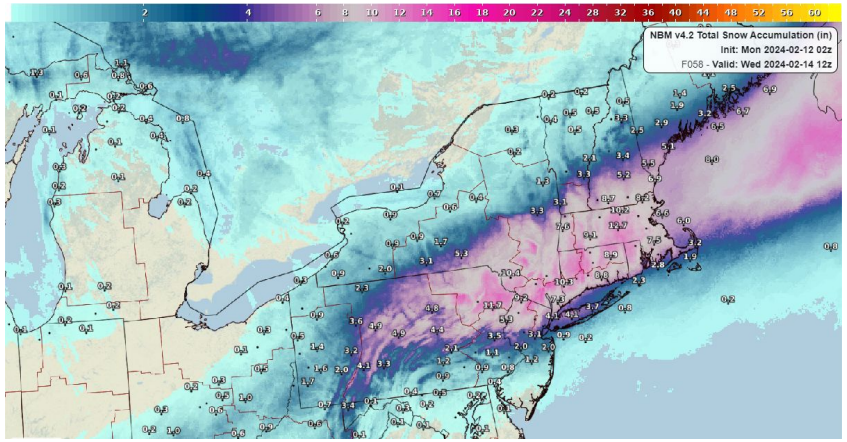

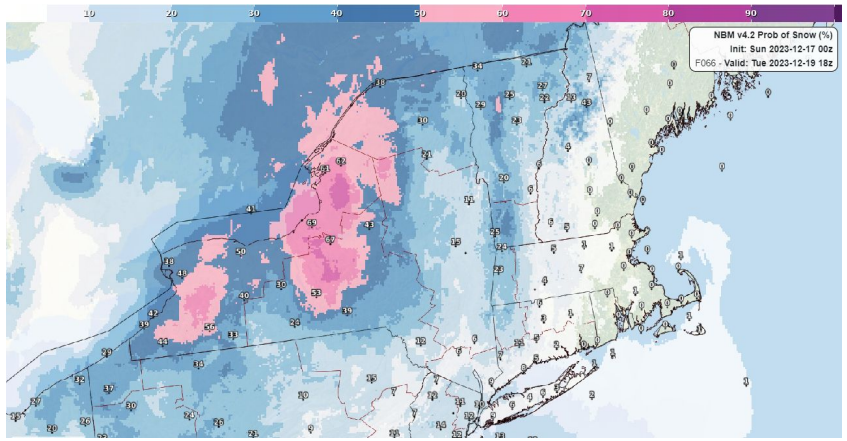

Winter Product Updates in Version 4.2 of the National Blend of Models

Geoff Manikin
NOAA/MDL/Statistical Modeling Division
15 February 2024

Acknowledgements

- Dave Rudack - Project Lead
- Robby James - QMD Prob 10m instantaneous wind speed/gusts, Maintaining/Running parallel runs
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- Scott Scallion - Operational NBM and NCO Code Handoff
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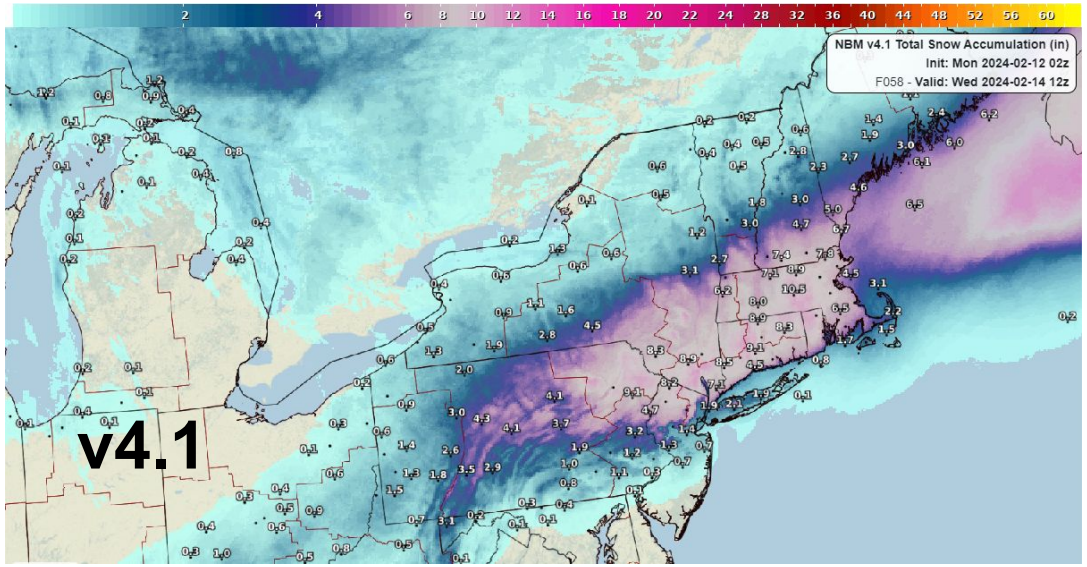
- Judy Ghirardelli (Acting SMD Chief during part of v4.2 development period)
- Bruce Veenhuis (WPC)
- Many SOOs and field forecasters for valuable feedback

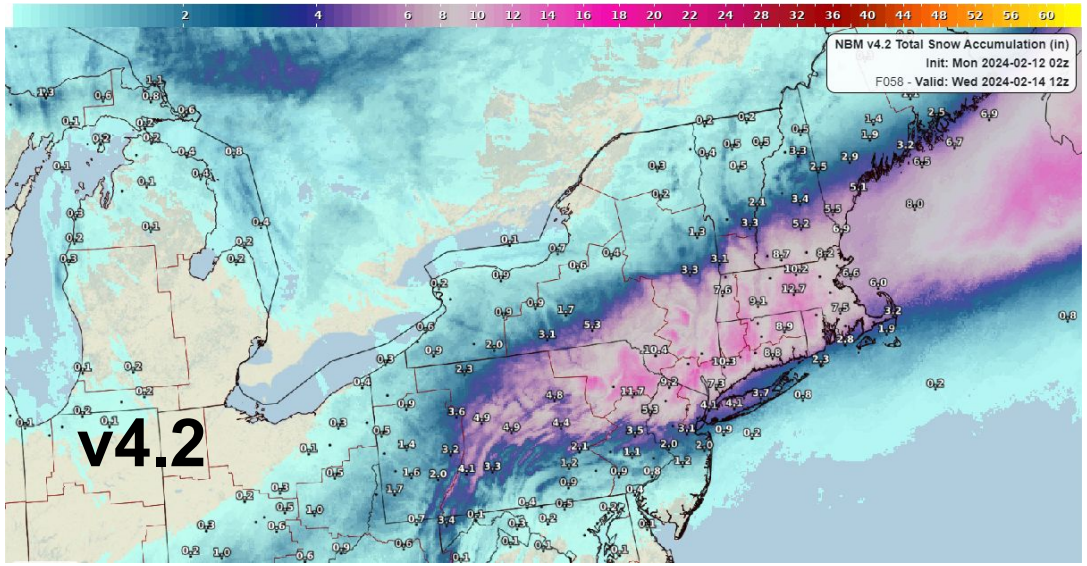
Winter Changes

- SLR changes
- Downscaled Wet-Bulb Temperature
- Lattice Issue
- Precip Type Probabilities

SLR

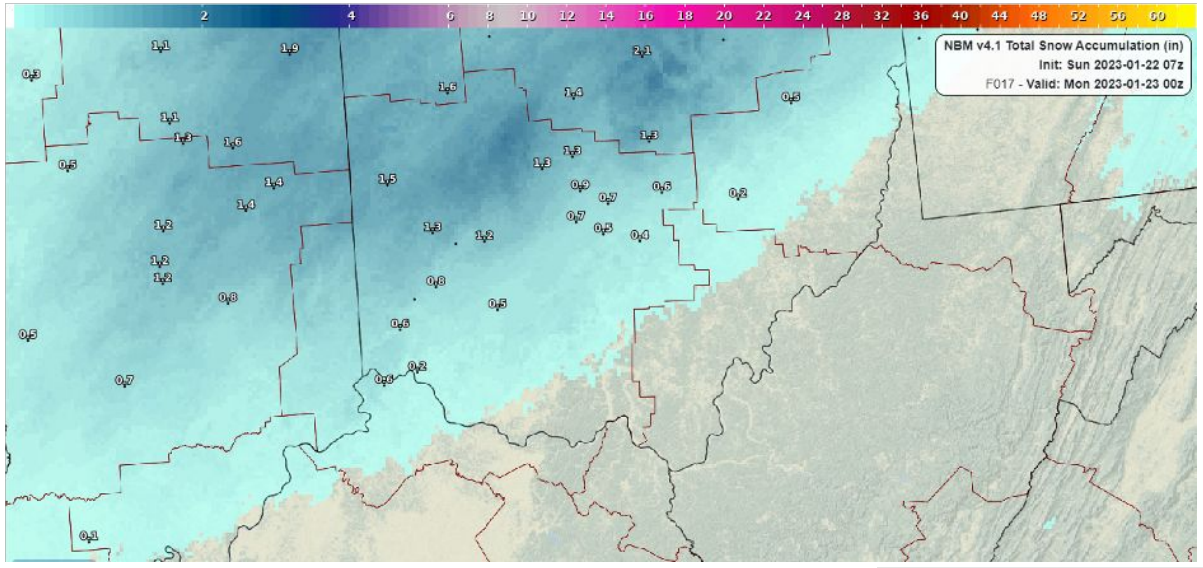
- The 25% reduction in the SLR computed for each member in the winter code, that has been in place for several versions of the NBM, is removed in v4.2

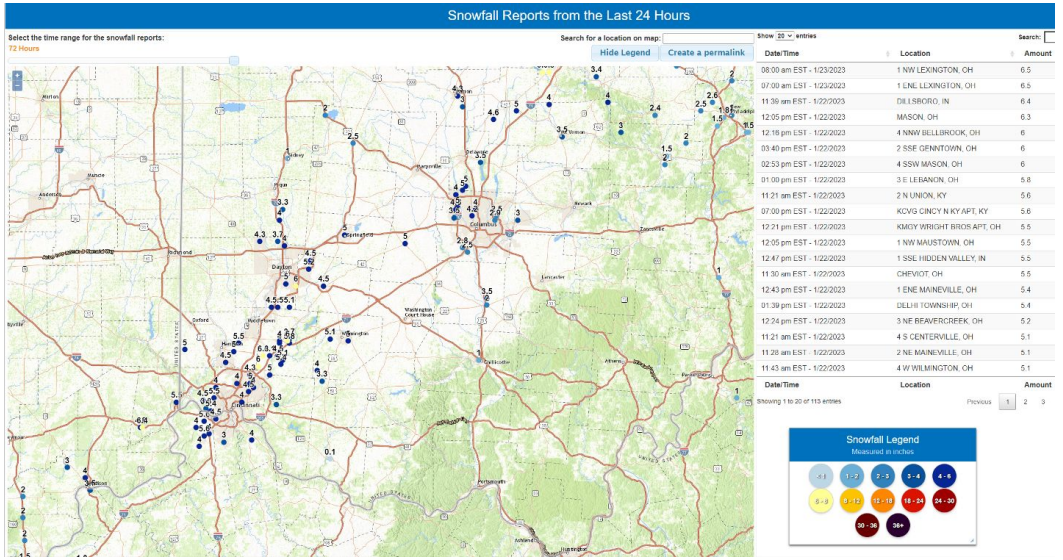


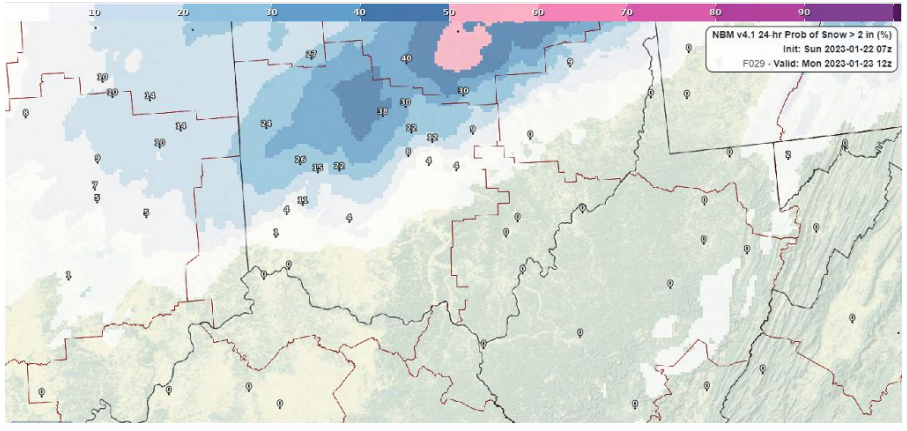


Cobb Methodology

Last winter featured multiple instances of the NBM showing low snowfall in environments with marginal temperatures







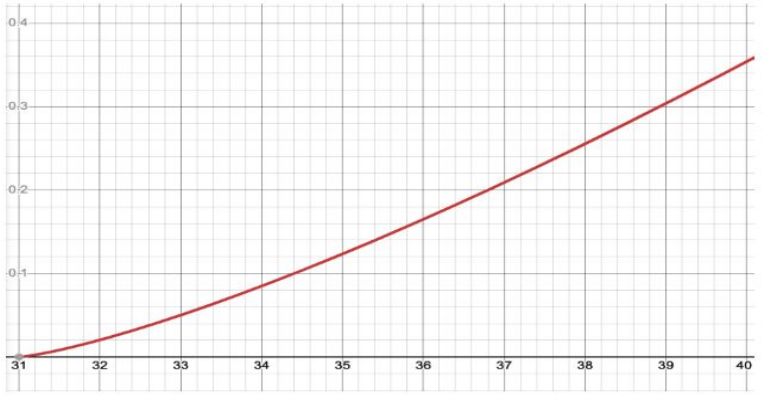
Cobb Methodology

NBM V4.2 Snow Melt Function for “Warm” Snowfall

Experiment 1: Steps to incorporate SLR correction to account for melting snow:

- Calculate each “cloud base” SLR and blend as previous.
- Calculate potential snow melt for falling snow based on the following equation:

$$QPFmelt = \left[\frac{(0.5Tsfc - 15.50)}{10}\right]^{1.3}$$



- Revise the blended SLR as:

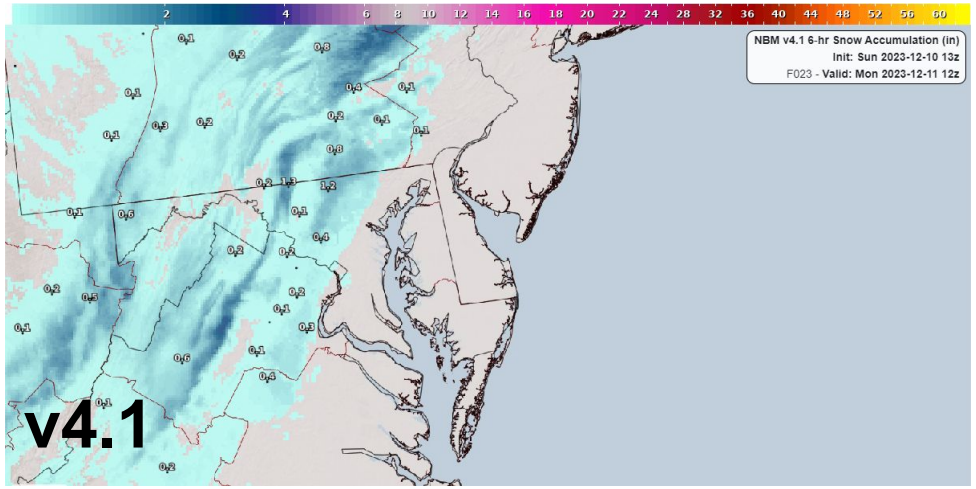
$$SLR_{new} = SLR \times \left[\frac{QPF - QPFmelt}{QPF}\right]$$

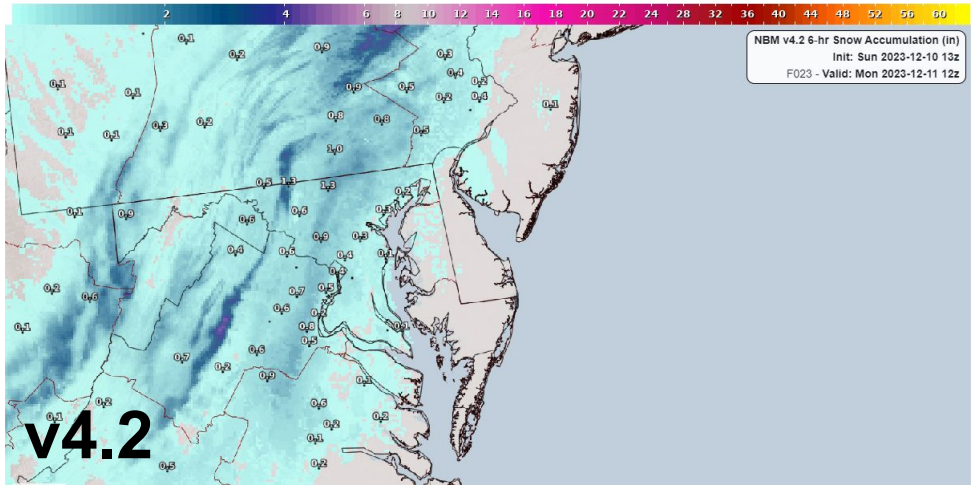
If QPF_{melt} > QPF set SLR_{new} to zero, i.e. there will be no snow accumulation.

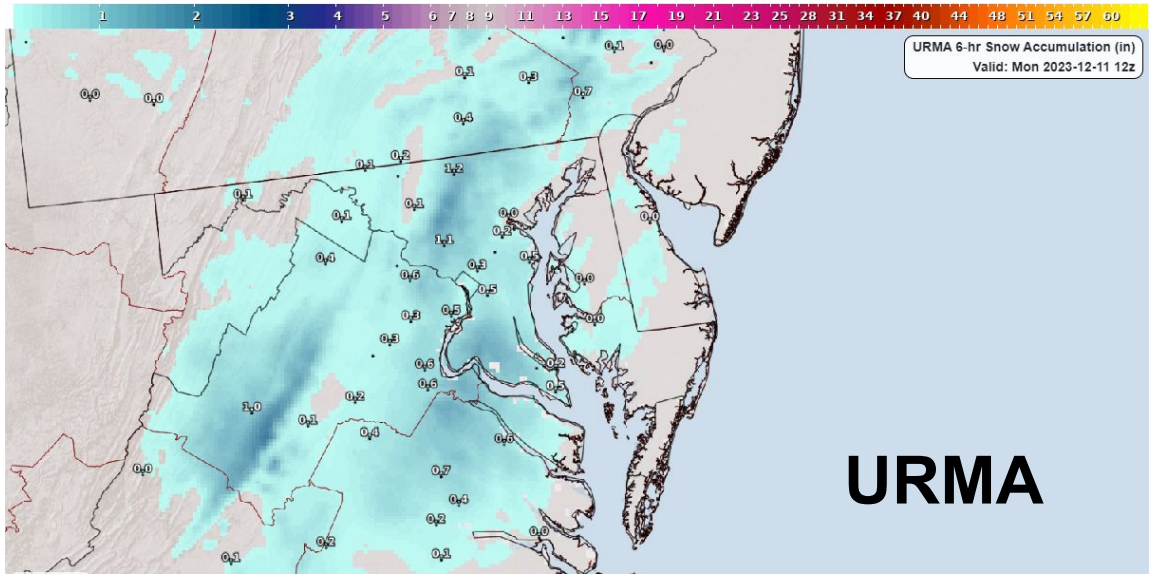
- Adjust logic to allow for a p-type of snow with temps ≤ 40F.

v4.1 sets SLR to 0 when Tw > 33

Snowfall Cases

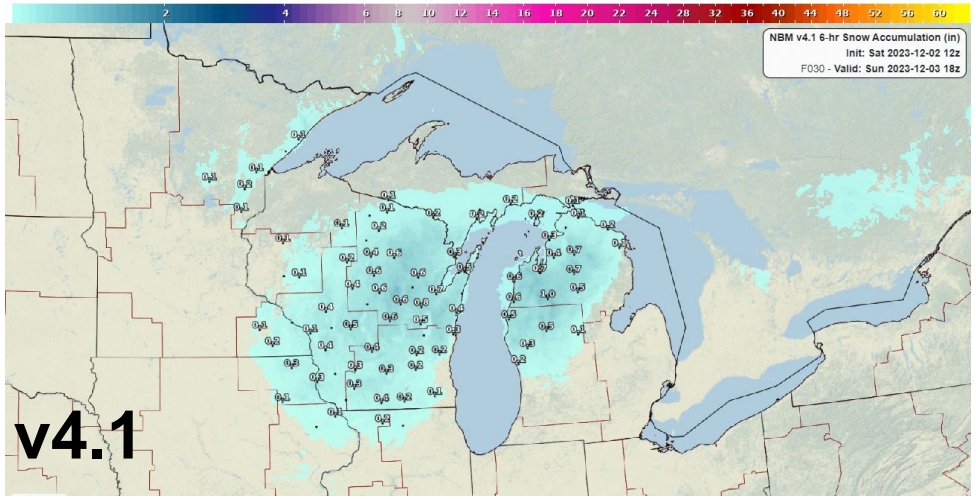


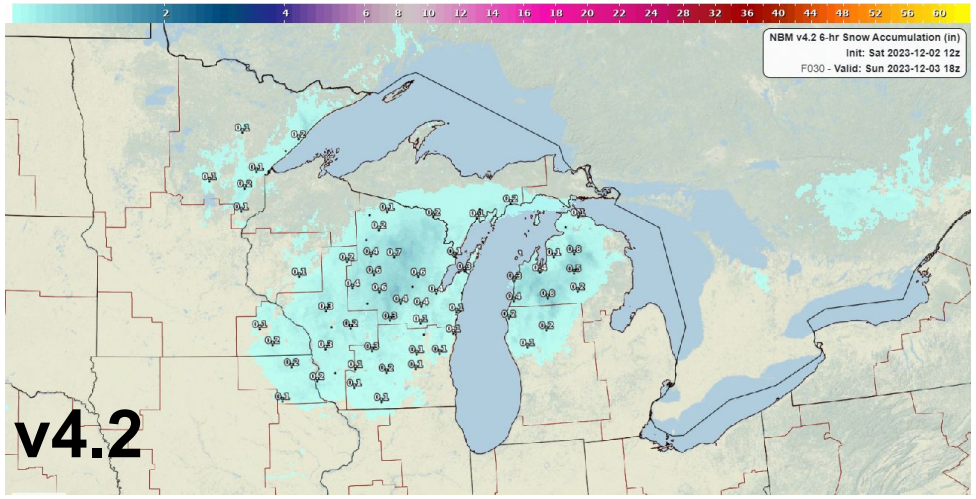


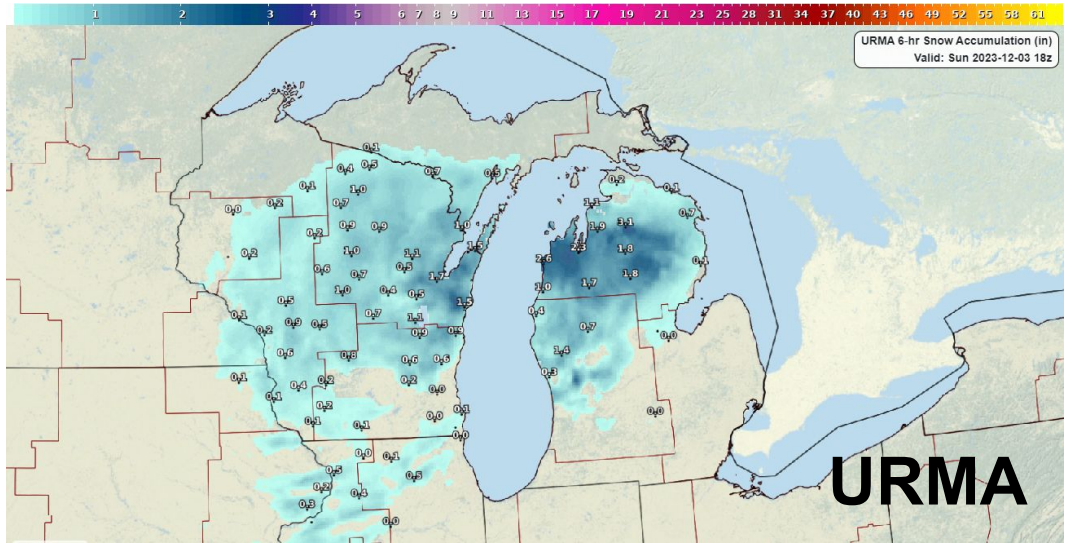


- This case was a nice success for the updated Cobb approach
- Snow can accumulate in environments with marginal temperatures if rates are high

