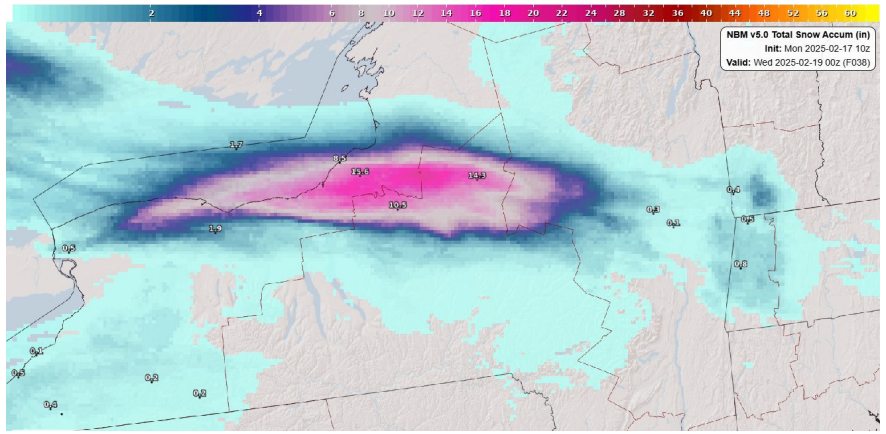
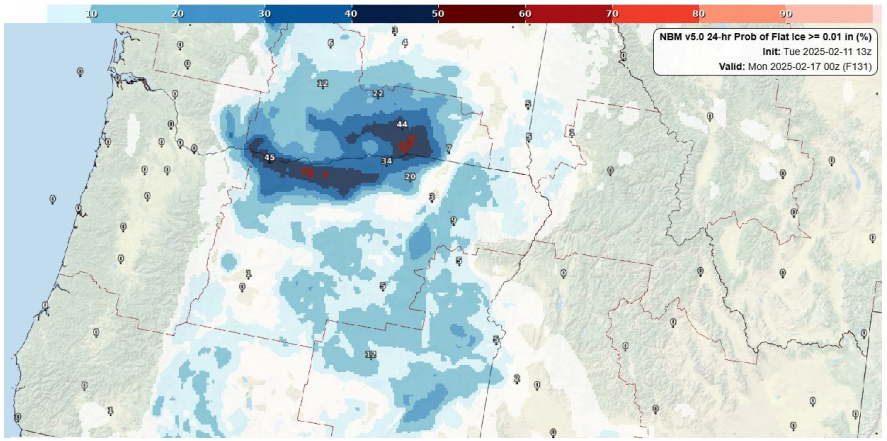




Planned Changes to the Winter Suite of the National Blend of Models

Geoff Manikin
NOAA/MDL/Statistical Modeling Division
11 March 2025

Acknowledgements

- Dave Rudack - NBM Project Lead and Winter Weather/QPF Product Development
- Greg Leone - NBM Winter Weather Development and Evaluation
- Robby James - Building/Maintaining NBM parallel runs and Winter Weather Development
- Eric Engle - NBM QMD PQPF
- Daniel Cobb - SLR Improvements to NBM Snow product
- Scott Scallion - Operational NBM and NCO Code Handoff
- Mike Baker and Brian Haynes - NBM Evaluation
- Dana Strom - WSUP Viewer and Verification
- John Wagner - Verification
- NBM Science Advisory Group (David Levin, Lead)
- Many SOOs and field forecasters for valuable feedback
- Bruce Veenhuis (WPC) - Consultation

NBMv4.3

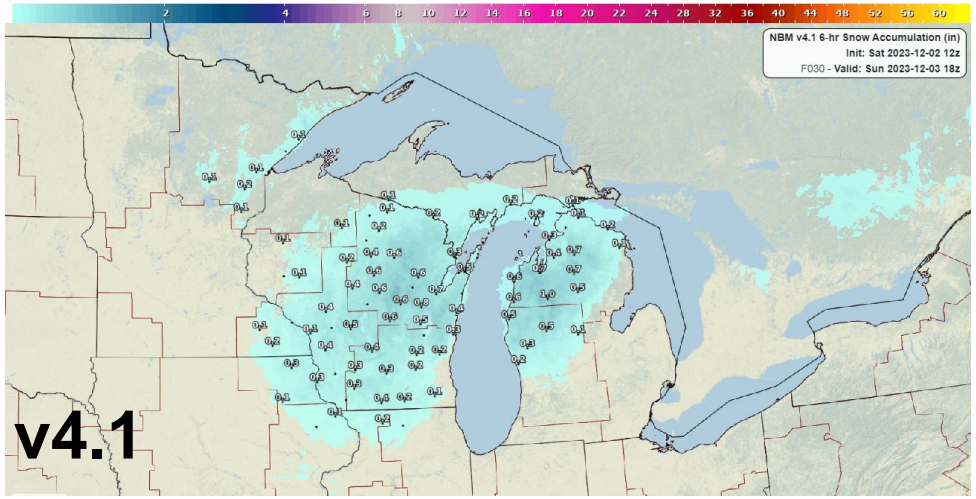
- An upgrade intended to get a major upgrade to NBM tropical winds into operations ahead of the 2025 Tropical Cyclone season
- Includes a few other fairly minor changes (including an update to SPC calibrated severe weather probabilities)
- Implementation targeted for early May 2025

