NCEP OD Science Briefing

High Resolution Ensemble Forecast (HREF) v2

HiresWindow v7

Presented by:

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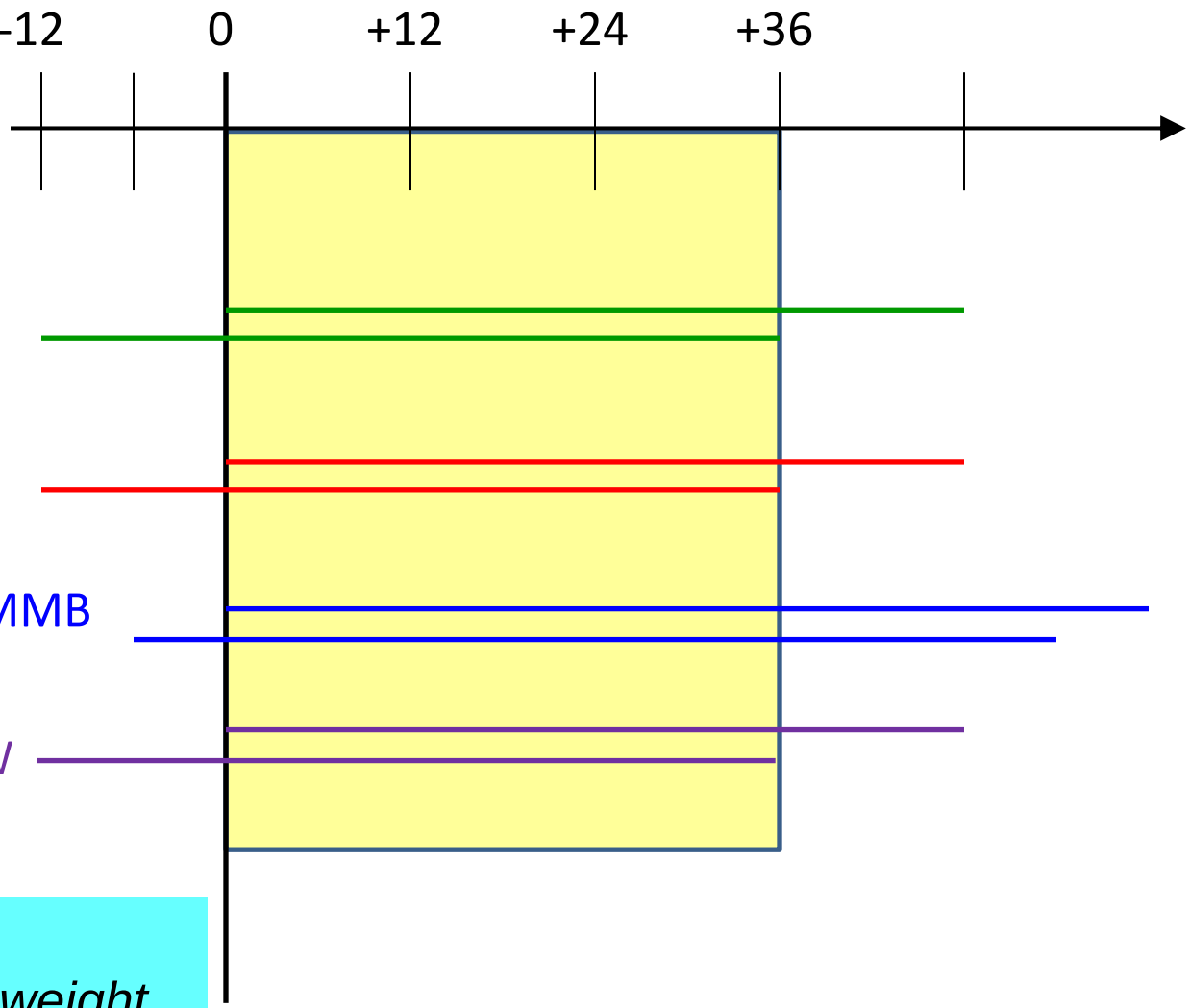
15 June 2017

HREF/HiresWindow Upgrade Overview

Reminder: The HiresWindow and NAM nest runs feed into HREF, which aggregates deterministic model runs into ensemble products.

- Transforms the HREF into something very similar to SPC's SSEO:
  - membership: Adds a NAM-initialized WRF-ARW run (configured like the NSSL WRF-ARW); reduces NAM nest contribution
  - products: Adds probability matched mean and neighborhood probability output for more isolated fields, and many other new output fields
- Increases HREF product frequency to hourly (from 3 hourly), adds non-CONUS HREF guidance (AK, HI, PR).
- Unifies HiresW model resolutions at ~ 3 km.
- *Significantly* earlier product delivery for HiresW and HREF – 60 to 90+ minutes earlier.

HREFv2 CONUS Membership



HiresW – ARW
(RAP init)

HiresW – NMMB
(RAP init)

NAM CONUS NEST - NMMB
(NAM init)

HIRESW - “mem2” ARW
(NAM init)

12 h old time-lagged members given 75% weight

HREF/HiresWindow Upgrade Overview – Expected benefits

- In HREF, the addition of neighborhood probability fields and the switch to hourly output provides better and more numerous tools to forecasters.

- The earlier product delivery will enable use of HiresW/HREF in more forecast products:

  "*I think the HiResW runs and ultimately the HREF would get more effective usage at SPC with an earlier receipt time*." - Israel Jirak, SPC, 10/18/2016 e-mail

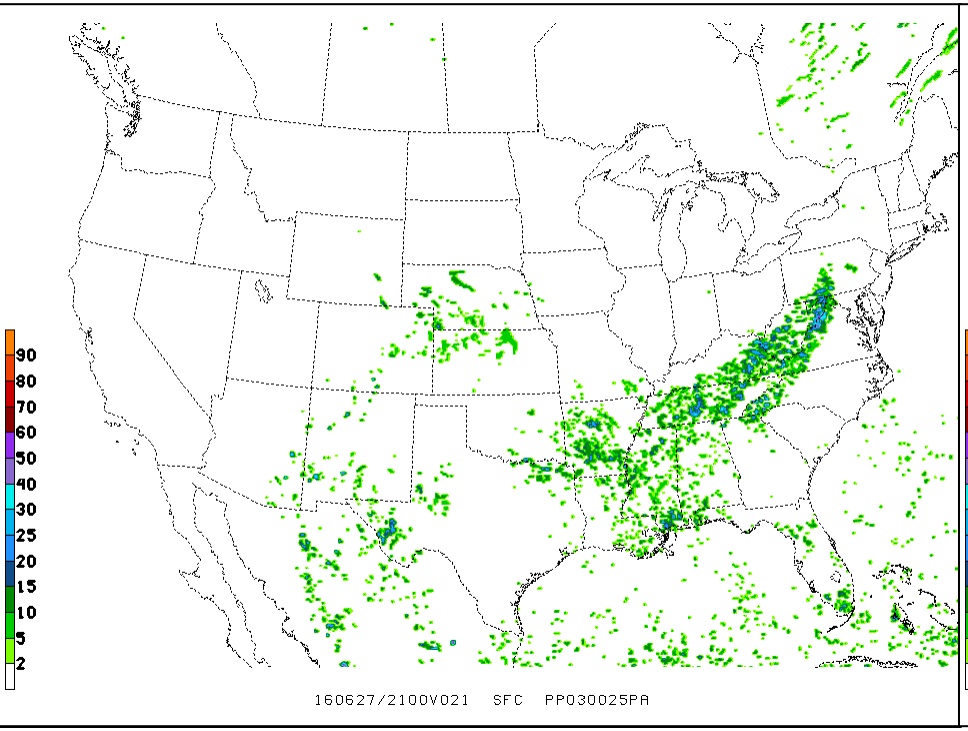
- More useful QPF guidance from HREF – new products and increased skill.

- Increased resolution, particularly for the CONUS ARW run, will enhance convective signatures.

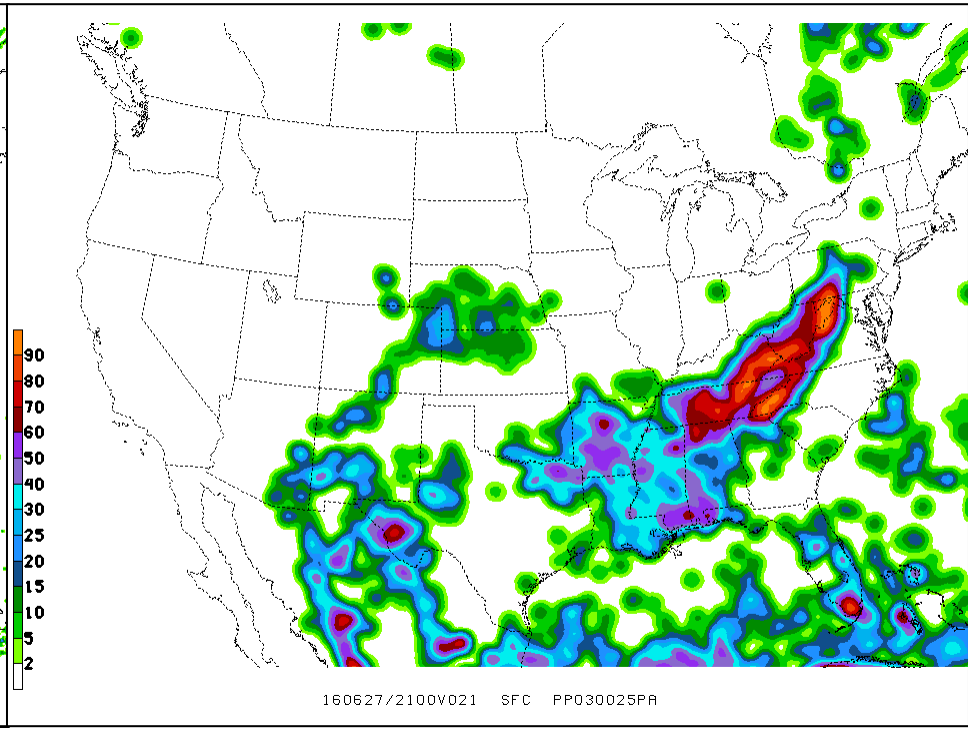
Neighborhood probabilities

- Accounts for slight displacement of features between different members by searching within a surrounding neighborhood of points.
- Applied to probabilistic output for more localized, discontinuous fields (e.g., precipitation, simulated reflectivity, other severe weather attributes)
- Following SPC's convention, the "neighborhood" extends 40 km out from a gridpoint, and smoothing is applied.