Snowfall Cases



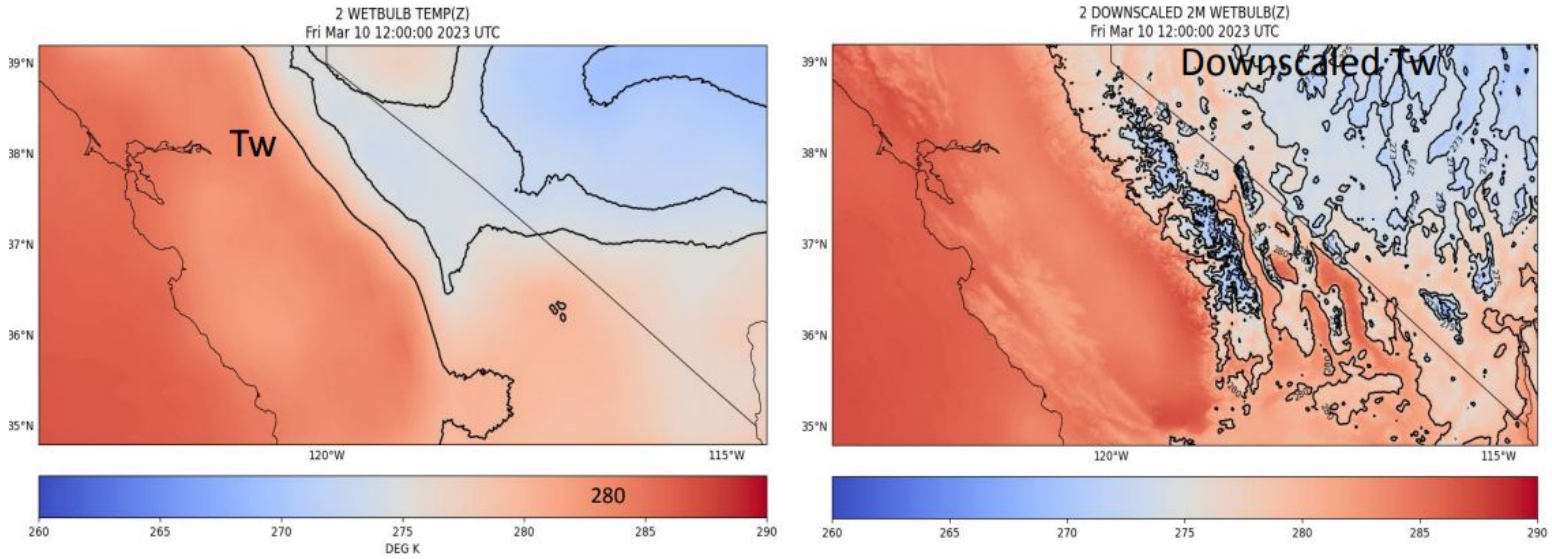




- This was also a light event with marginal temperatures, but the forecasted rates were lighter
- It shows that the melting can be too aggressive in events with marginal temperatures and light rates
- Forecast Builder already has an update to the snow melt factor to address this issue

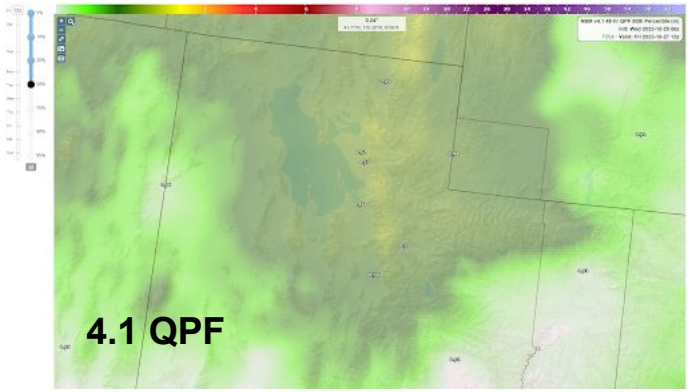
Downscaled Wet-Bulb Temperature

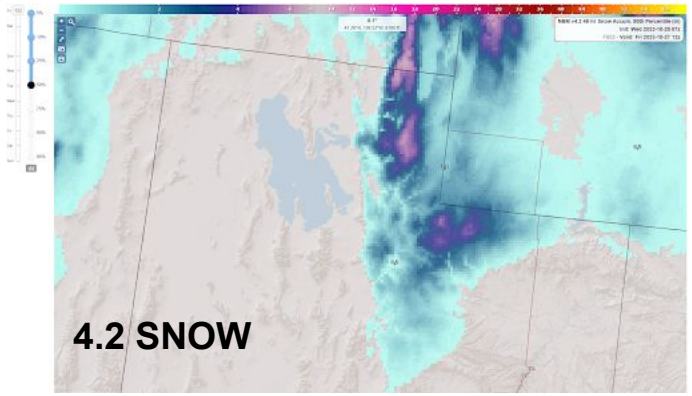
- Use a downscaled Tw for low resolution ice and snow accumulation inputs (EPS, GEFS, SREF), rather than their native resolution values
- The difference between the T and Tw is computed and saved. When the downscaled T is computed, that difference is used to compute a downscaled Tw



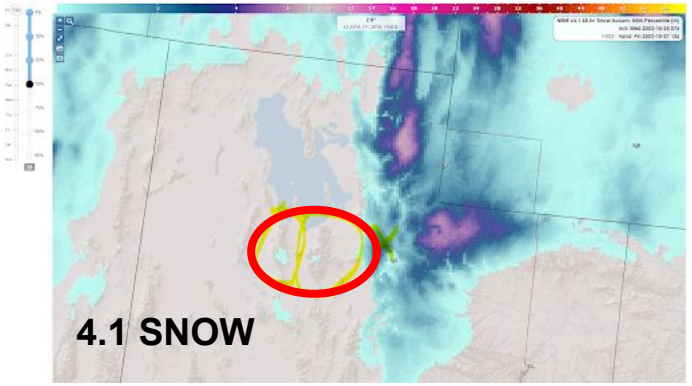
- This adjustment affects both SLR (and thus snow accumulation) as well as ice accumulation (per the Freezing Rain Accumulation Model)

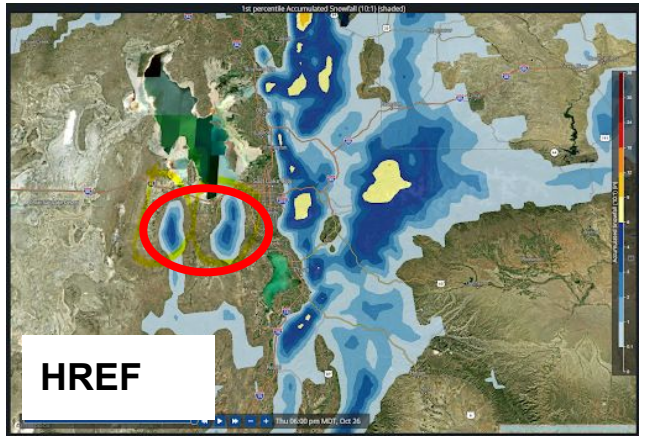
Snowfall Over Terrain



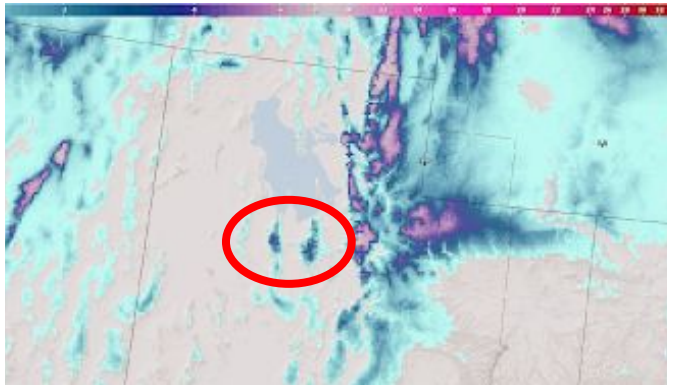


During the early fall, WR noted persistent issues with 4.2 not showing snow over higher terrain; it was expected that the new downscaled wet bulb temperature approach in 4.2 would show a significant improvement over ops

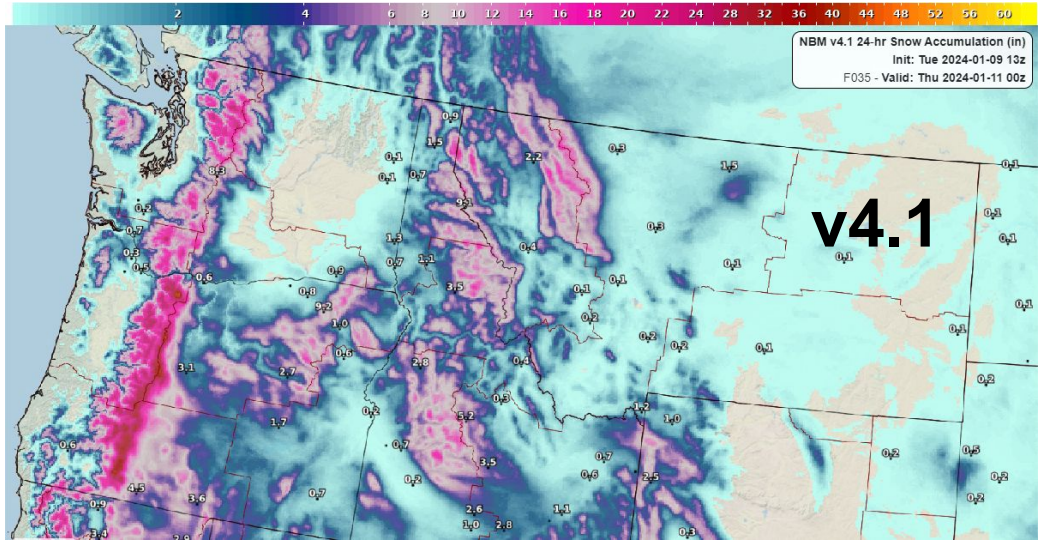


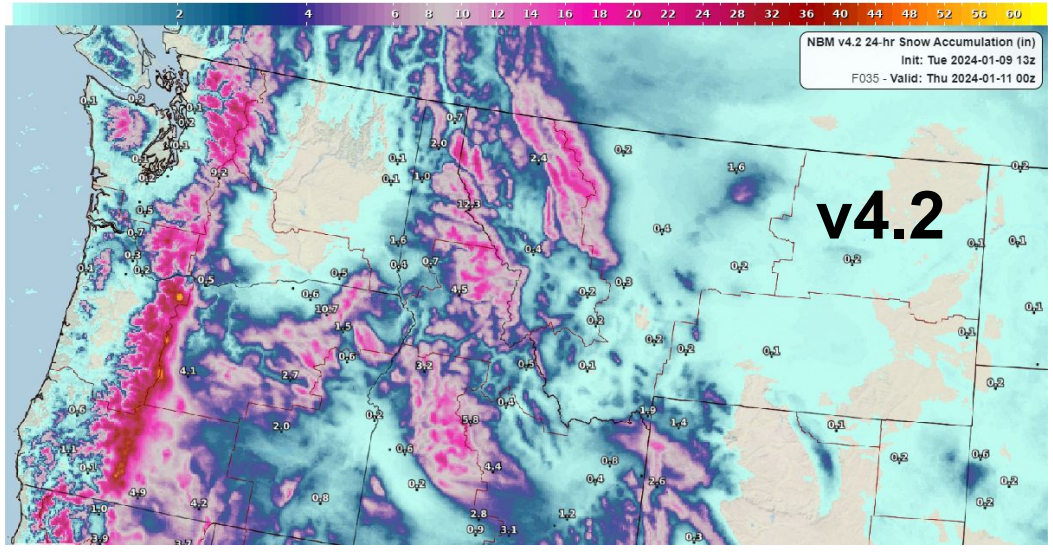


SMD found a bug that was causing the new downscaled wet bulb temperature to not be used for snow; correcting this shows a huge improvement (below)



Impact of Snow Changes





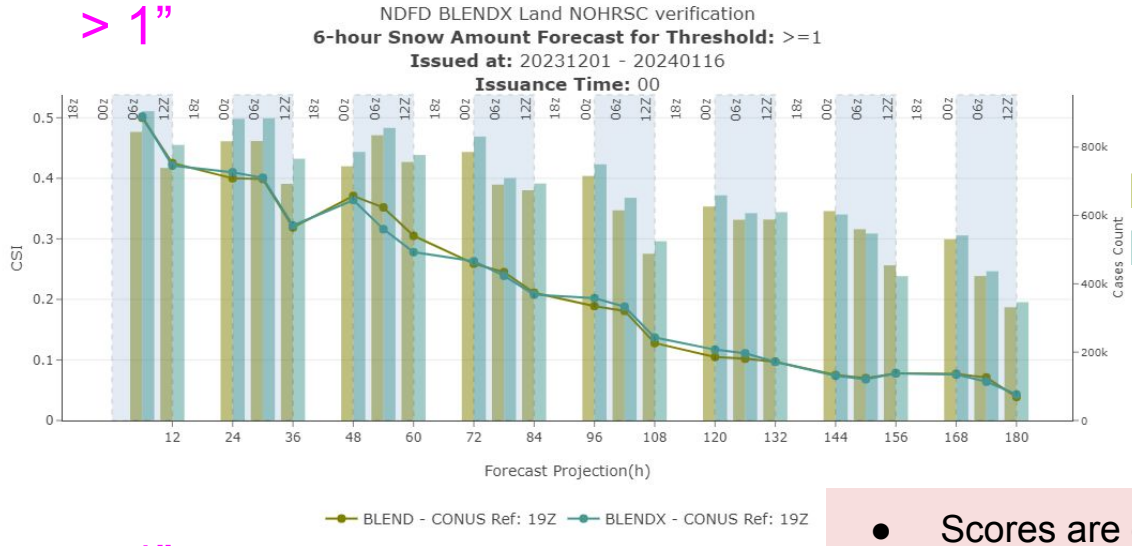
- Example of the impact of the usage of the downscaled wet bulb temperature to enhance snow totals over higher terrain and the elimination of the 25% reduction of each member's SLR that is used in v4.1

Snow Stats

- note that a bug discovered in mid January may have caused erroneously low QPF to be used for snow computations in v4.2

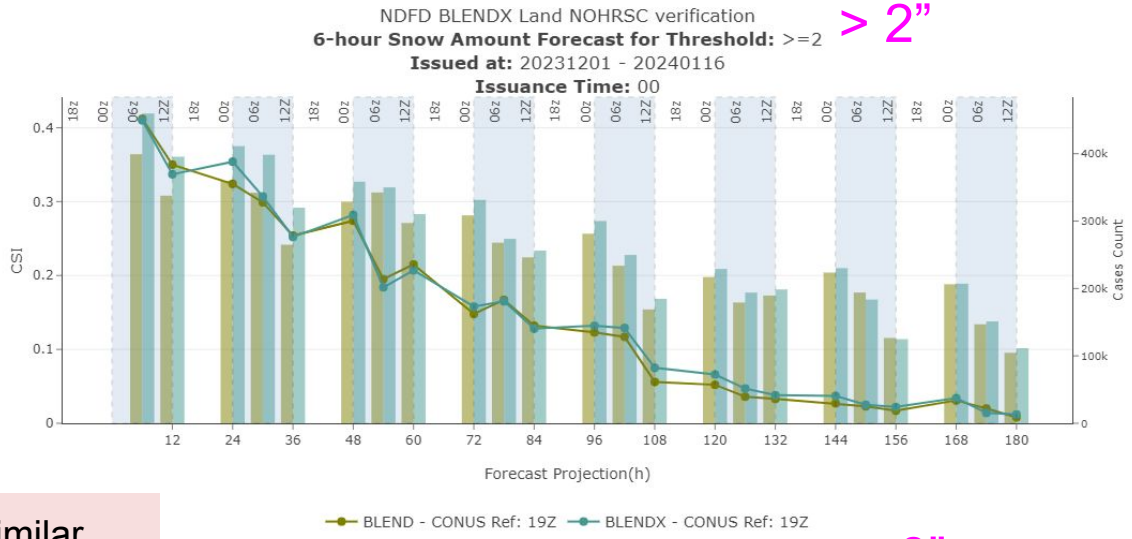
CSI

> 1”



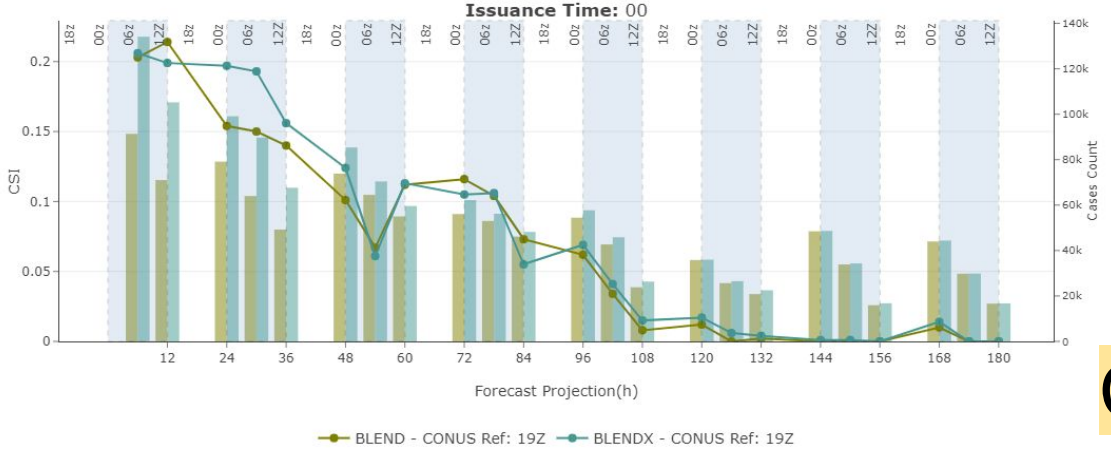
NBMv4.1
NBMv4.2

> 2”

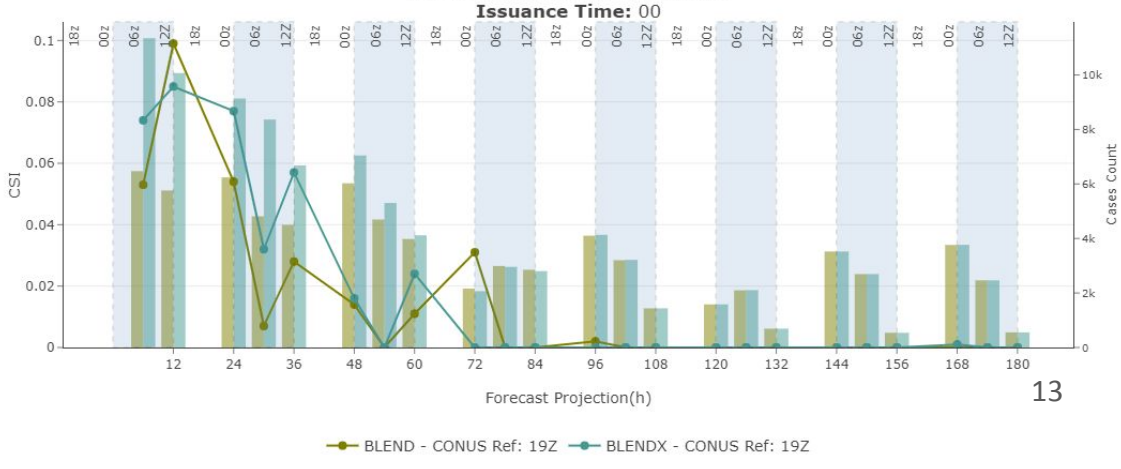


- Scores are overall quite similar

> 4”



> 8”



CONUS

Snow Stats

POD

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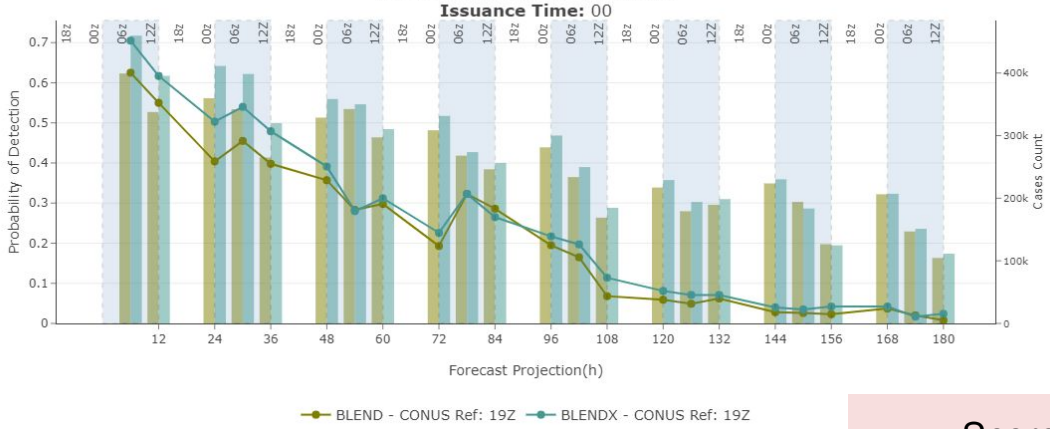
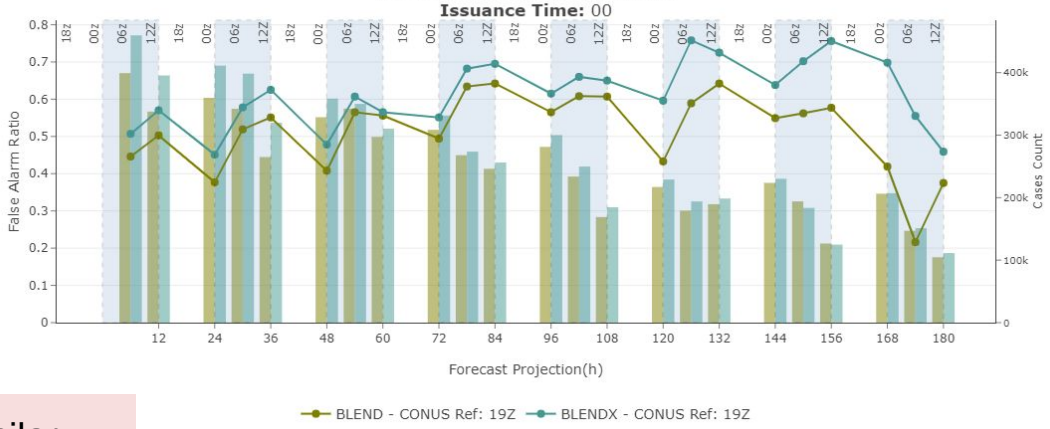


