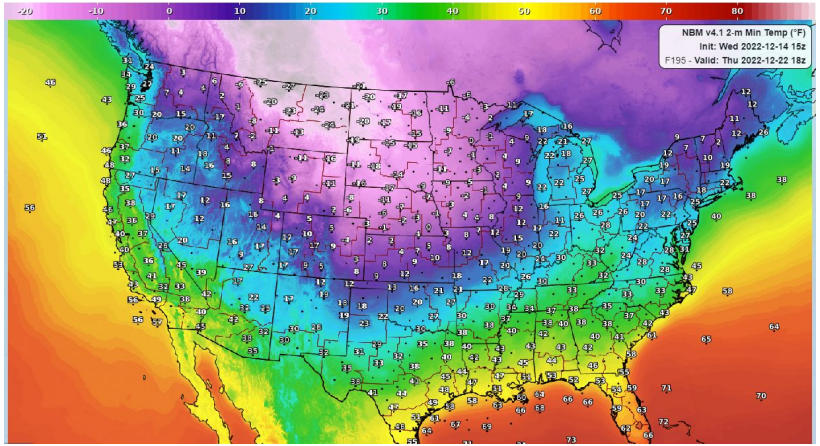
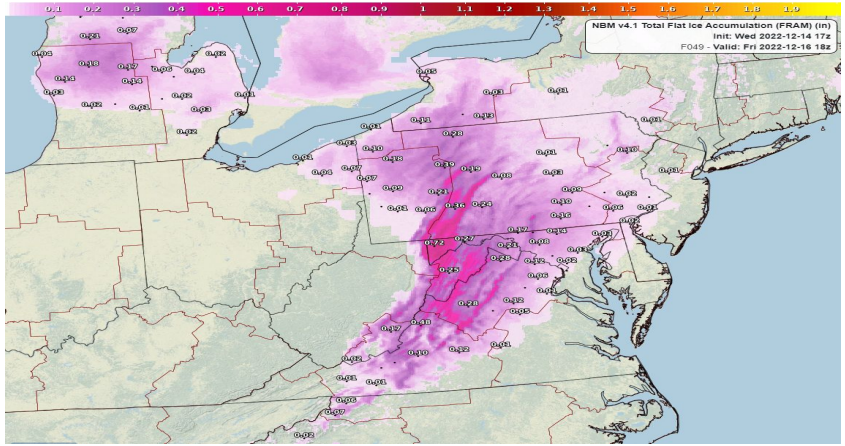
National Blend of Models (NBM) v4.2 NCEP Science Briefing
September 5, 2023





David Rudack, Robert James, Scott Scallion, Geoffrey Manikin, Sarah Perfater

NWS/OSTI/MDL Silver Spring, MD

Notable Upgrades for NBM v4.2

(1) New probabilistic Quantile Mapping-based (QM) 10m instantaneous wind speed and wind gust percentiles and exceedance values (CONUS)

(2) Corrected Mixing Height calculation now dependent upon URMA surface terrain height rather than the RAP model surface height (CONUS)

(3) Elimination of “lattice-like” features in the NBM blended snow amount guidance by introducing smoothing to the European Centre for Medium-Range Weather Forecasts, Ensemble (ECMWFE), Global Ensemble Forecasting System (GEFS), and Short-Range Ensemble Forecasting System (SREF) QM precipitation amount Cumulative Distribution Functions (CDFs) (CONUS, Alaska)

(4) Modified the Snow Liquid Ratio (SLR) calculation by taking into account the melting of snow where temperatures are at or above freezing at the surface and removed the 25% reduction factor to each model input SLR value (CONUS, Alaska)

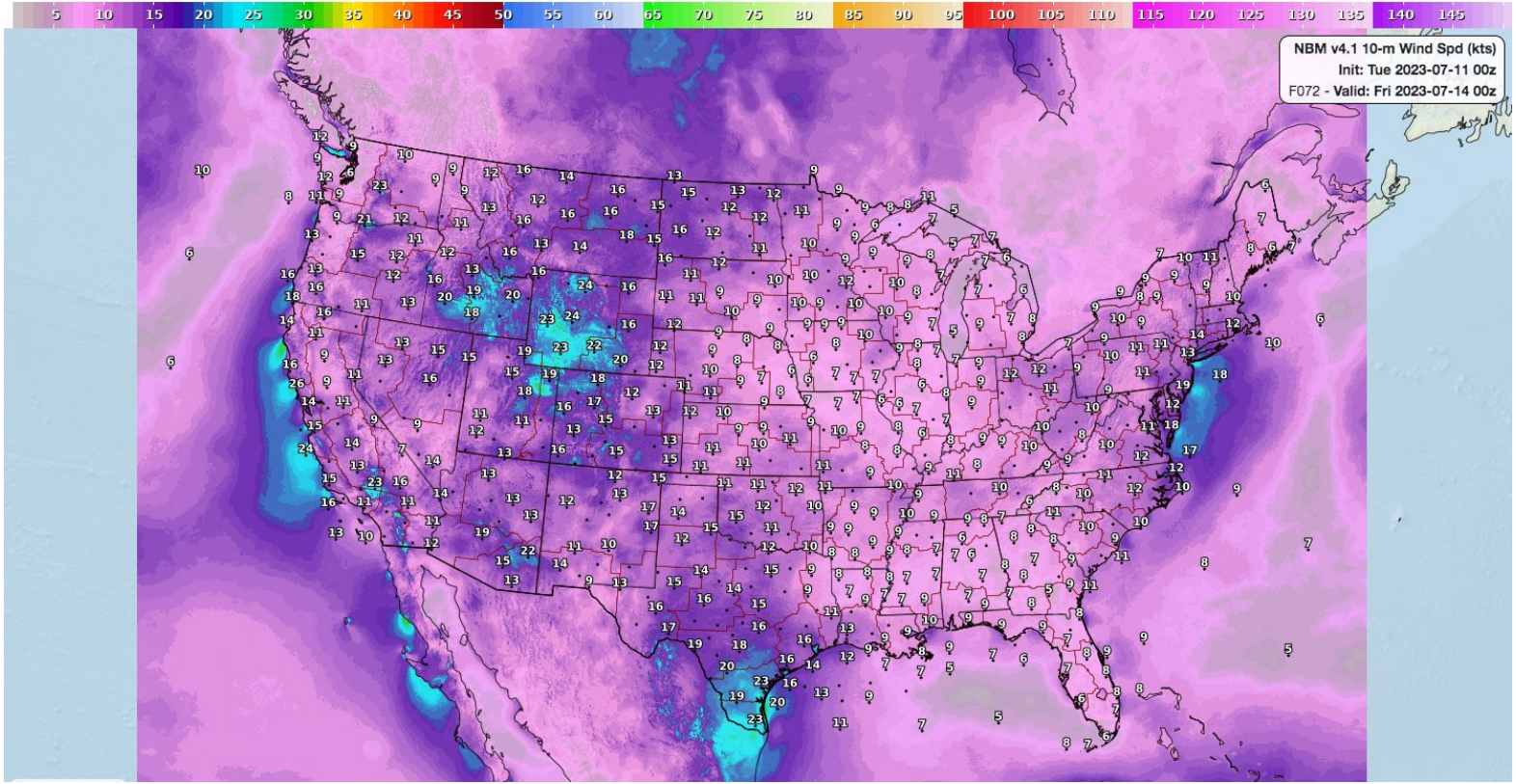
(5) Downscaled wet bulb temperature for ECMWFE, GEFS, and SREF models for improvement in ice accumulations (CONUS, Alaska)

(6) Introduced smoothing to the ECMWFE, GEFS, and SREF precipitation amount CDFs. This modification was made to support the winter weather product note above which uses these model inputs (CONUS, Alaska, Hawaii, Puerto Rico, Oceanic)

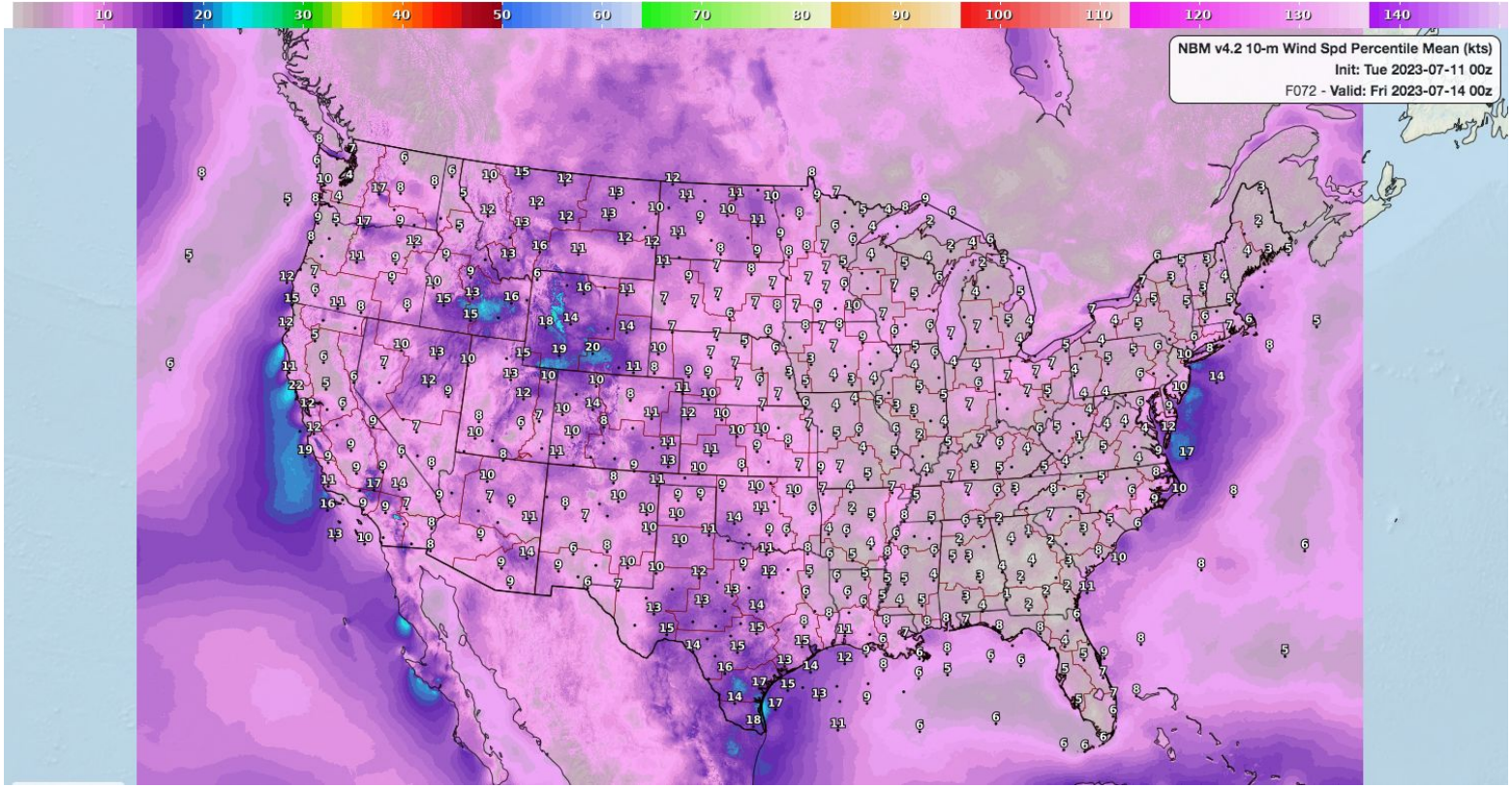
Quantile Mapped Probabilistic 10m Instantaneous Wind Speed and Wind Gust

- This probabilistic product has been created in response to Fire Weather needs in the Field and will assist with IDSS.
- 10m instantaneous Quantile Mapped wind speed and wind gust percentiles are now being generated at 0000-, 0600-, 1200-, and 1800 UTC Cycles.
- Deterministic 10m wind speed and wind gust are now being replaced by the Quantile Mapped mean wind speed and wind gust, respectively.