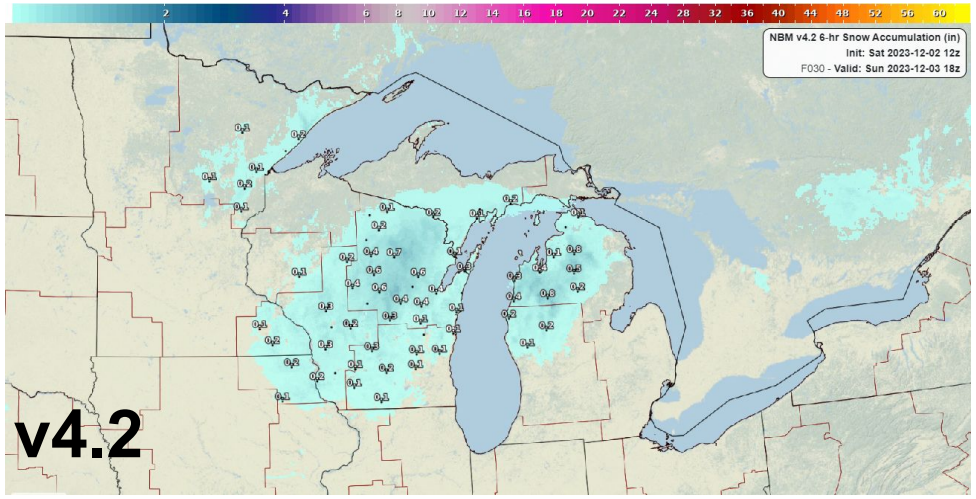
NBMv4.3

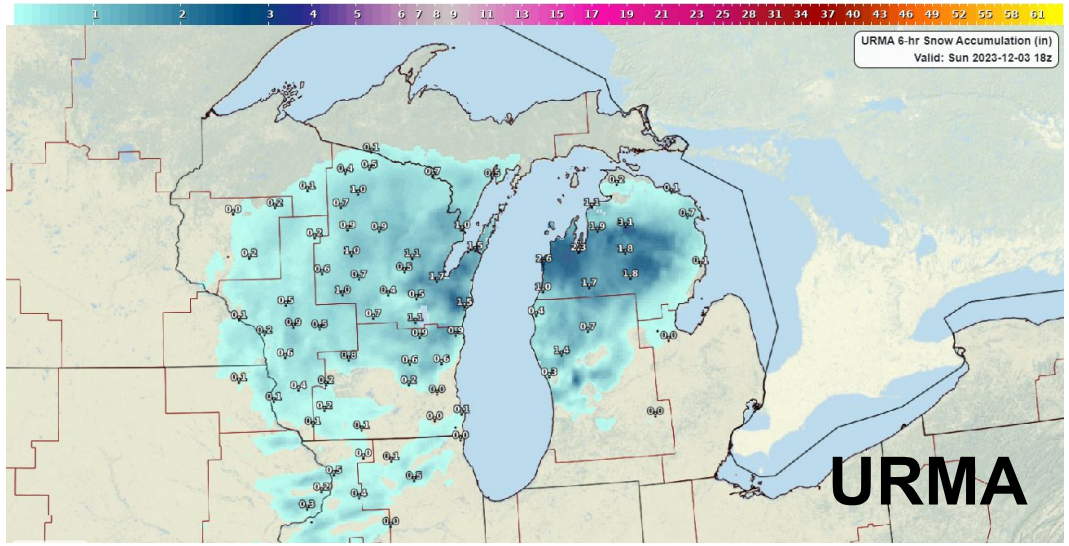
Snowfall Changes

- A Cobb method for melting snowfall was added to NBMv4.2; it allows snow to accumulate in environments with marginal temperatures but good snowfall rates
- There were examples last winter, however, of snowfall being erroneously reduced when forecasted temperatures were warmer than observed
- A Cobb update allows for the possibility that the forecasted temperature is too warm and is less aggressive with melting
- This change was made in ForecastBuilder (FB) towards the end of last winter; this update makes the NBM consistent with FB

Too Much Melting w/ Low Rates

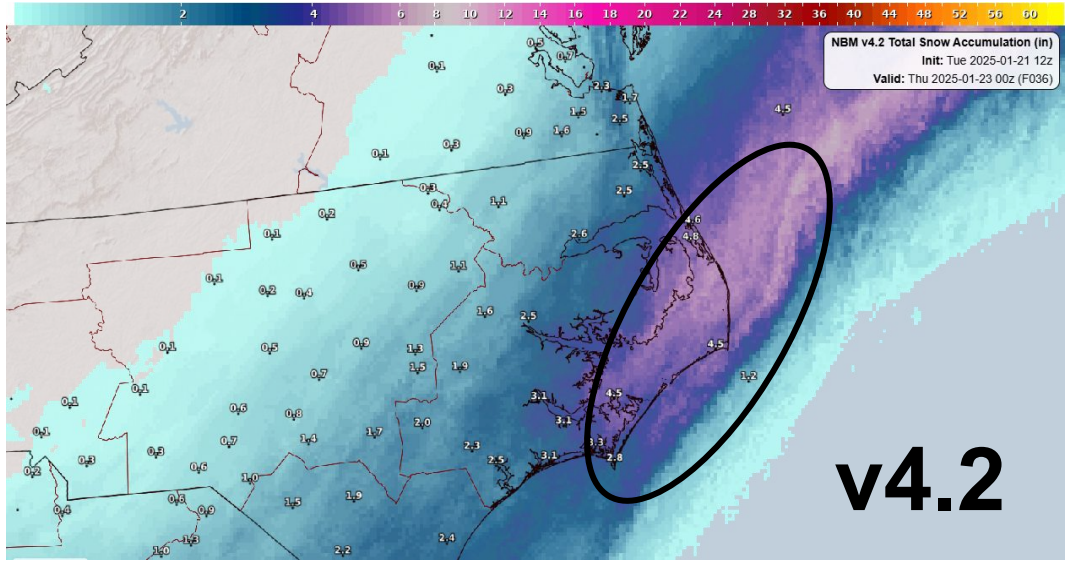


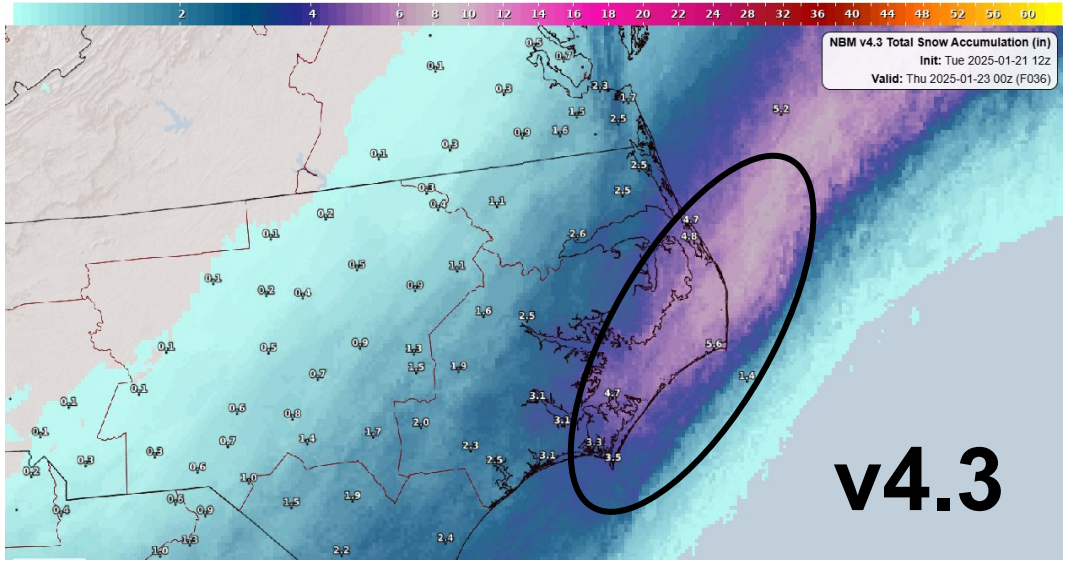




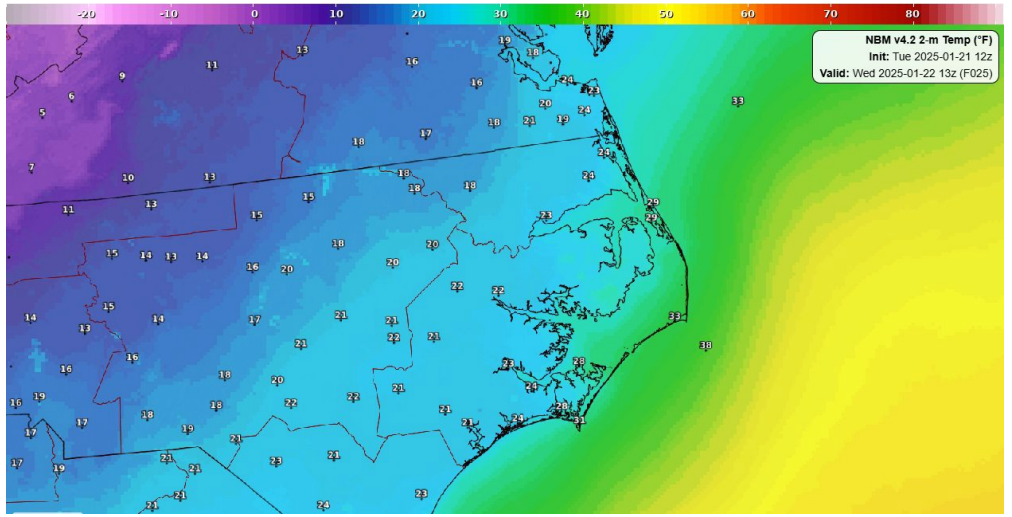
- This was an event from the 2023-24 winter with marginal temperatures but low rates
- It showed that the melting could be too aggressive in events with marginal temperatures and light rates
- Cases like these spurred Dan Cobb to make changes to his melting technique