Probability of 3 h QPF > 1.0”



Ops HREF – point probabilities

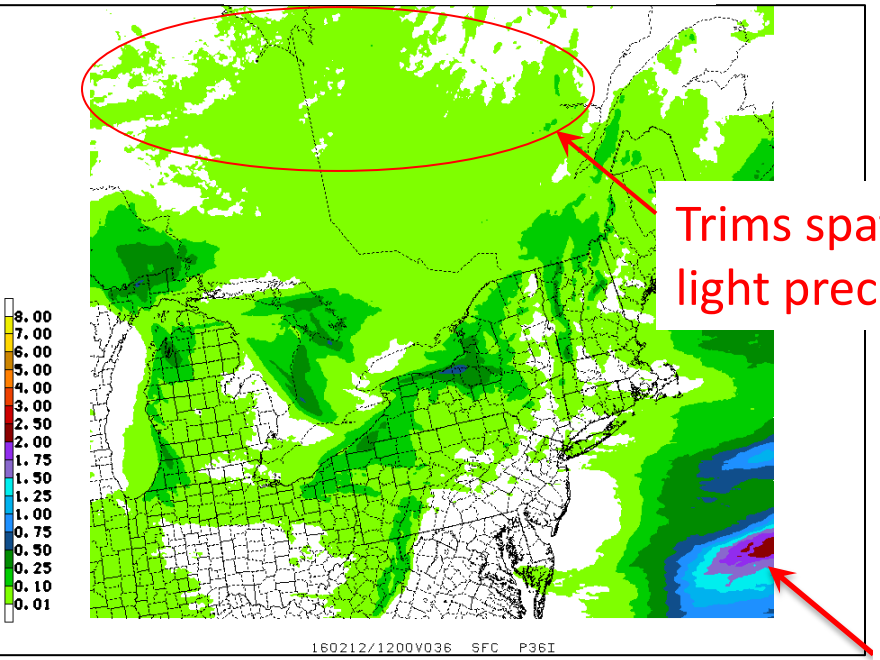


Para HREF – w/ smoothed neighborhood probabilities

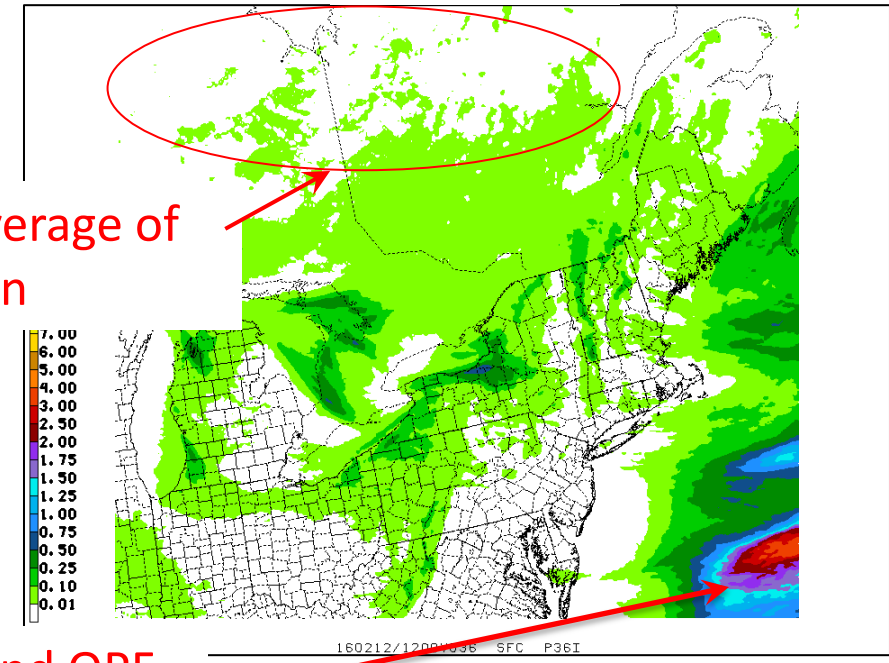
Probability matched (PM) mean

Restores amplitude from the individual ensemble member forecasts, but guided by the skill of the arithmetic mean (which typically highlights proper regions but underdoes amounts).

arithmetic mean



PM mean

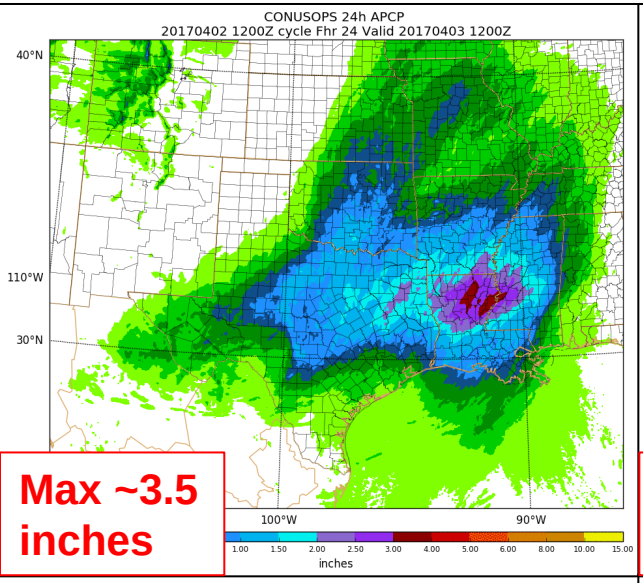


Trims spatial coverage of light precipitation

High end QPF values larger

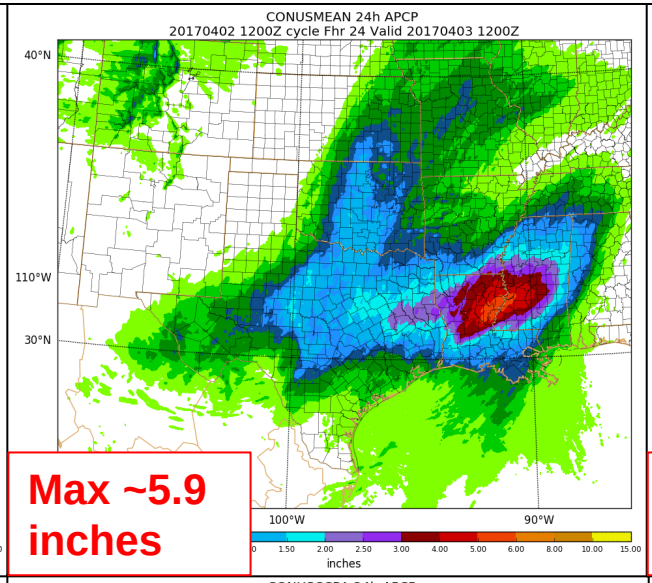
24 h HREF totals, ending 0403/12Z

Ops Mean



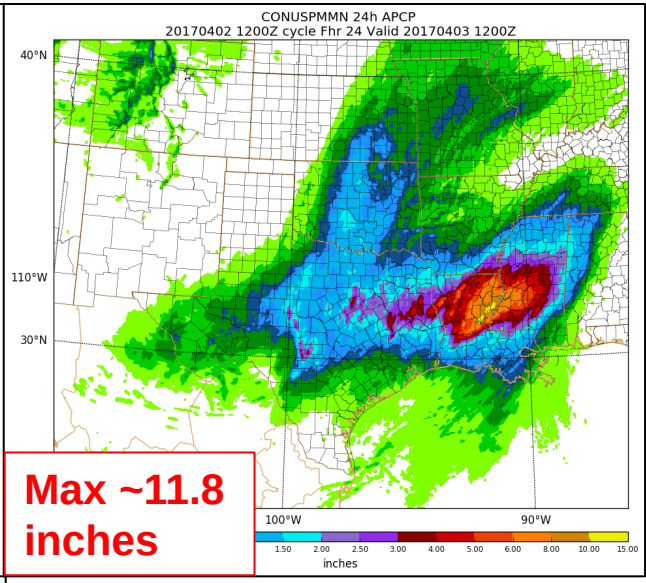
Max ~3.5 inches

Para Mean



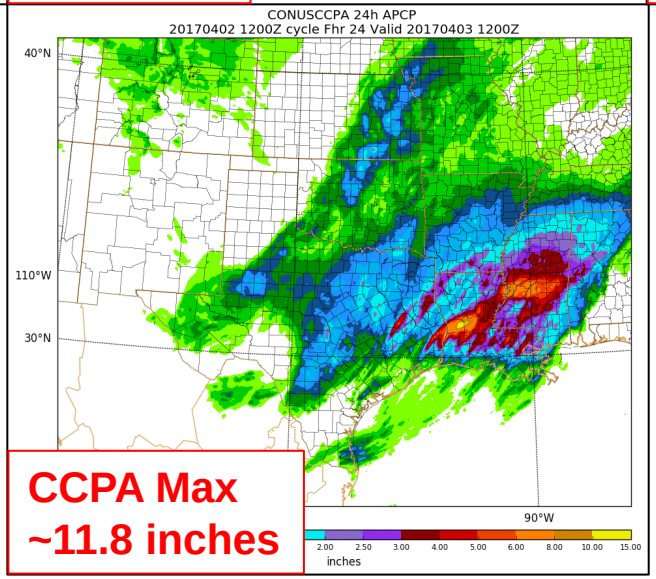
Max ~5.9 inches

Para PM Mean



Max ~11.8 inches

CCPA verification



CCPA Max ~11.8 inches

HiresW changes

- **What is changing:**
  - Resolution unified at 3 km (3.2 km CONUS)
  - NMMB run will call physics more frequently
  - SPC-requested product tweaks
  - 2nd WRF-ARW member added
  - When it runs and how initialized