FAR

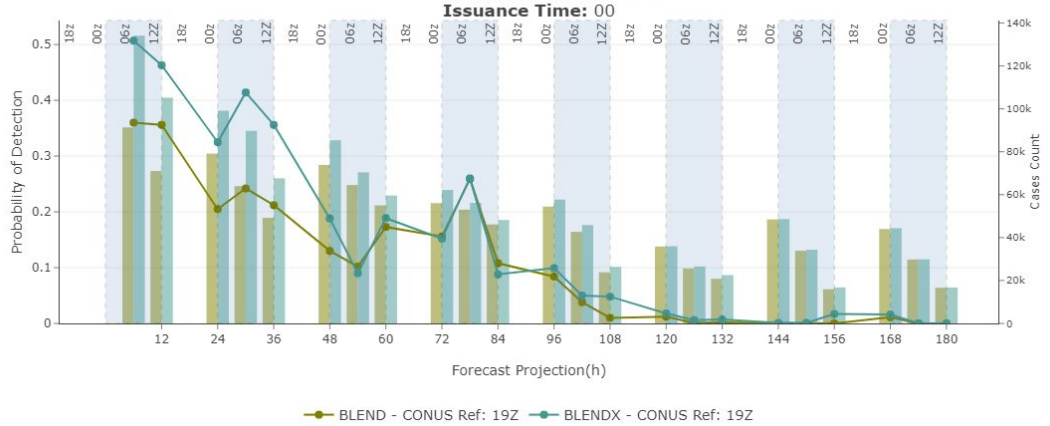
> 2”



NBMv4.1
NBMv4.2

- Scores are overall quite similar
- v4.2 overall has a higher POD, but also a higher FAR

> 4”



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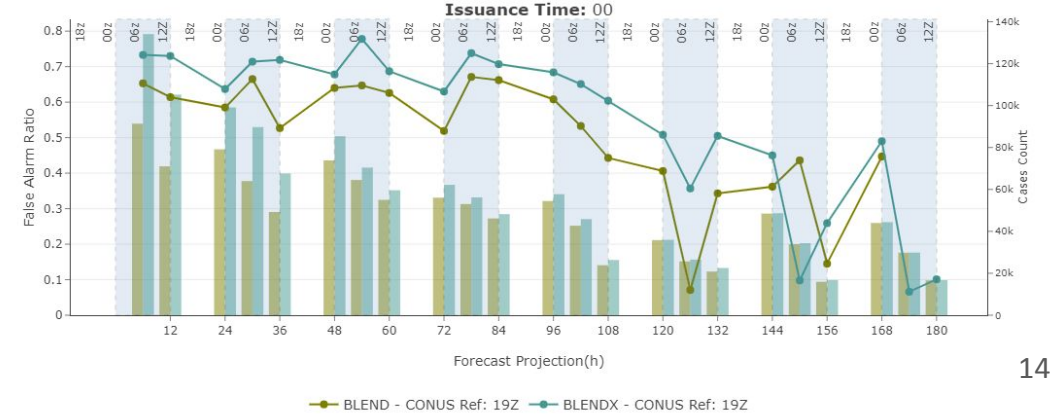
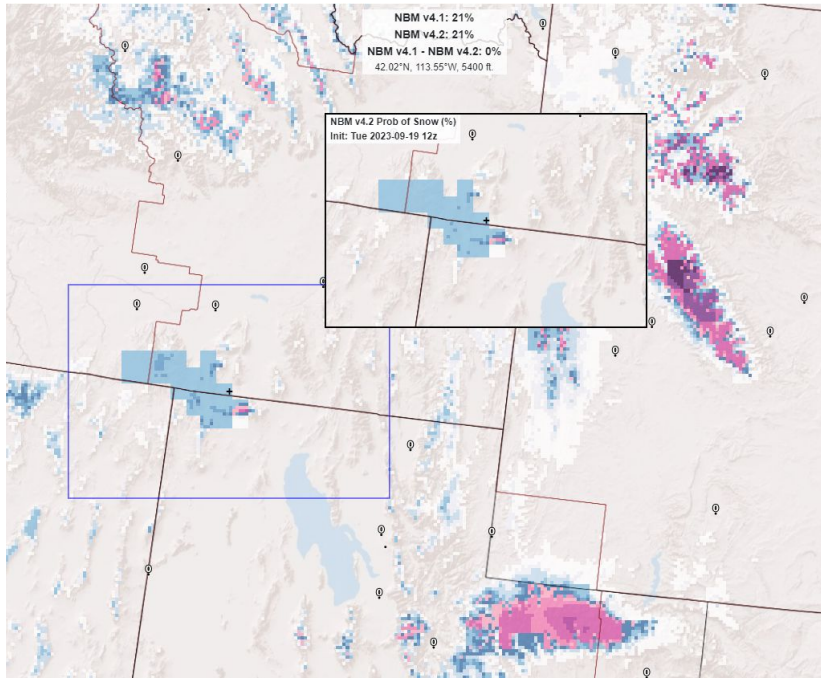


CONUS

Blocky Winter Fields

- Users started point out the issue of blocky precip fields in the NBM VLab forum in early October
- It was not a new issue, but it started getting attention as we moved into the winter precip season
- The issue was most pronounced in the F60-F84 time range
- NAM parent (12 km) was getting a 15% weighting at this range in v4.1, and that percentage was higher if other inputs were unavailable; for comparison, the GFS got 3%
- The parent NAM input is not downscaled in v4.1 (neither is the GFS), and this was identified as the primary cause of the blockiness
- The parent NAM is not part of the QPF QMD, so downscaled QPF output for the NAM does not exist
- The SAG recommended removing the *parent* NAM from the winter suite in October in v4.2 to try to address the blocky features
- Downscaled QMD QPF does exist for the GFS, so while the GFS may currently be contributing slightly to the blockiness, we did not want to discard that input; the v4.2 winter suite switched to using downscaled GFS QPF in October to improve the blockiness



Winter Weighting

4.1

Input Models	1-16	17-19	20-42	43-60	61-84	84+
HRRR	16					
HRRRX	6	17	17			
RAP	5	5				
RAPX	3	3	3			
HiResARW	10	11	12			
HiResARW 2	12	12	13			
HiResFV3	12	13	14	14		
NAM	3	3	4	7	15	
NAMnest	10	13	14	14		
10 SREF ARW	1/mem	1/mem	1/mem	3/mem	3/mem	
GFS	1	1	1	3	3	4
30 GEFS	0.15/mem	0.15/mem	0.15/mem	0.4/mem	0.65/mem	1.2/mem
50 ECMWF	0.15/mem	0.15/mem	0.15/mem	0.4/mem	0.65/mem	1.2/mem

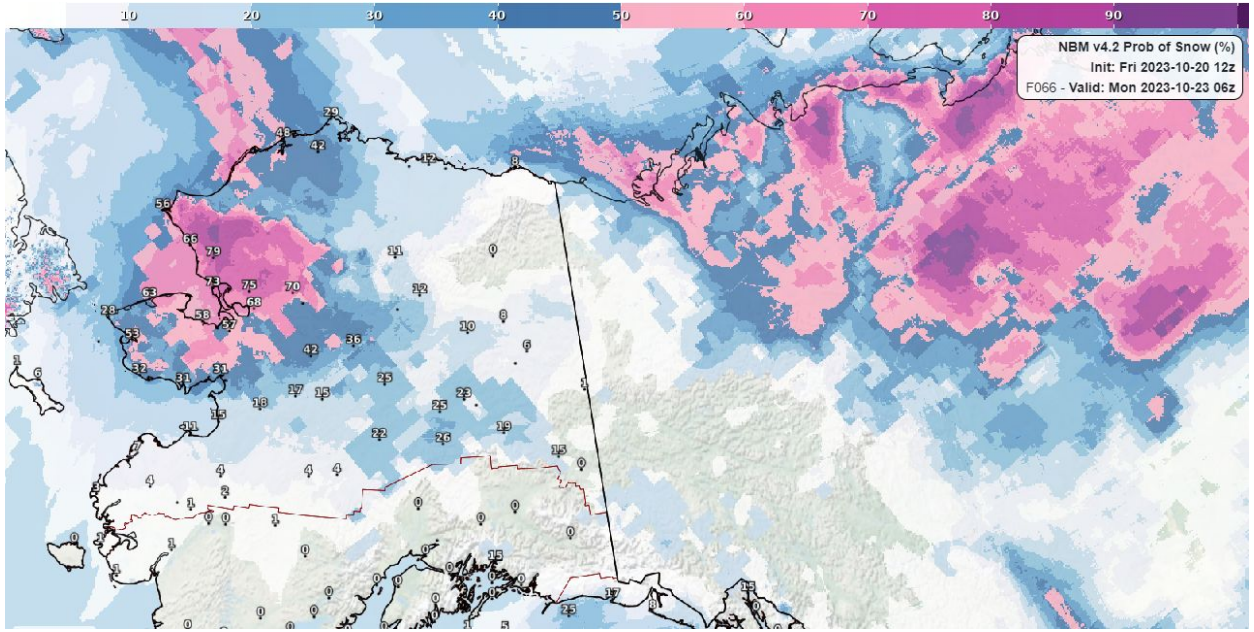
4.2

Input Models	1-16	17-19	20-42	43-60	61-84	84+
HRRR	16					
HRRRX	6	17	17			
RAP	5	5				
RAPX	3	3	3			
HiResARW	10	11	12			
HiResARW 2	12	12	13			
HiResFV3	12	13	14	17		
NAM	0	0	0	0	0	
NAMnest	12	15	16	17		
10 SREF ARW	1/mem	1/mem	1/mem	3/mem	3/mem	
GFS	2	2	3	4	4	4
30 GEFS	0.15/mem	0.15/mem	0.15/mem	0.4/mem	0.825/mem	1.2/mem
50 ECMWF	0.15/mem	0.15/mem	0.15/mem	0.4/mem	0.825/mem	1.2/mem

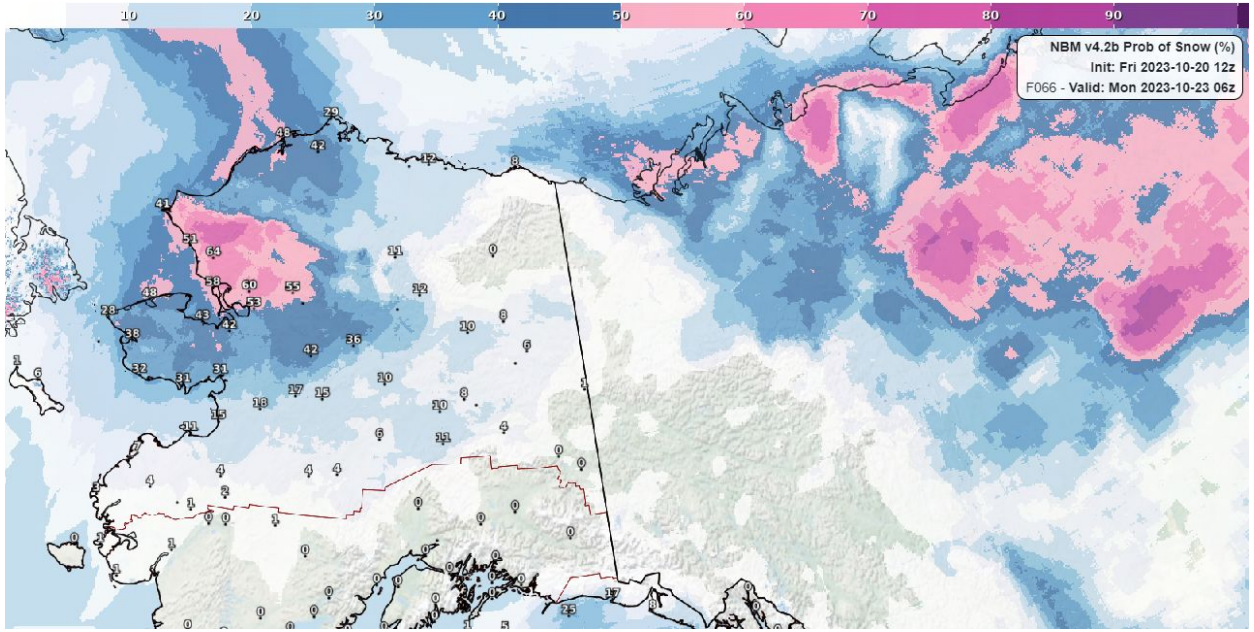
- A decision was made in October to remove usage of parent NAM for winter fields in v4.2 and redistribute weights to NAM Nest, GFS, and global ensembles

Removal of Blocky Features

v4.1

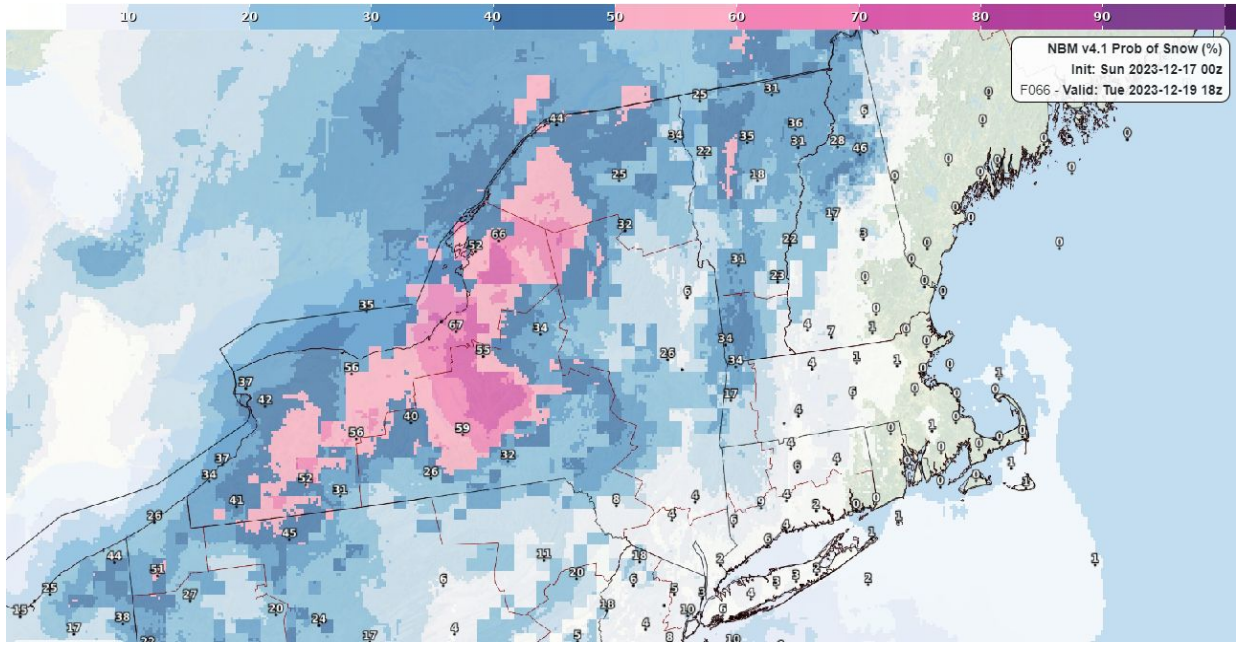


v4.2

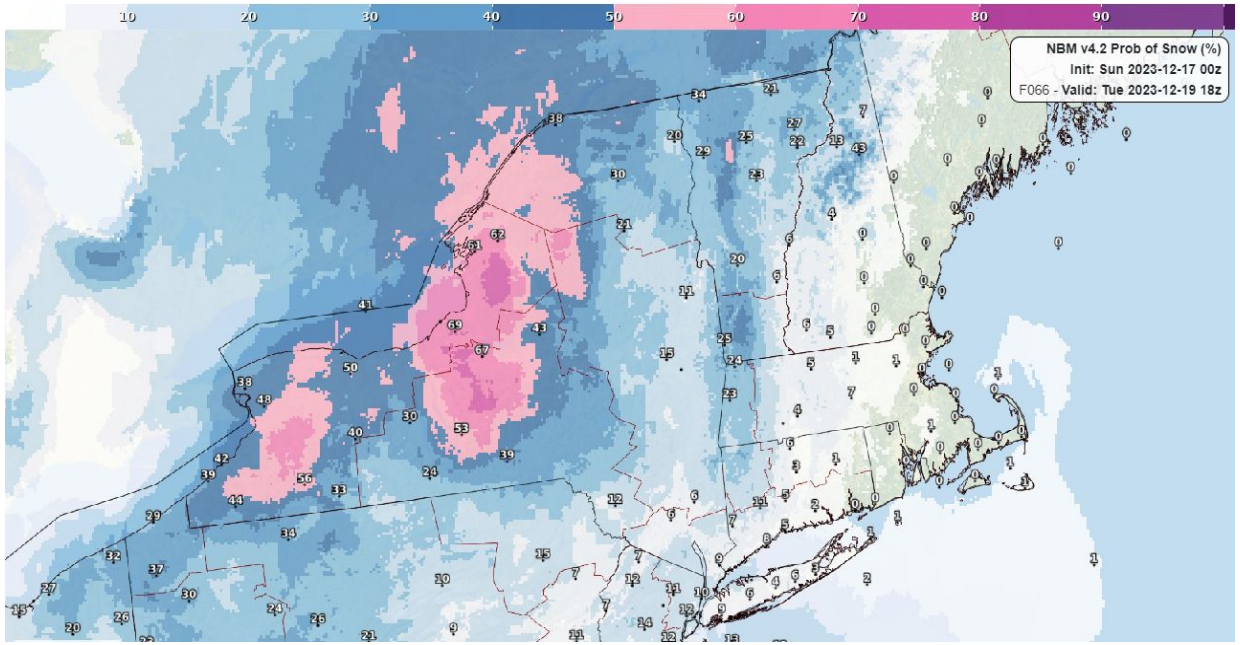


Removal of Blocky Features

v4.1



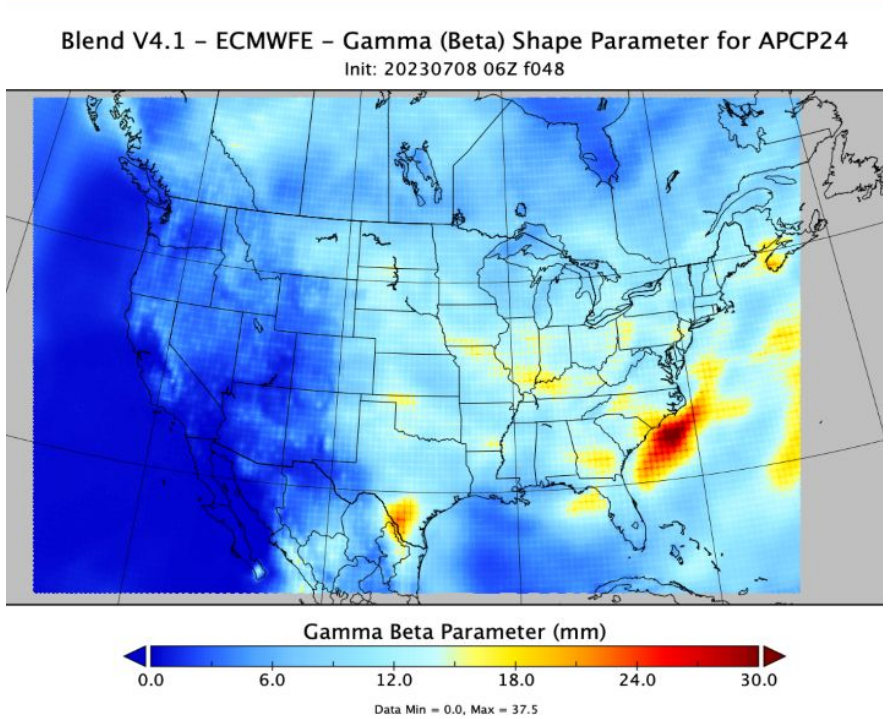
v4.2

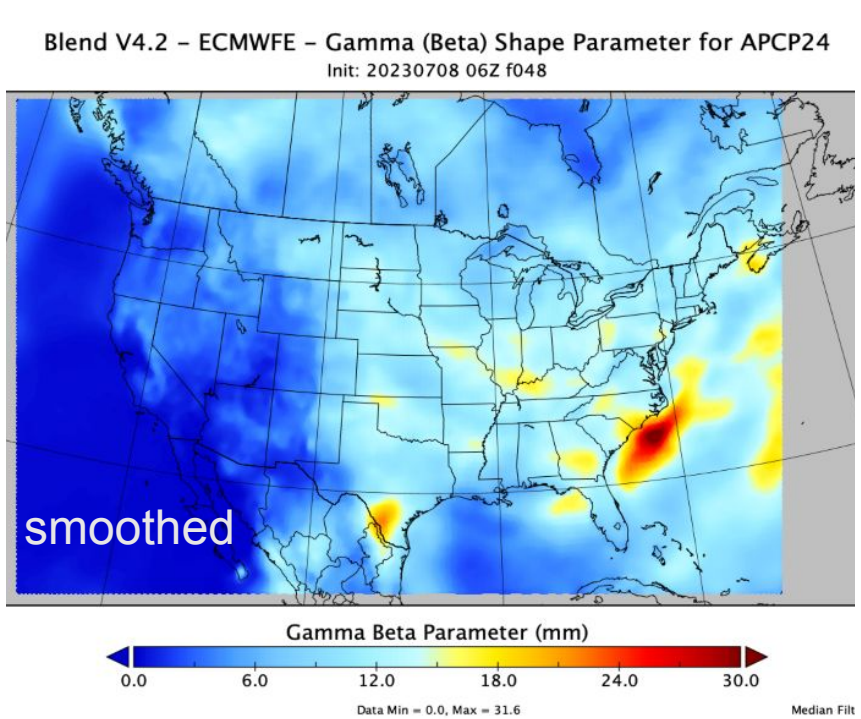


Mitigation of Lattice Features

- Lattice features are attributable to the individual model QPF CDFs used to generate the quantile mapping for snowfall amounts

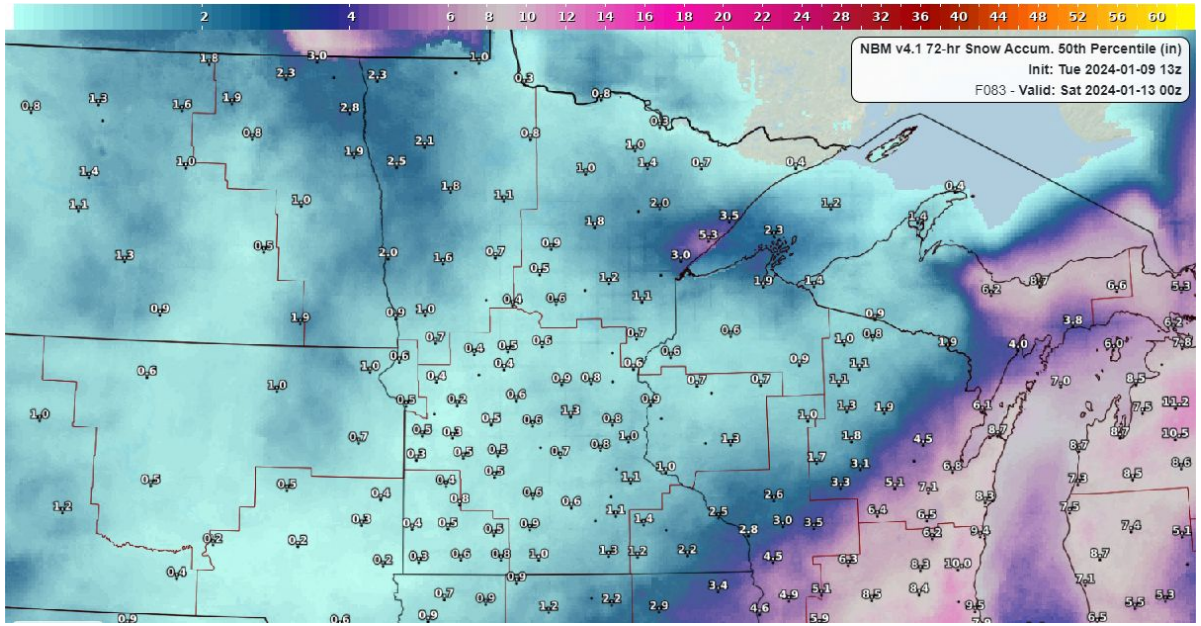
- The individual model QPF CDFs are now smoothed prior to the quantile mapping so that the snowfall probability distribution takes on a smoother appearance