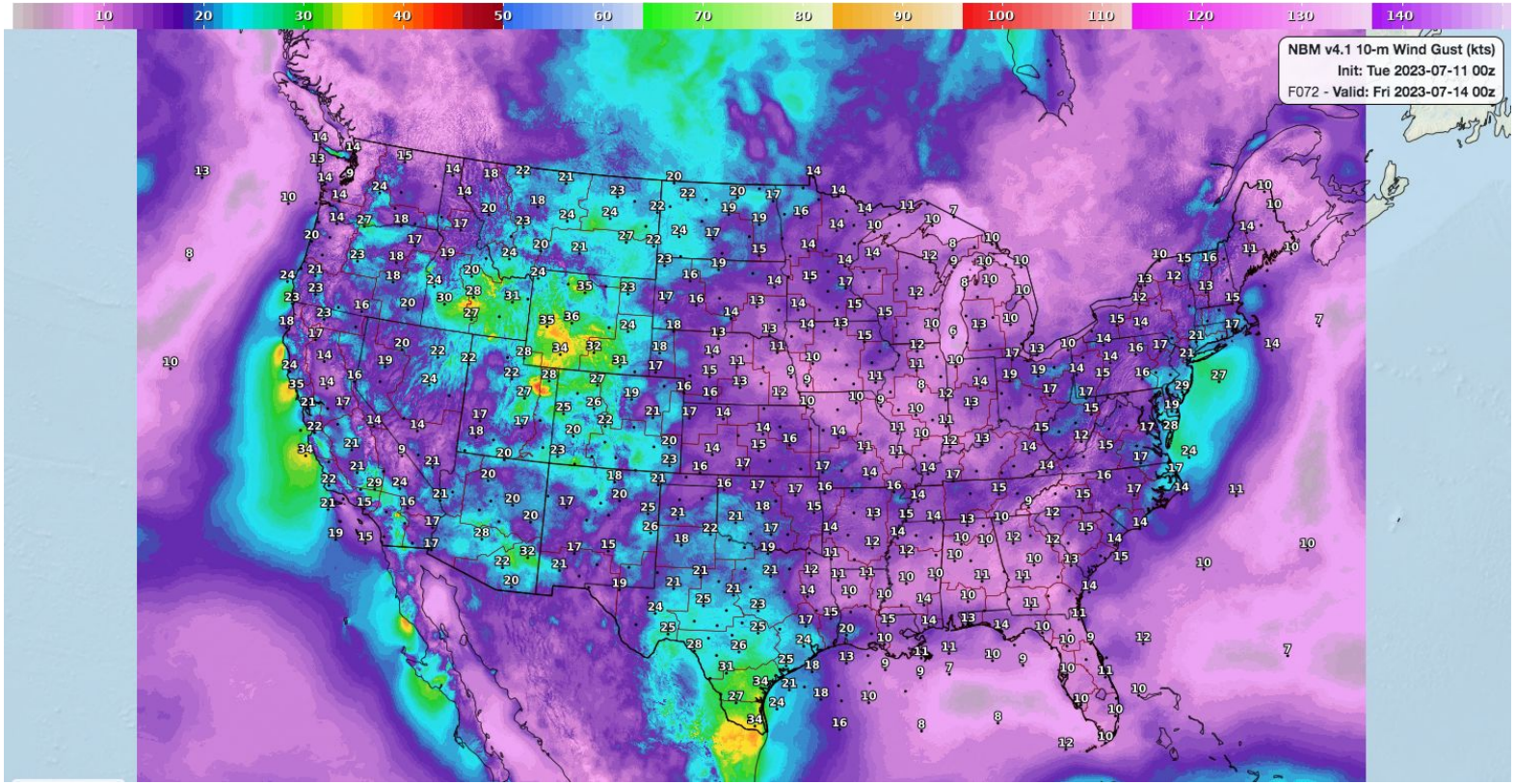
NBM v4.1 10m Wind Speed (72h Projection)



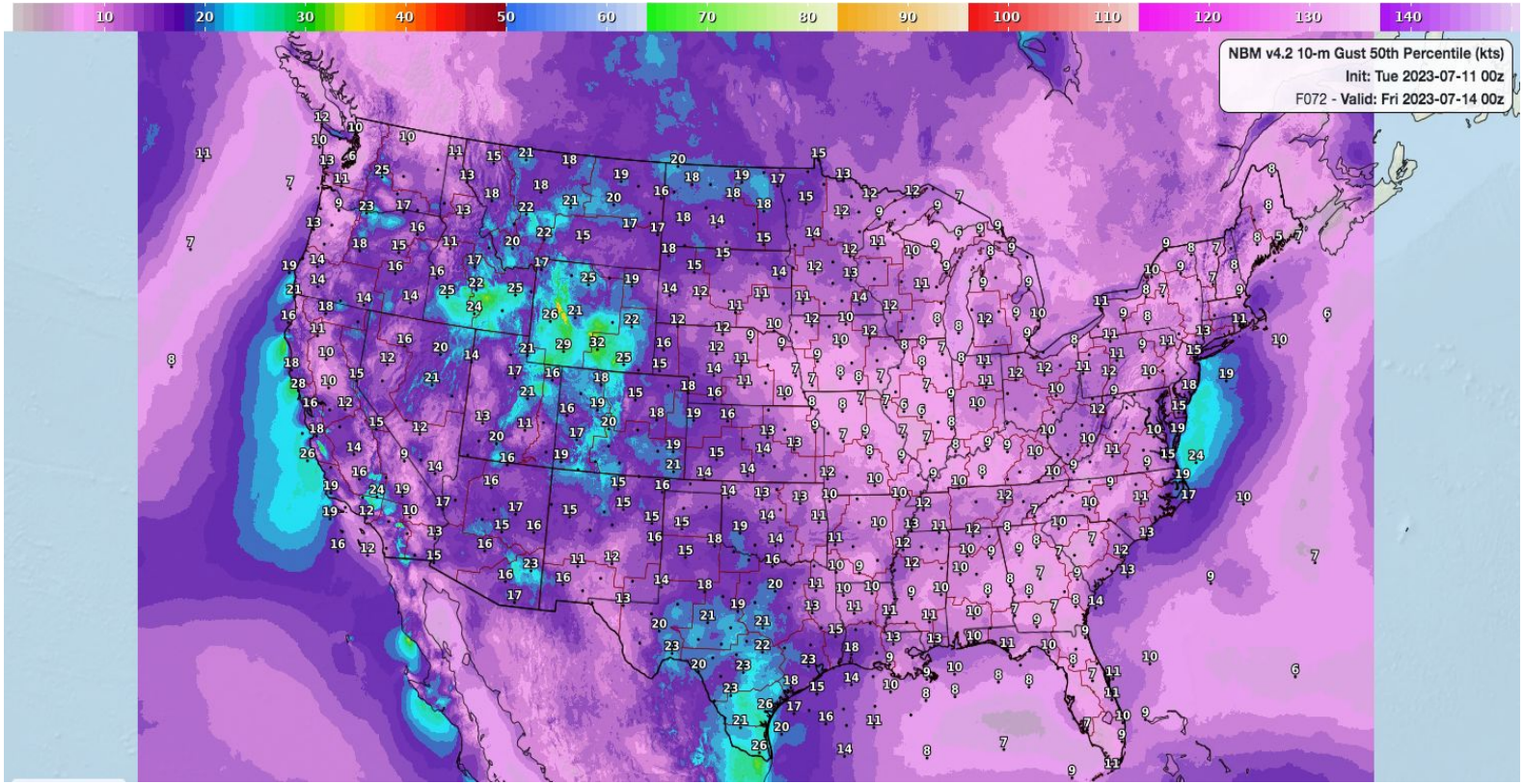
NBM v4.2 Quantile Mapped 10m Mean Wind Speed (72h Projection)



NBM v4.1 10m Wind Gust (72h Projection)



NBM v4.2 Quantile Mapped 10m Mean Wind Gust (72h Projection)