v4.3 Snowfall Example





- Amounts are increased in 4.3 where the temperatures are marginal



v5.0 Winter Changes

- Probabilistic vs. Deterministic
- Changes to Inputs
- QPF Changes
- Preserving Inversions
- New Products

v5.0 Winter Changes

- Probabilistic vs. Deterministic
- Changes to Inputs
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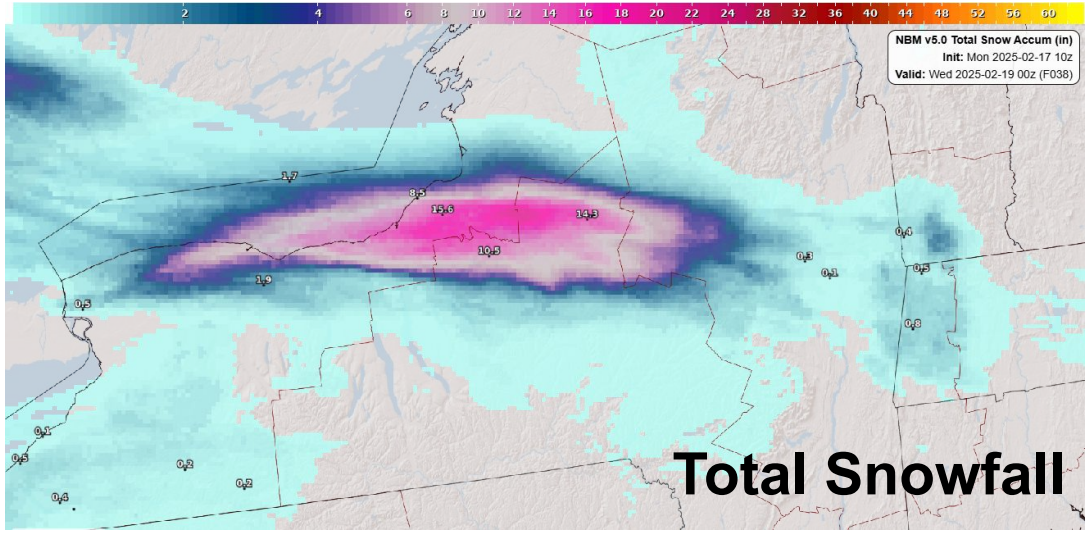
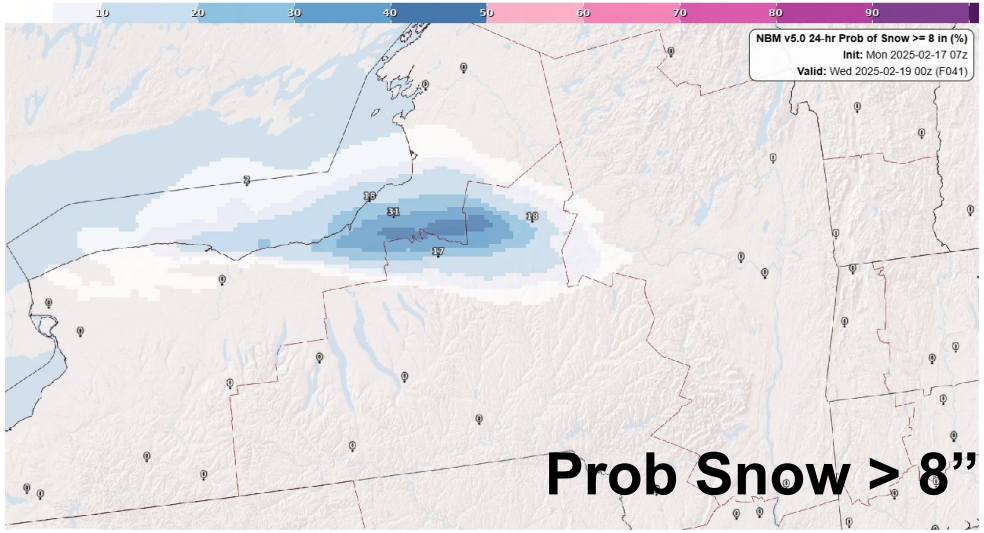
Deterministic vs. Probabilistic

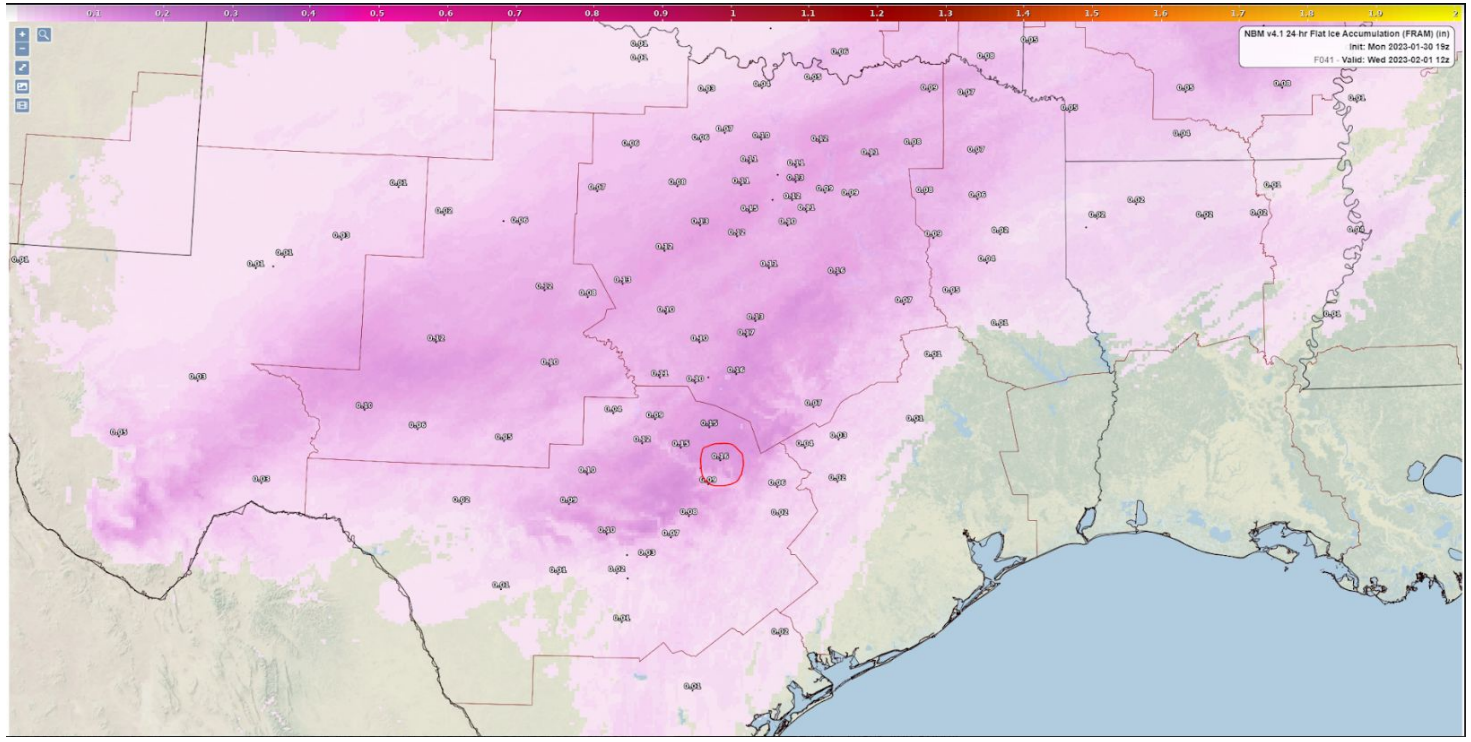
- Deterministic and Probabilistic NBM fields are computed differently
- Probabilistic fields count every input equally and effectively represent a frequency of occurrence within the inputs
- Many deterministic fields use some sort of weighting (MAE or expert)
- The deterministic and probabilistic fields can therefore be inconsistent