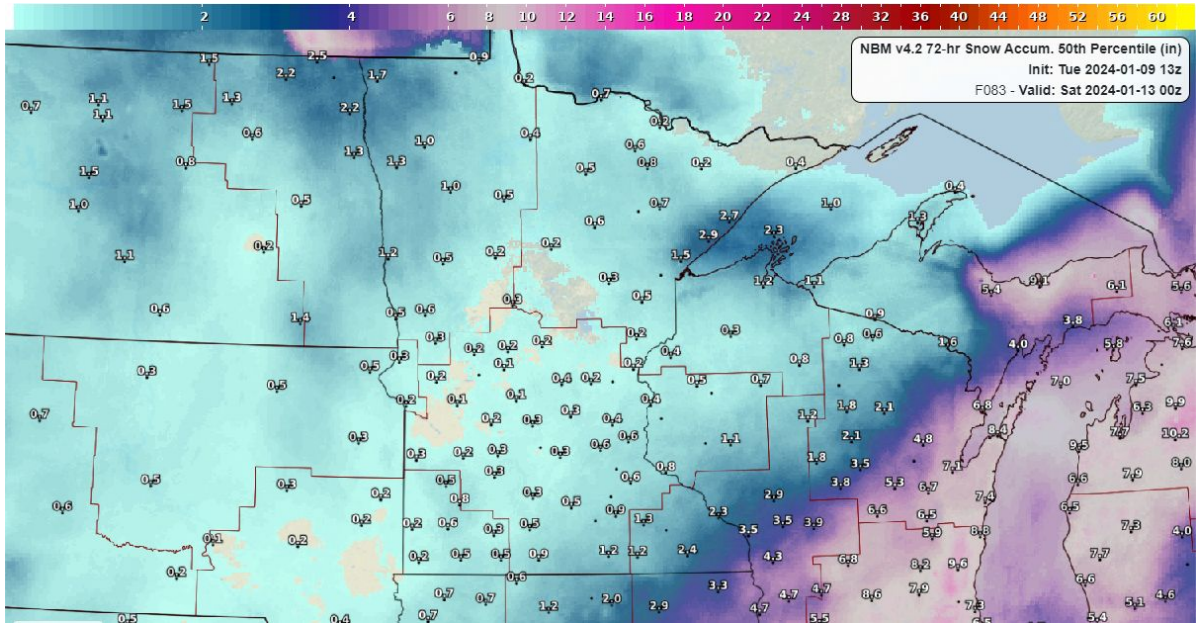


Mitigation of Lattice Features

v4.1



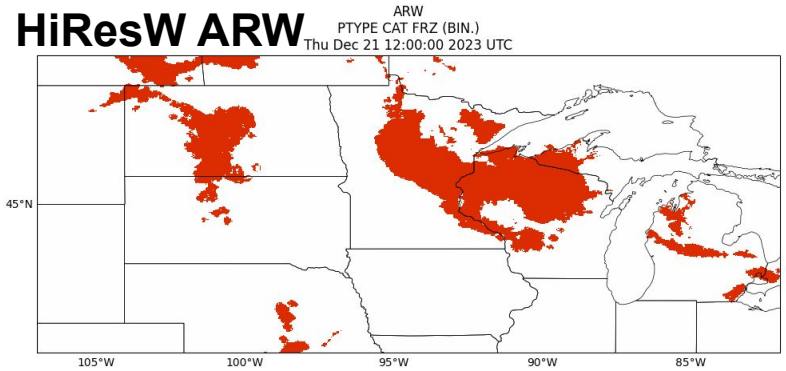
v4.2



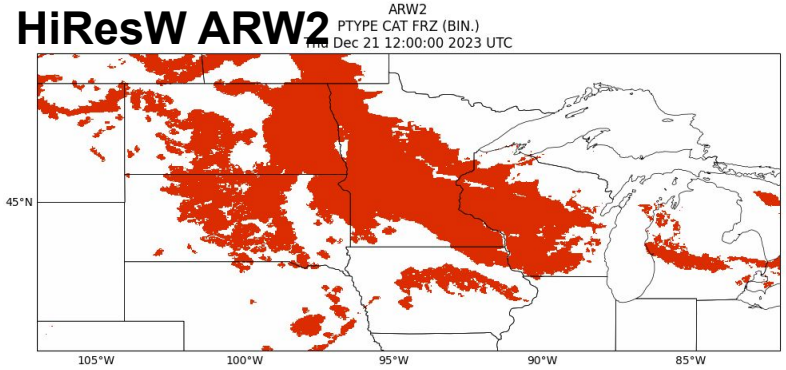
smoothed

High Freezing Rain Probs in Ops

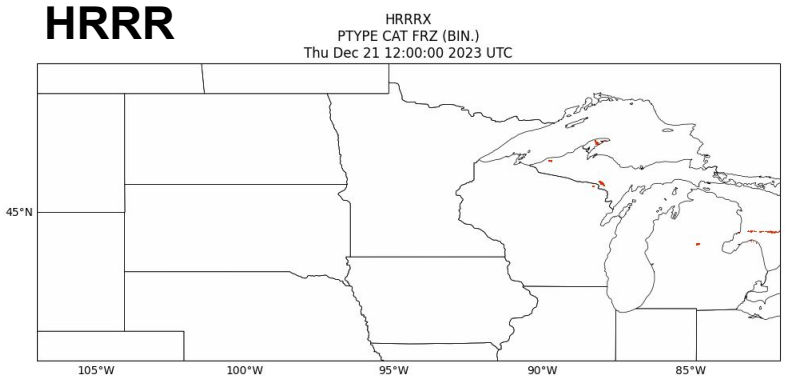
HiResW ARW



HiResW ARW2

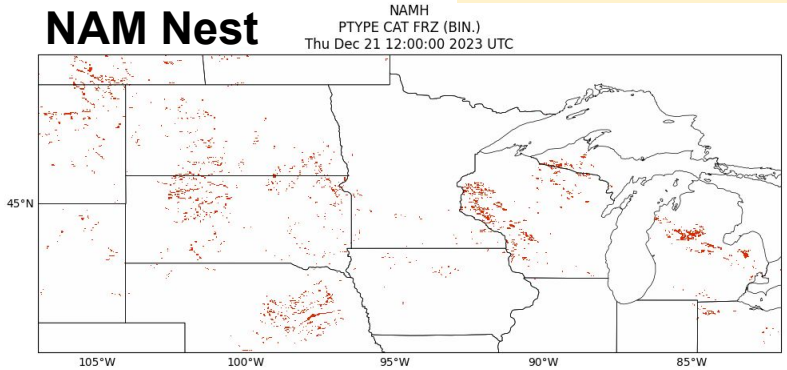


HRRR

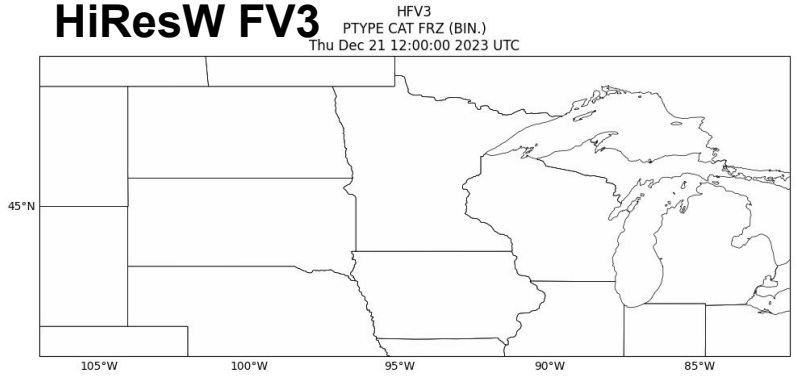


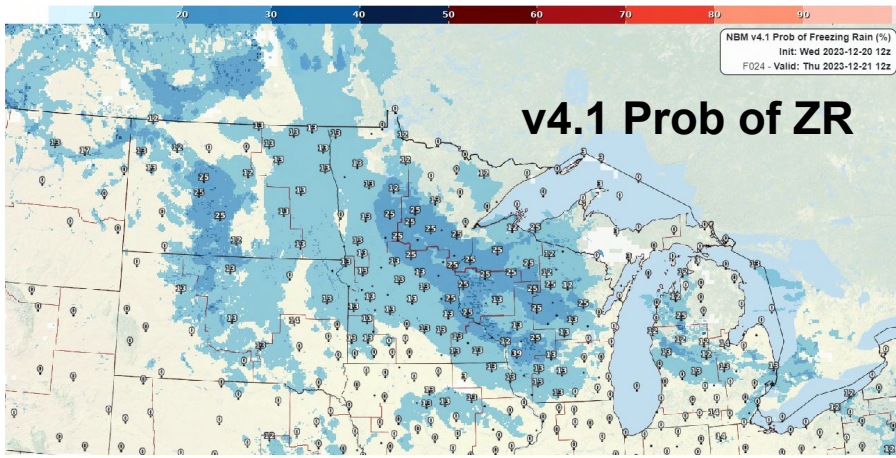
clearly driven by HiResW ARWs

NAM Nest



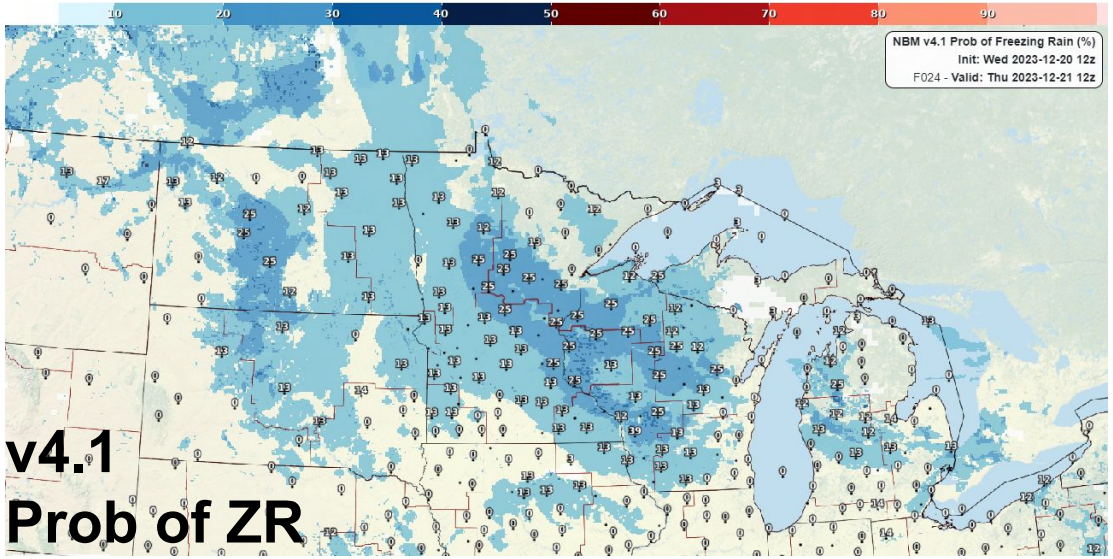
HiResW FV3



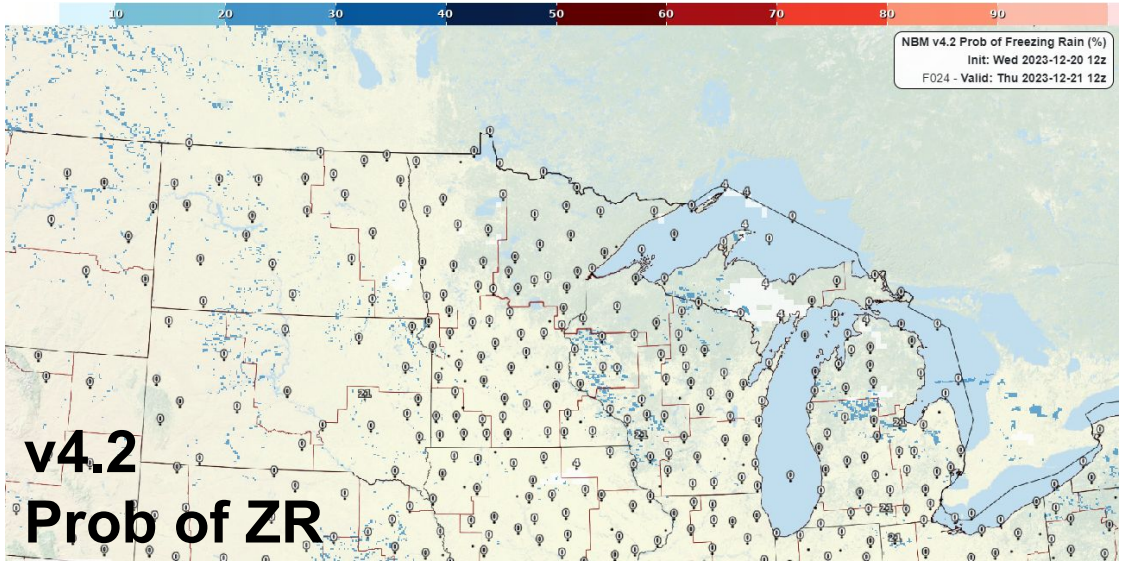


change was made to zero out HiResW ARW precip type if hourly QPF < 0.01”

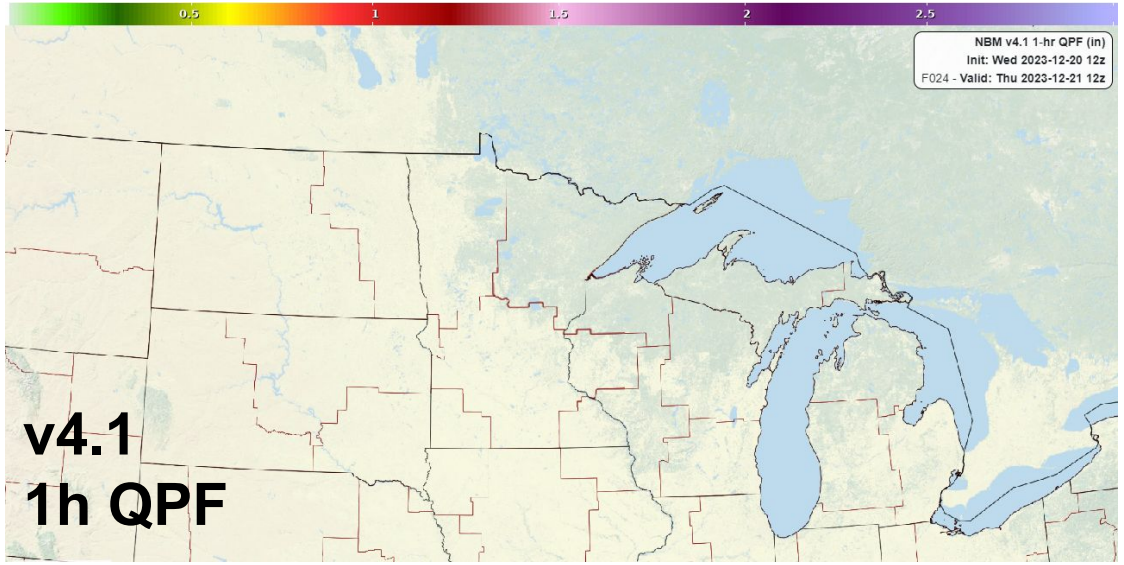
4.1 vs 4.2 ZR Comparison



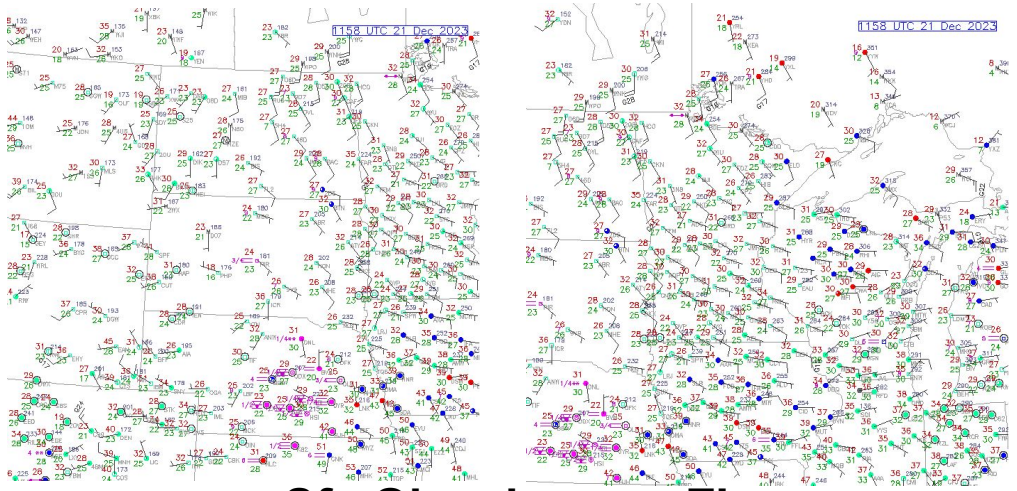
v4.1
Prob of ZR



v4.2
Prob of ZR



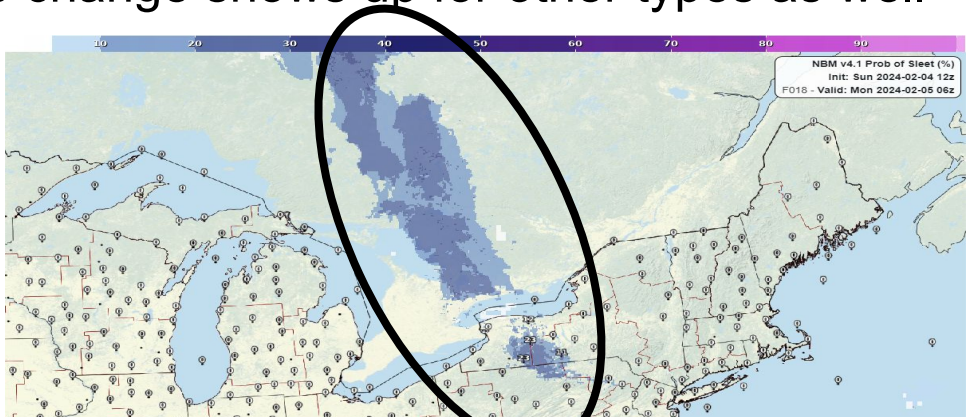
v4.1
1h QPF

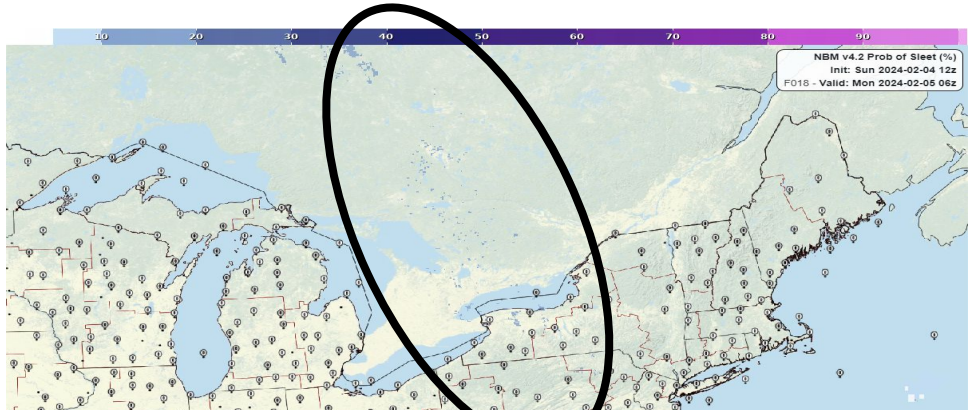


Sfc Obs show no ZL

ZR Discussion

- SMD is confident that this change significantly reduces the freezing drizzle footprint in the probability of ZR output, as the precip rate threshold needed for the ARW HiResWs to compute ptype is lower than for other inputs
- SMD and the SAG believes that this change is an overall improvement
- SMD believes that the NAM Nest covers the freezing drizzle threats fairly well, although the coverage is spotty (generally not a continuous field)
- This change was noted as a positive by several evaluators
- The change shows up for other types as well





Winds

- **Quantile mapping of instantaneous wind speed and gust is introduced in NBMv4.2**
- Wind speed and gust stats were overall improved, but most of the improvement was for light wind speeds; a significant low speed bias was found for higher wind speeds
- The initial quantile mapping for wind speed / gust used a single analysis CDF for each hour of the day, leading to small sample sizes, especially for stronger wind speeds during the late night / early morning
- Testing was performed with using a single analysis CDF covering the entire day, but this had the undesirable effect of reducing the wind speeds during “peak wind hours” (afternoon)
- SMD, with input from Science Advisory Group members, instead decided to again create an analysis CDF for each hour, with flexible time windows (using obs from multiple hours) used to increase the sample size. After more trial and error, this was set as the final configuration

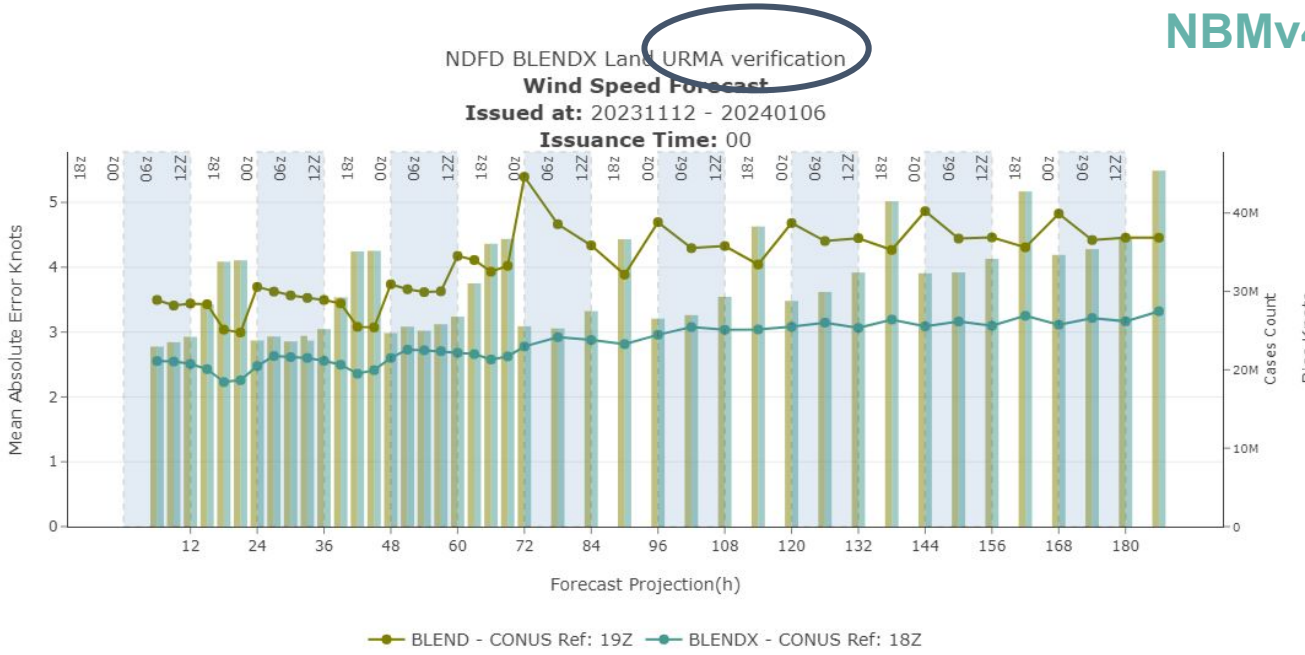
00z	01z	02z	03z	04z	05z	06z	07z	08z	09z	10z	11z	12z	13z	14z	15z	16z	17z	18z	19z	20z	21z	22z	23z
3	5	7	9	11	11	13	13	13	13	11	9	7	7	5	5	3	3	3	3	3	3	3	3

This chart shows how many hours are used to create the analysis CDF at each hour of the day. For example, at 09Z, a 13 hour window is used, meaning that analysis data is used from 03, 04, 05, 06, 07, 08, 09, 10, 11, 12, 13, 14, and 15Z to create the 09Z analysis CDF