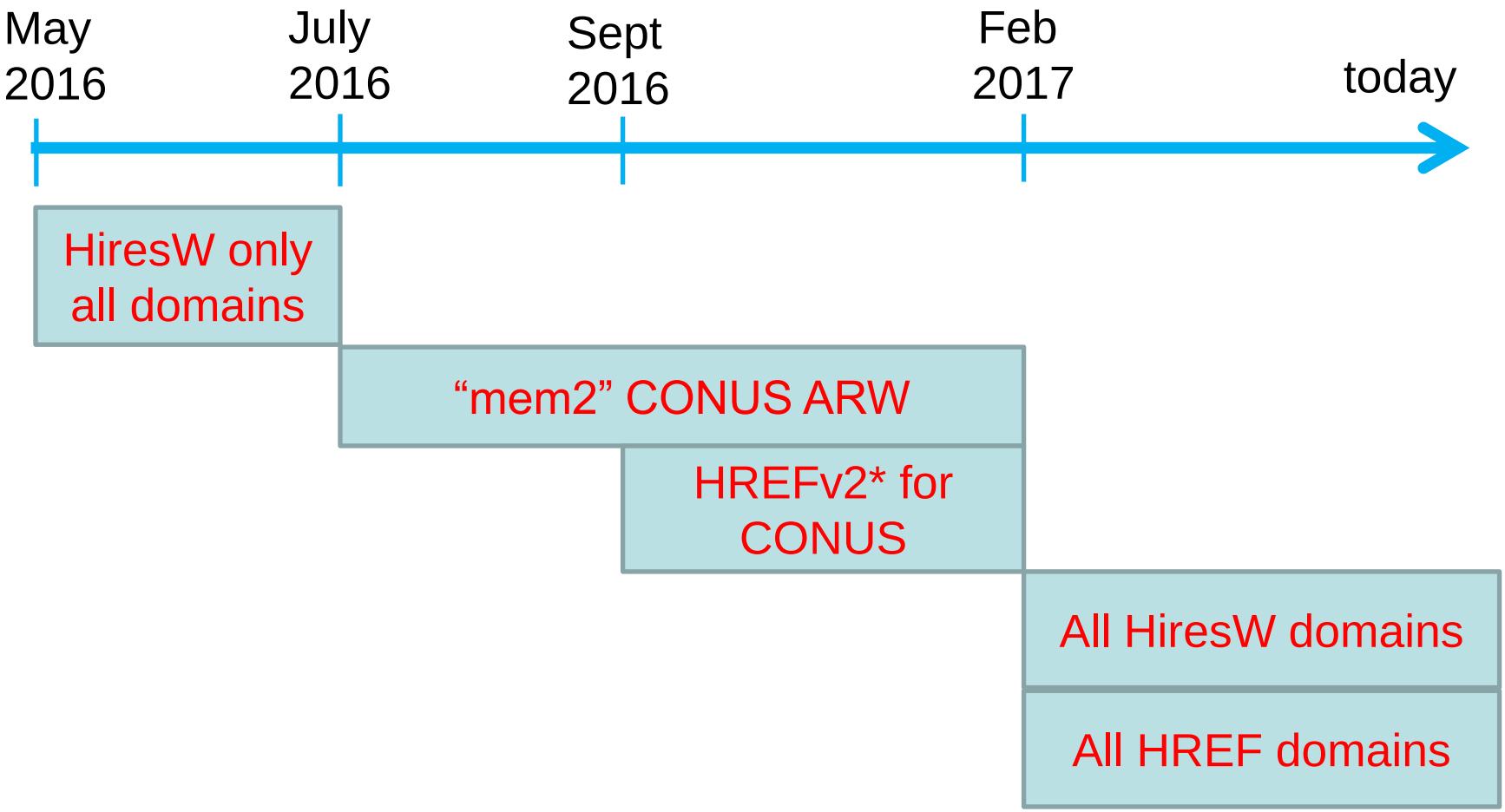
- **What isn't changing:**
  - Model forecast codes

* Initially planned to update NMMB code to match latest NAM version, but saw QPF degradation using that version in HiresW

Running much earlier in production suite

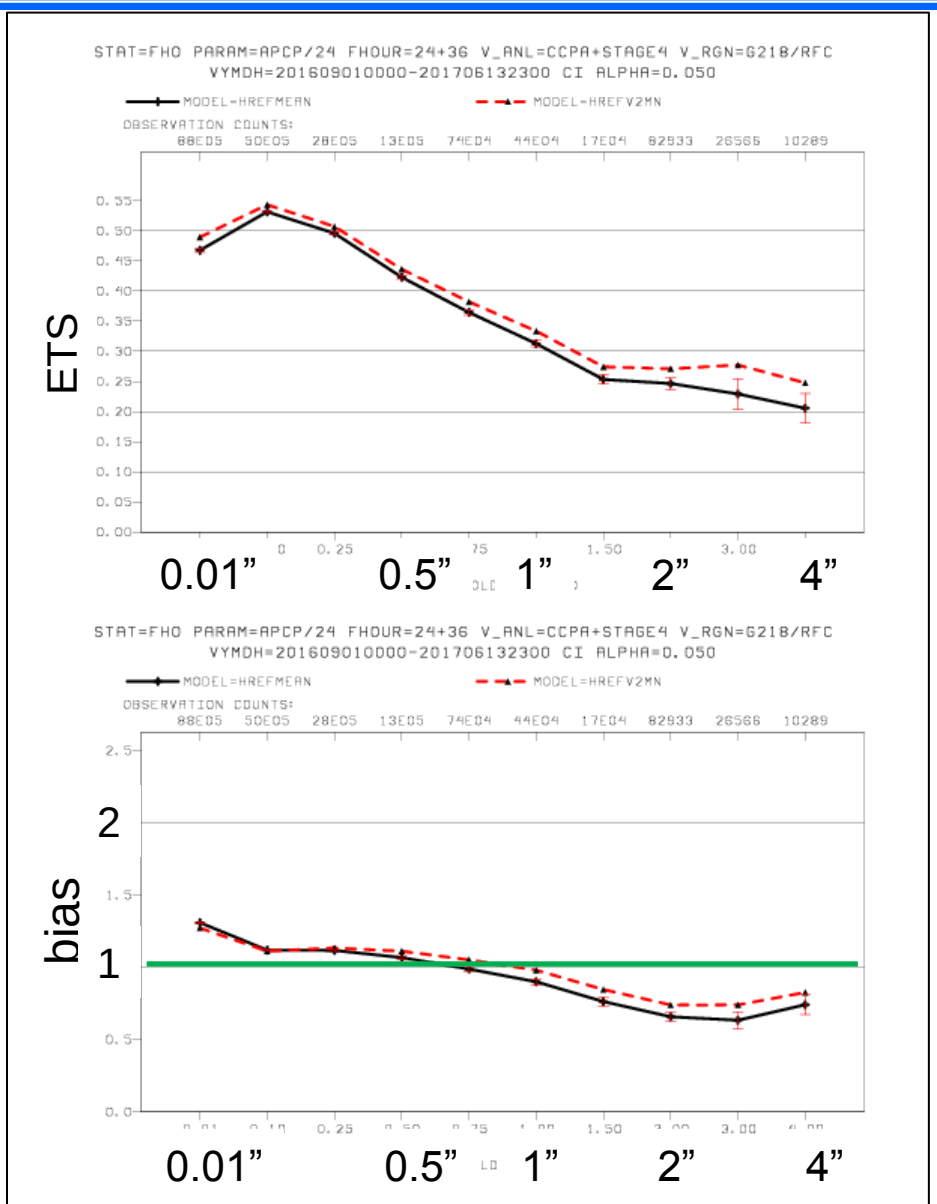
- With NCO's blessing, a decision was made to shift the HiresW/HREF to an earlier slot in the production suite (pre-GFS instead of post-GFS).
- Running this early requires utilizing 6 h old model data for lateral boundaries – just like the NAM.
- HiresW/HREF products should be available roughly 60-90 minutes earlier than in current ops.