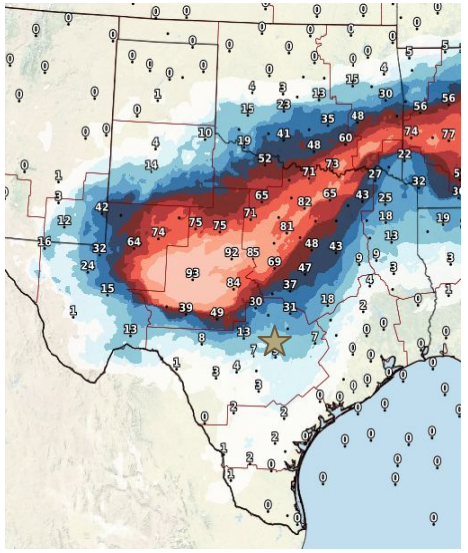




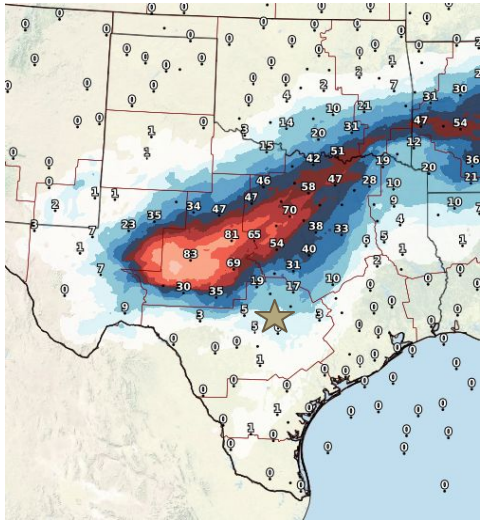
Austin, TX 2023 Ice Storm

19Z 1/30/23 Deterministic ZR Total at F41





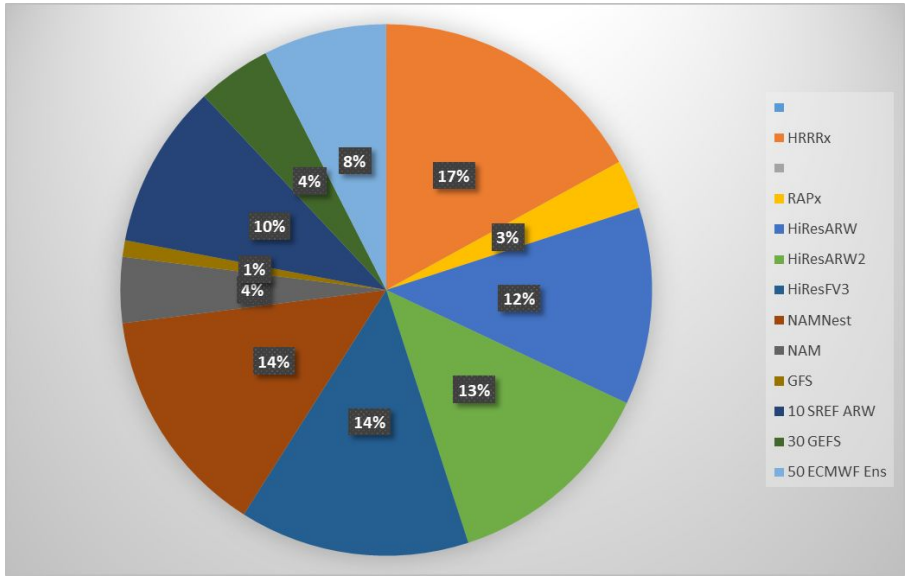
Prob > .01” ZR

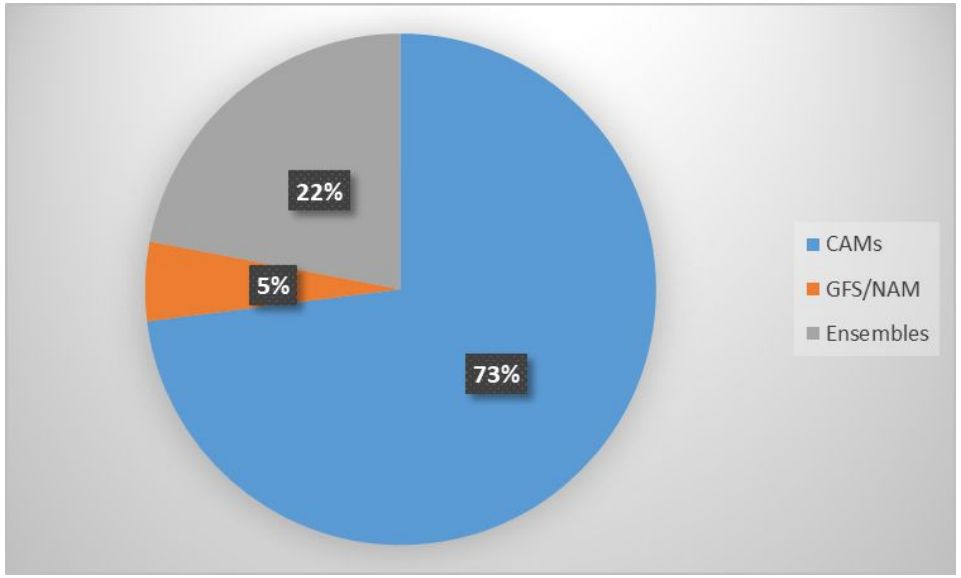


Prob > .1” ZR

credit: Andy Just, formerly of CRH, now at CP

Austin, TX 2023 Ice Storm

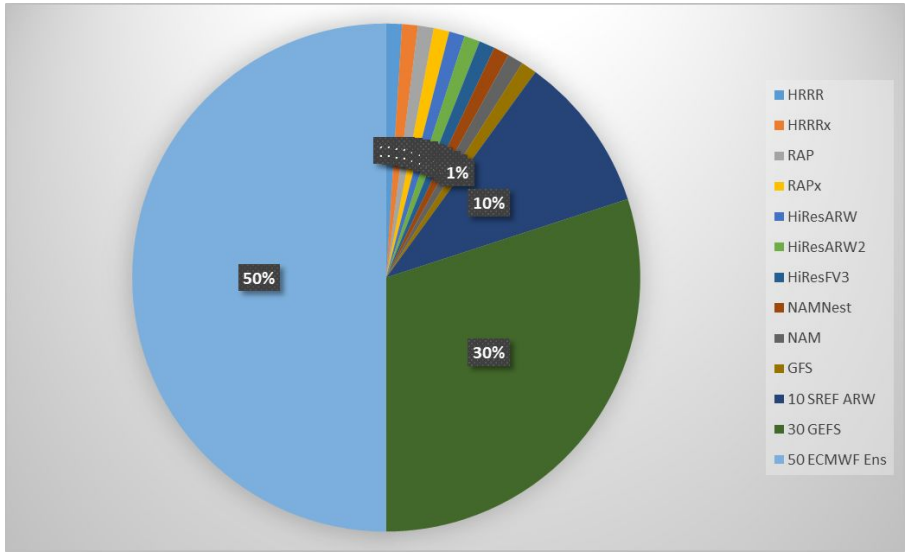


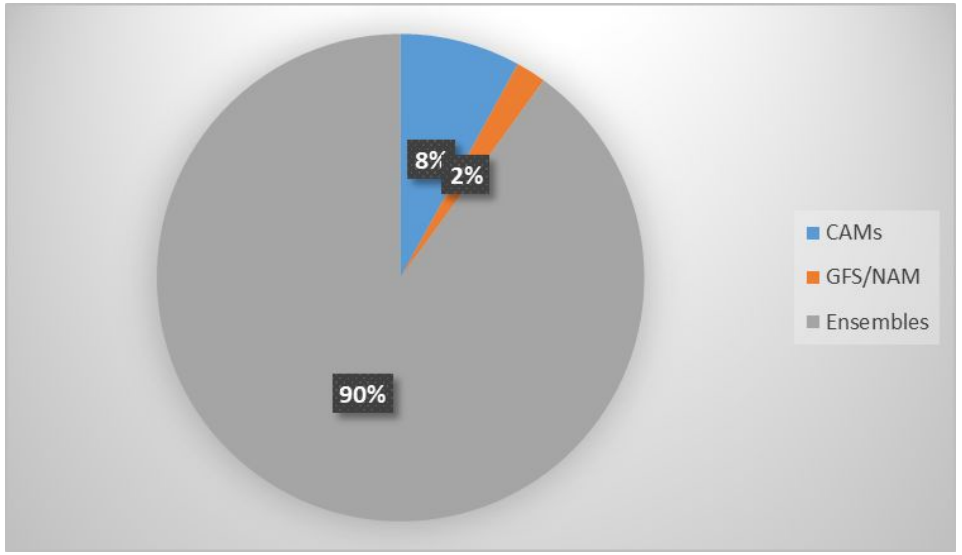


Deterministic Hours 20-41

largest influence is from the hi-res guidance

note that the percentages are *slightly* different now in v4.2 than from when these figures were generated

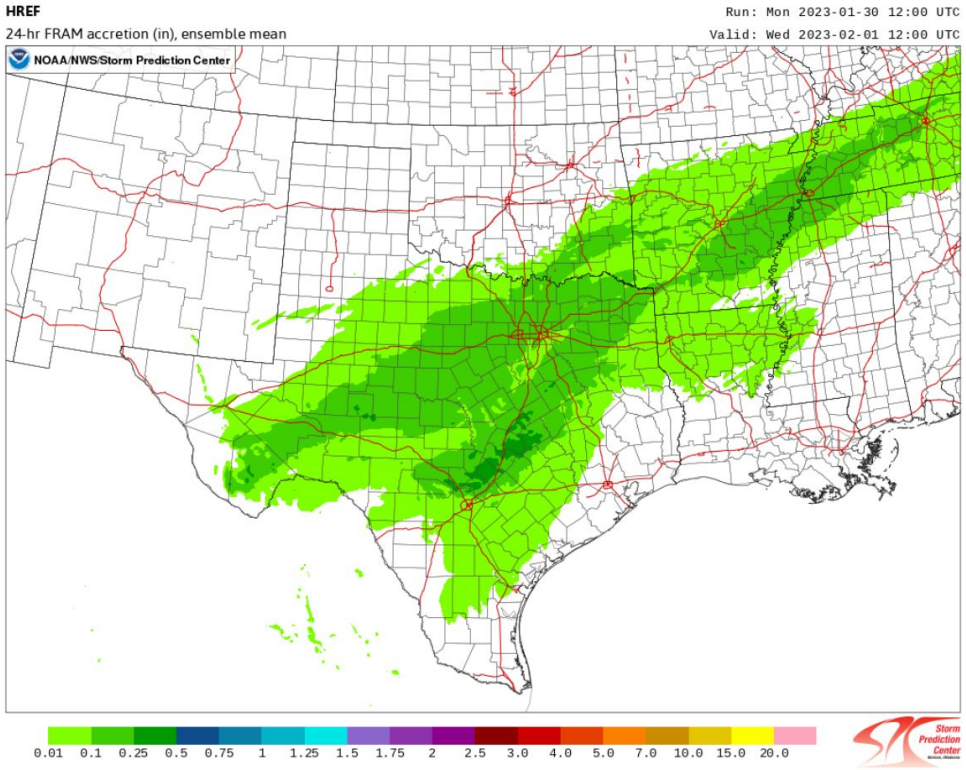


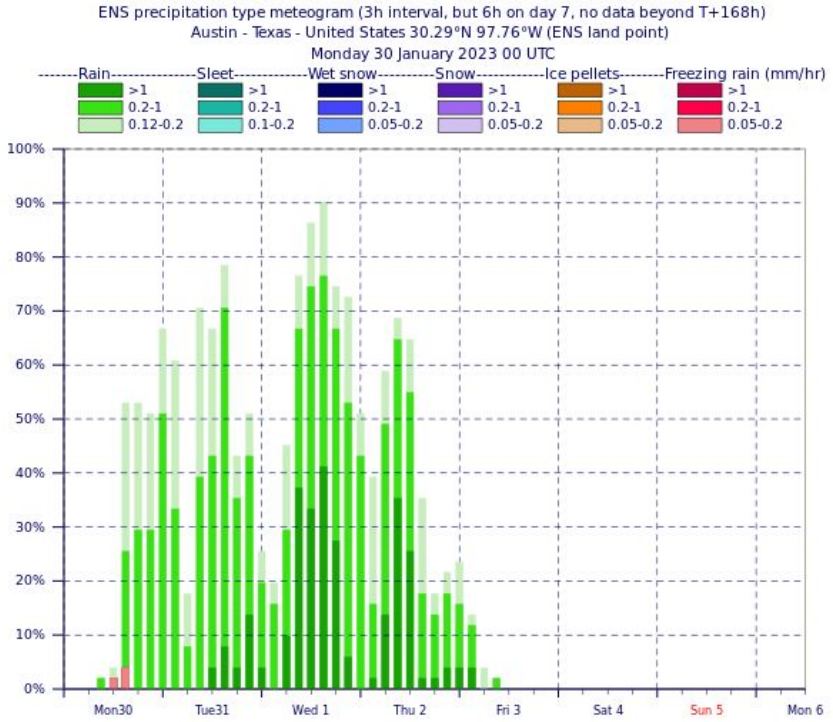


Probabilistic All Fcst Hours

largest influence is from the ensembles

Austin, TX 2023 Ice Storm





CAMs had strong signal for significant ice accumulations near Austin (big influence on deterministic ice amounts)

But the global ensembles, especially the EPS, showed mostly rain near Austin at this range (big influence on probabilistic output)

What to Do

- Currently constructing ways to revise the distribution based on the applied weighting
- Create an unequal expert-weighted Cumulative Distribution Function for the probabilistic solution that better aligns with the weights assigned to the deterministic forecast
- This will remove much of the probabilistic and deterministic inconsistencies

v5.0 Winter Changes

- Probabilistic vs. Deterministic
- Changes to Inputs
- QPF Changes
- Preserving Inversions
- New Products

Adding Canadian Input Data

- With the likely SREF retirement in the next 1-3 years, we are going to end usage of the SREF in the NBM in v5.0
- This, along with recognizing that we could invoke existing precip type rate data in the Canadian models, opens the door to using Canadian model data in the NBM Winter Suite
- Removal of the parent NAM from the winter suite in v4.2 opened an additional slot