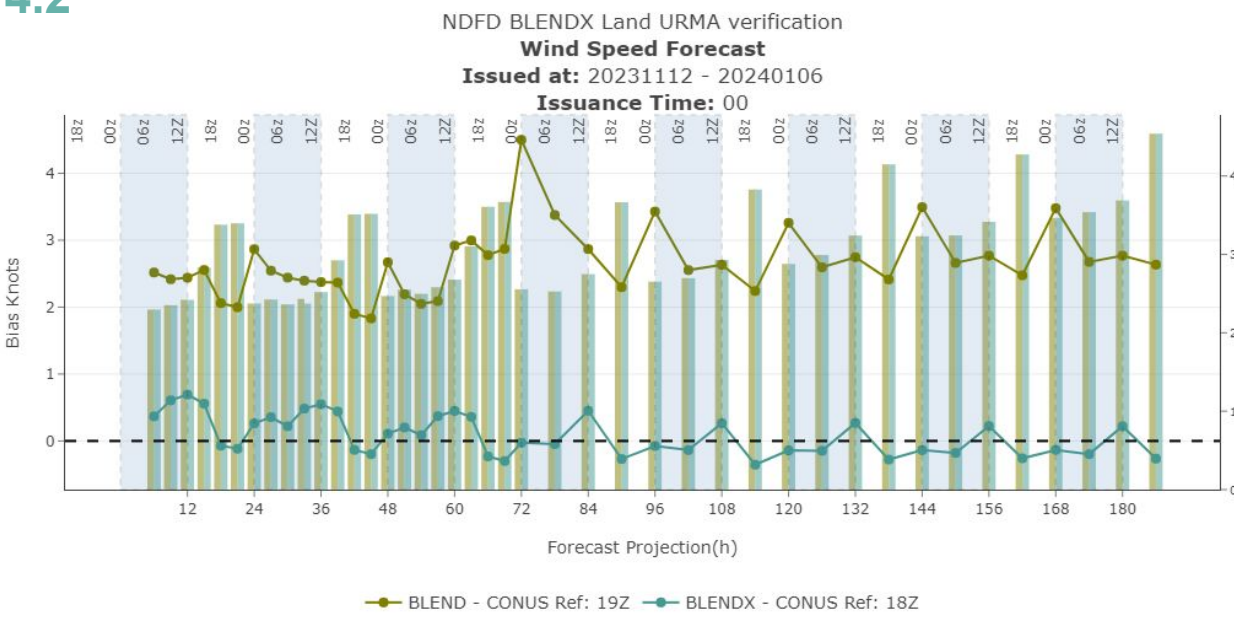
Wind Stats

MAE

NBMv4.1
NBMv4.2



BIAS



- Clear improvement in MAE and Bias for v4.2 across all wind speeds

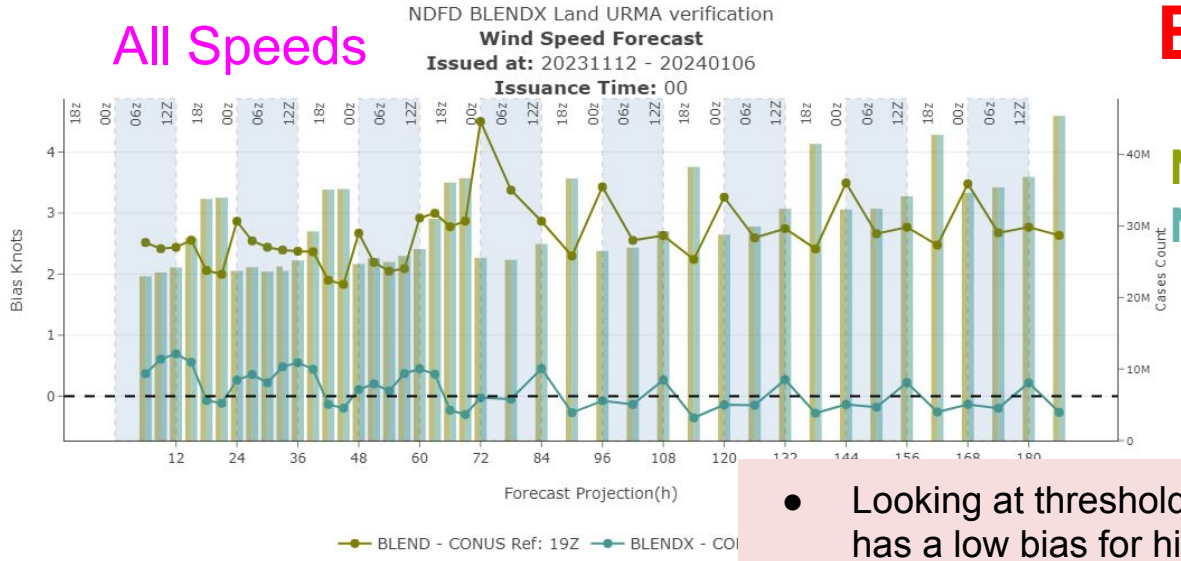
CONUS

- The high speed bias in v4.1 (ops) is quite evident, and v4.2 bias looks great

Wind Stats

BIAS

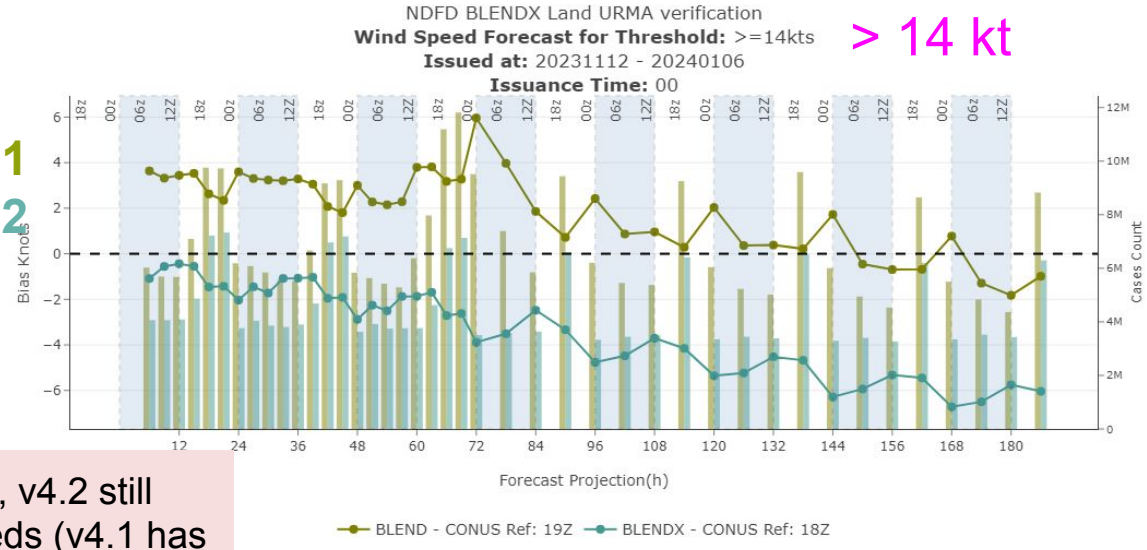
All Speeds



NBMv4.1

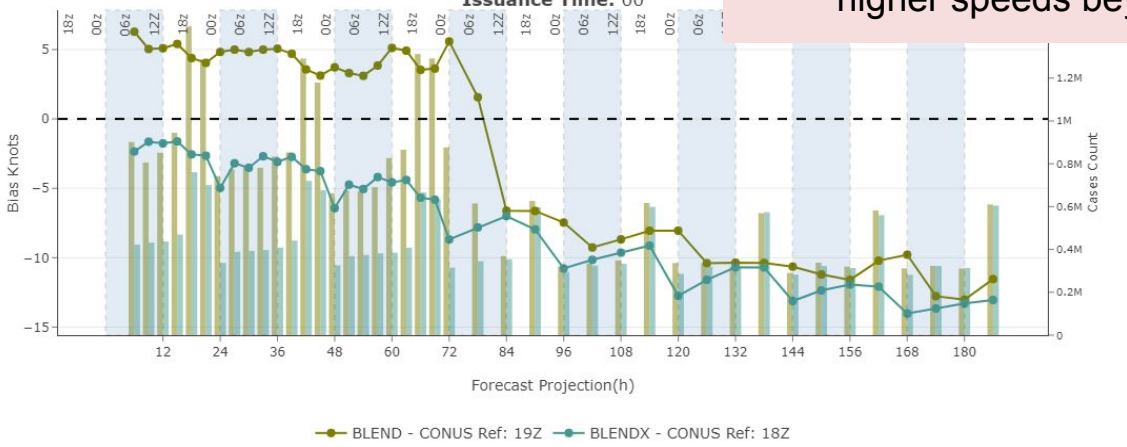
NBMv4.2

> 14 kt

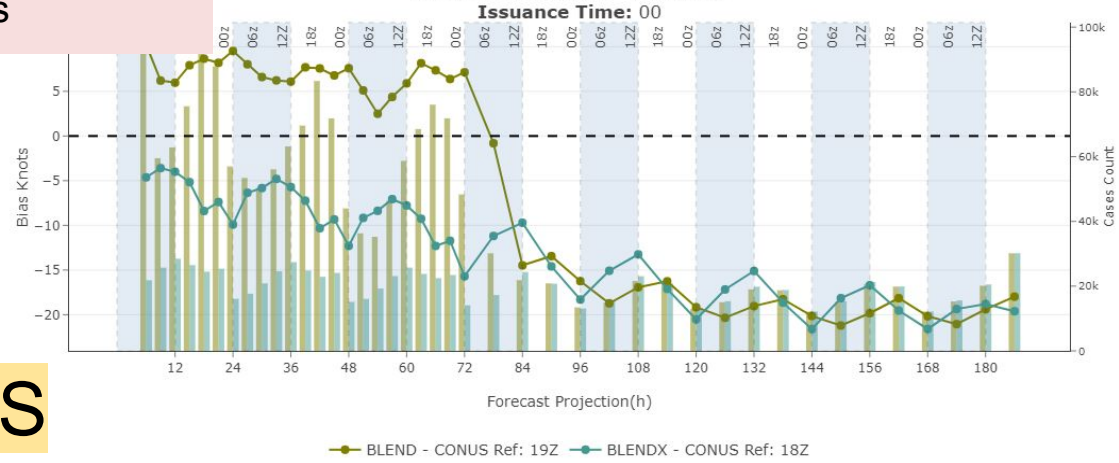


- Looking at thresholds, though, v4.2 still has a low bias for higher speeds (v4.1 has a high bias); both have a low bias at higher speeds beyond 78 hours

> 23 kt



> 32 kt

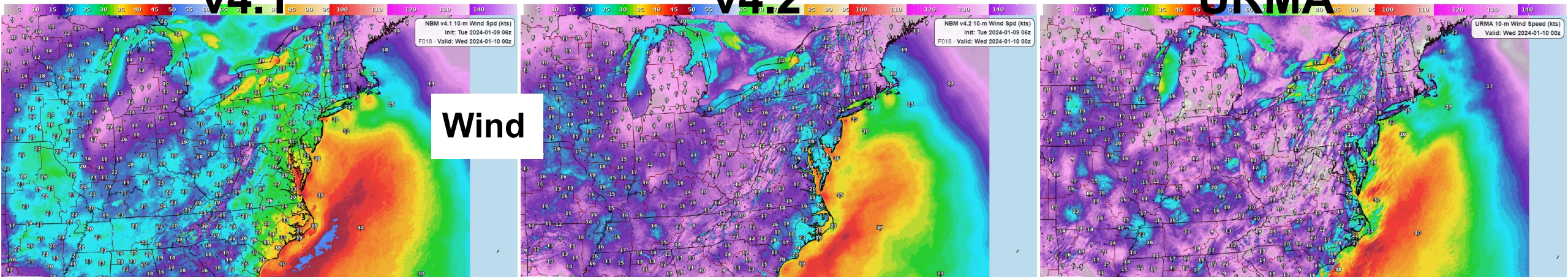


CONUS

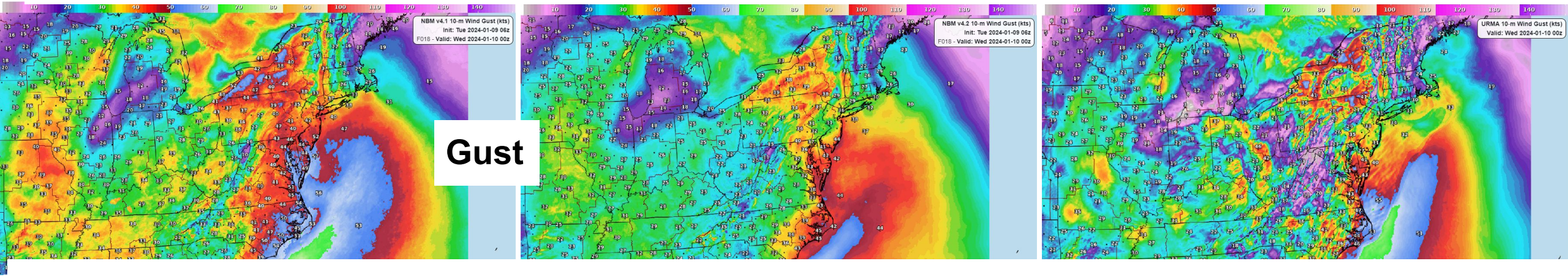
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

January 8 Storm Wind & Gusts

v4.1 | v4.2 | URMA

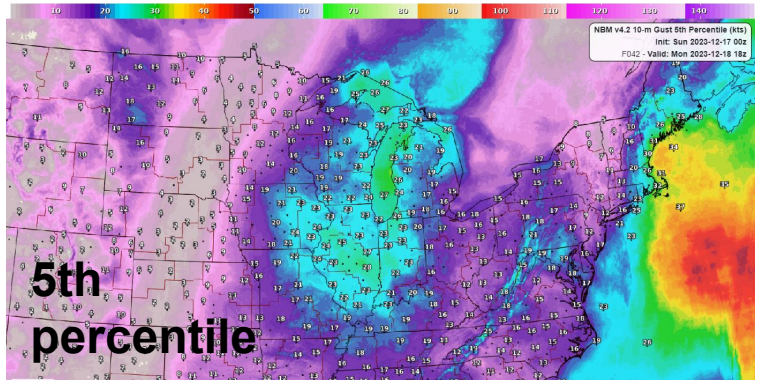


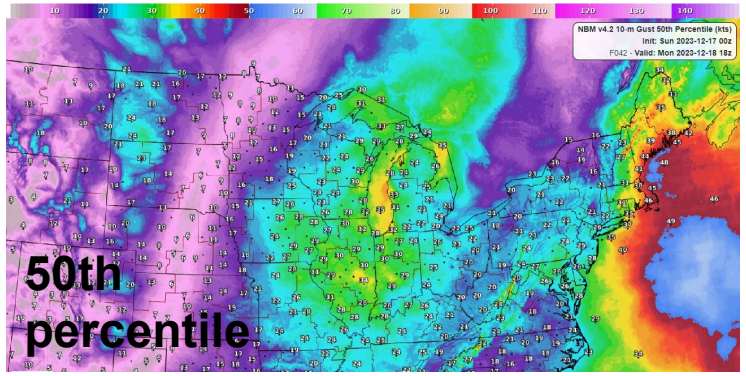
- for wind, 4.1 is too strong; 4.2 is a bit too weak in a few areas but is consistently closer to URMA

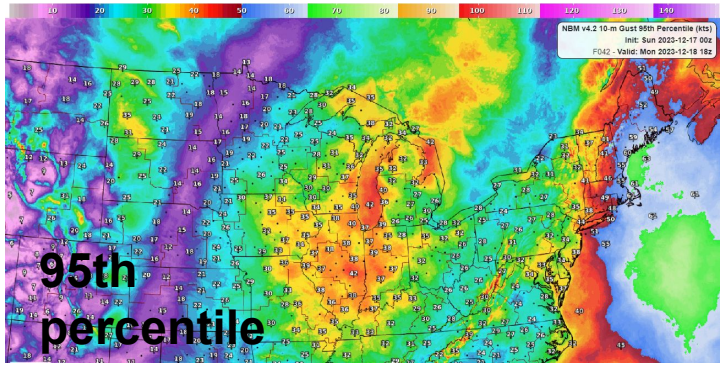


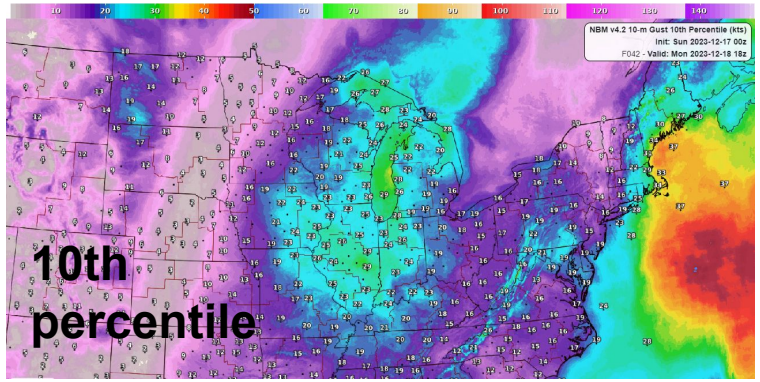
- for gust, 4.1 has too much coverage of high speeds, but 4.2 misses the higher end events, esp. over terrain

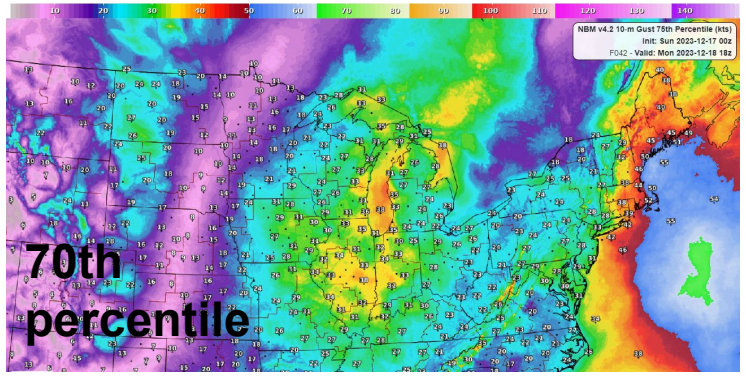
December Storm - v4.2 Gust Percentiles

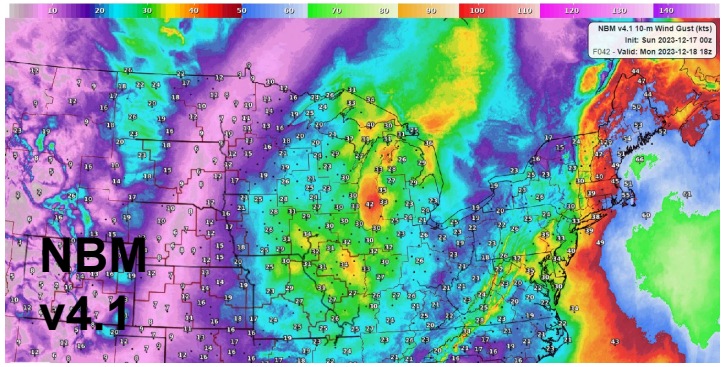


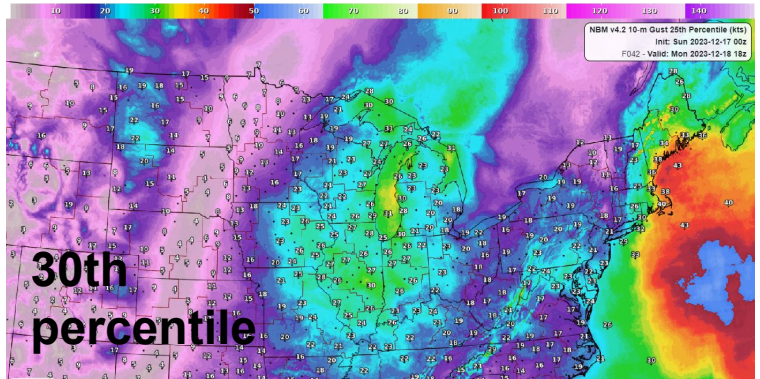


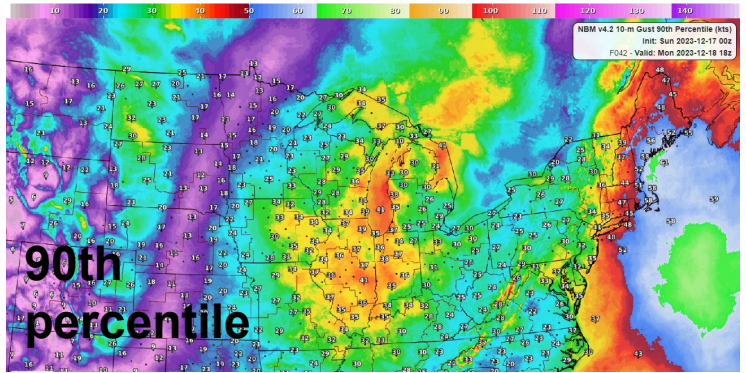


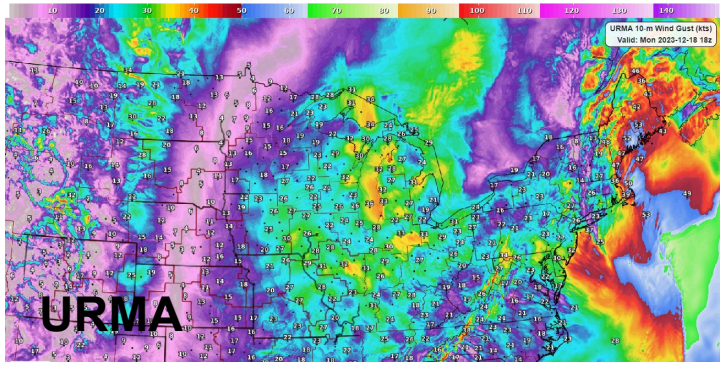












Overall Thoughts on v4.2 Winds

- Sustained wind speed appears to be significantly improved in v4.2; the winds in v4.1 have a notable high bias at shorter forecast lengths and have been called “unusable” by some forecasters

- That said, v4.2 wind speed has a clear very low bias for higher thresholds, especially at longer forecast lengths; higher percentiles should be a good alternative for much higher thresholds, and even the highest v4.2 percentiles may be needed for the very high end events, especially over higher terrain

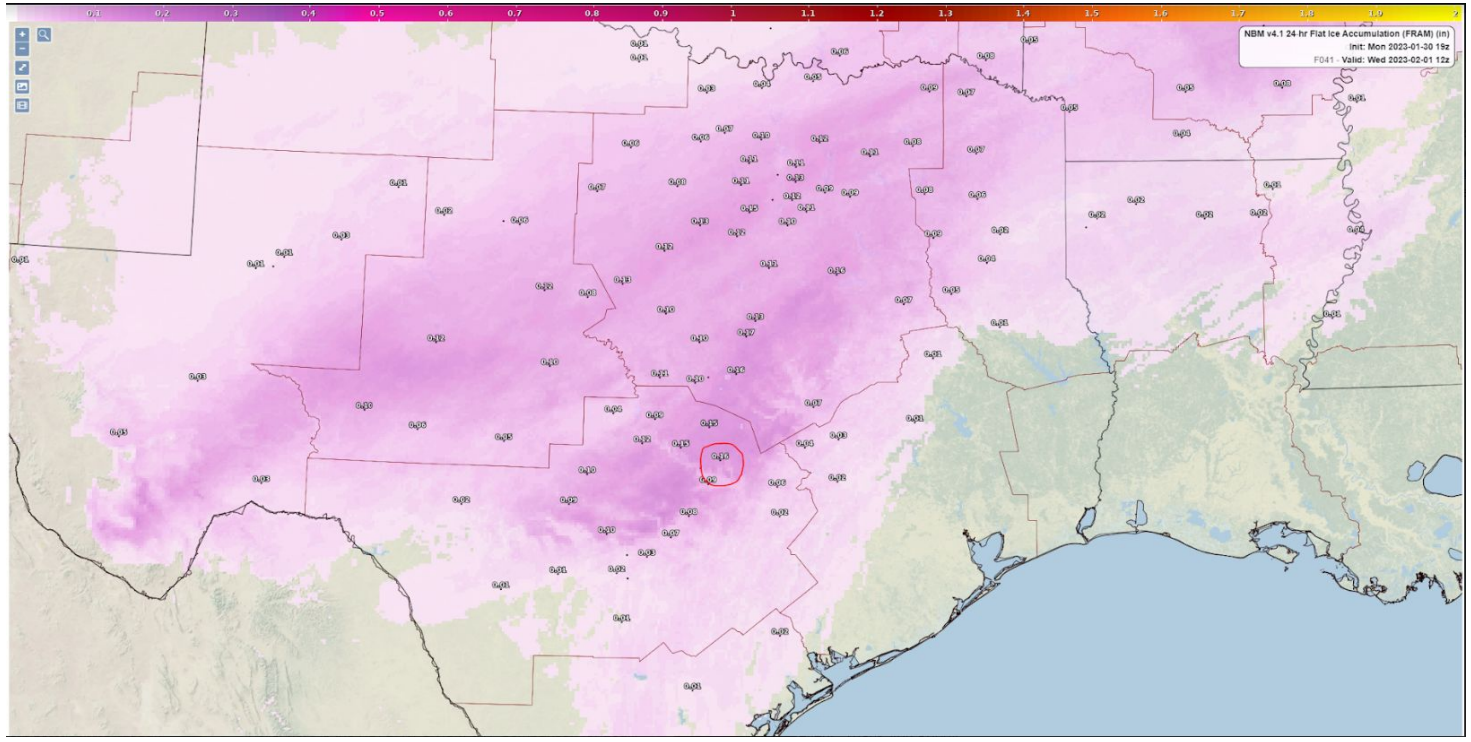
- The same is true for gusts; there is a low bias, especially at longer forecast lengths, but higher percentiles should be usable to capture the observed values