Pre-Implementation Testing



HREF precipitation

Sept 1, 2016 to June 13, 2017



Ops HREF mean

Para HREF mean

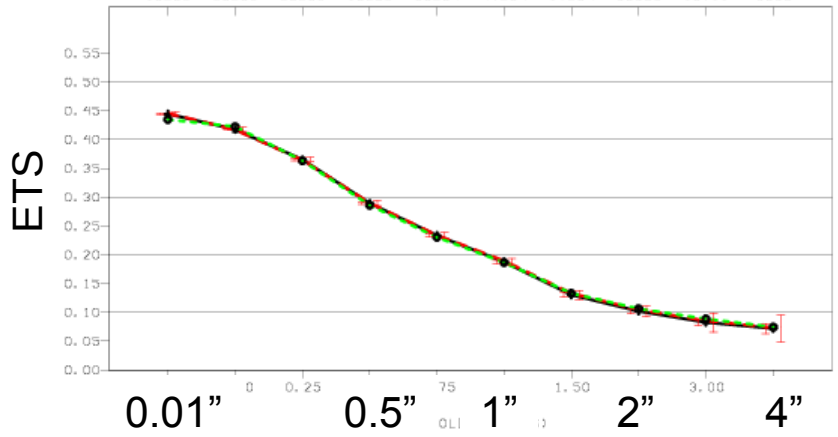
HiresW CONUS precipitation

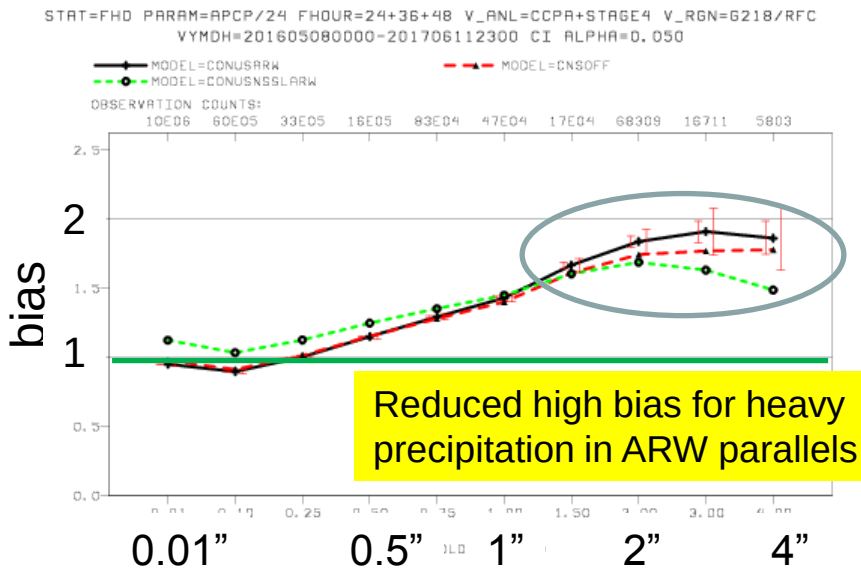
May 8, 2016 to June 11, 2017

(discontinuous; ~175 days to date)