Removed in v4.2

Model
HRRR
HRRRX
RAP
RAPX
HiResARW
HiResARW2
HiResFV3
~~NAM~~
NAMNest
10 SREF ARW
GFS
30 GEFS
50 ECMWF Ens

NAM and SREF removal opens 11 winter slots

Model
HRRR
HRRRX
RAP
RAPX
HiResARW
HiResARW2
HiResFV3
CMC GDPS
NAMNest
CMC RDPS
GFS
30 GEFS
50 ECMWF Ens

5 GEPS

4 REPS

Legacy NBM Winter Suite Code is limited to 100 inputs

v5.0 Winter Changes

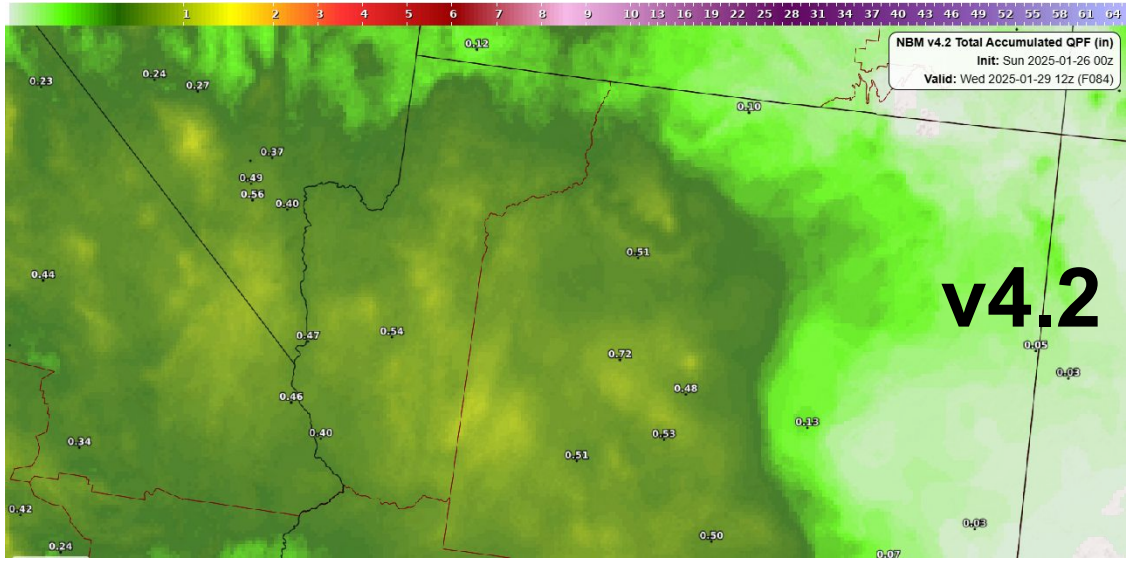
- Probabilistic vs. Deterministic
- Changes to Inputs
- QPF Changes
- Preserving Inversions
- New Products

Changes to Quantile-Mapped Precipitation

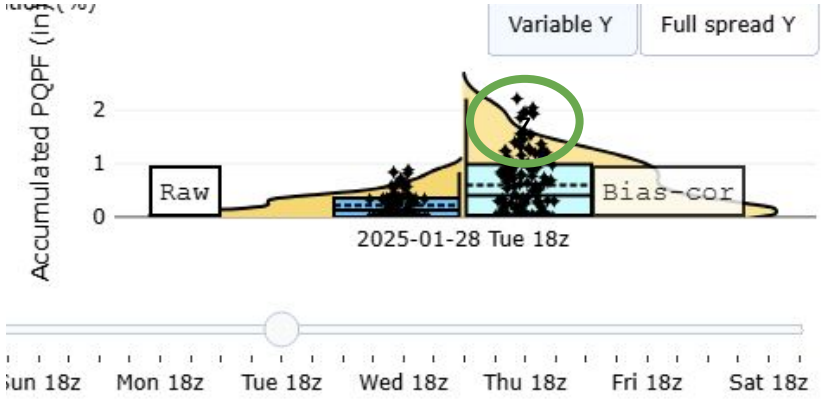
- Reintroduction of monthly supplemental locations
  - MSWEP climatology (2002-2023)
  - Used to inflate most recent 60-day training sample for ***analysis and model*** CDF generation
  - Replaces current method of equally weighting climatology with most recent 60-day data for **analysis only**
- Removal of negligible precipitation amounts
  - Values < 0.245mm are set to 0.0 for analysis and model CDF training data (also used in supplemental location workflow)
- Removal of 9-point stencil
  - Legacy feature used when there were fewer models; used to artificially increase multi-model ensemble members
- Incorporation of WPC MMEBC into the distribution (it's already used in 6h NBM QPF)
  - Assist with higher-end precipitation events

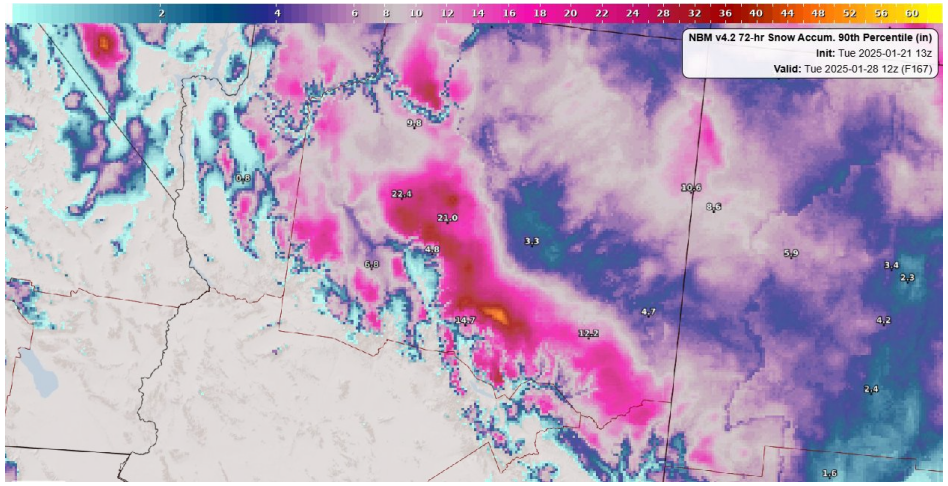
Not yet in v5.0 parallel

Southwest QPF



- QPF was extremely wet in the ops NBM in the Southwest in the first wet events of the season