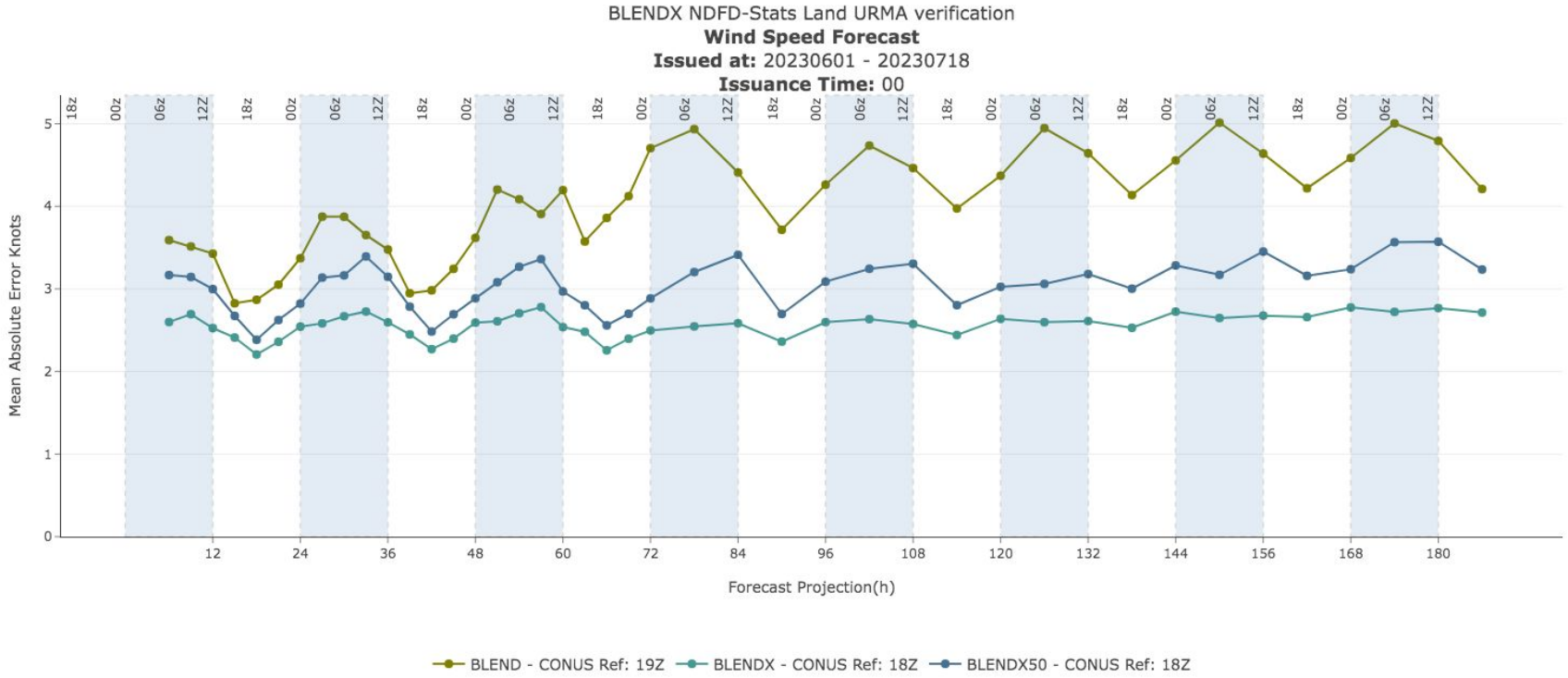


Preliminary Gridded Verification of QM 10m Wind Speed and Wind Gust

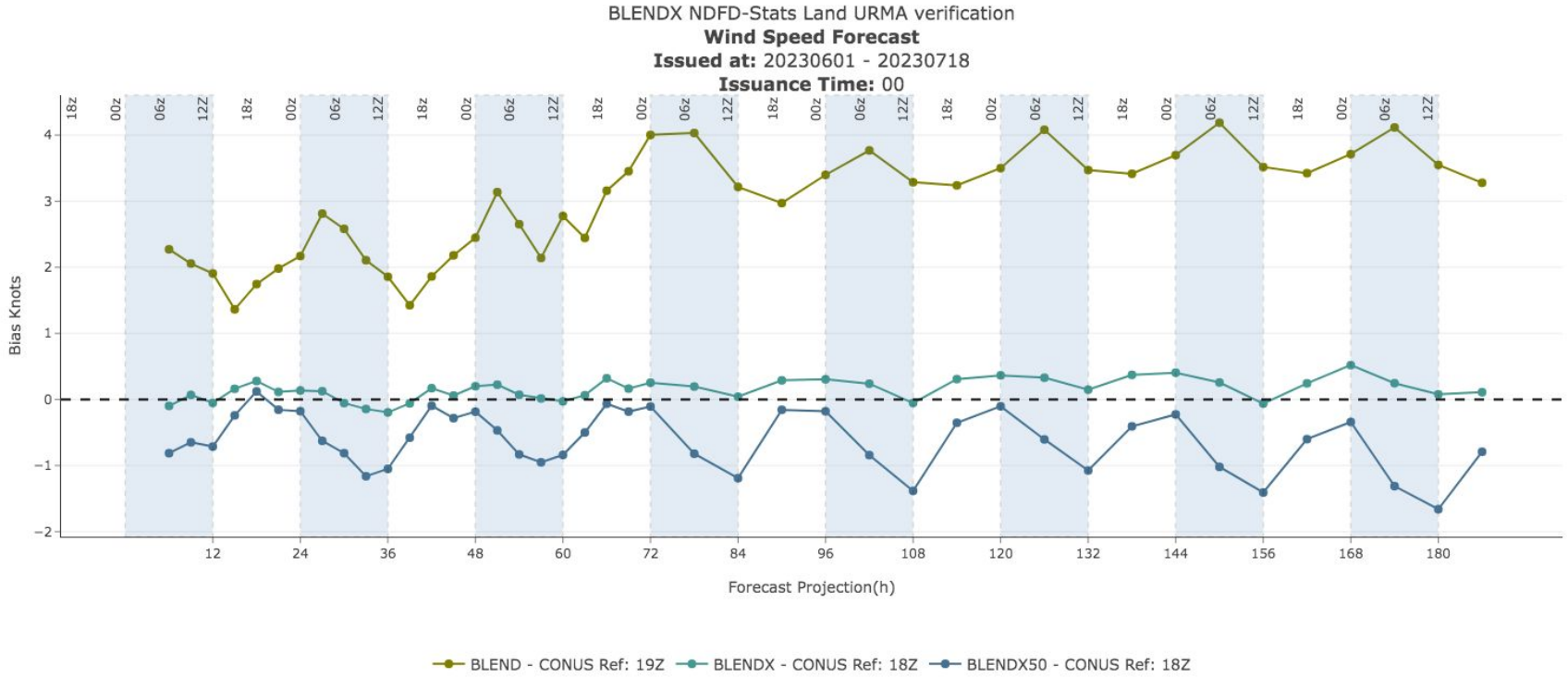
Three products are verified on the subsequent eight slides:

BLEND = Operational (NBM v4.1) deterministic 10m Wind Speed or Wind Gust
BLENDX = Development NBM v4.2 **QM Mean** of 10m Wind Speed or Wind Gust
BLENDX50 = Development NBM v4.2 **QM 50th percentile** of 10m Wind Speed or Wind Gust

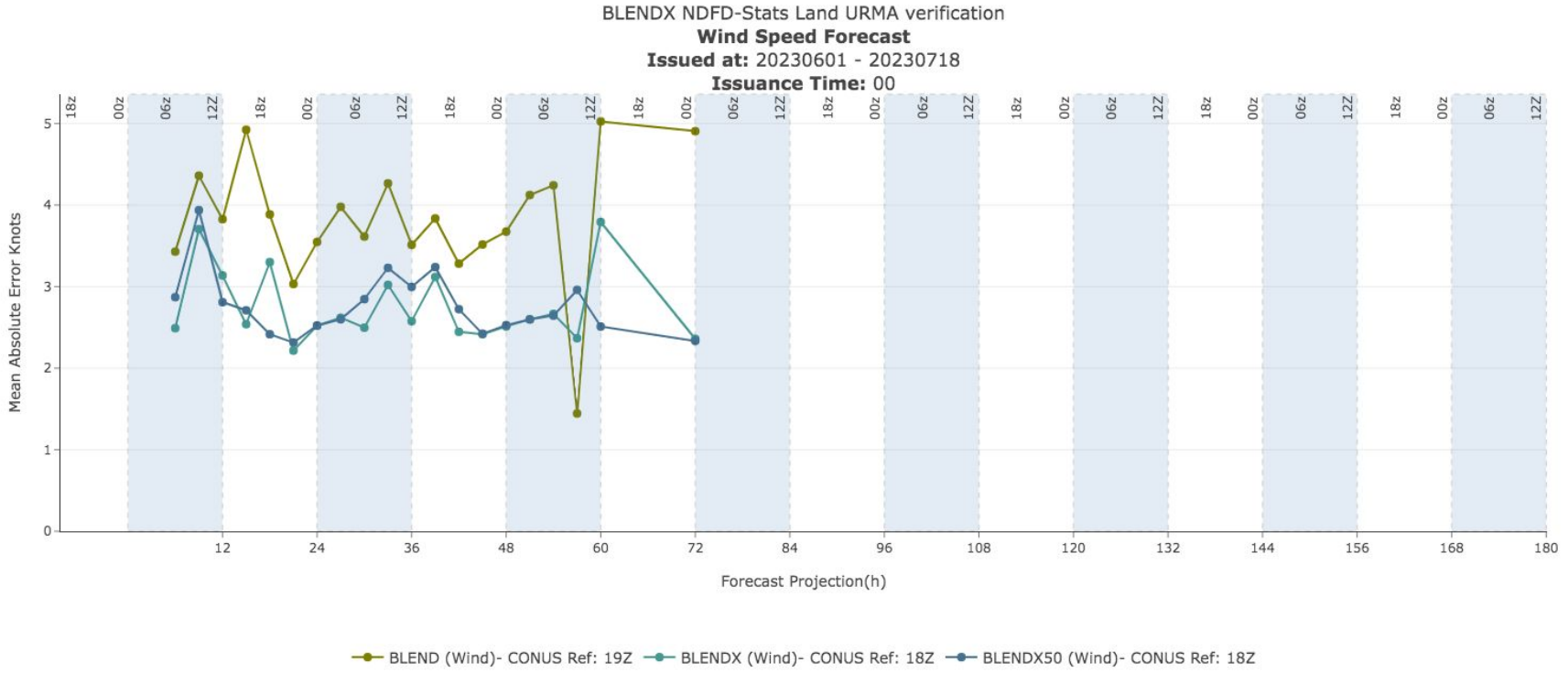
MAEs Verified for all cases



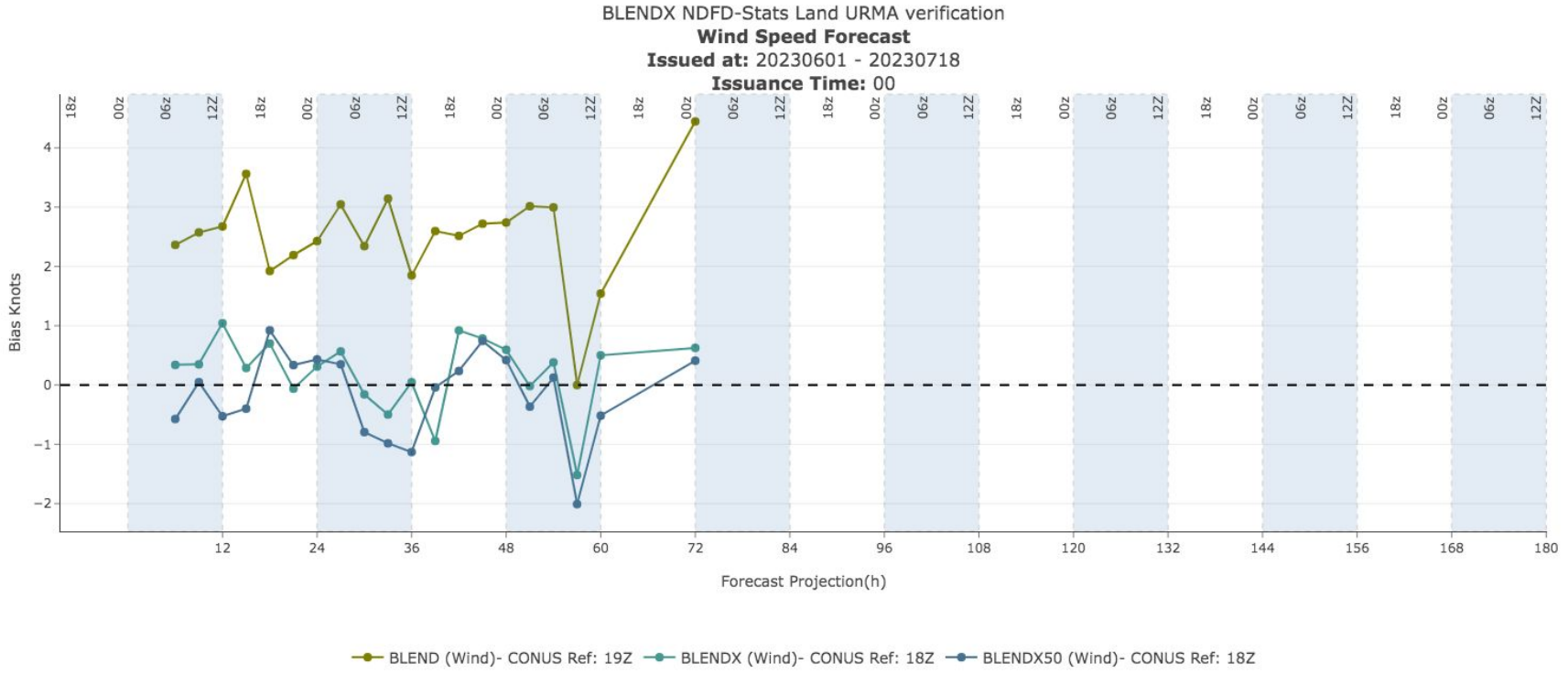
Biases Verified for all cases



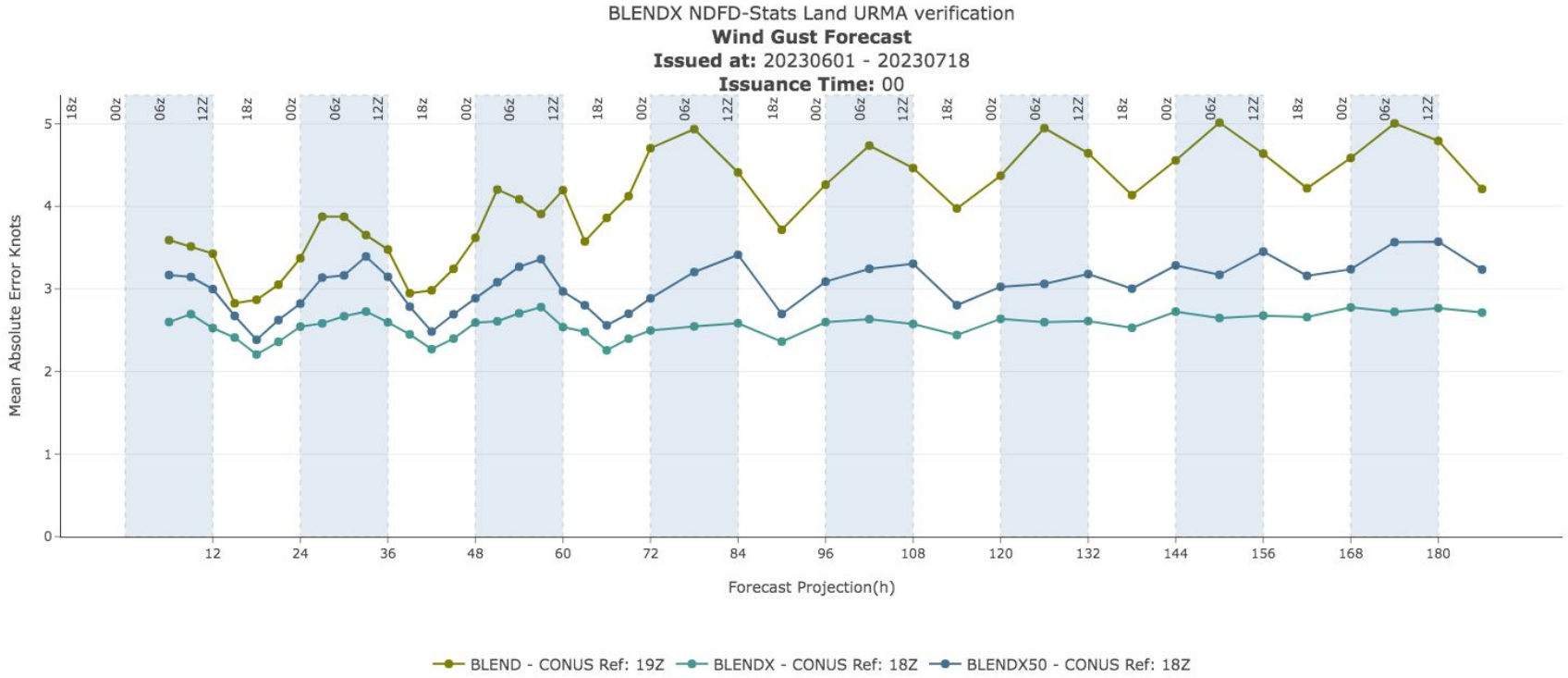
MAEs Verified only for cases where a Watch, Warning, or Advisory was issued by the NWS