Ops mem2 (NSSLlike) Para

ARW

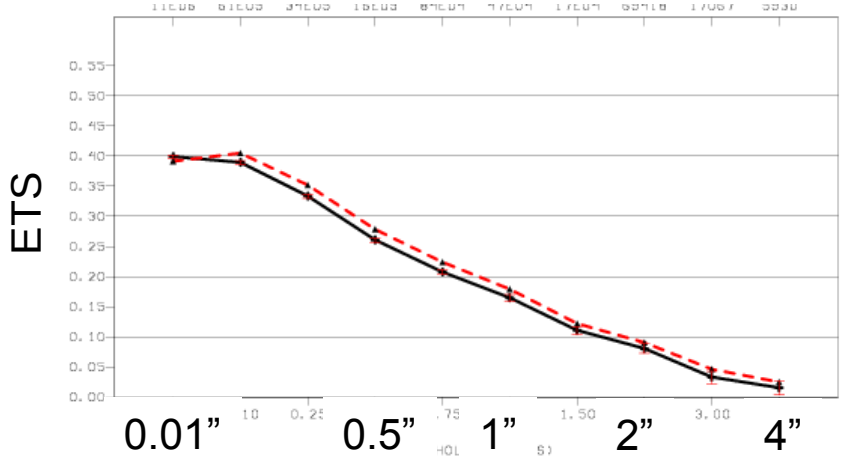


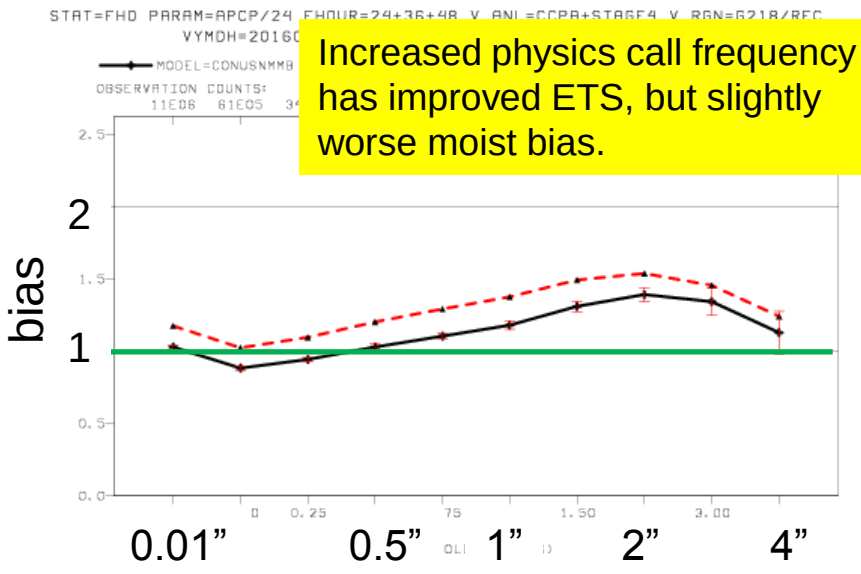


Reduced high bias for heavy precipitation in ARW parallels

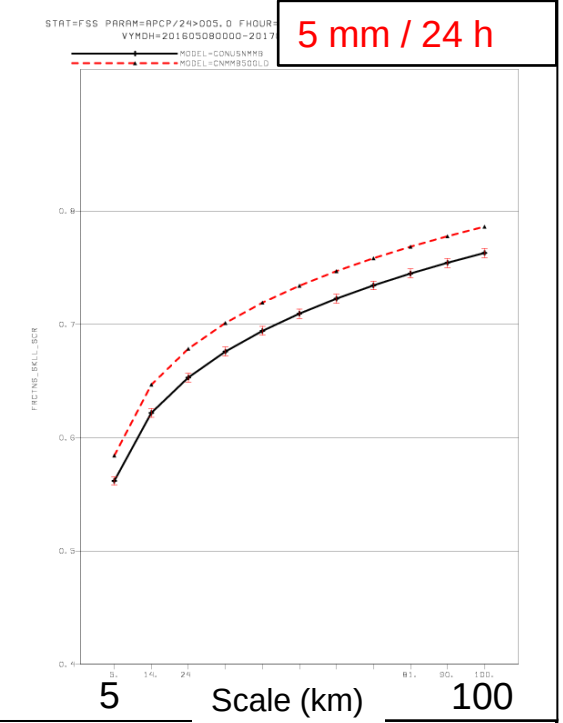
Ops Para

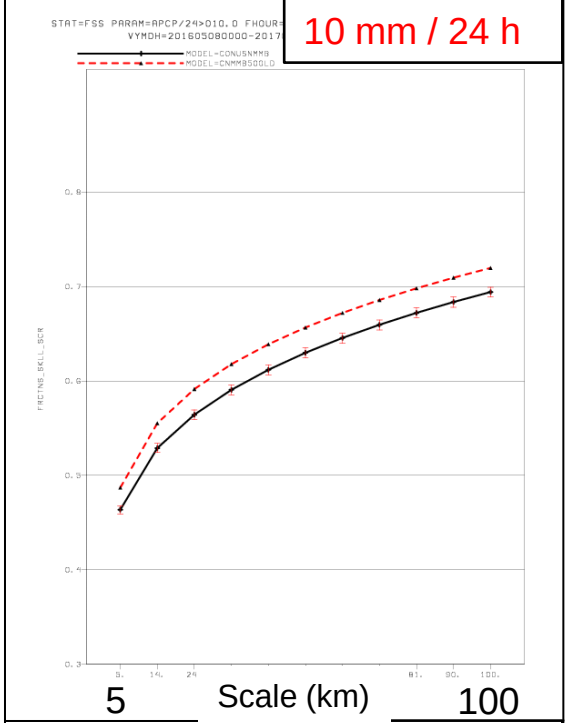
NMMB

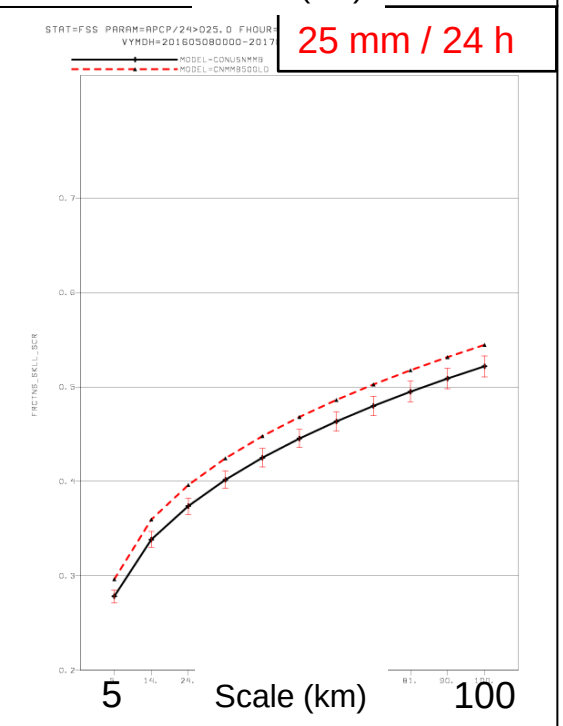


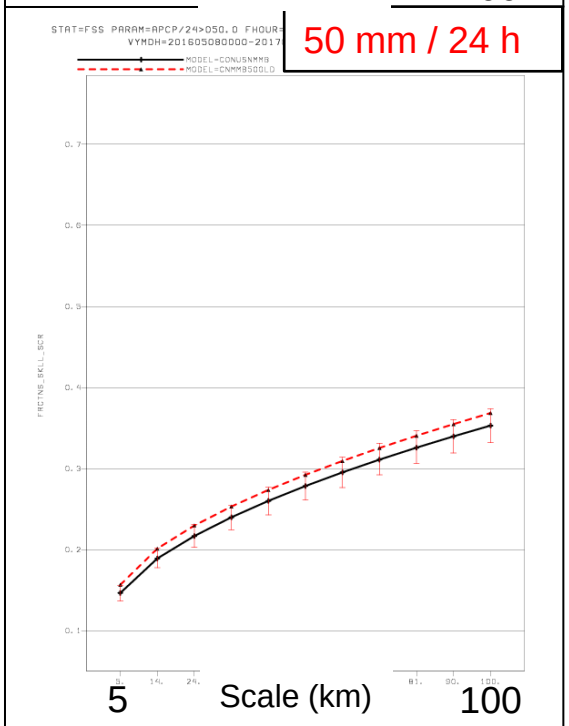


Increased physics call frequency has improved ETS, but slightly worse moist bias.









Ops NMMB

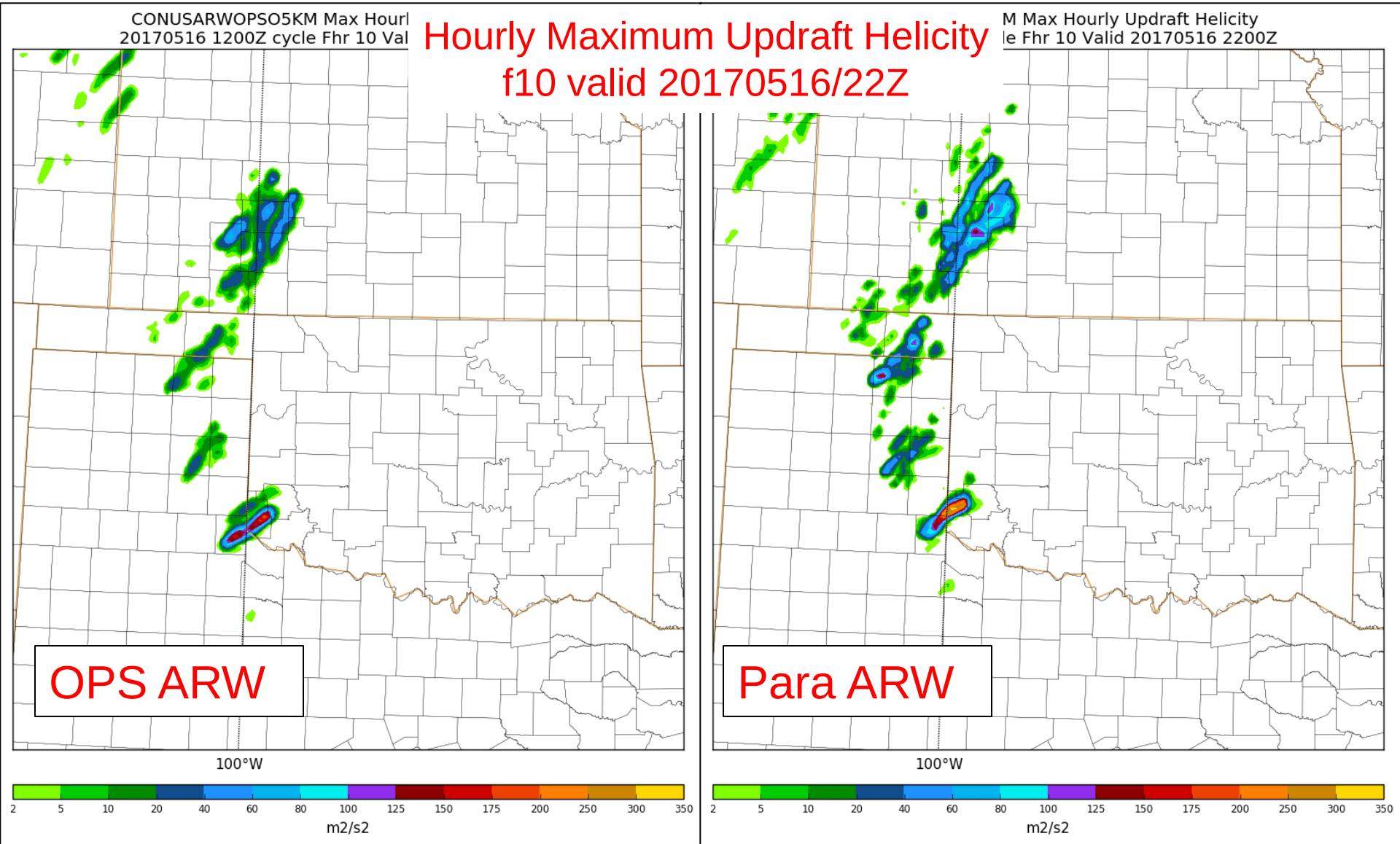
Para NMMB

Fraction Skill Score (neighborhood verification – rewards being “close”)

May 8, 2016 – June 11, 2017

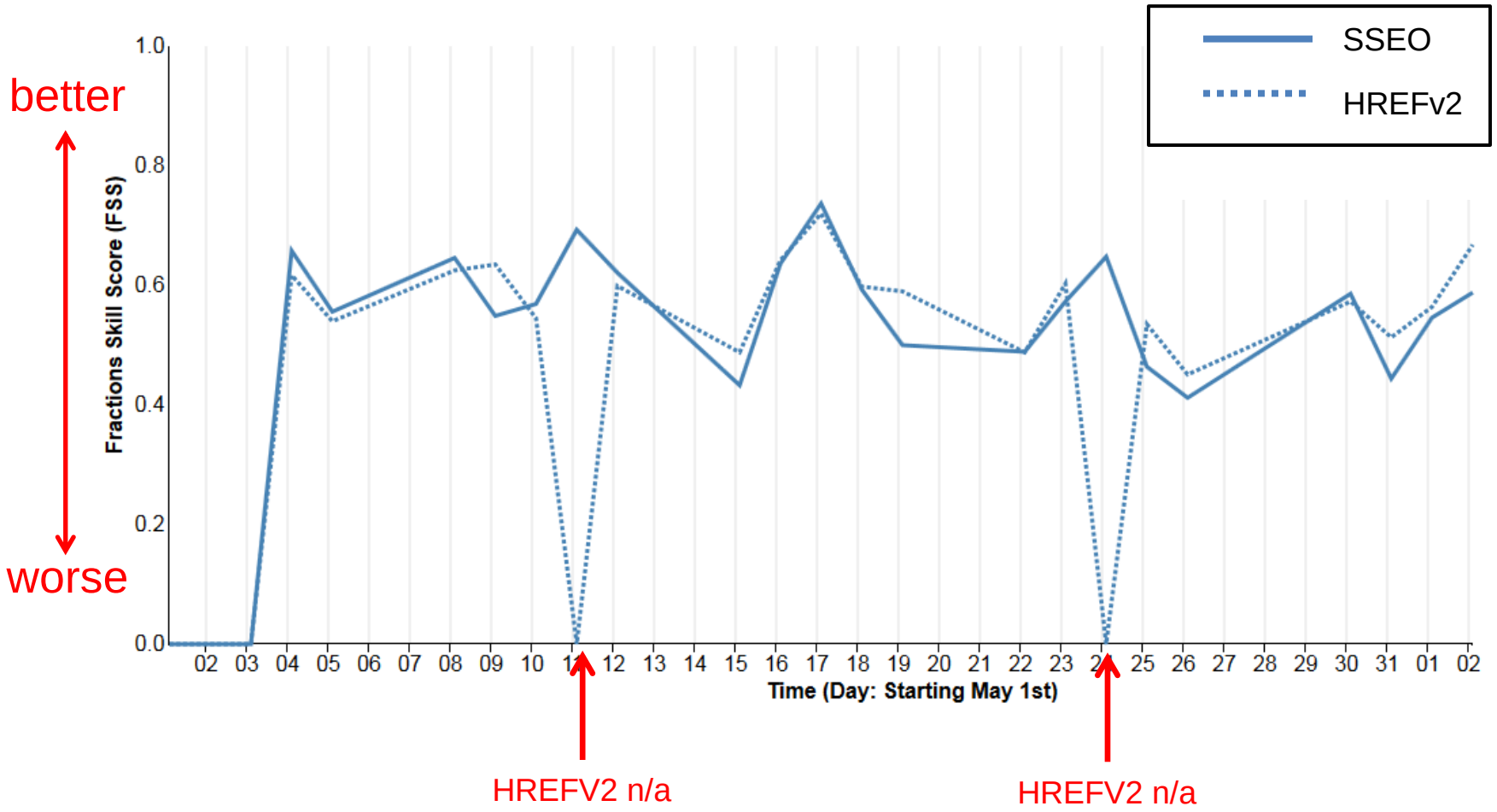
Para NMMB much better than Ops NMMB for light to moderate precipitation