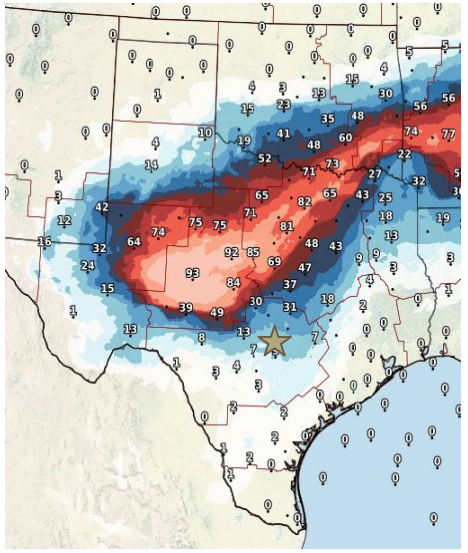
- There is concern that only the 10th, 50th, and 90th percentiles will be distributed over the SBN; regional LDM feeds can hopefully be leveraged to provide additional percentiles

Winter Product Inconsistencies

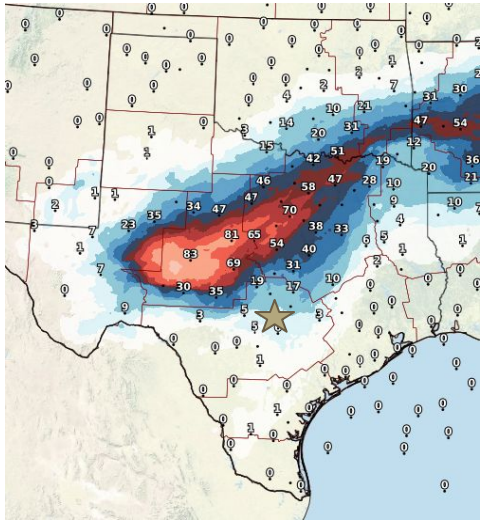
Austin, TX 2023 Ice Storm

19Z 1/30/24 Deterministic ZR Total at F41





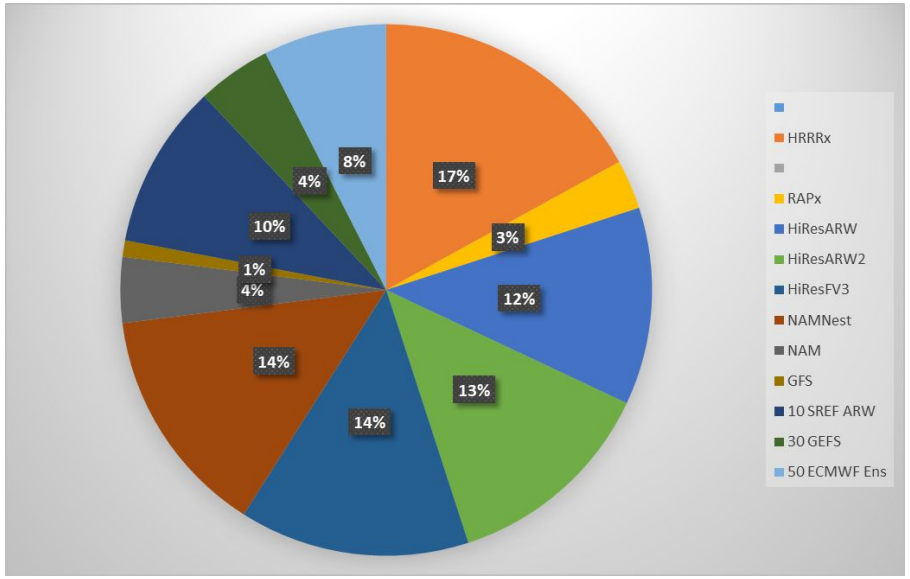
Prob > .01” ZR

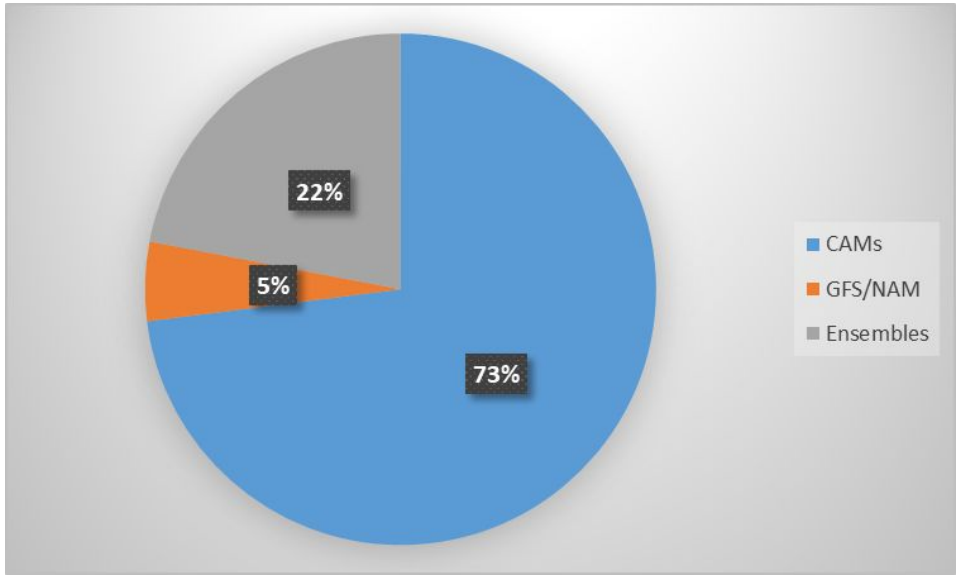


Prob > .1” ZR

credit: Andy Just, CRH

Austin, TX 2023 Ice Storm

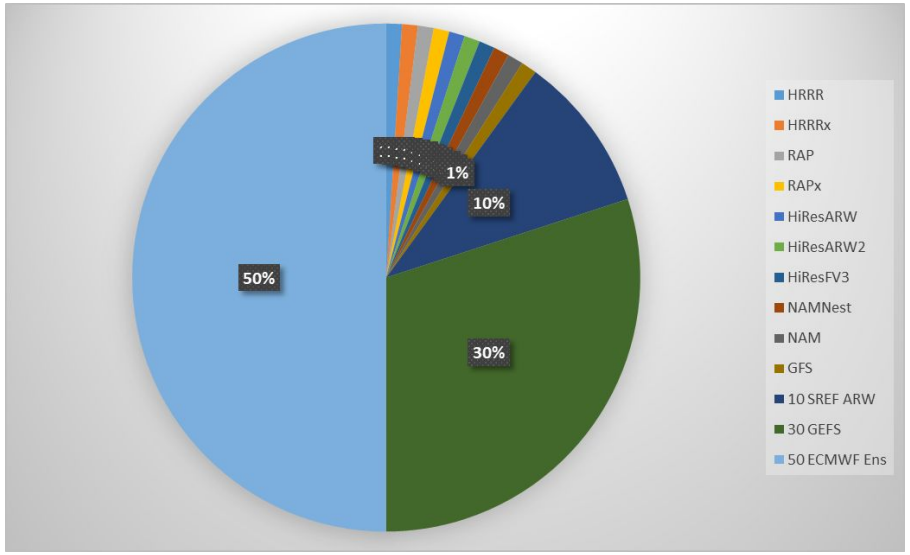


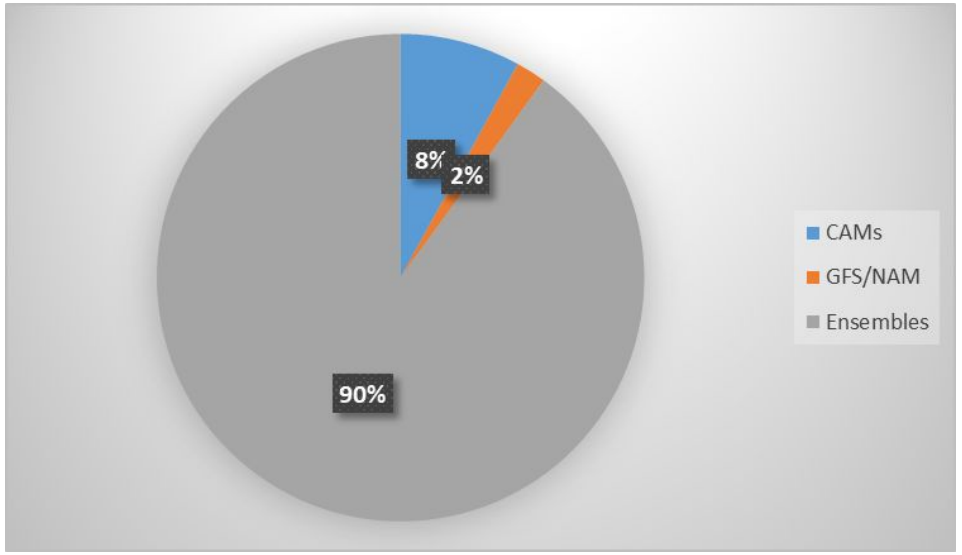


Deterministic Hours 20-41

largest influence is from the hi-res guidance

remember that the percentages are slightly different now in v4.2 (see slide 16)

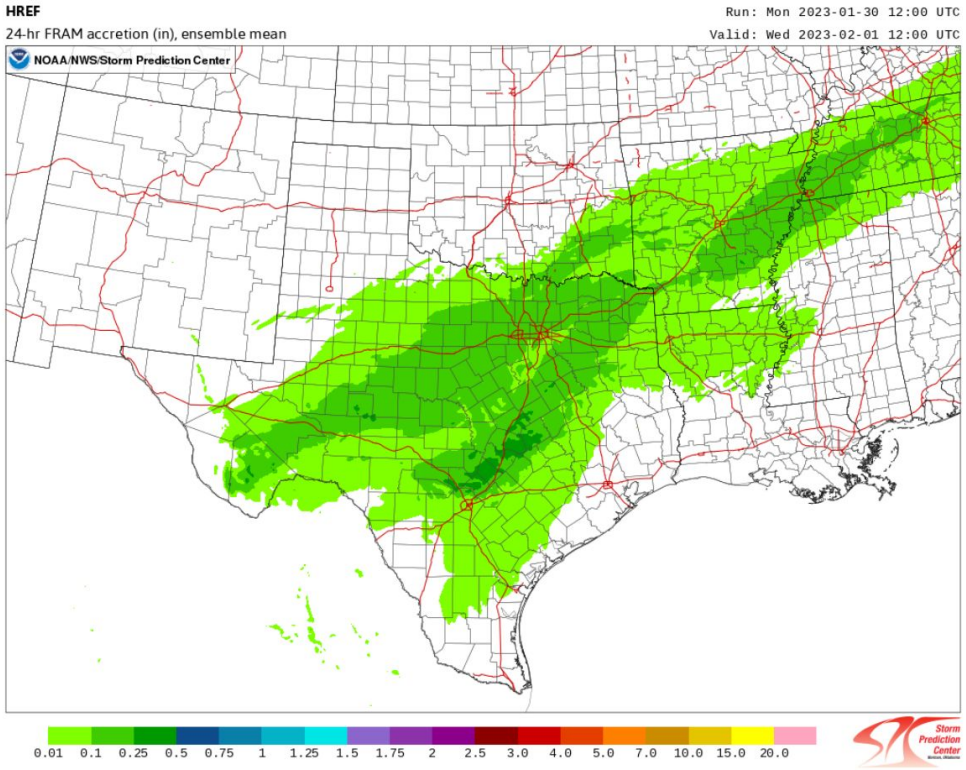


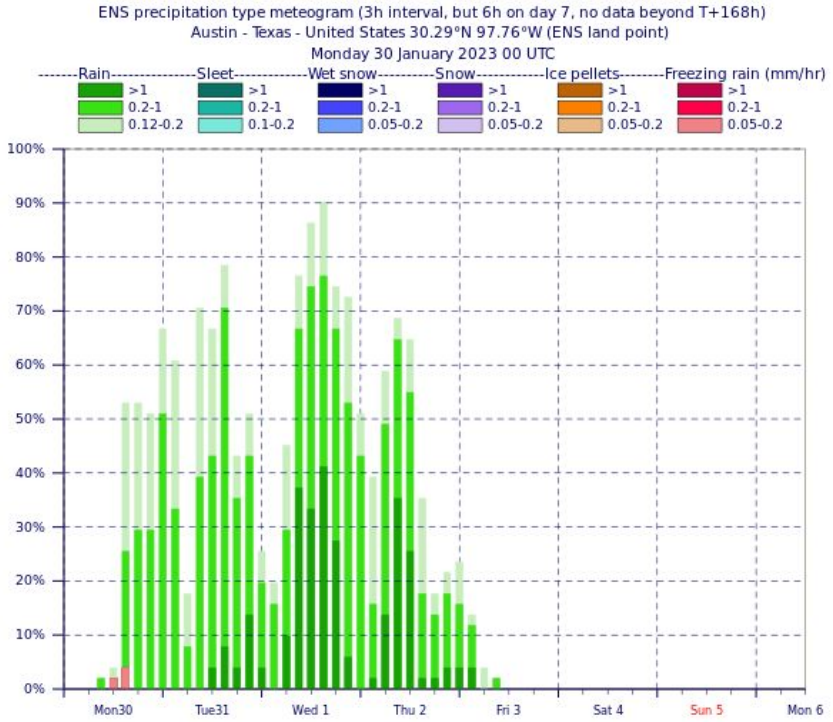


Probabilistic All Fcst Hours

largest influence is from the ensembles

Austin, TX 2023 Ice Storm





CAMs had strong signal for significant ice accumulations near Austin

But the global ensembles, especially the EPS, showed mostly rain near Austin at this range

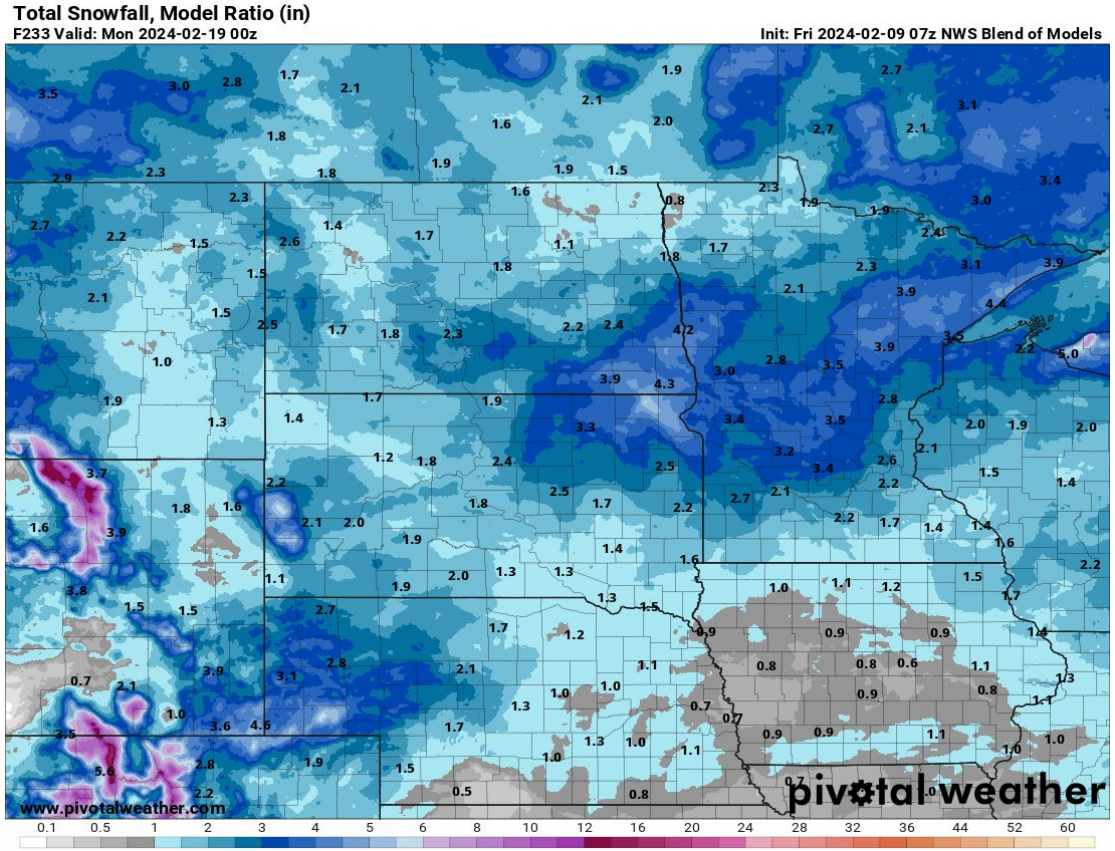
Austin, TX 2023 Ice Storm

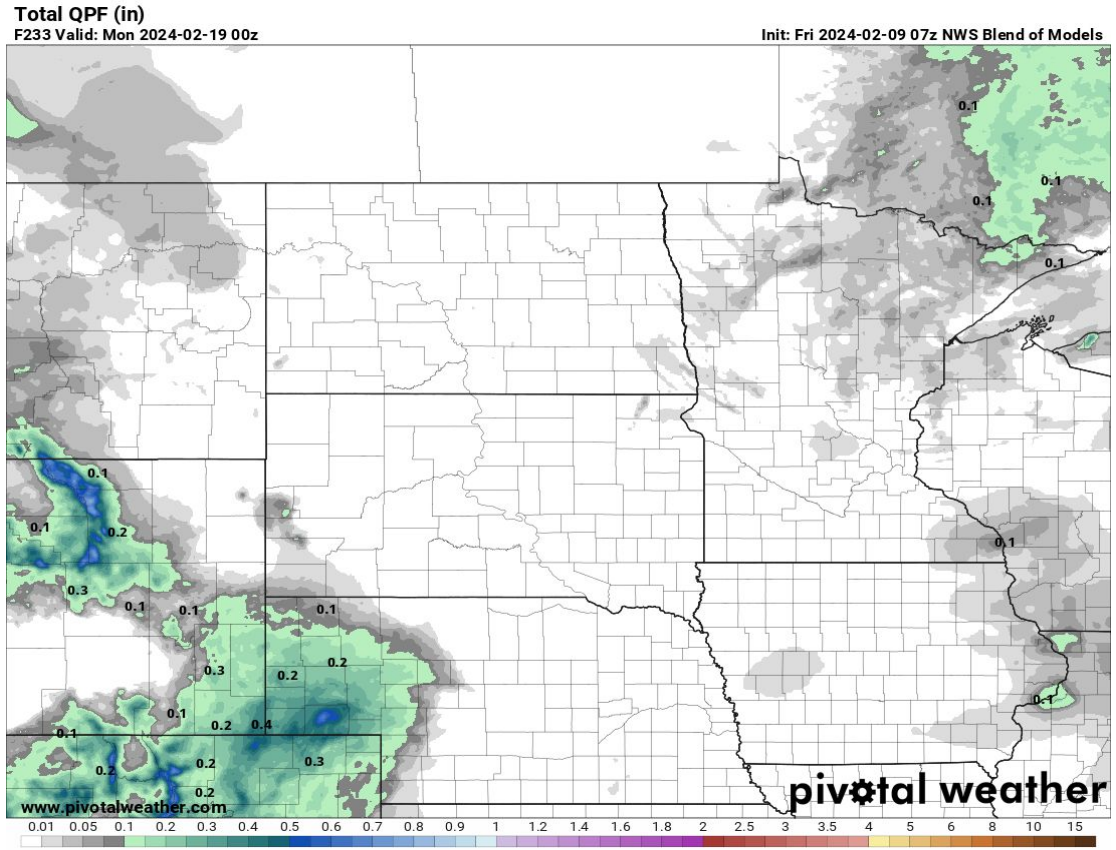
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1	NBM	HRRR	RAP	GLMP	NAM	HRRRX	RAPX	NAMNest	ARW	ARW2	FV3	HWRF	HMON	RDPS	REPS	SREF	GFS	GEFS	GMOS	GDPS	GEPS	NAVGEMD	NAVGEME	ECMWFD	ECMWFE
2	Res	3km	13km	2.5km	12km	3km	13km	3km	3km	3km	3km	1.5km	1.5km	10km	15km	16km	13km	25km	2.5km	25km	50km	50km	50km	25km	50km
3	00z	22z	22z	23z	18z	18z	**21z**	18z	12z	12z	12z	**18z**	**18z**	18z	12z	15z	18z	**18z**	12z	12z	12z	**18z**	12z	12z	12z
4	01z	23z	23z	00z	18z	18z	21z	18z	12z	12z	12z	18z	18z	18z	12z	**21z**	18z	18z	12z	12z	12z	18z	12z	12z	12z
5	02z	00z	00z	01z	18z	18z	21z	18z	12z	12z	12z	18z	18z	18z	12z	21z	18z	18z	12z	12z	12z	18z	12z	12z	12z
6	03z	01z	01z	02z	**00z**	**00z**	21z	**00z**	12z	12z	12z	18z	18z	18z	12z	21z	18z	18z	12z	12z	12z	18z	12z	12z	12z
7	04z	02z	02z	03z	00z	00z	21z	00z	**00z**	**00z**	**00z**	18z	18z	**00z**	12z	21z	18z	18z	12z	12z	12z	18z	12z	12z	12z
8	05z	03z	03z	04z	00z	00z	21z	00z	00z	00z	00z	18z	18z	00z	12z	21z	**00z**	18z	12z	**00z**	12z	18z	12z	12z	12z
9	06z	04z	04z	05z	00z	00z	**03z**	00z	00z	00z	00z	**00z**	**00z**	00z	12z	21z	00z	**00z**	12z	00z	12z	**00z**	**00z**	12z	12z
10	07z	05z	05z	06z	00z	00z	03z	00z	00z	00z	00z	00z	00z	00z	**00z**	**03z**	00z	00z	**00z**	00z	**00z**	00z	00z	12z	12z
11	08z	06z	06z	07z	00z	00z	03z	00z	00z	00z	00z	00z	00z	00z	00z	03z	00z	00z	00z	00z	00z	00z	00z	**00z**	12z
12	09z	07z	07z	08z	**06z**	**06z**	03z	**06z**	00z	00z	00z	00z	00z	00z	00z	03z	00z	00z	00z	00z	00z	00z	00z	00z	**00z**
13	10z	08z	08z	09z	06z	06z	03z	06z	00z	00z	00z	00z	00z	**06z**	00z	03z	00z	00z	00z	00z	00z	00z	00z	00z	00z
14	11z	09z	09z	10z	06z	06z	03z	06z	00z	00z	00z	00z	00z	06z	00z	03z	**06z**	00z	00z	00z	00z	00z	00z	00z	00z
15	12z	10z	10z	11z	06z	06z	**09z**	06z	00z	00z	00z	**06z**	**06z**	06z	00z	03z	06z	**06z**	00z	00z	00z	**06z**	00z	00z	00z
16	13z	11z	11z	12z	06z	06z	09z	06z	00z	00z	00z	06z	06z	06z	00z	**09z**	06z	06z	00z	00z	00z	06z	00z	00z	00z
17	14z	12z	12z	13z	06z	06z	09z	06z	00z	00z	00z	06z	06z	06z	00z	09z	06z	06z	00z	00z	00z	06z	00z	00z	00z
18	15z	13z	13z	14z	**12z**	**12z**	09z	**12z**	00z	00z	00z	06z	06z	06z	00z	09z	06z	06z	00z	00z	00z	06z	00z	00z	00z
19	16z	14z	14z	15z	12z	12z	09z	12z	**12z**	**12z**	**12z**	06z	06z	**12z**	00z	09z	06z	06z	00z	00z	00z	06z	00z	00z	00z
20	17z	15z	15z	16z	12z	12z	09z	12z	12z	12z	12z	06z	06z	12z	00z	09z	**12z**	06z	00z	**12z**	00z	06z	00z	00z	00z
21	18z	16z	16z	17z	12z	12z	**15z**	12z	12z	12z	12z	**12z**	**12z**	12z	00z	09z	12z	**12z**	00z	12z	00z	**12z**	**12z**	00z	00z
22	19z	17z	17z	18z	12z	12z	15z	12z	12z	12z	12z	12z	12z	12z	**12z**	**15z**	12z	12z	**12z**	12z	**12z**	12z	12z	00z	00z
23	20z	18z	18z	19z	12z	12z	15z	12z	12z	12z	12z	12z	12z	12z	12z	15z	12z	12z	12z	12z	12z	12z	12z	**12z**	00z
24	21z	19z	19z	20z	**18z**	**18z**	15z	**18z**	12z	12z	12z	12z	12z	12z	12z	15z	12z	12z	12z	12z	12z	12z	12z	12z	**12z**
25	22z	20z	20z	21z	18z	18z	15z	18z	12z	12z	12z	12z	12z	**18z**	12z	15z	12z	12z	12z	12z	12z	12z	12z	12z	12z
26	23z	21z	21z	22z	18z	18z	15z	18z	12z	12z	12z	12z	12z	18z	12z	15z	**18z**	12z	12z	12z	12z	12z	12z	12z	12z