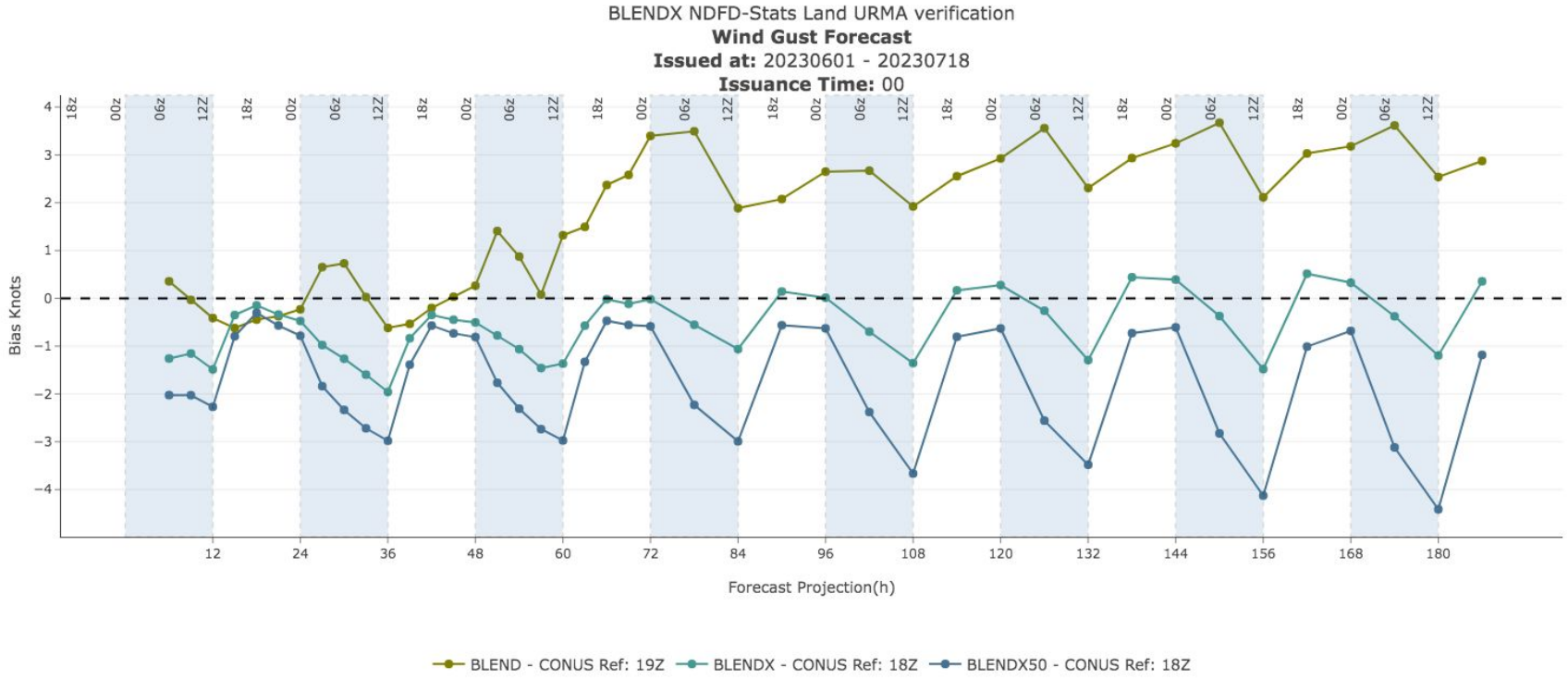
Biases Verified only for cases where a Watch, Warning, or Advisory was issued by the NWS



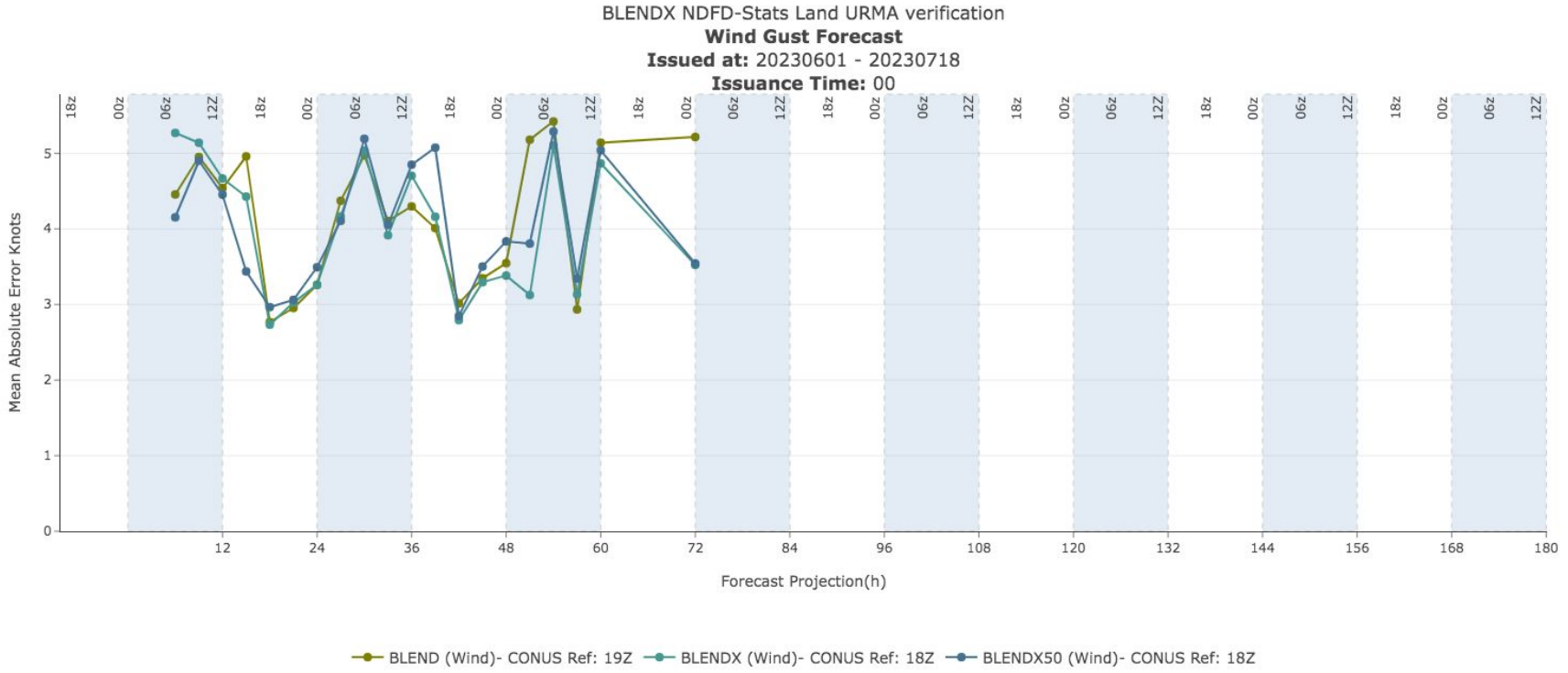
MAEs Verified for all cases



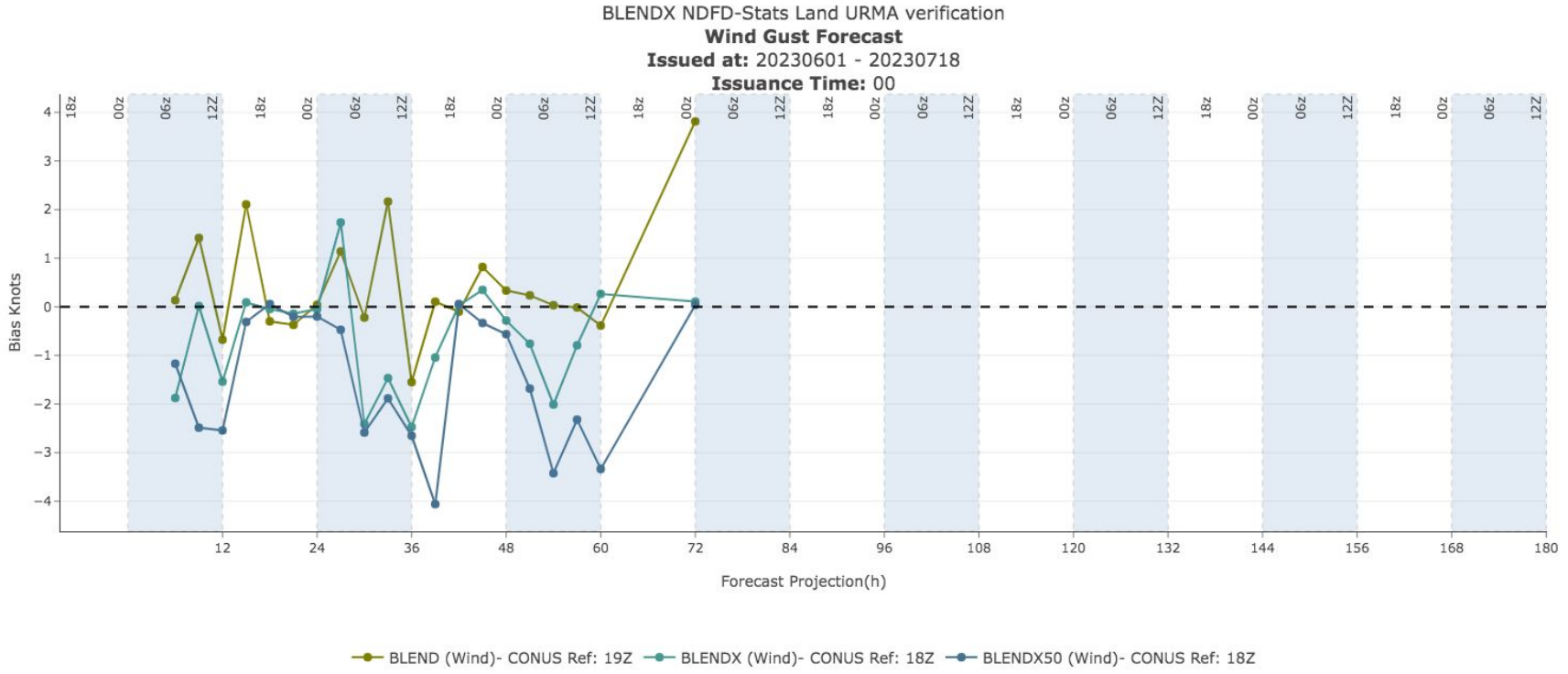
Biases Verified for all cases



MAEs Verified only for cases where a Watch, Warning, or Advisory was issued by the NWS