More intense, sharper convective signals



HWT experiment 1 km REFD (prob > 40 dBZ)

Fraction Skill Score (FSS) summary for daily region of interest



NMMB surface verification scorecard

	CONUS RMS	**CONUS bias**	AK RMS	AK bias	HI RMS	HI bias	PR RMS	PR bias
2 m T								
2 m Td					--	--		
10 m V								
SLP			--	--	--	--	--	--
VIS					--	--		

Para sig worse

Para slightly better

Fairly neutral

Para slightly worse

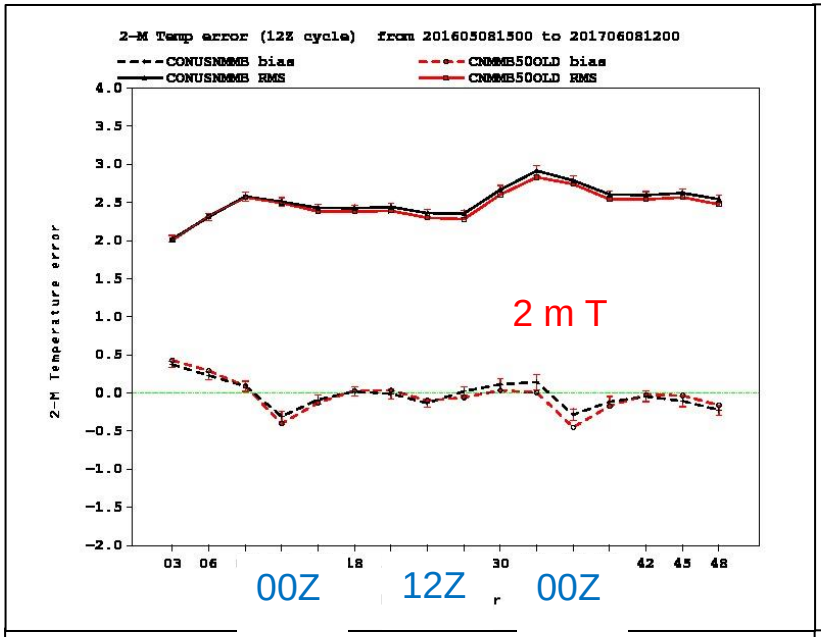
Para significantly better

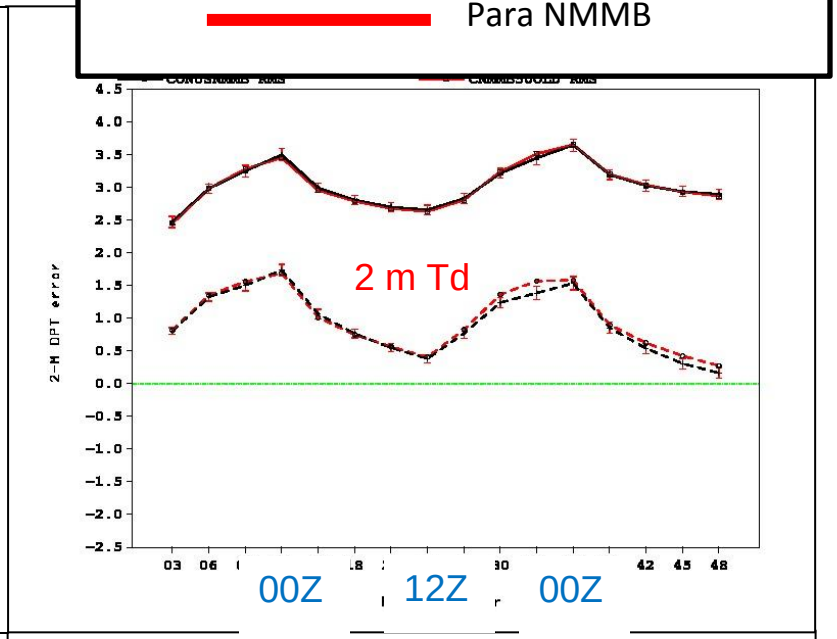
-- **N/A**

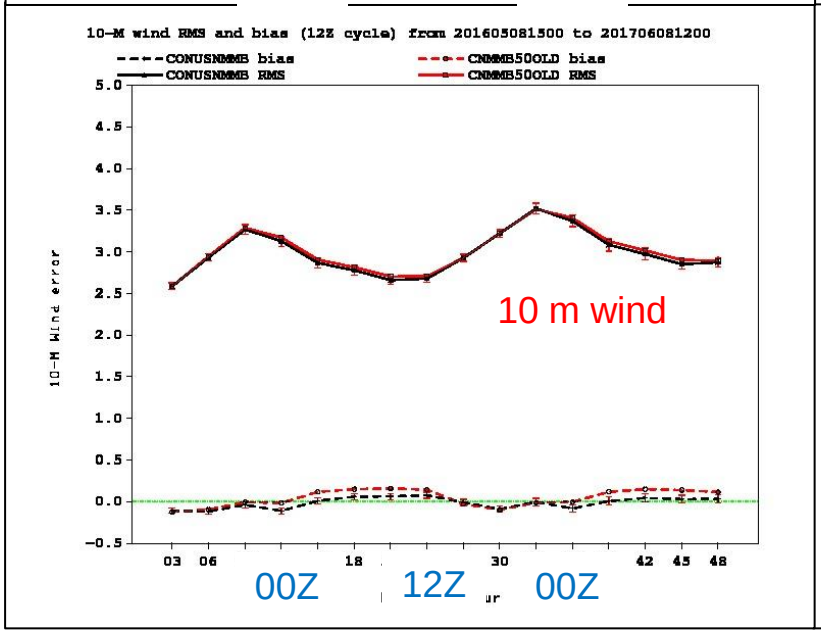
CONUS NMMB, 12Z cycles

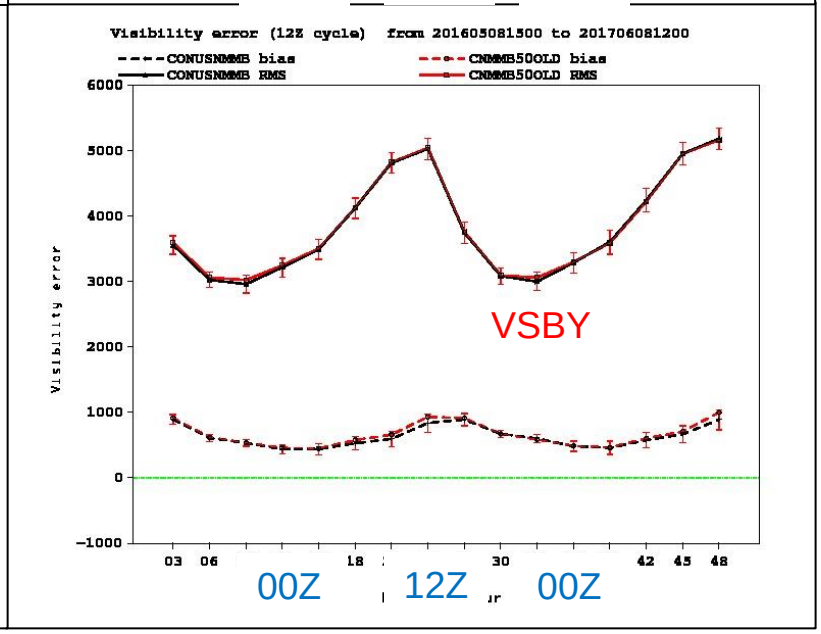
Ops NMMB

Para NMMB









ARW surface verification scorecard

	CONUS RMS	CONUS bias	AK RMS	AK bias	HI RMS	HI bias	PR RMS	PR bias
2 m T								
2 m Td					--	--		
10 m V								
SLP			--	--	--	--	--	--
VIS					--	--		