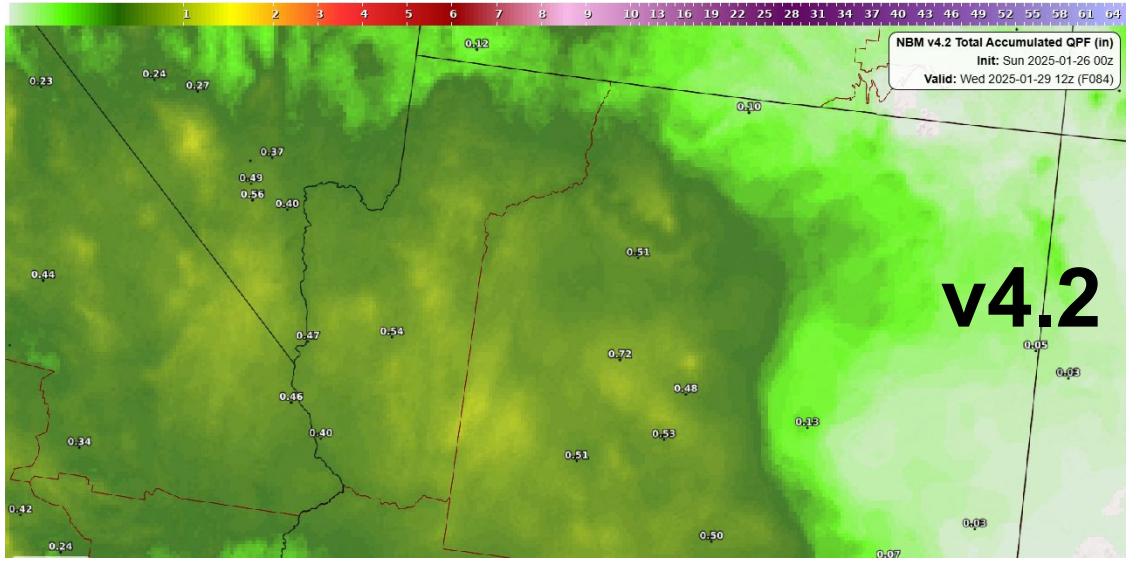


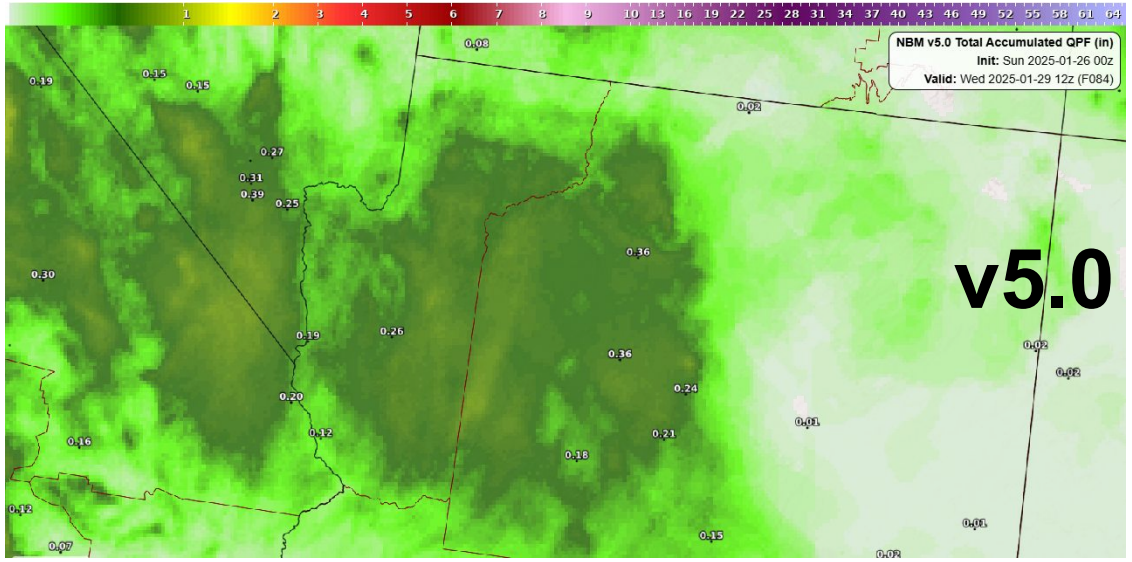


- Upper percentiles for snowfall were incredibly high

- Issue was that the bias correction treated this as an event in the tails of the distribution and was incredibly aggressive

