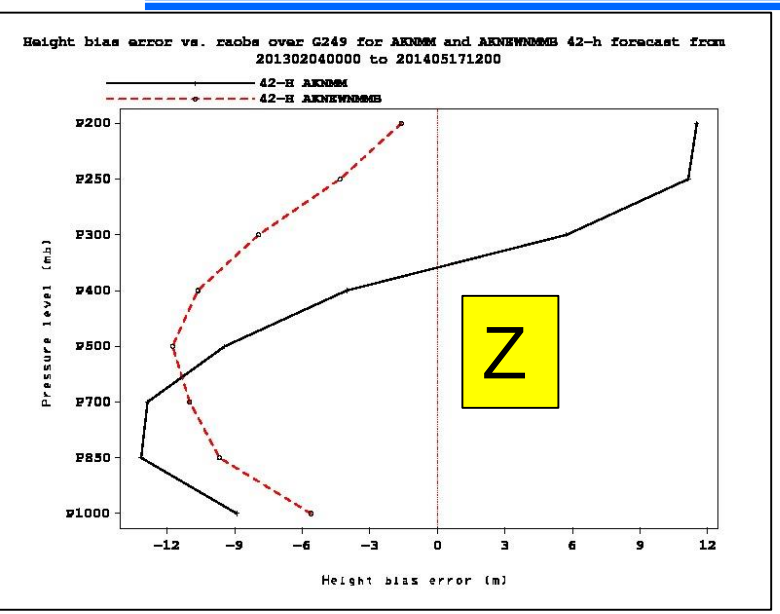
OPS ARW

PARA ARW





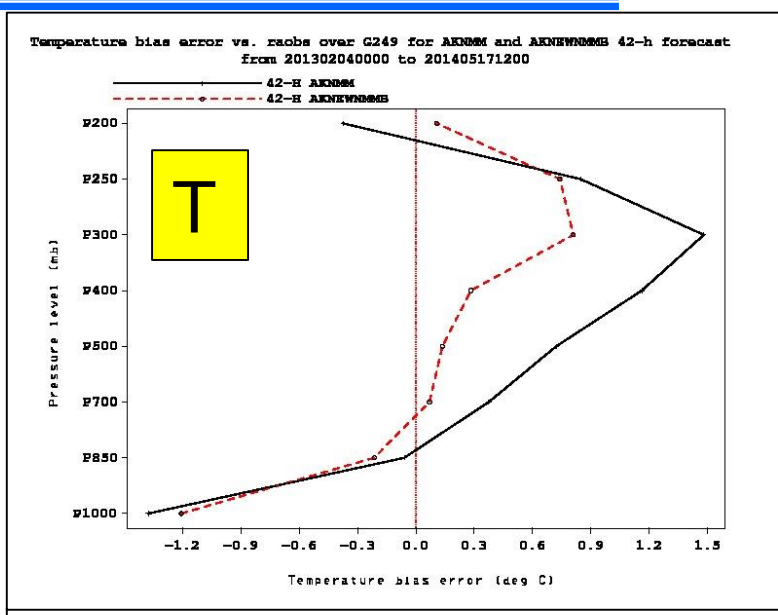
Bias errors at 42 h for AK - WRF-NMM / NMMB (18Z cycles only)

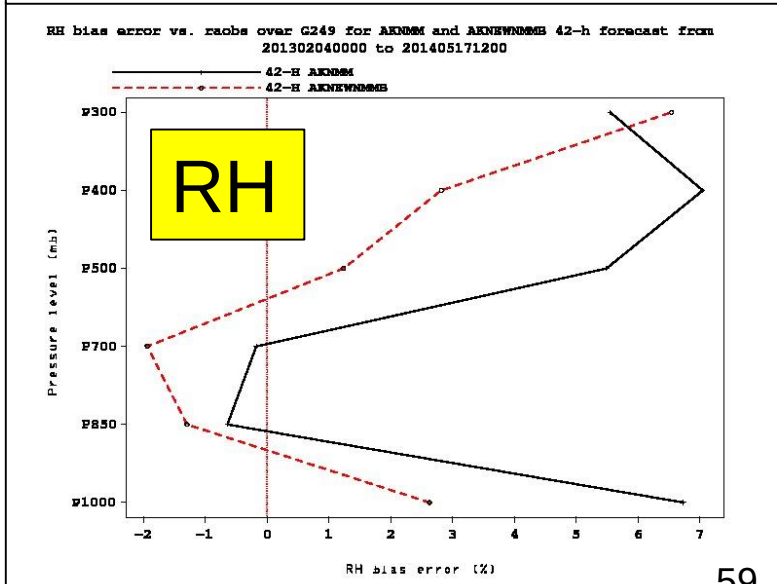


All test runs

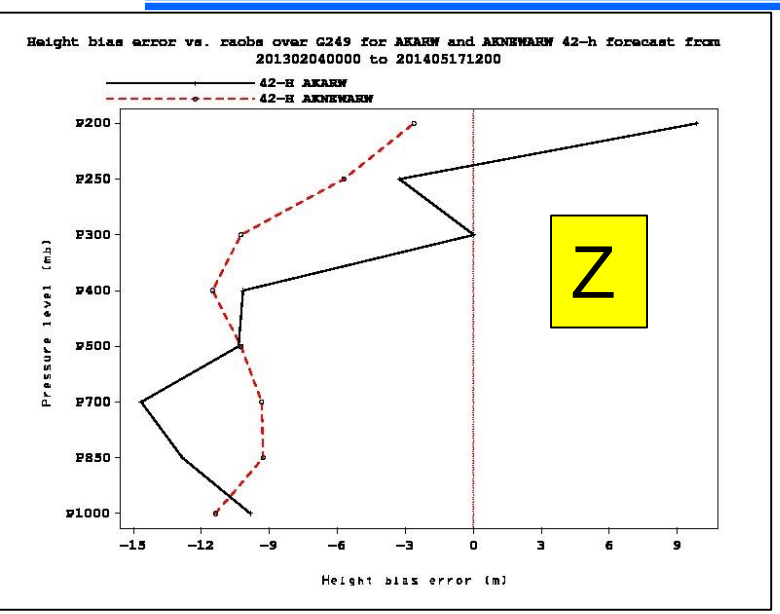
OPS NMM

PARA NMMB





Bias errors at 42 h for AK
WRF– ARW (18Z cycles only)



All test runs

OPS ARW

PARA ARW