Para sig worse

Para slightly better

Fairly neutral

Para slightly worse

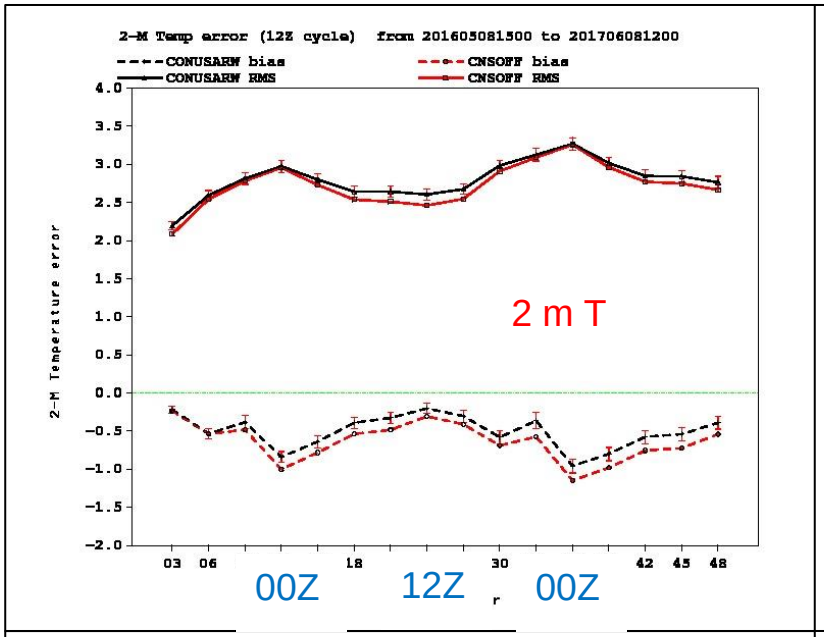
Para significantly better

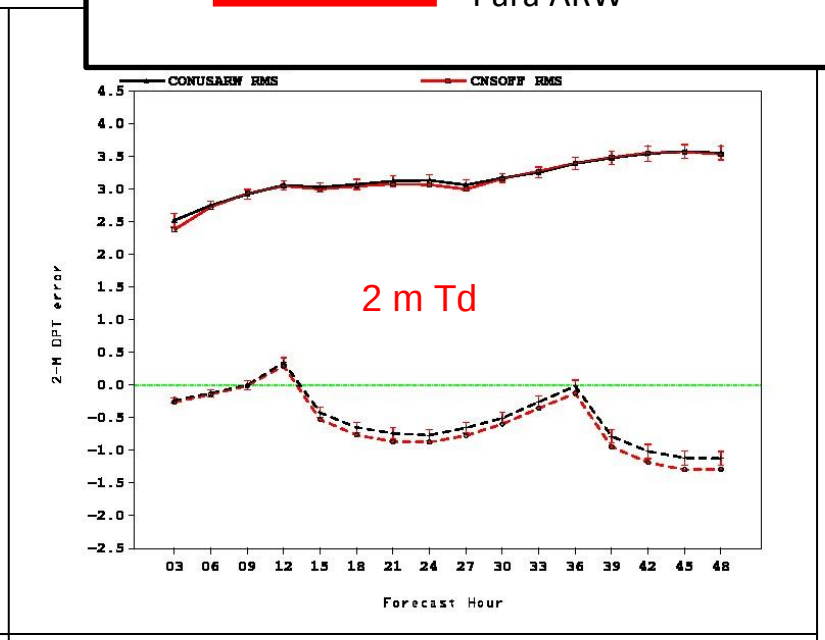
-- **N/A**

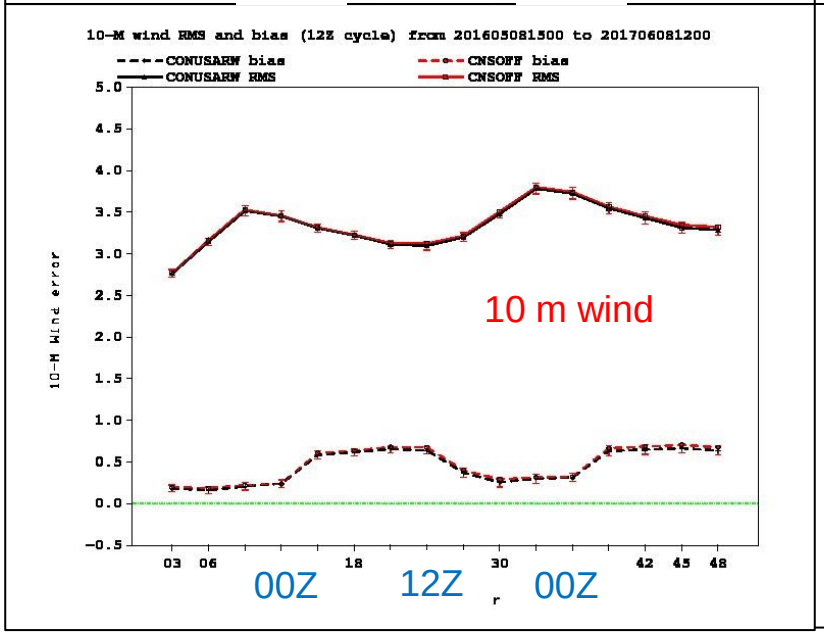
CONUS ARW, 12Z cycles

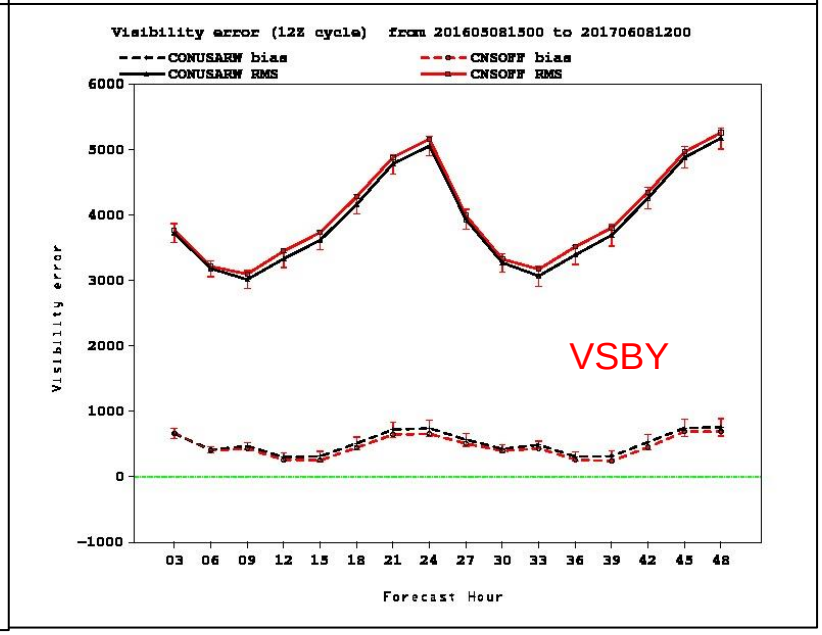
Ops ARW

Para ARW









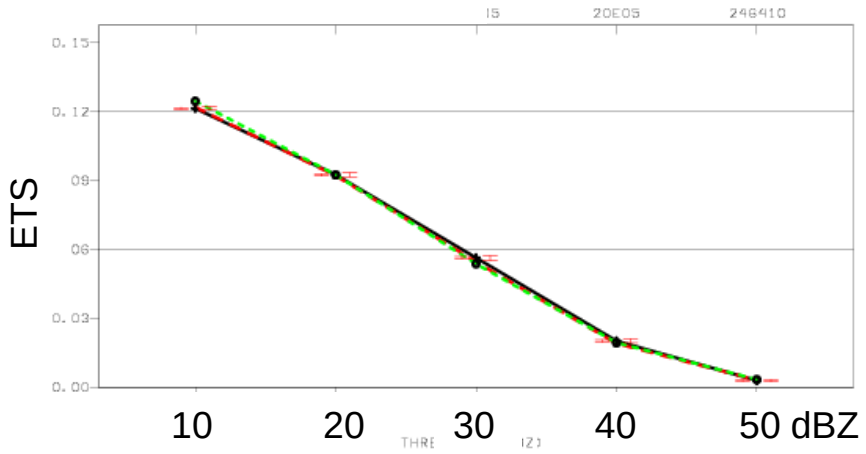
Ops Mem2 (ARW only) Para

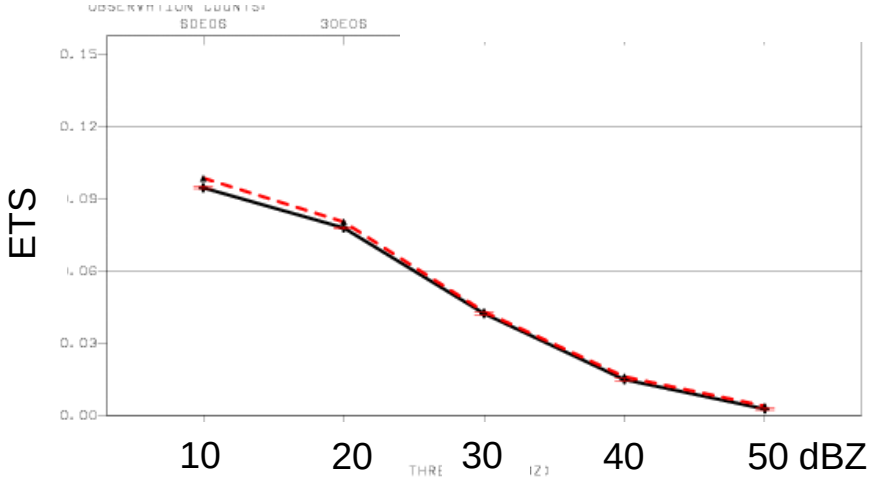
CONUS, all cases

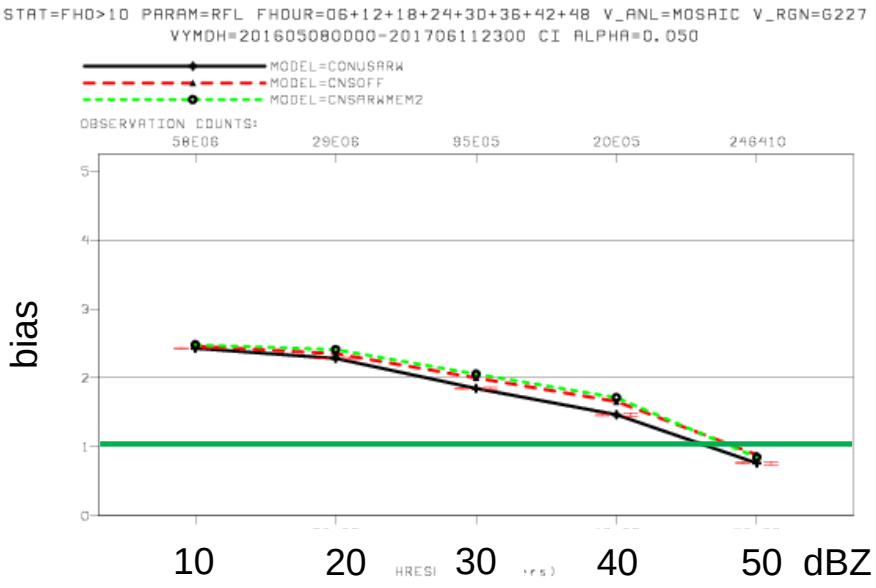
ARW

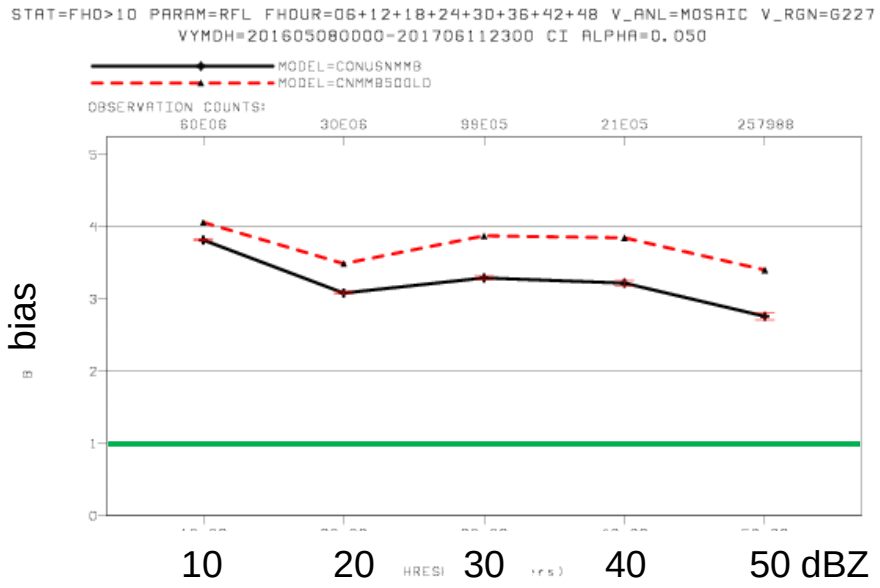
Composite reflectivity

NMMB









Ops

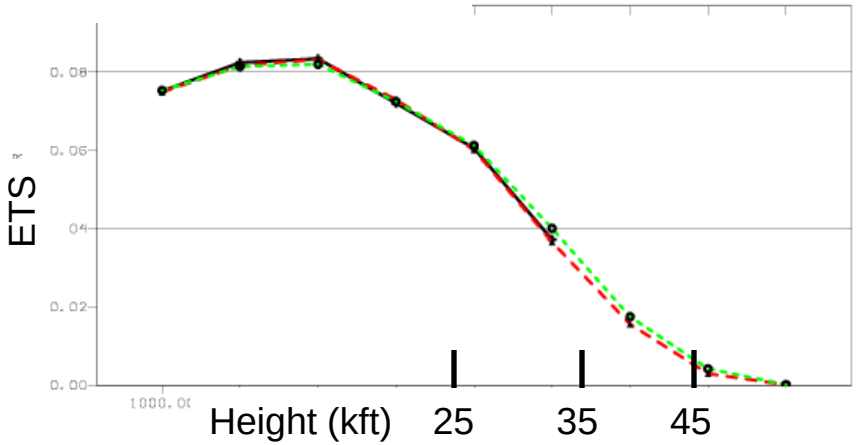
Mem2 (ARW only)

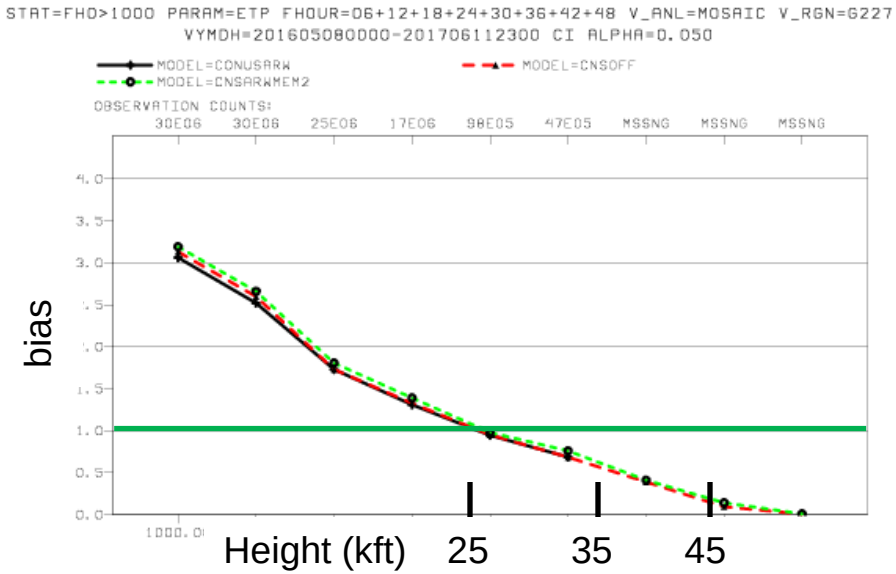
Para

CONUS, all cases

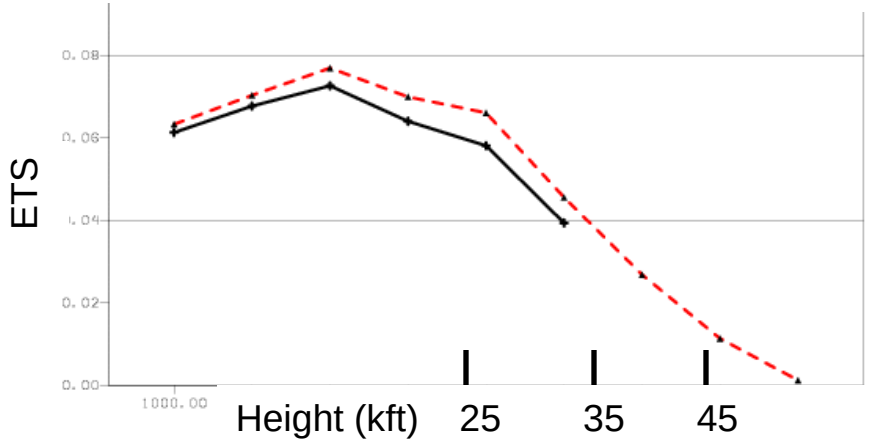
Echo Top Height

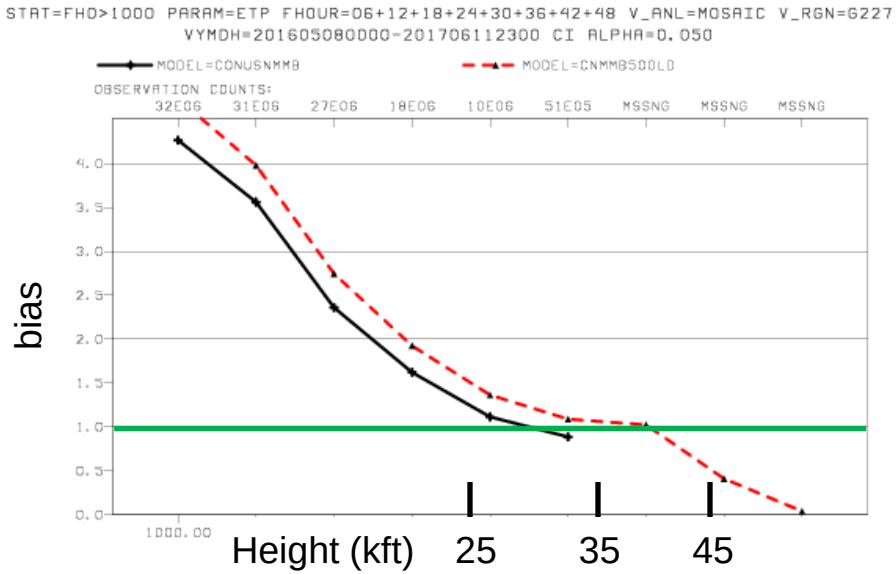
ARW





NMMB





Evaluations received

NWS SR & CR, SPC, WPC, AWC, and the MEG/MEG-STI high-res ensemble team all submitted evaluations, and *all recommend it being implemented as proposed*.

Some of the positive comments:

"*These implementations are a big step forward…*" – NWS CR

"*…enthusiastically support this upgrade*." – MEG + MEG STI

"*…WPC strongly recommends implementation of the new HREF and HiresW…*"

"*…the HREFv2 performs similarly to the SSEO and provides useful guidance for severe weather forecasting*." - SPC

Evaluations received

Some concerns/suggestions for future consideration:

- AWC worried about echo top height skill (would like to see improved in future upgrade), and NMMB composite reflectivity.
- Concerns about the generality of the neighborhood probability approach, particularly for coastal and mountainous regions.
- HREF winds seem to have a low bias (in convective and post-frontal environments).

Resource Changes

- Pushing resolution to ~3 km and adding 2nd ARW member for most domains adds significant resource expense for HiresW

	Prod	Dev para
HIRESW peak node usage (00/12Z)	101	243*
HIRESW peak node usage (06/18Z)	93	176*
HIRESW total to /com (GB/day)	412	826

- For HREF, hourly output, new domains, and new products all add to its (small) footprint

	Prod	Dev para
HREF Node usage (00/12Z)	12	15*
HREF Node usage (06/18Z)	12	24*
HREF total to /com (GB/day)	2	20

* Subject to change once NCO takes over code

Remaining challenges

- Keeping the process to get HREF output distributed over AWIP/SBN on track:
  - Currently helping NCO dataflow get the needed paperwork submitted
  - Barring complications will be distributed over SBN when new HREF is implemented
- Better educating the NWS field on what is coming, and how best to utilize it – currently working on briefing materials