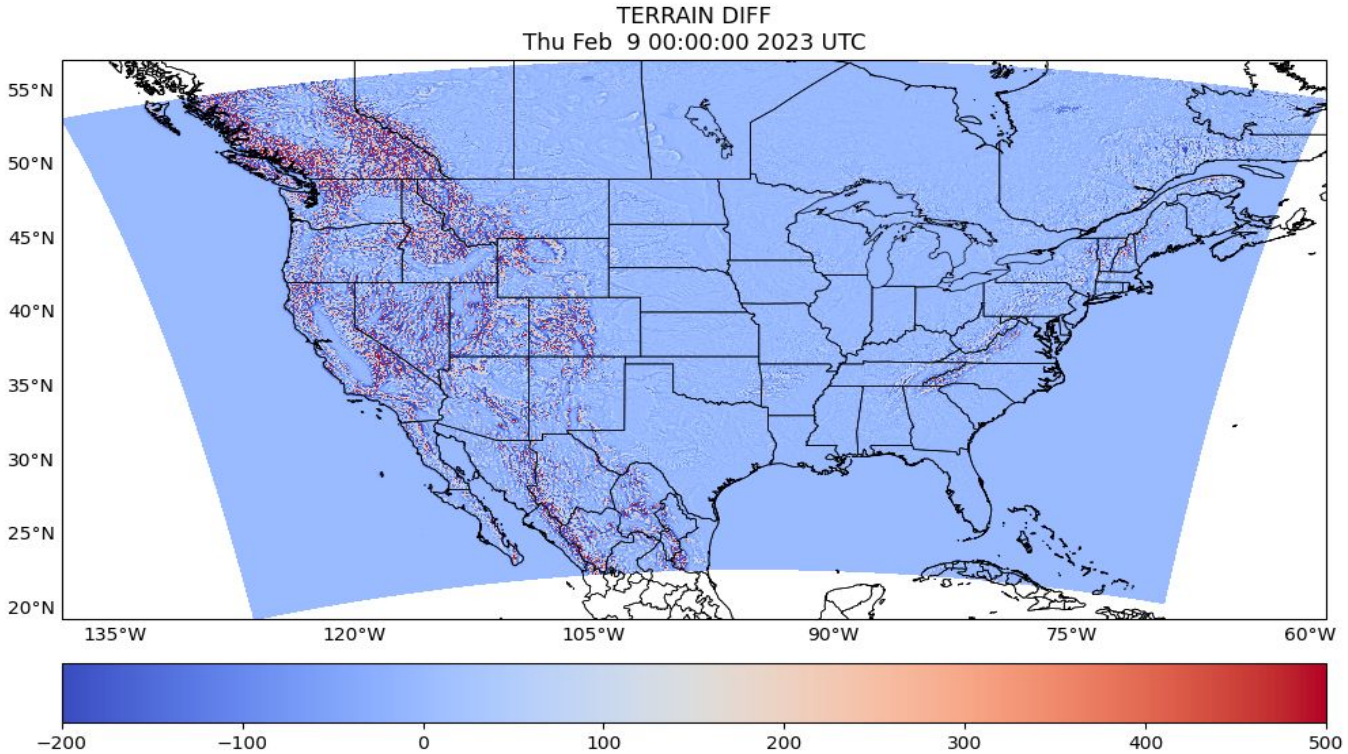
Biases Verified only for cases where a Watch, Warning, or Advisory was issued by the NWS



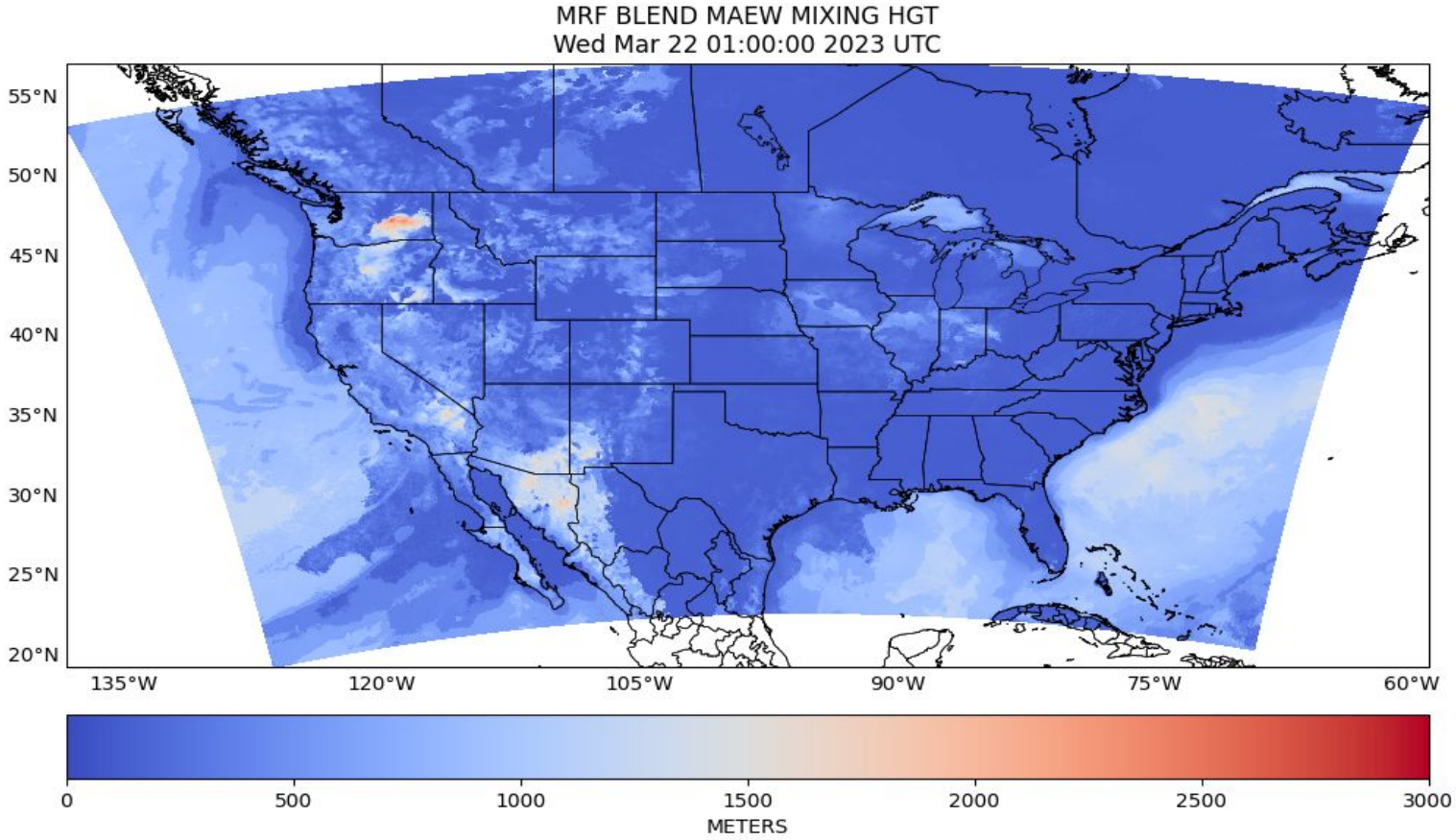
NBM v4.2 Mixing Height Adjustment

Terrain Difference between RAP and the URMA Unified Terrain

NBM v4.2 is now incorporating the difference between the RAP and URMA Unified terrain height in the calculation of Mixing Heights. This is a more accurate depiction of the true Mixing Height above the surface. Note the terrain detail in the subsequent slides.

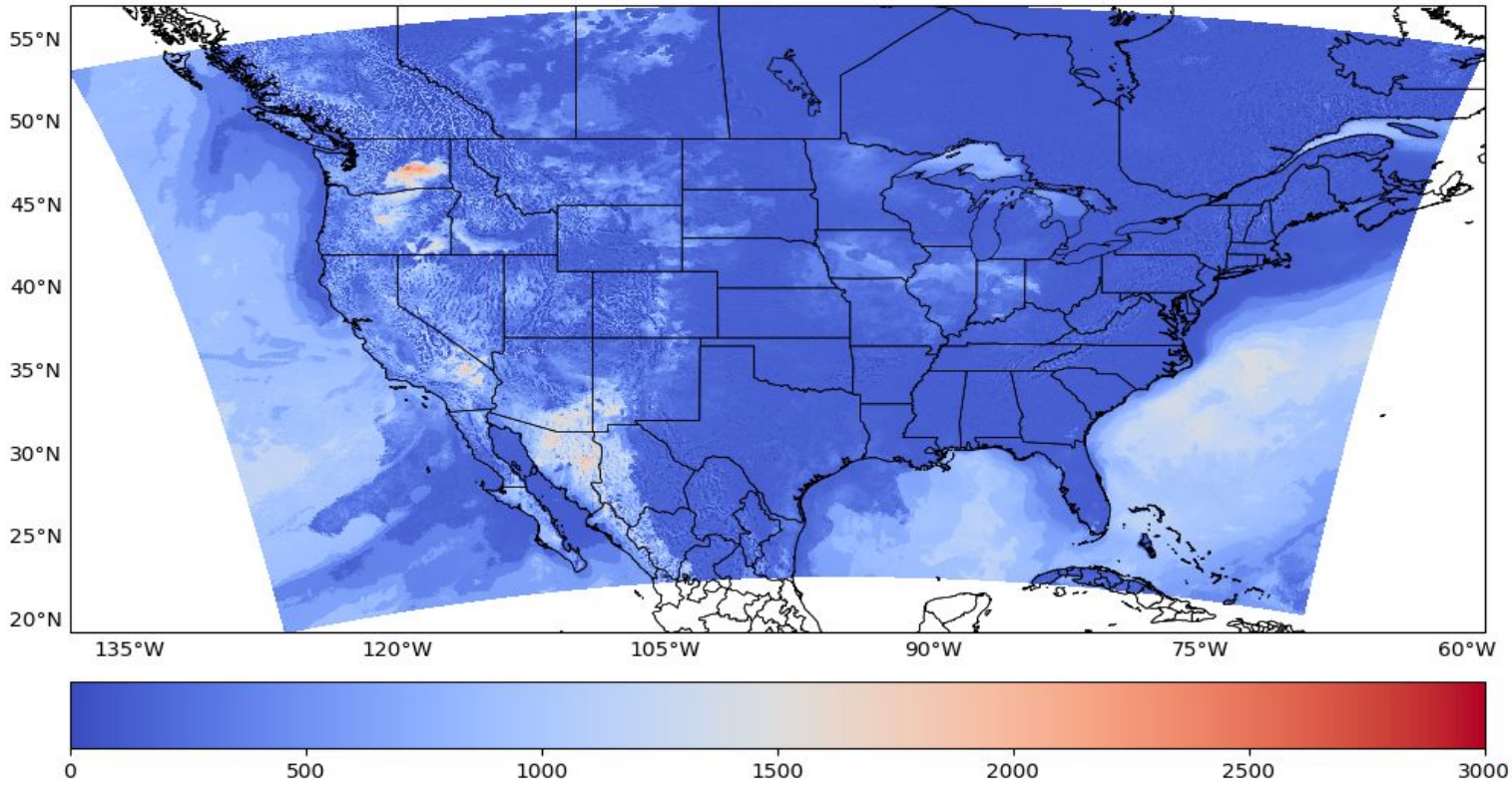


generated at Fri Mar 31 13:50:58 2023 UTC from 20230209 00 UTC data



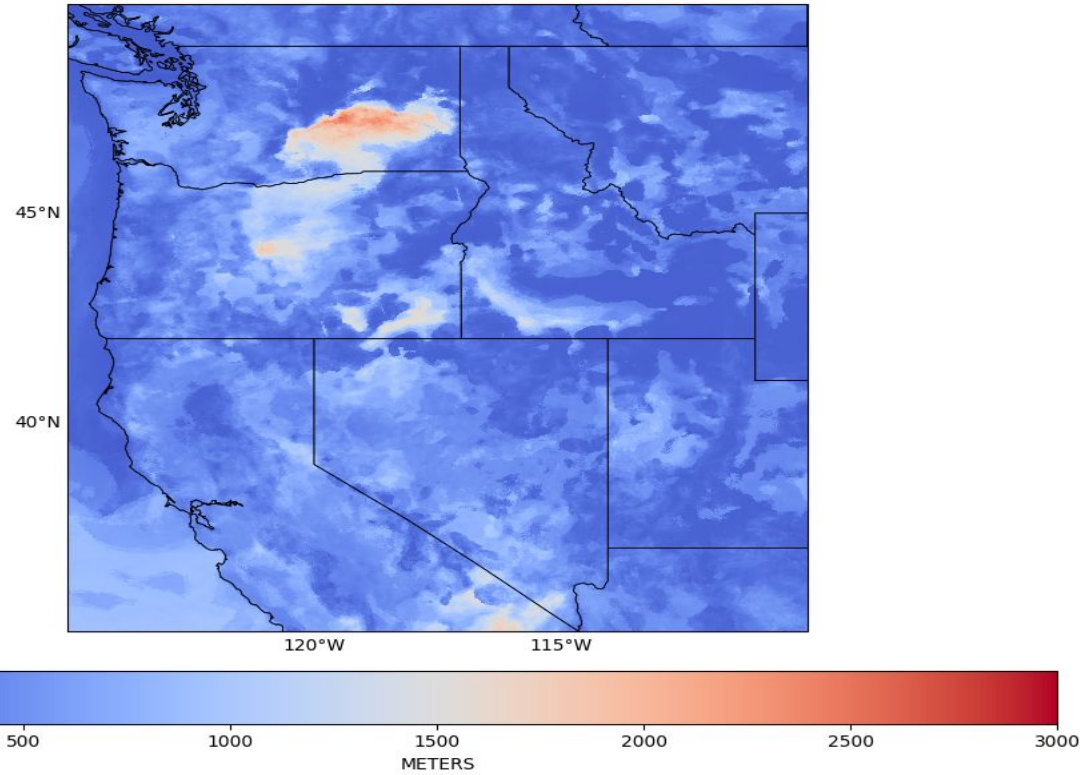
generated at Fri Mar 31 13:56:18 2023 UTC from 20230322 00 UTC data