The 19Z NBM cycle uses the 00Z EPS for input

- Currently constructing ways to avoid this type of deterministic vs probabilistic inconsistency

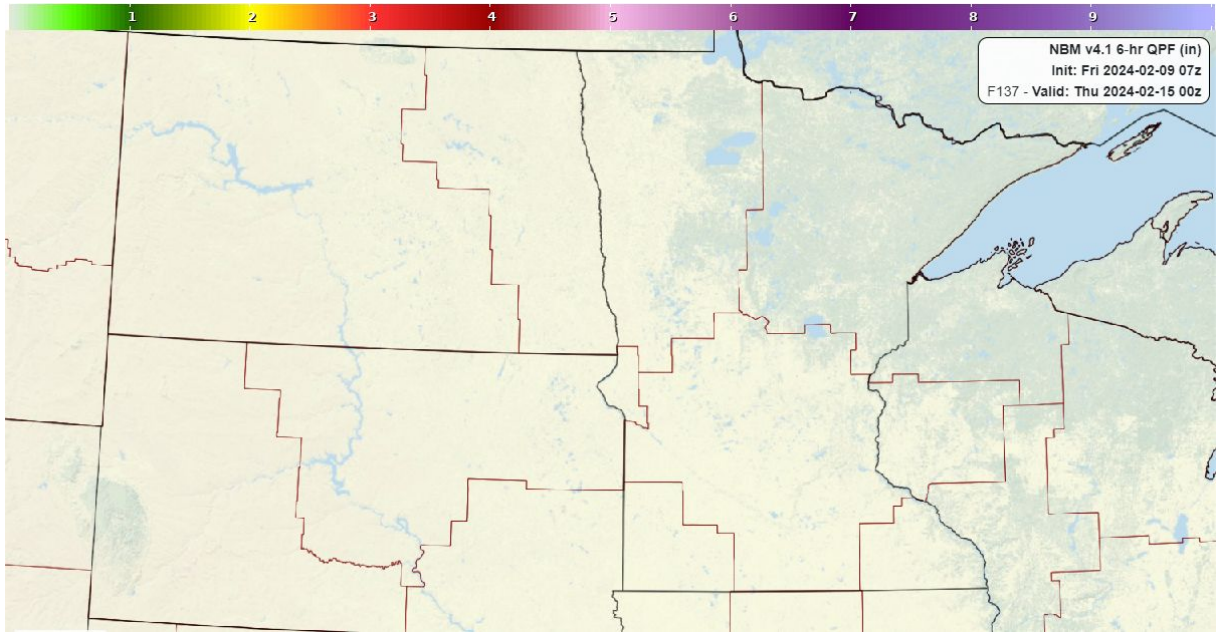
Recent Product Confusion



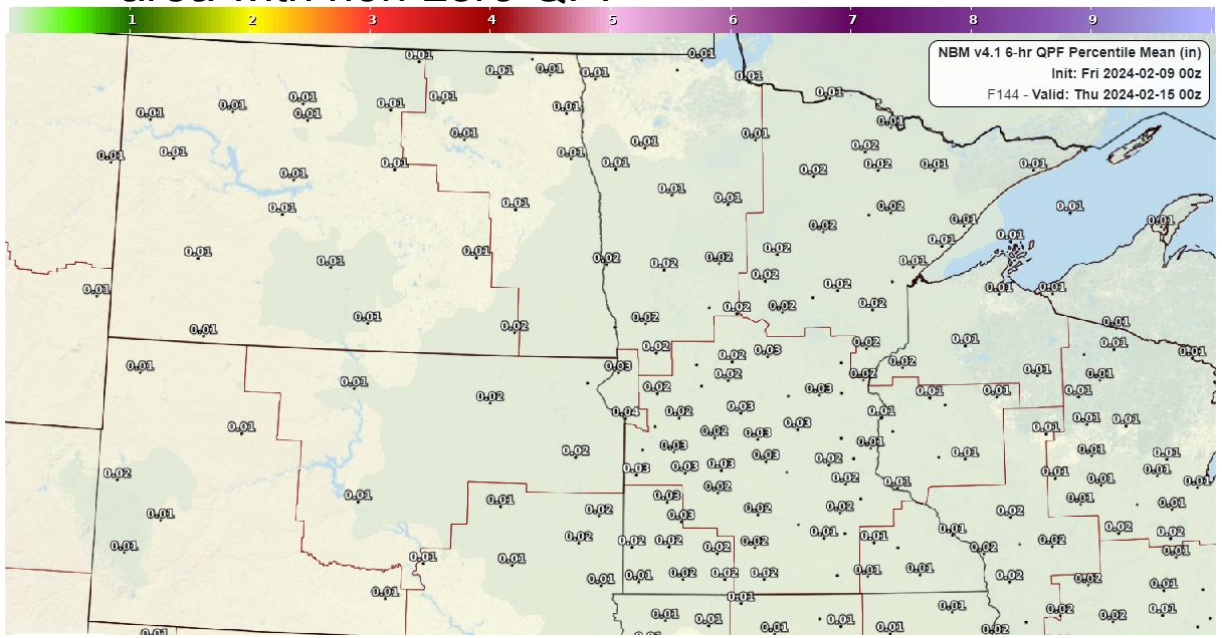


Recent Product Confusion

Let’s pick a representative 6h period with 0 hr QPF



Quantile-Mapped QPF percentile mean has lots of area with non-zero QPF



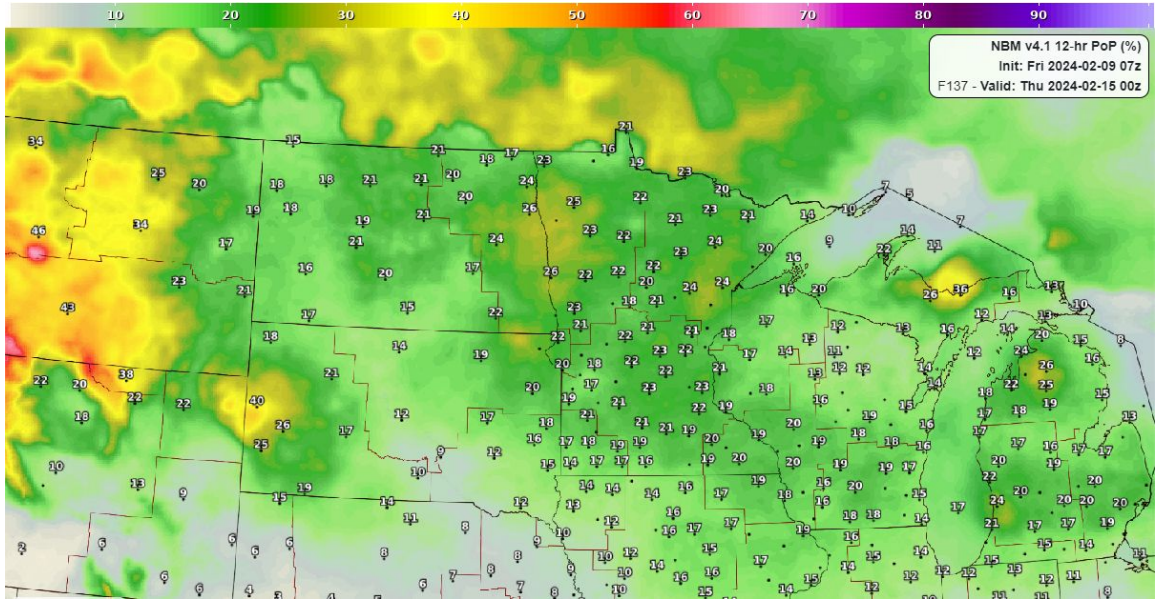
- QPF06 at this range is 50/50 mix of Quantile-Mapped and WPC QPF
- With decent coverage of QM QPF >= .02”, the QPF06 should not be 0 everywhere

Recent Product Confusion

But wait! There is a section of code that adjusts the QPF06 downward if 12h POP is low:

```
C
C         PURPOSE
C            PERFORMS A QPF06 QC TO MITIGATE HIGHER QPF06 VALUES
C            FOR SPECIFIC POP12 RANGES.
C
C            IF THE FINAL QC'D POP12 IS BETWEEN:
C               0% QC'D QPF06=0.0 INCHES
C               1%-4% THE QC'D QPF06=QPF06 - 0.05 INCHES
C               5%-14% THE QC'D QPF06=QPF06 - 0.04 INCHES
C               15%-24% THE QC'D QPF06=QPF06 - 0.03 INCHES
C               25%-34% THE QC'D QPF06=QPF06 - 0.02 INCHES
C               35%-44% THE QC'D QPF06=QPF06 - 0.01 INCHES
C
C             THE FOLLOWING IDPARS(1) AND IDPARS(2) ARE ACCOMMODATED:
```

The corresponding 12h PoP for our period is low!



- This adjustment serves in our case to repeatedly wipe out very low QPF06 amounts through the period
- Currently thinking about ways to make QPF and snowfall products more consistent

Calibrating Snow Exceedance Probs

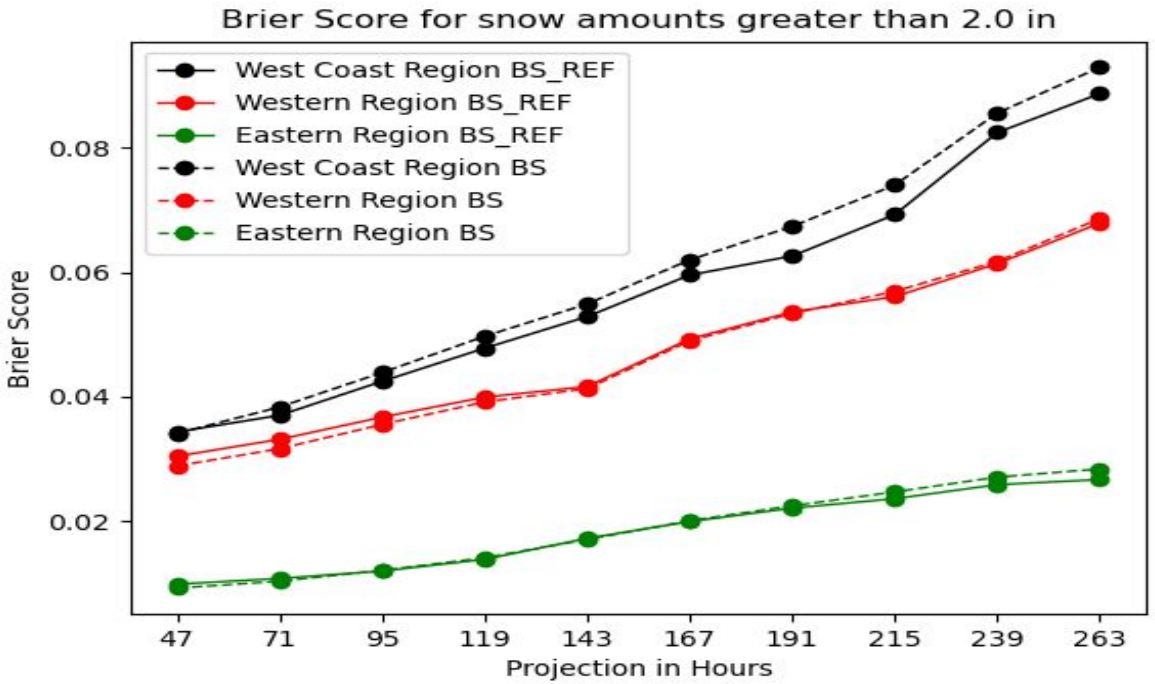
- Work by Dave Rudack to improve NBM Snow Exceedance Probabilities

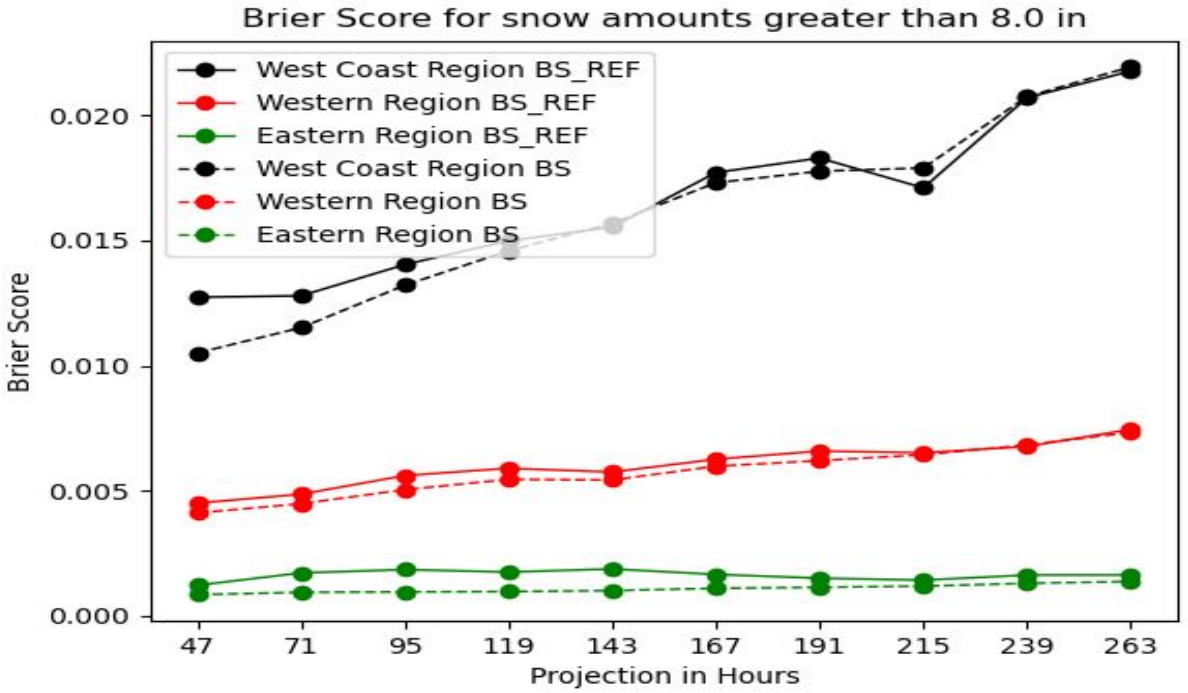
- Uses these NBM 24h snow exceedance probabilities in the regression predictors:
  - **Exceedance amounts greater than a Trace:**
    - > Trace, > 1.0 inch, > 2.0 inches, > 4.0 inches, daily snowfall climatology.
  - **Exceedance amounts greater than one inch:**
    - > Trace, > 1.0 inches, > 2.0 inches, > 4.0 inches, > 6.0 inches, daily snowfall climatology.
  - **Exceedance guidance for > 2.0, > 4.0 inches, > 6.0 inches, > 8 inches, > 12 inches, > 18 inches:**
    - > Trace, > 1.0 inch, > 2.0 inches, > 4.0 inches, > 6.0 inches, > 8 inches, > 12 inches, > 18 inches, daily snowfall climatology.

- NOHRSC 24h snowfall analyses (from 1200 UTC - 1200 UTC) covering the sample period are used as the predictand in the multiple linear regression.

Calibrating Snow Exceedance Probs

Solid Line is Ops NBM Dash is the output from the Regression Technique





- improvement is mixed for lower thresholds, particularly along the West Coast, possibly due to an underforecast of lower amounts (regression generally does not “correct up”)
- improvement is more substantial for higher amounts

Takeaways from this Study

- Based on the findings, performing a seasonal regression analysis using the NBM snow percentiles and daily snow climatologies as predictors further improves upon both the accuracy and reliability of the NBM v4.1 snowfall exceedance forecasts
- Leveraging predictors such as QMD QPF and Ptype may help improve the equations in the West
- This additional multiple linear regression post-processing step provides confidence to forecasters that the NBM guidance is properly calibrated and can be used in IDSS without much apprehension
- Care must be taken to not use equations for some of the higher threshold values as the reduction of variance drops considerably especially in the extended range. In those instances, the uncalibrated NBM products should be used

Summary

- NBMv4.2 is on track for implementation in May 2024
- There are several winter weather improvements in this package including SLR changes, the downscaled wet-bulb temperature, mitigation of the lattice effect, and reduction of ARW HiResW-driven probabilities of winter precip
- Instantaneous quantile-mapped winds and gusts will be available; the high bias at lower speeds is reduced, but a low bias at higher speeds will now exist
- Removing product inconsistencies, especially with regard to snow/ice vs QPF, is a major goal for v5.0
- Calibration of snow exceedance probabilities may also be included in v5.0, especially given the need for good probabilistic guidance to support IDSS
- Preparations are also underway for upcoming changes to the NPS

Extra Slides

Extra Slides

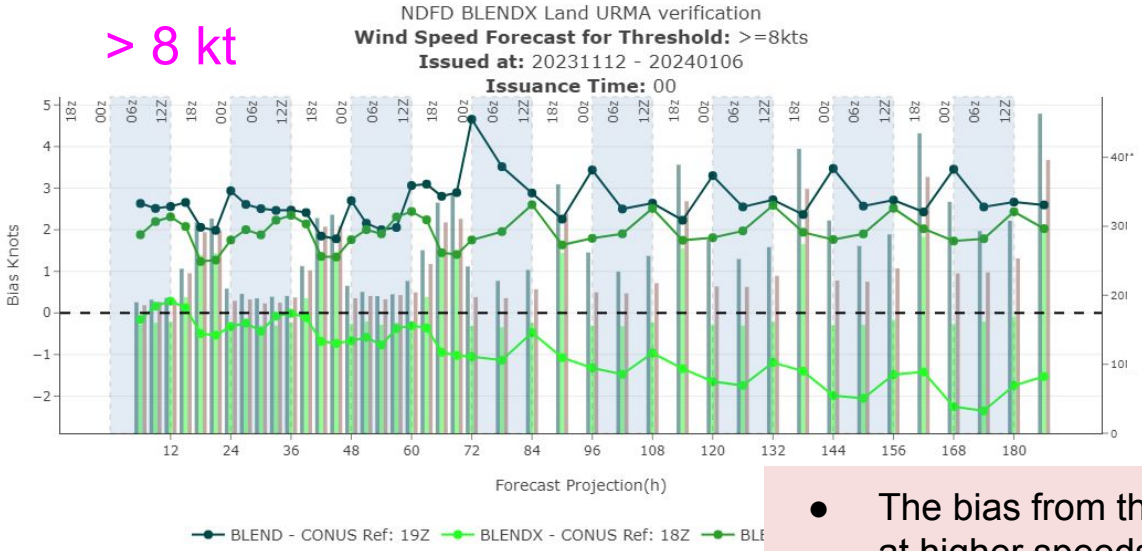
NBM Snow Liquid Ratio (SLR) Blends

Model	Snow Ratio Techniques
HRRR	50% Cobb, 50% MaxTAloft
HRRRX	50% Cobb, 50% MaxTAloft
RAP	50% Cobb, 50% MaxTAloft
RAPX	50% Cobb, 50% MaxTAloft
HiResARW	50% Cobb, 50% MaxTAloft
HiResARW2	50% Cobb, 50% MaxTAloft
HiResFV3	50% Cobb, 50% MaxTAloft
NAM	33% Cobb, 33% MaxTAloft, 33% Roebber
NAMNest	50% Cobb, 50% MaxTAloft
10 SREF ARW	50% Cobb, 50% MaxTAloft
GFS	33% Cobb, 33% MaxTAloft, 33% Roebber
30 GEFS	33% Cobb, 33% MaxTAloft, 33% 850-700mb thickness
50 ECMWF Ens	33% Cobb, 33% MaxTAloft, 33% 850-700mb thickness