MRF BLENDED, TERR ADJ MIXHGT
Wed Mar 22 01:00:00 2023 UTC



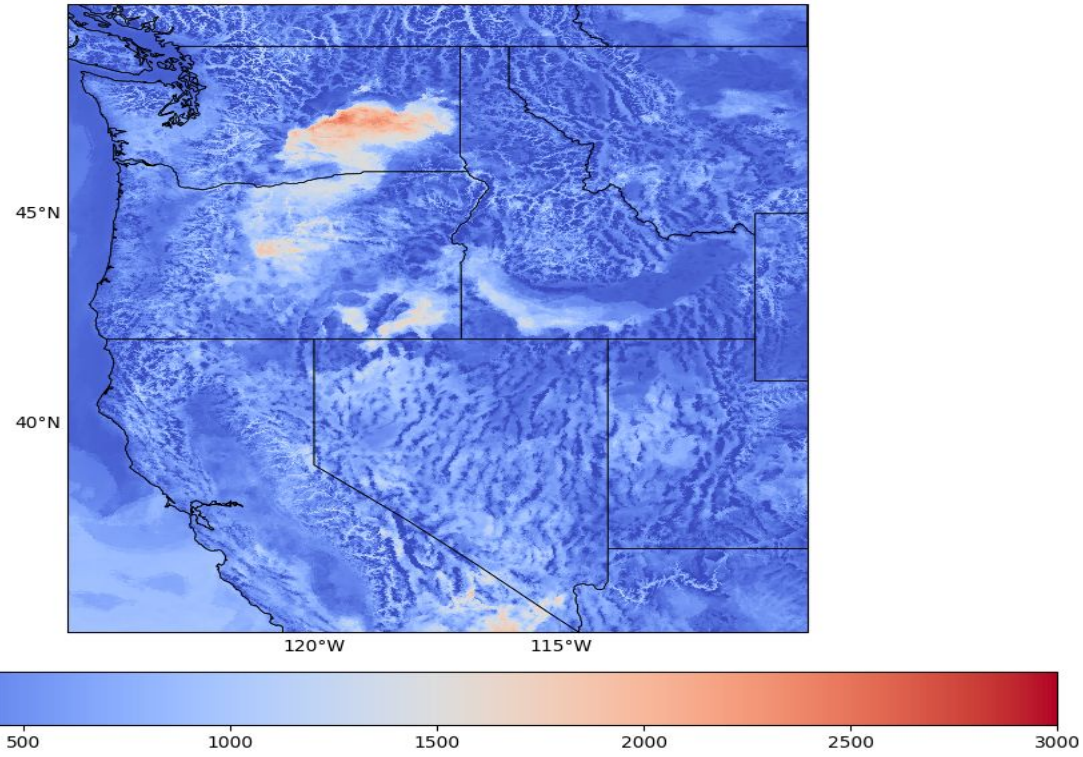
generated at Fri Mar 31 13:57:21 2023 UTC from 20230322 00 UTC data

MRF BLEND MAEW MIXING HGT
Wed Mar 22 01:00:00 2023 UTC



generated at Mon Apr 24 18:06:24 2023 UTC from 20230322 00 UTC data

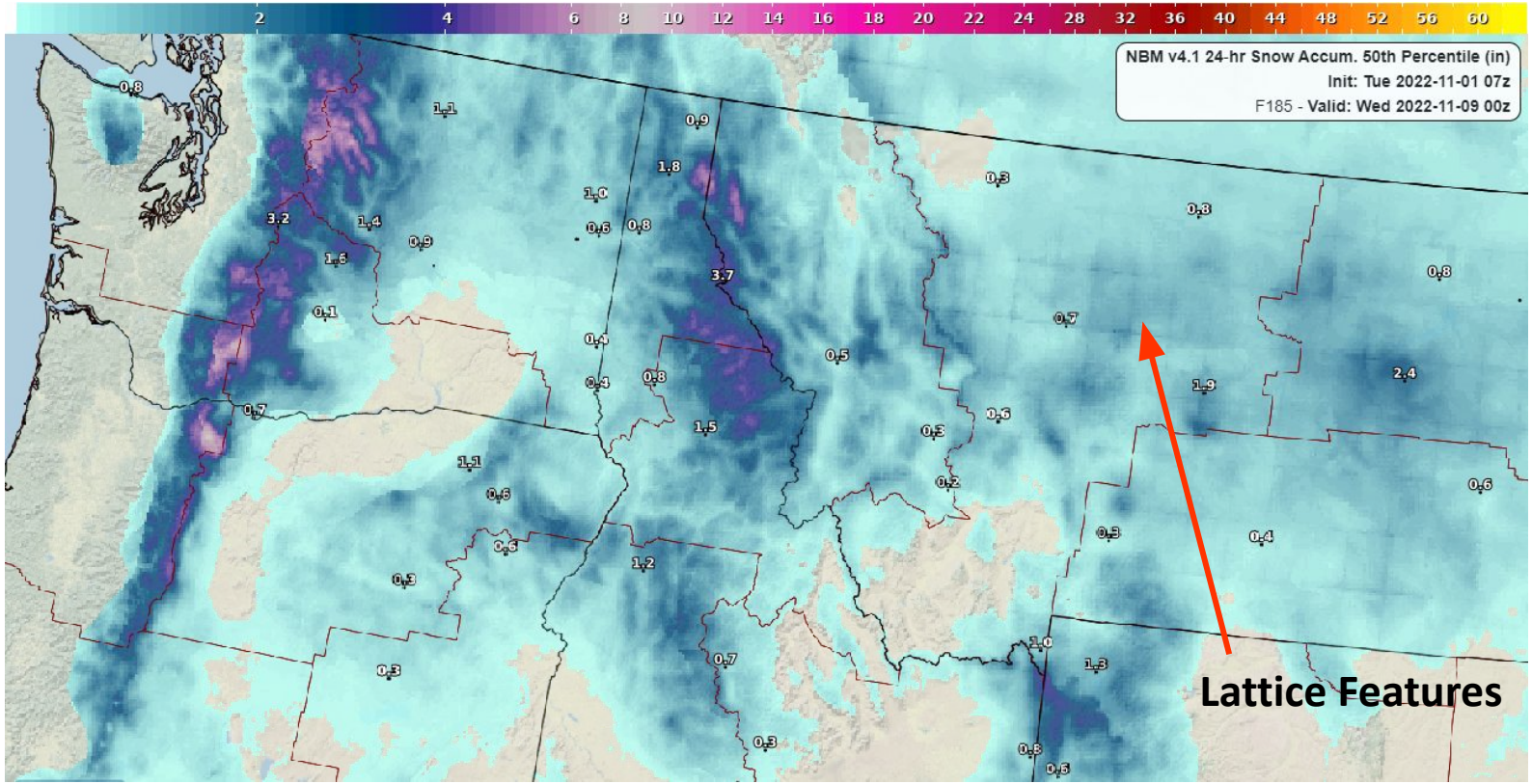
MRF BLENDED, TERR ADJ MIXHGT
Wed Mar 22 01:00:00 2023 UTC



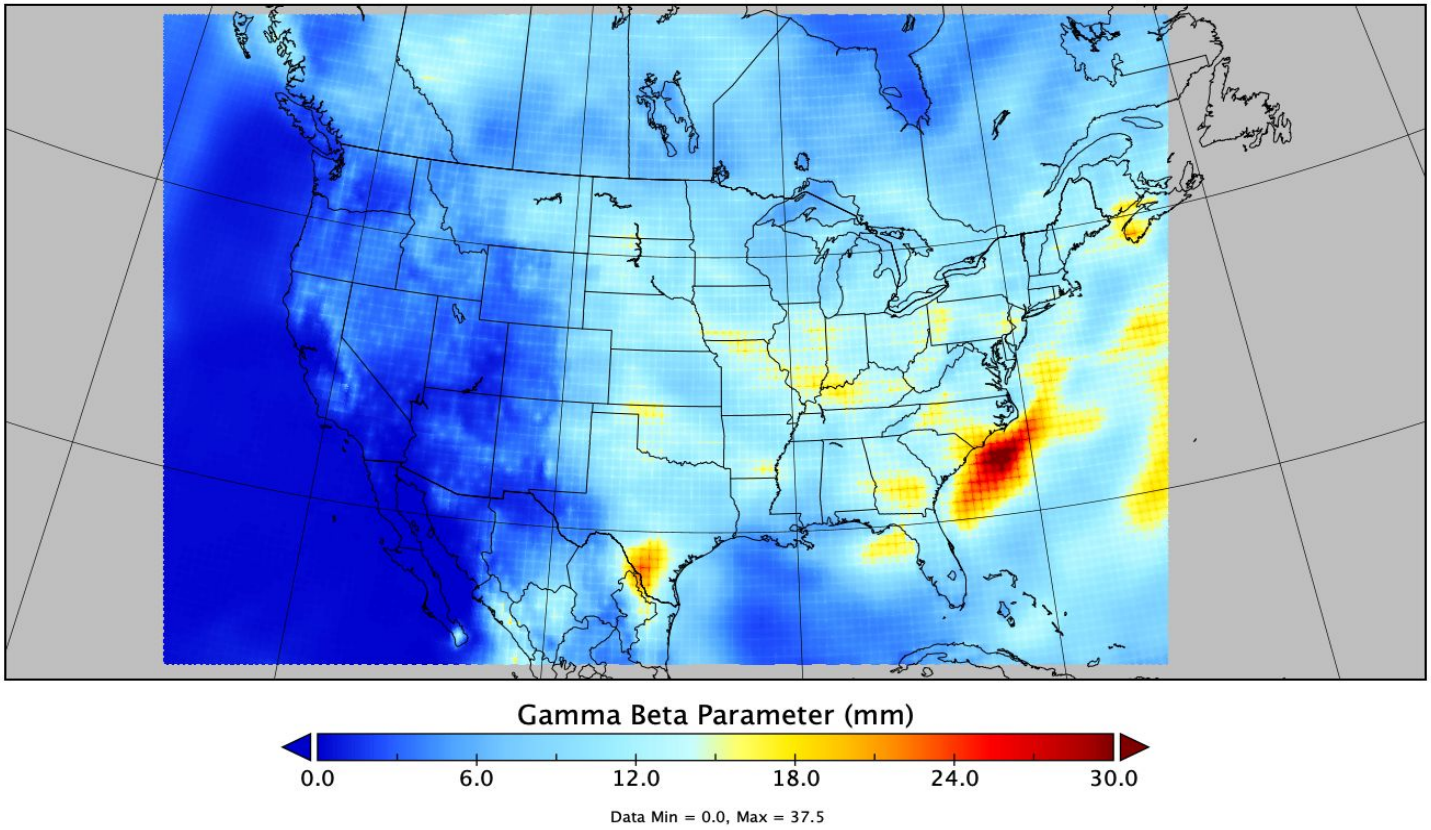
generated at Mon Apr 24 18:09:04 2023 UTC from 20230322 00 UTC data

Removal of lattice features in the NBM snow/ice product

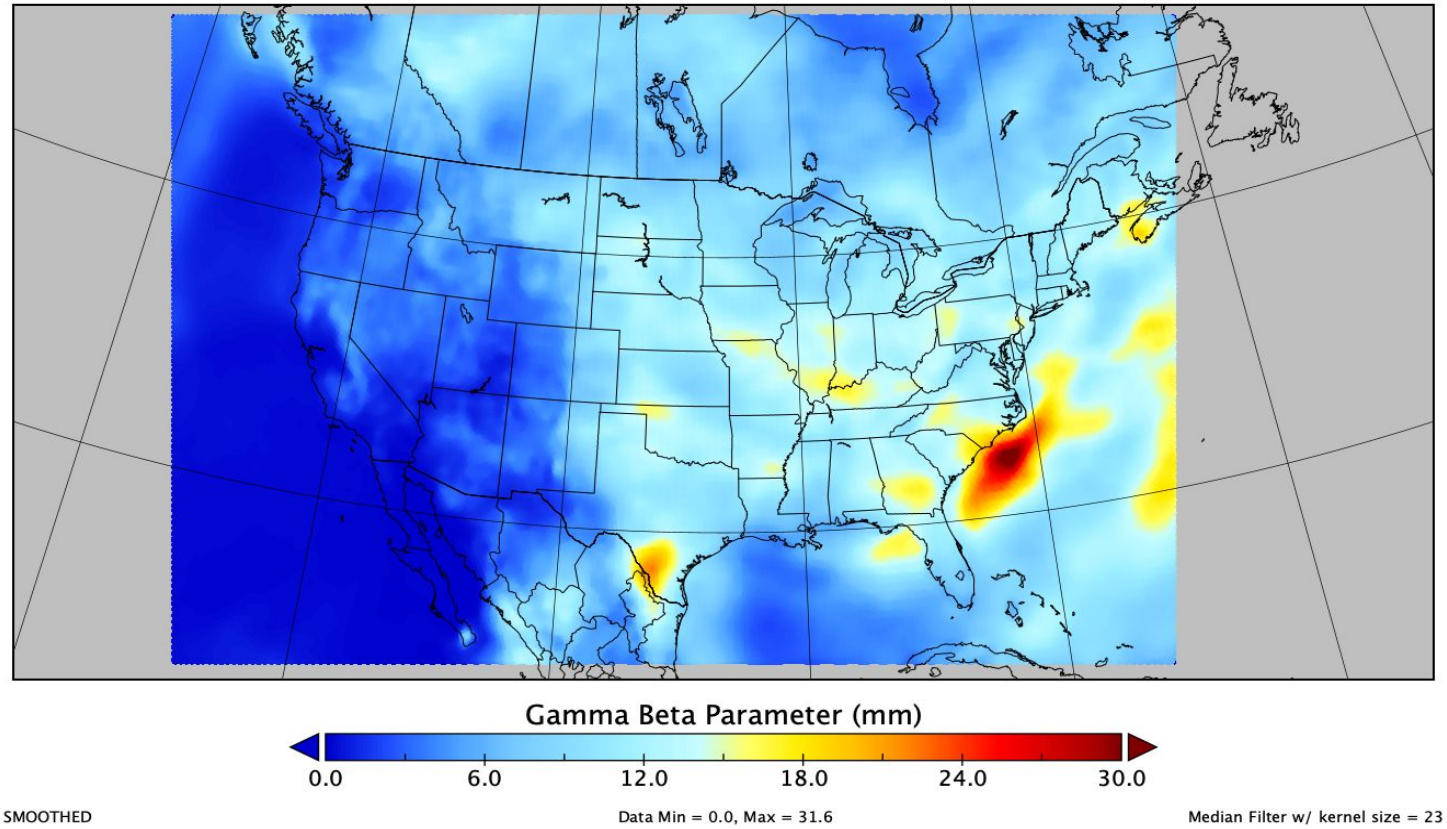
Example 1 of Lattice features in the snow accumulation product



The lattice features are attributable to the QPF CDF used to generate the quantile mapping for snowfall amounts.



The QPF CDF is now smoothed prior to the quantile mapping so that the snowfall probability distribution takes on a smoother appearance.



NBM snow liquid ratio (SLR) improvements in marginal snow environments

NBM Snow Liquid Ratio (SLR) Blends

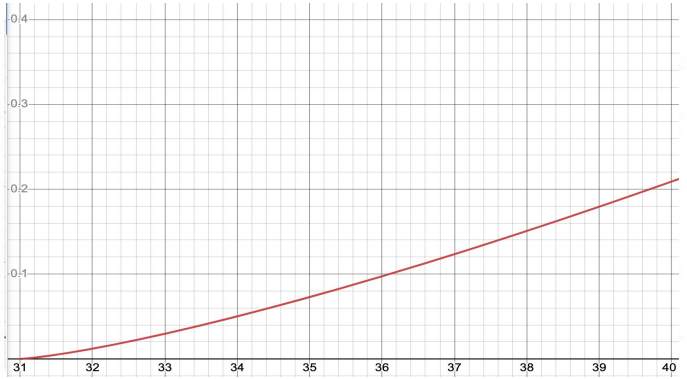
Model	Snow Ratio Techniques
HRRR	50% Cobb, 50% MaxTAloft
HRRRX	50% Cobb, 50% MaxTAloft
RAP	50% Cobb, 50% MaxTAloft
RAPX	50% Cobb, 50% MaxTAloft
HiResARW	50% Cobb, 50% MaxTAloft
HiResARW2	50% Cobb, 50% MaxTAloft
HiResFV3	50% Cobb, 50% MaxTAloft
NAM	33% Cobb, 33% MaxTAloft, 33% Roebber
NAMNest	50% Cobb, 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

NBM V4.2 Proposed SnowMelt 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:

$$QPFmelt = \left(\frac{(0.5 \cdot x - 15.50)}{15} \right)^{1.3}$$



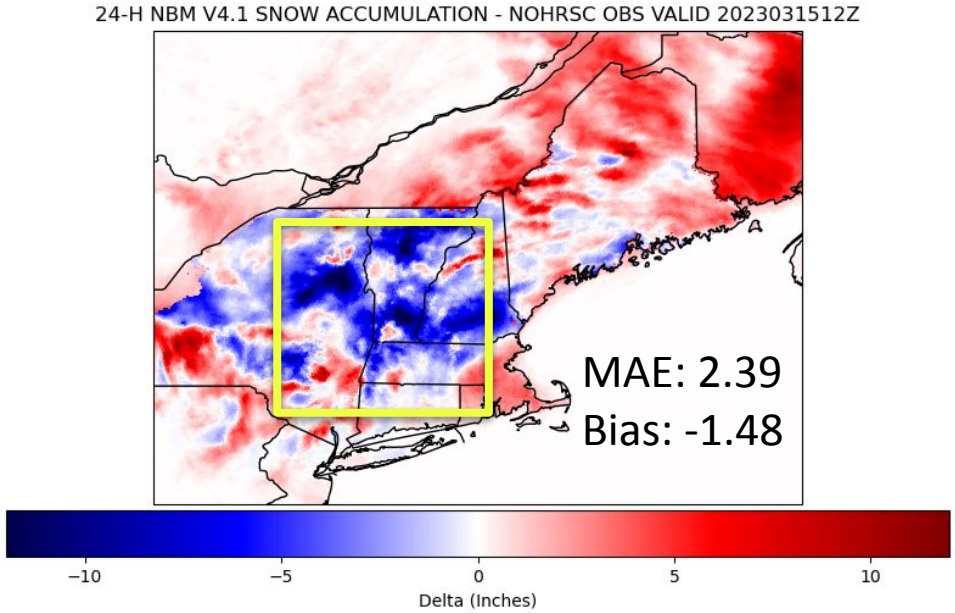
- Revise the blended SLR as:

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

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

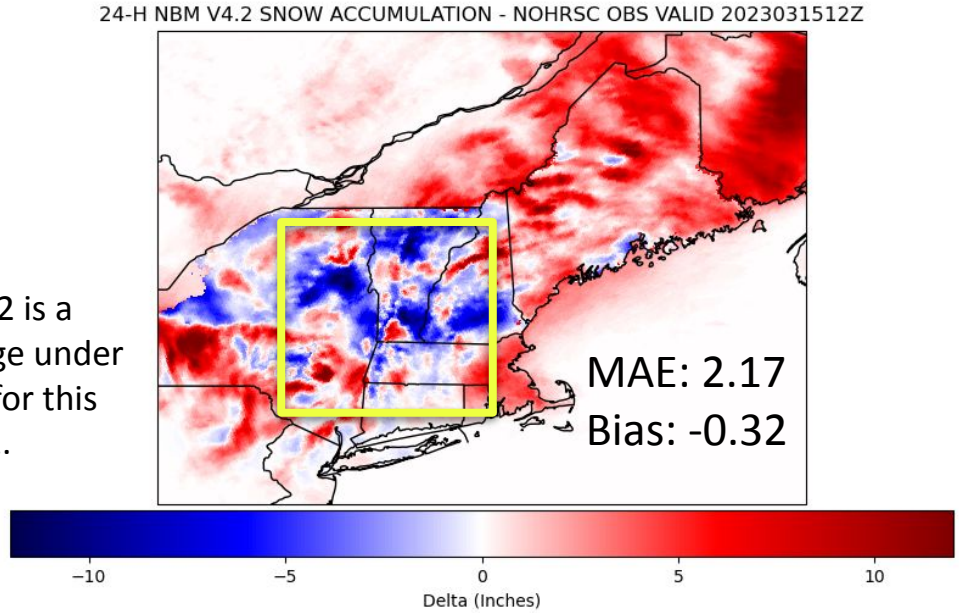
- Adjust logic to allow for a p-type of snow with temps ≤ 40F.

24h Snow Accumulation Difference between NBM v4.1 and NOHRSC



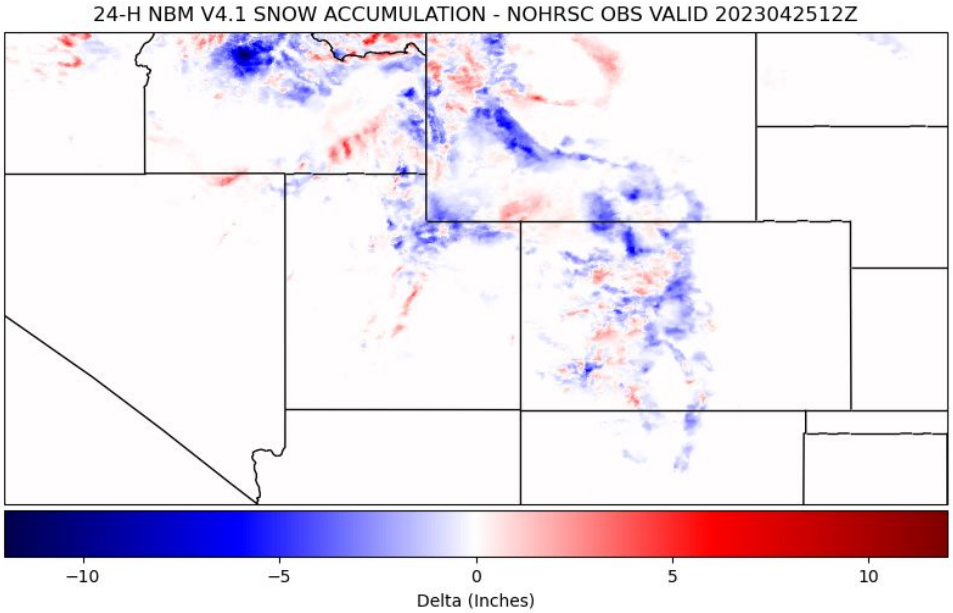
24h Snow Accumulation Difference between NBM v4.2 and NOHRSC

While the MAE for NBM v4.2 is a modest improvement, a large under forecast bias improvement for this event is noted for NBM v4.2.