Wind Stats

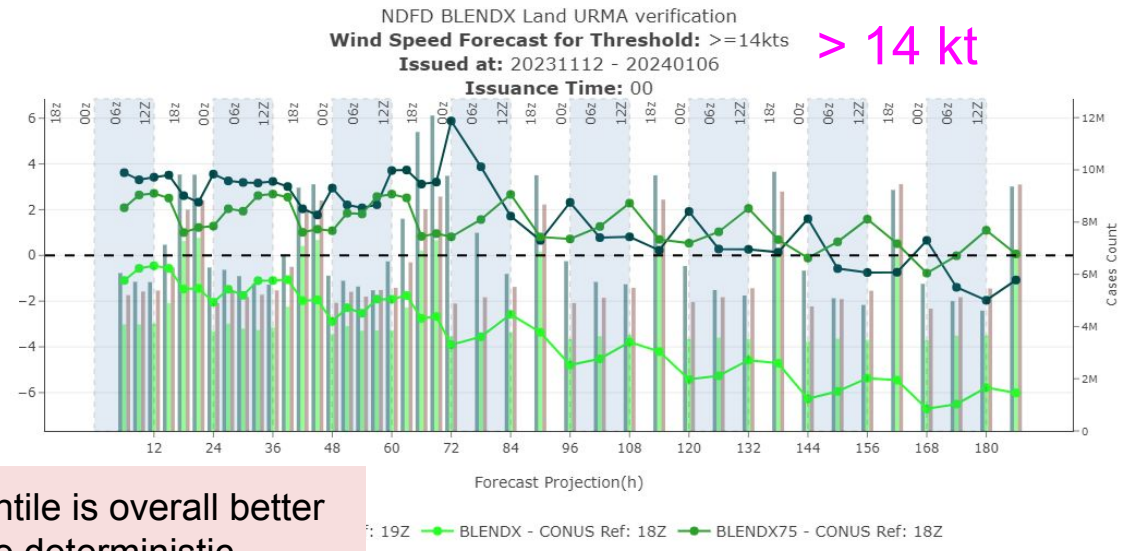
BIAS

> 8 kt



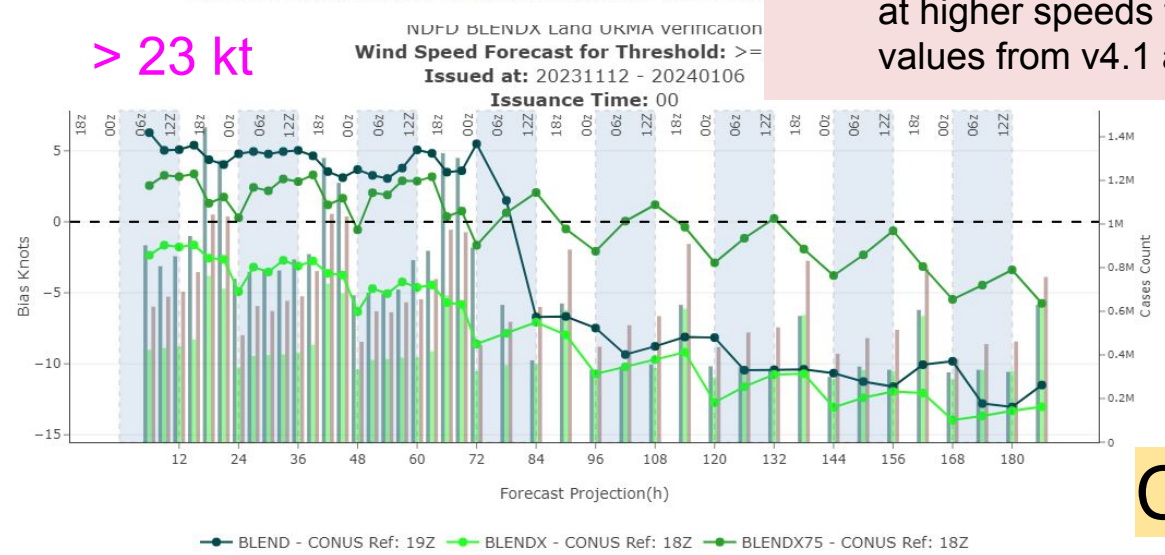
NBMv4.1
NBMv4.2
75th perc

> 14 kt

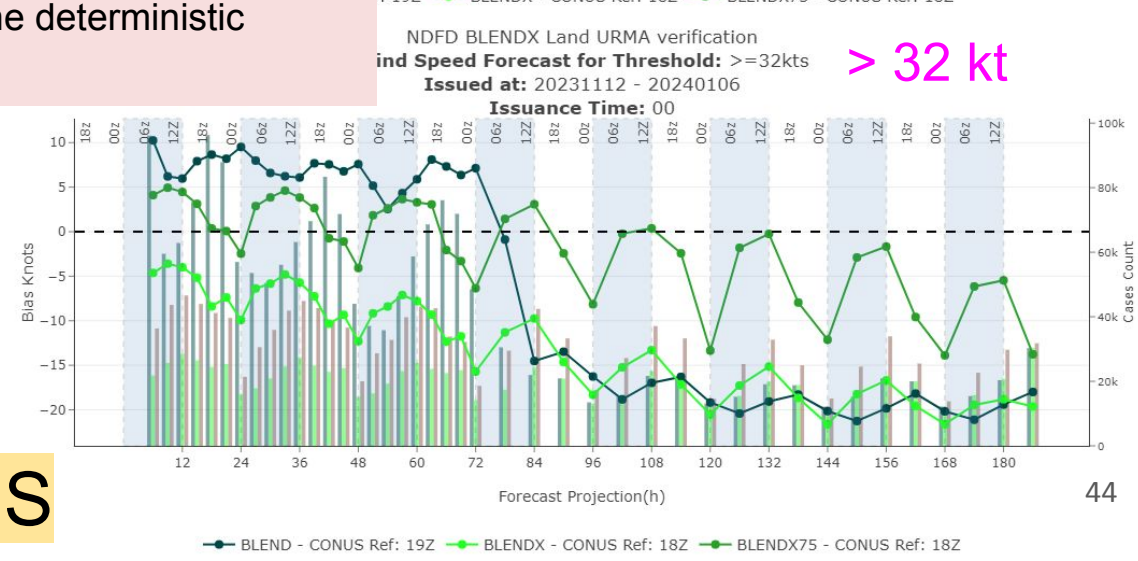


- The bias from the 75th percentile is overall better at higher speeds than with the deterministic values from v4.1 and v4.2

> 23 kt



> 32 kt

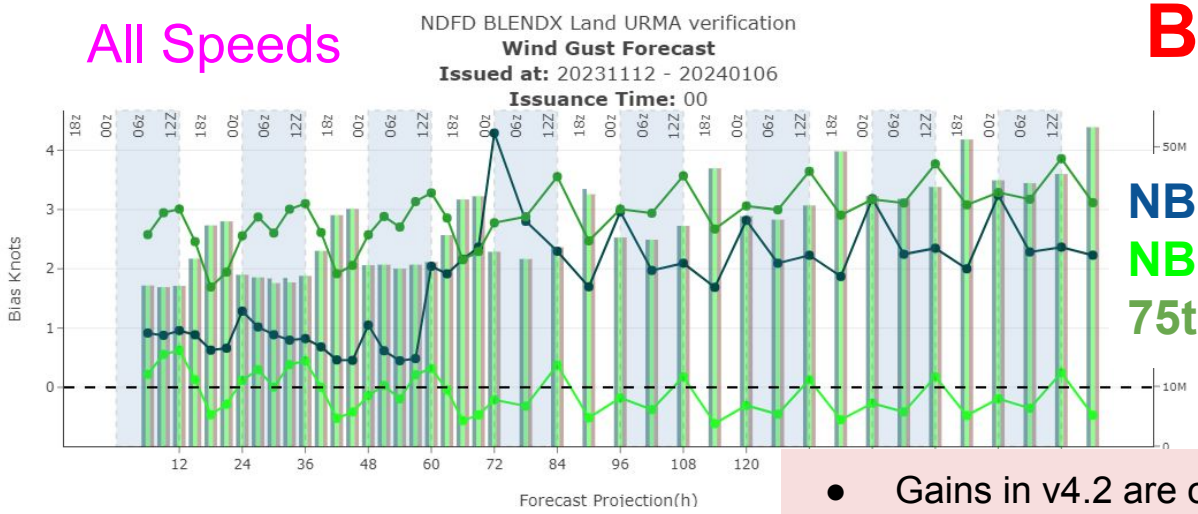


CONUS

Gust Stats

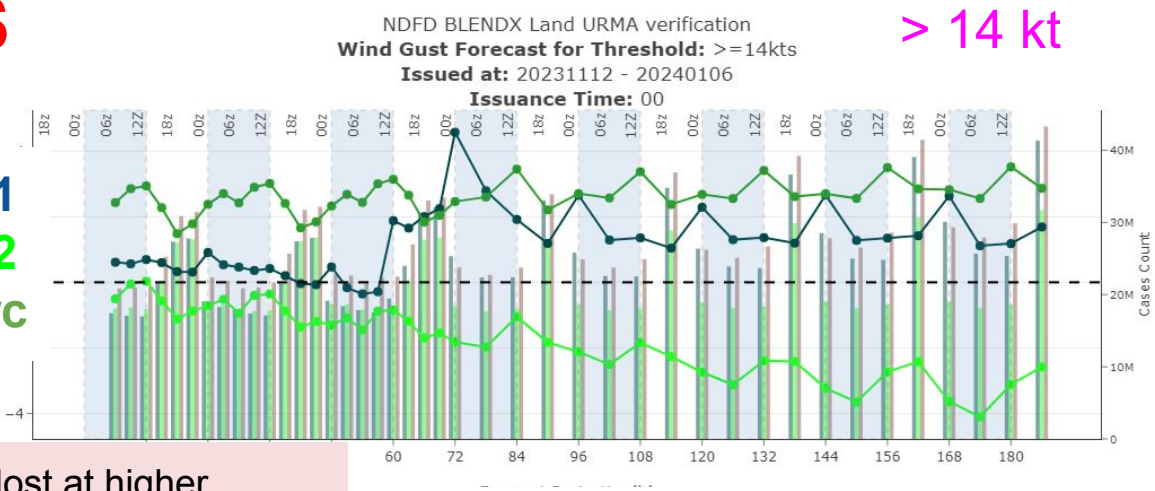
BIAS

All Speeds



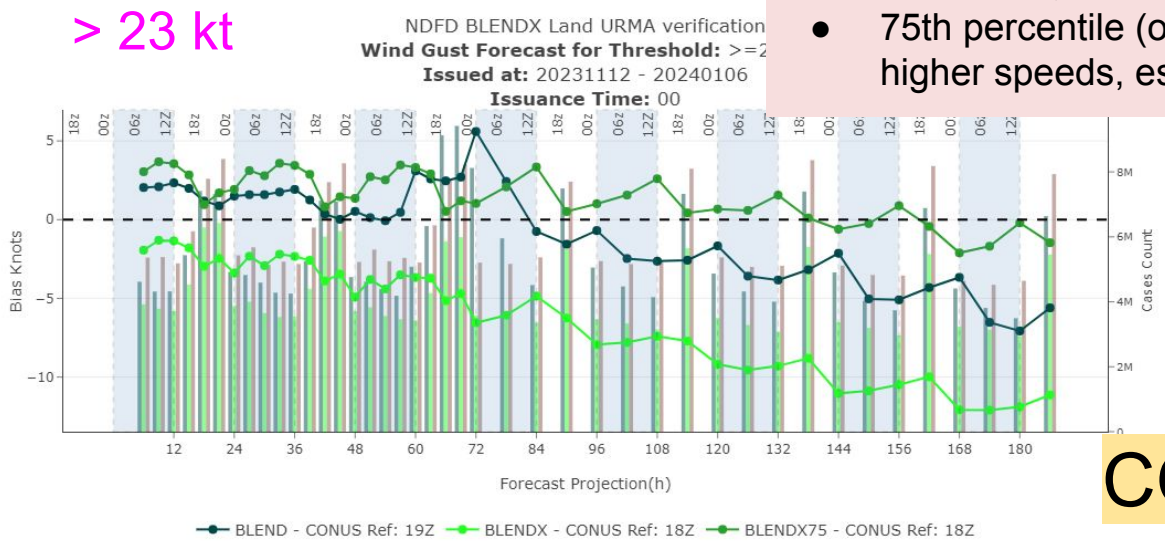
NBMv4.1
NBMv4.2
75th perc

> 14 kt

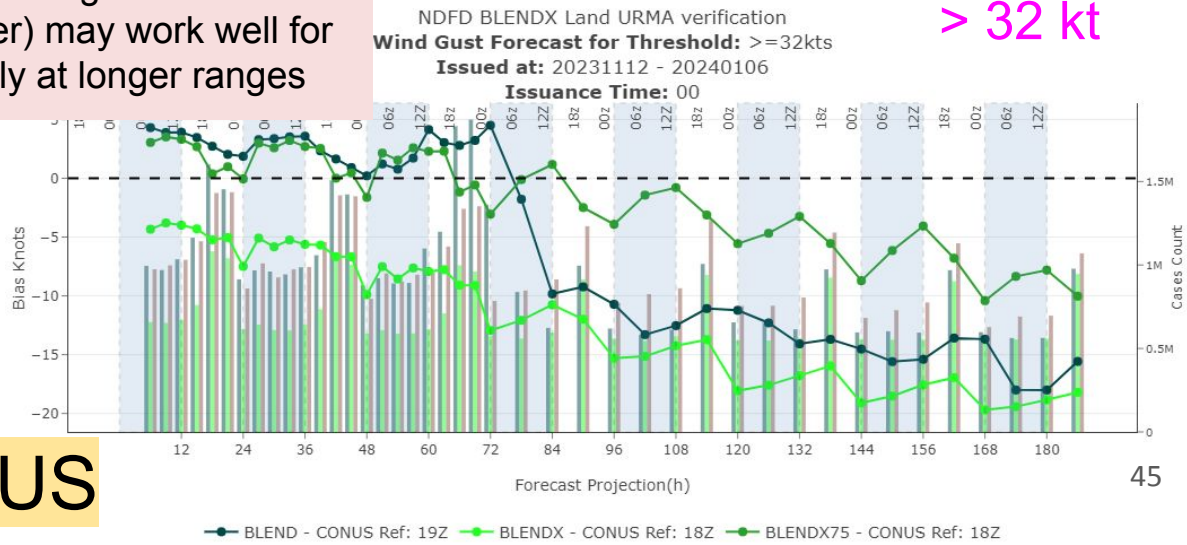


- Gains in v4.2 are overall lost at higher thresholds, most clearly at higher thresholds
- 75th percentile (or higher) may work well for higher speeds, especially at longer ranges

> 23 kt

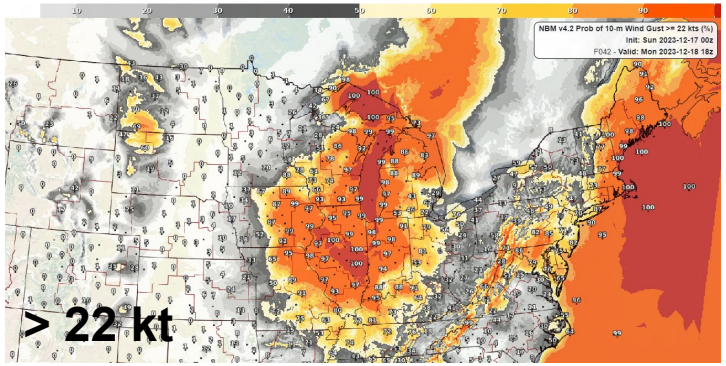


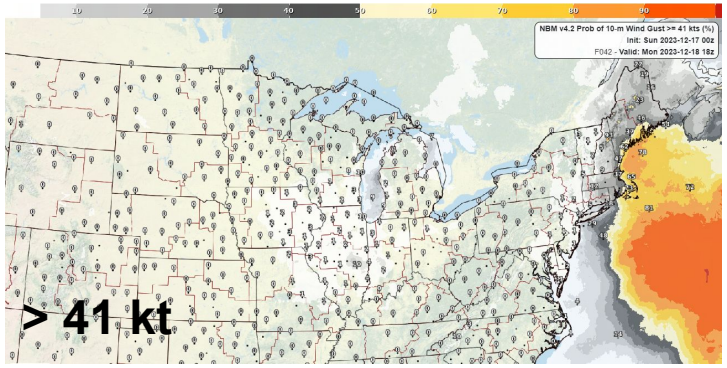
> 32 kt

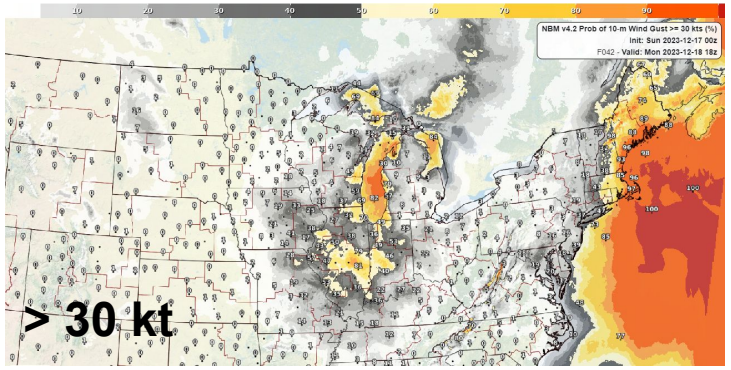


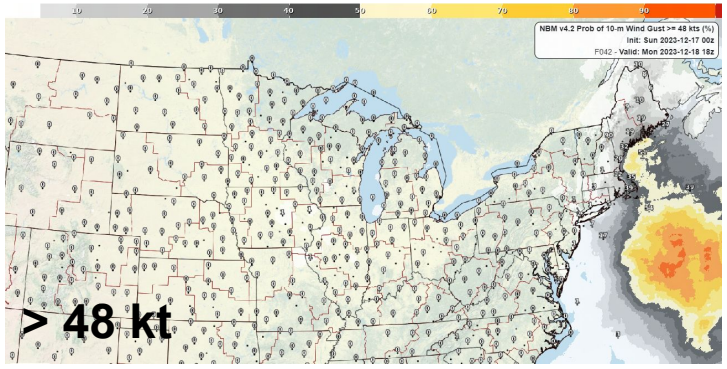
CONUS

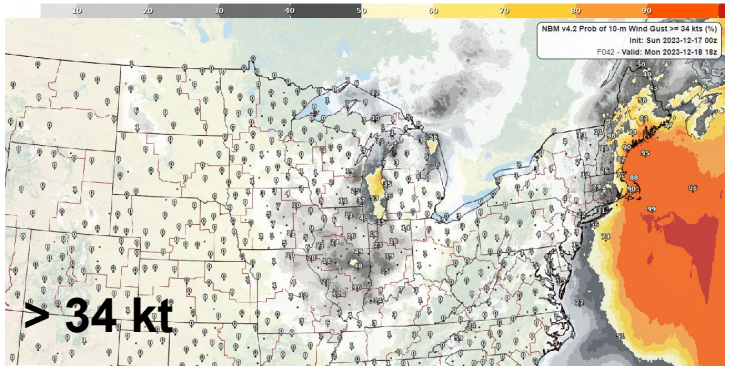
December Storm - Gust Probs

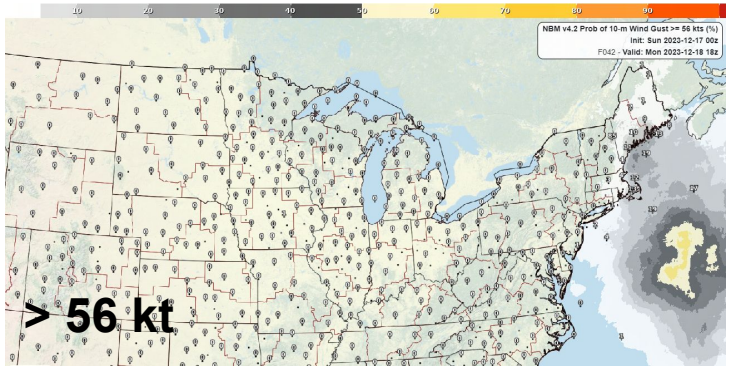




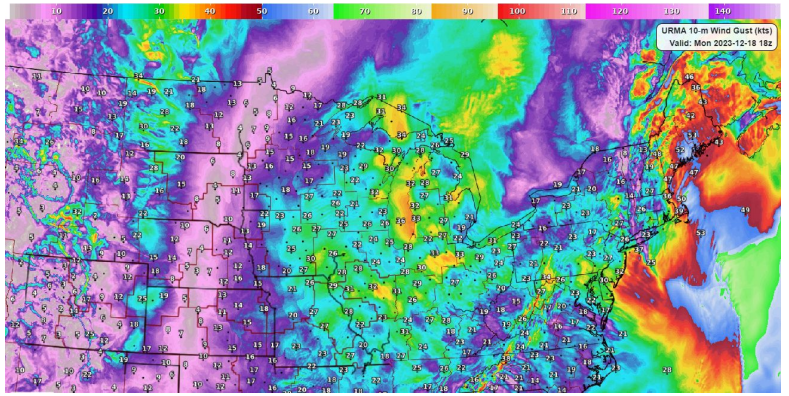




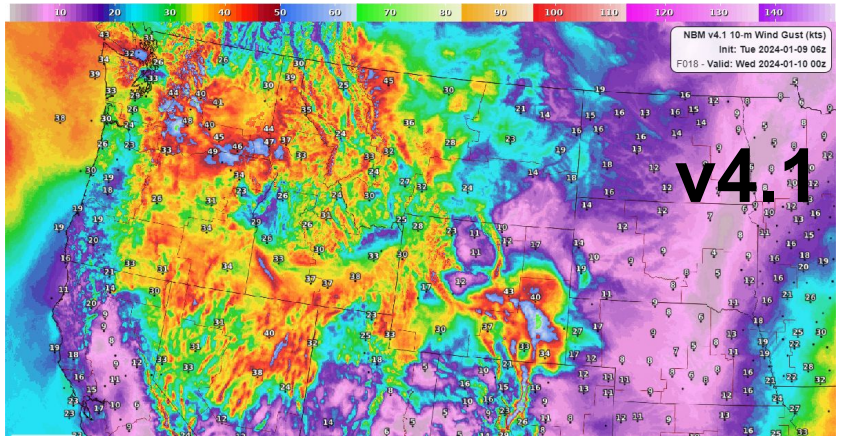


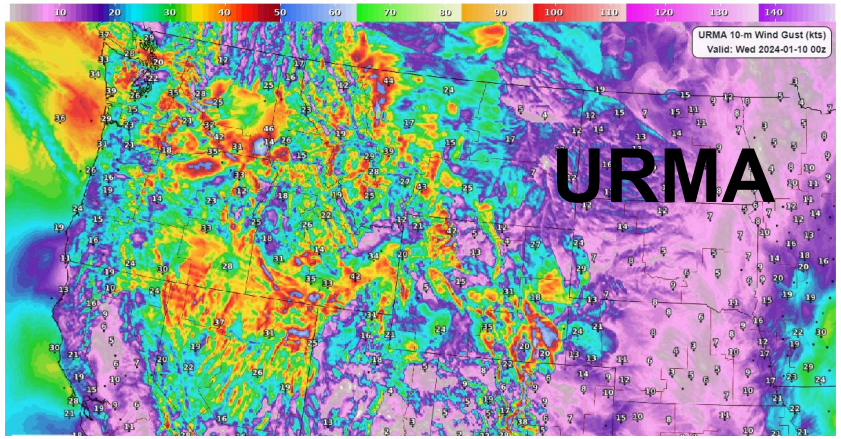


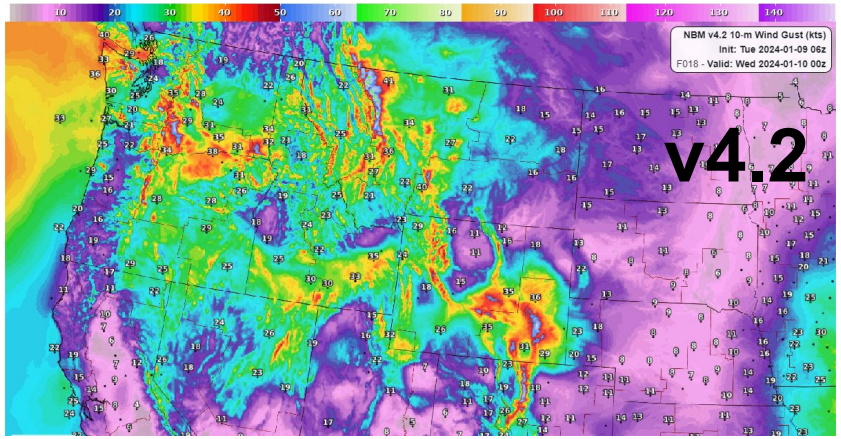
URMA

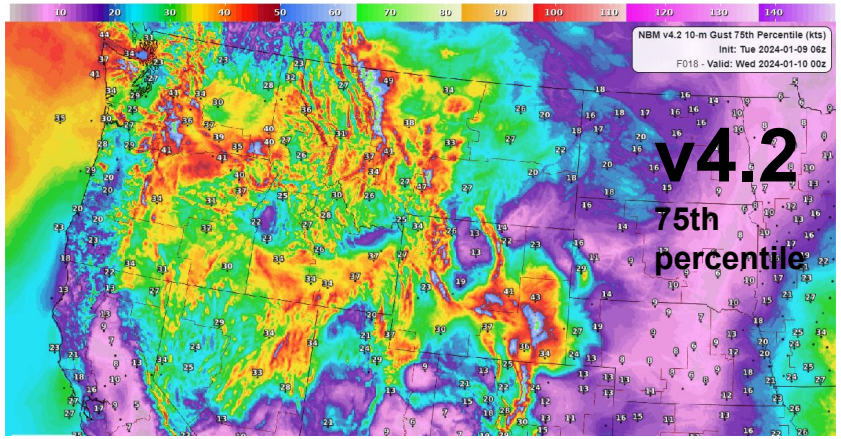


Western Region Gust Case









F18 Gust
Valid 00Z

- Stats showed that for 00Z valid times, 4.2 gusts had a significant low bias, and this is clear in this case
- Stats also showed that the 75th percentile had near 0 bias at 00Z in the short range, and that is also evident here