24h Snow Accumulation Difference between NBM v4.1 and NOHRSC

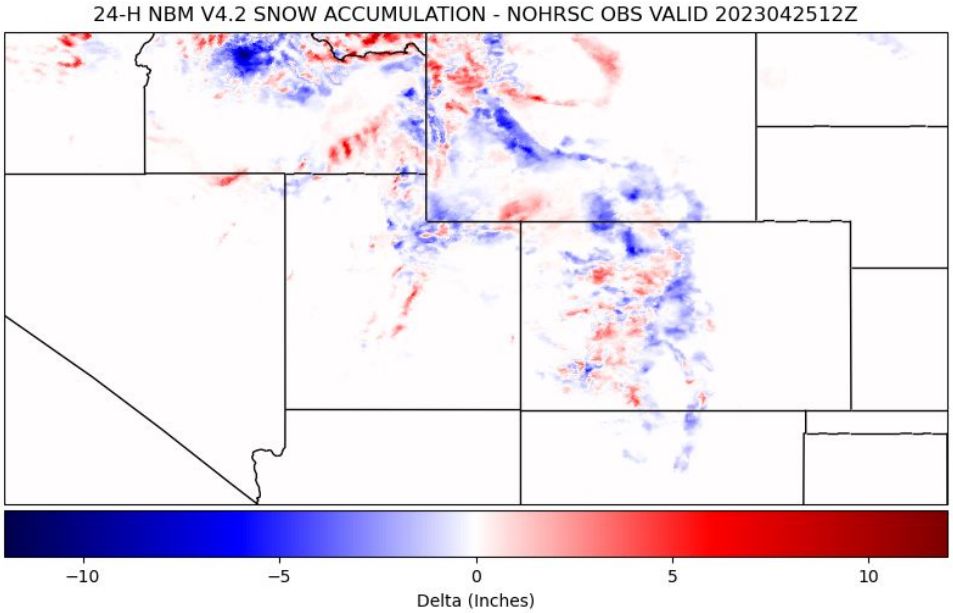
MAE = 0.156 in
Bias = -0.076 in



24h Snow Accumulation Difference between NBM v4.2 and NOHRSC

MAE = 0.162 in
Bias = -0.028 in

While the MAE for NBM v4.1 is a little worse, a modest under forecast bias improvement for this event is noted for NBM v4.2.

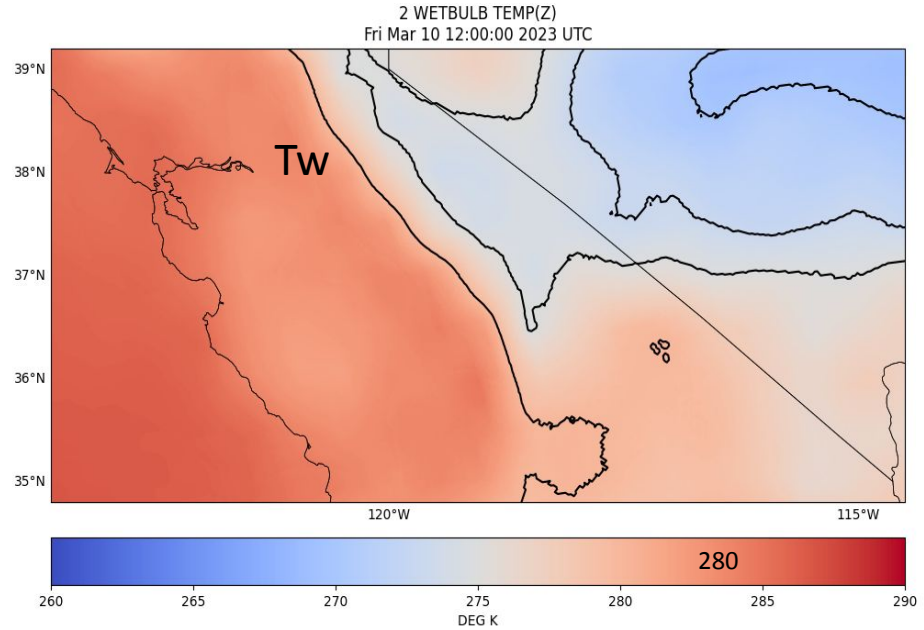


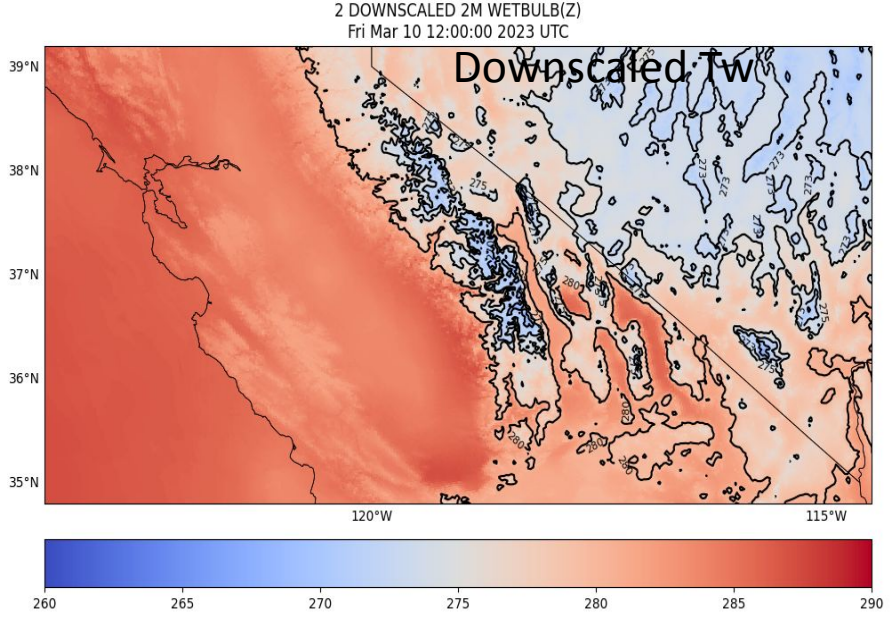
Calculating a Downscaled Wet Bulb Temperature from lower Resolution Model Data for NBM Ice Amounts

Downscaled Wet Bulb Calculation

- Downscaled wet bulb computed by subtracting the difference between the non-downscaled temperature and downscaled temperature from the non-downscaled wet bulb (per communication with Dr. Daniel Cobb). That is:
  - delta=(T - DST)
    - T=non-downscaled temp
    - DST=downscaled temp (obtained from WPC's algorithm based on thermal lapse rates)
  - DSTw=(Tw - delta)
    - DSTw=downscaled wet bulb
    - Tw=non-downscaled wet bulb (from model or computed)
- According to Dr. Cobb, subtracting the temperature difference from the wet bulb should be a reasonably accurate estimate of a downscaled value at least near wet bulb temperatures within +/- 10 degrees F of freezing (~ +/- 5.6 deg K).
- Downscaled wet bulb is applied to the ECMWFE, GEFS, and SREF ensembles only (coarser model resolution).

GEFS Member p25 Tw
0000Z 60-h Forecast from 20230308
valid 20230310/12Z
**(NOTE: the 0700Z Blend would use the 0000Z GEFS)





Stakeholder Evaluations (Positive/Neutral Feedback)

- 10m Instantaneous probabilistic wind speed and wind gust:
  - We have noted a reduction in the high bias from NBM 4.1 at our METAR and RAWS locations. In a recent wind event, we noted that the NBM 4.2 winds seemed to be better calibrated to what occurred than the NBM 4.1 winds, which were too high.
  - Particularly over inland, non-mountain areas, the NBM v4.2 winds are weaker and therefore, in most situations, superior to NBM V4.1.
  - ER offices have noticed improvements in the wind guidance. There is still room for improvement, but definitely a step in the right direction.
  - I have noticed a significant improvement in the quality of NBM wind guidance.
  - It is really hard to say whether it is better or worse but we have not seen any obvious artifacts or errors.
  - Good incremental improvements, Still unclear how the QMD wind will perform in higher wind situations - especially during the transition season where the training data set will have limited representation.
- SLR Changes:
  - This will need to be watched closely once we get into winter and evaluated further, but conceptually we do support this enhancement.
  - The removal of the lattice effect is a welcome change to the winter weather accumulation products, and it does not appear (at first glance) to have degraded the QPF.
  - WPC has some concerns about the removal of the 25% SLR reduction. From a few cases we've seen, there was a somewhat high bias for snow totals. We'll be watching this closely when 4.2 is implemented.
- Smoothing of QMD QPF:
  - QMD QPF has been more smoothed since 4.1 and I haven't noticed much difference in 4.2. The smoothing effect introduced (likely by the climo) in 4.1 has caused some issues with our often sharp terrain gradients but only in cases where orographics favor it...so...it's a bit of a wash since it's actually better in cases where orographics don't make as much difference.
  - Did not notice a substantial difference.
  - The removal of the lattice effect does not appear (at first glance) to have degraded the QPF.
- Mixing Height Changes:
  - The increased resolution seems to help daytime mixing height.
  - Need to continue to monitor, but initial impressions are favorable

Stakeholder Evaluations (Negative Feedback)

- 10m Instantaneous probabilistic wind speed and wind gust: - None
- SLR Changes:
  - I think the SLR is too higher overall. Has any verification been done? Have you consulted Dan Baumgardt or Tom Hultquist's work on SLR climatology? We frequently have to lower SL
  - Reviewed the cases provided, while it is hard to tell, it seems the removal of the 25% reduction may allow higher elevation SLR values to run away on the high side more than we are used to. I'd really like to see some verification of the SLR methodology over the intermountain west. If the SLR values are systematically too higher of our terrain, that is going to cause numerous negative impacts to snow safety (avalanche) and transportation partners.
- Smoothing of QMD QPF:
  - Especially for heavier rainfall events, there is too much QPF and it is spread over too large of an area.
- Mixing Height Changes:
  - My ask is that this methodology be scaled back during the winter months when this will likely result in too high of mixing heights in deep narrow valleys.
  - Overnight the change reverses what happens in reality by maintaining relatively deep mixing over valley and zero mixing height over slopes and ridges.

Stakeholder Implementation Recommendation

- Western Region - Implement as Proposed (Representative: Matt Jeglum)
- Central Region - Implement as Proposed (Representative: Randy Graham, SSD)
- Southern Region - Implement as Proposed (Representative: Matthew Moreland, SSD)
- Eastern Region - Implement as Proposed (Representative: Jeff Waldstreicher, SSD)
- Alaska Region - Implement as Proposed (Representative: David Levin)
- WPC - Implement as Proposed (Representative: Mark Klein, SOO)

Thanks to NBM v4.2 developers

- Robby James - QMD Prob 10m instantaneous wind speed/gusts, Maintaining/Running NBM v4.2 on WCOSS2
- Carly Buxton - Fire Weather (Mixing height changes)
- Eric Engle - QMD PQPF Smoothing/Removing Lattice features in the snow/ice product
- Daniel Cobb, Greg Leone - SLR Improvements to Snow product
- Mike Baker - Wet Bulb Downscaling for Snow/Ice product
- Adam Schnapp - Cig, Vsby, Prob Cig, Prob Vsby
- Geoff Wagner - Tropical Feature Matching timing improvements
- Scott Scallion - Operational NBM and NCO Code Handoff
- Dana Strom - NBM viewers and download pages
- Steven Levine, John Wagner and Tamarah Curtis - NBM v4.2 Verification
- Brian Haynes - NBM Web Page Support

Special Thanks to NBM Contributors

- NBM SAG (Science Advisory Group)
- Regional SSD Chiefs
- WFO SOO/Forecaster feedback
- Andy Just (CRH SSD)
- Brian Miretzky, Sarah Perfater (AFS)
- Bruce Veenhuis (WPC)

Too many SOOs, ITOs, and forecasters to name

Contact Information for NBM v4.2

David Rudack
MDL/Silver Spring, MD
david.rudack@noaa.gov

or

Judy Ghirardelli
MDL/Silver Spring, MD
Judy.Ghirardelli@noaa.gov