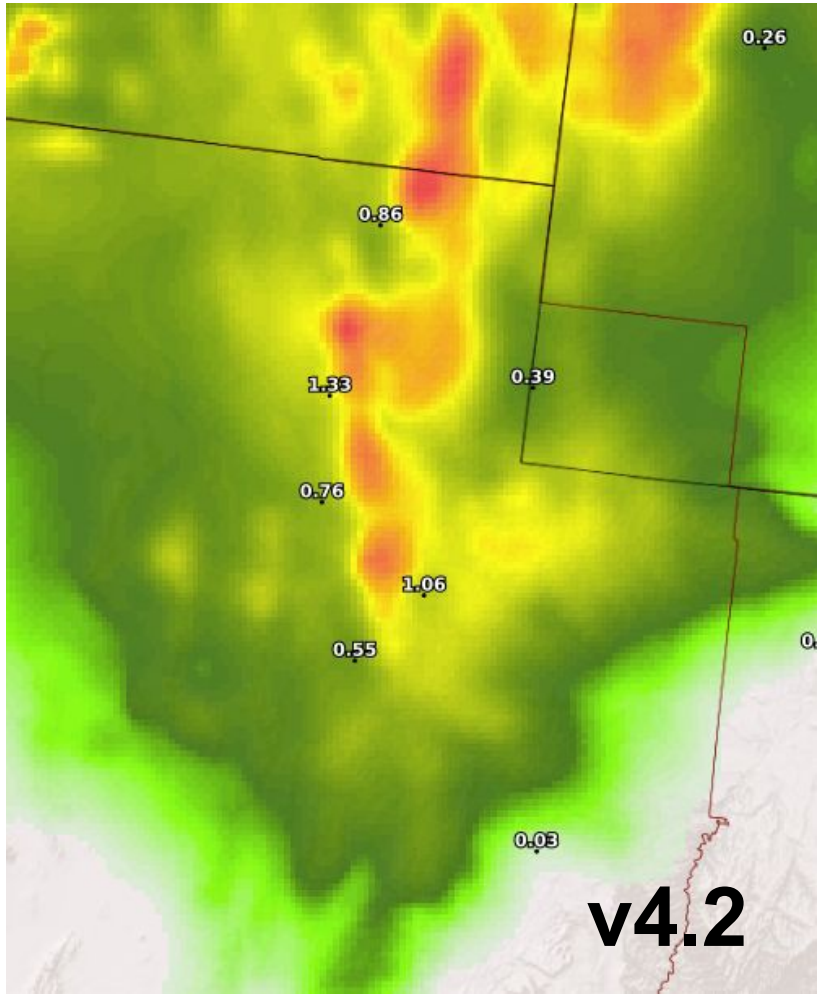
Southwest QPF

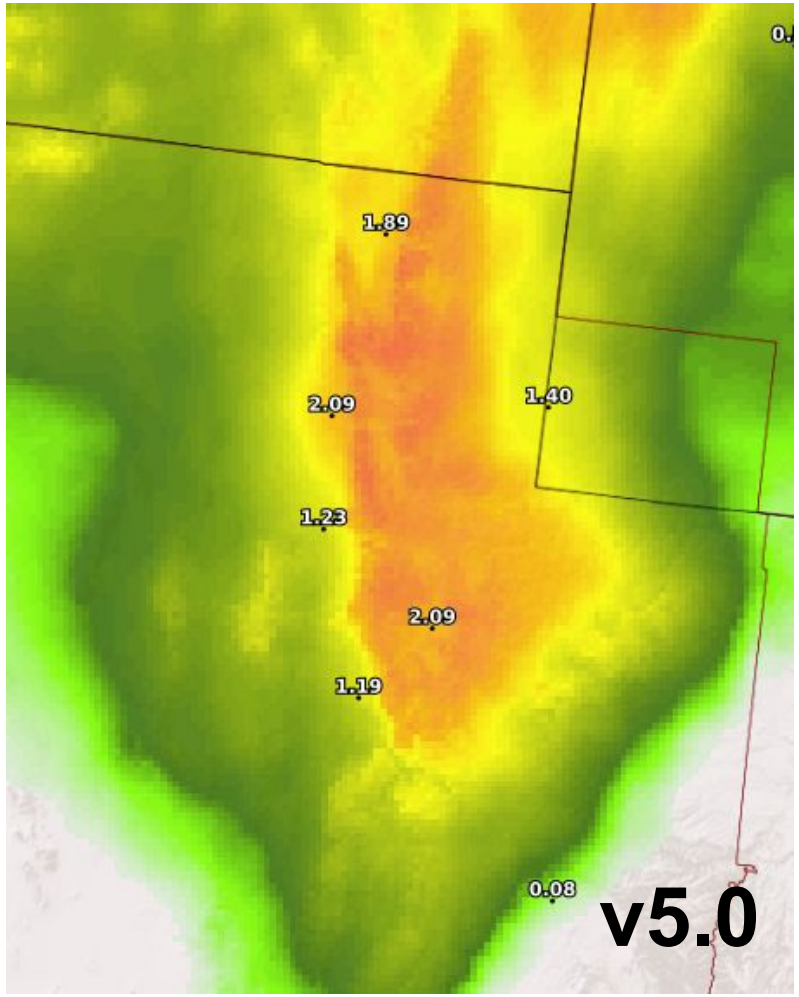




- v5.0 amounts and coverage were more reasonable

Southwest QPF





- The usage of supplemental stations, however, may mute terrain signals
- We're currently looking further into this

v5.0 Winter Changes

- Probabilistic vs. Deterministic
- Changes to Inputs
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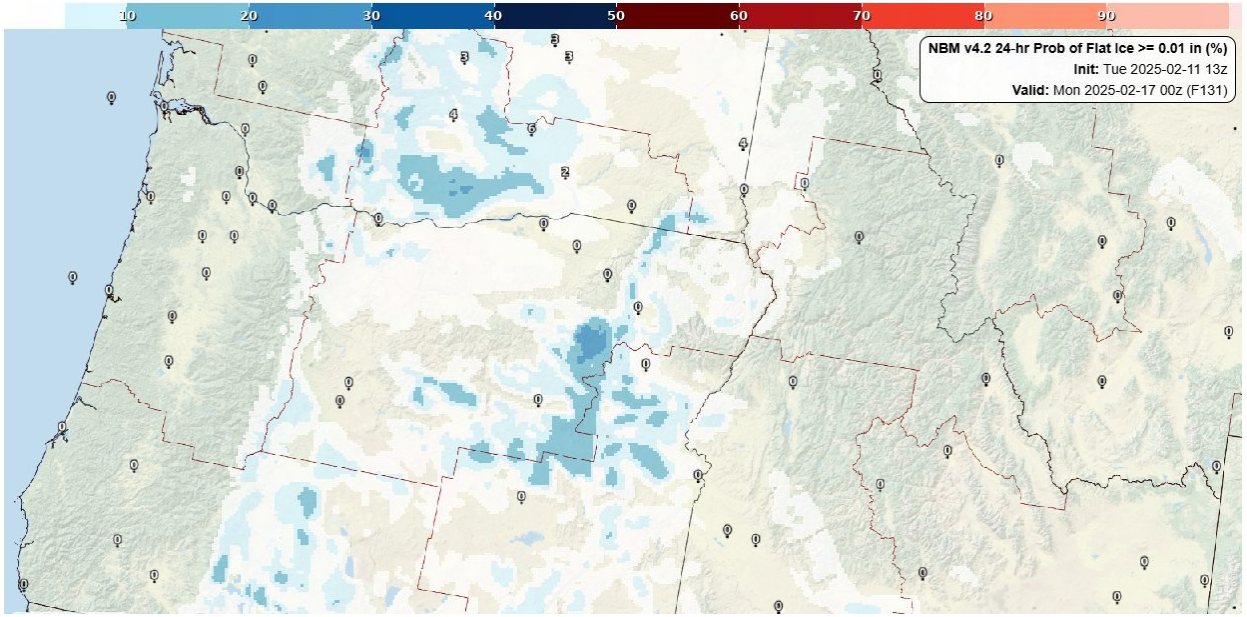
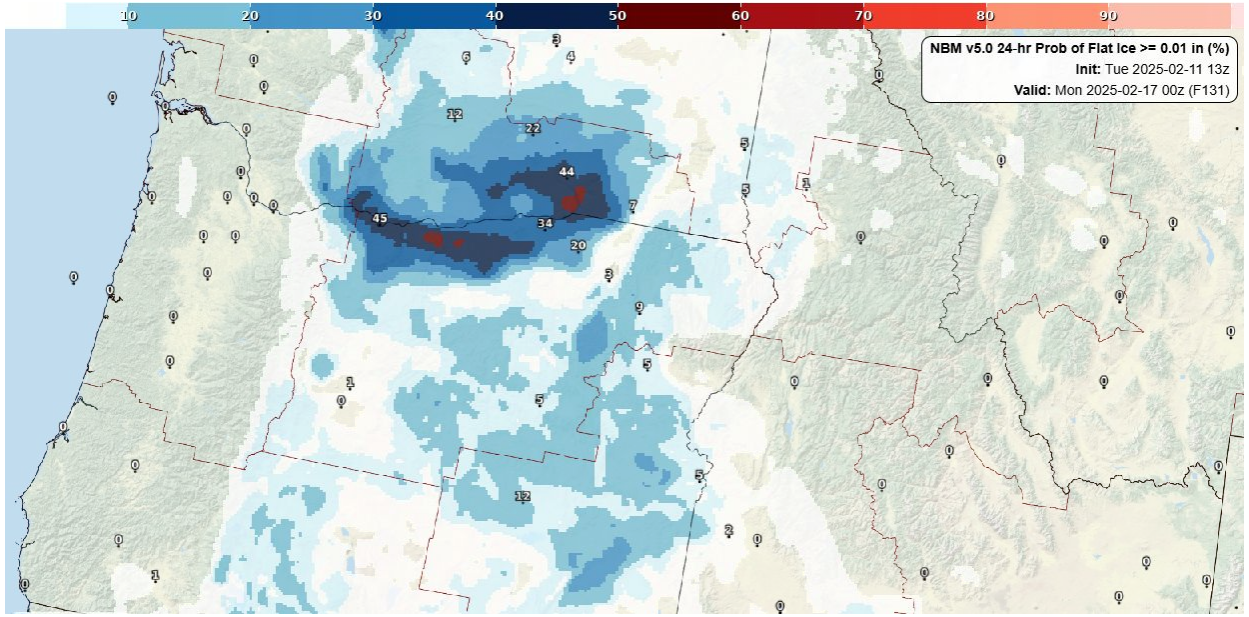
- Preserving Inversions
- New Products

ZR over Terrain

- NBM team was alerted in February to extremely low probabilities for a likely icing event in the Northwest
- The low probabilities were traced to the code that performs downscaling for winter products
- The surface temperature for low-res inputs is downscaled, and Direct Model Output ZR/SN can be changed to RA in the ops NBM if the downscaled dry bulb temperature (DsT) is greater than 32/33.8℉
    - note that Direct Model Output RA cannot be changed to a frozen type
- The operational downscaling code assumes that the lapse rate changes linearly with height based on the two closest isobaric surfaces to the ground.
    - Inversions are not well defined in this code. Improvements have been made in v5.0 to include a check on the Direct Model Output 2m Temperature to see if an inversion exists close to the surface, and compute the DsT differently if detected
    - In operations, there is also a limit on the magnitude of an inversion lapse rate. This limit has been removed in v5.0

ZR Case 2-17-25

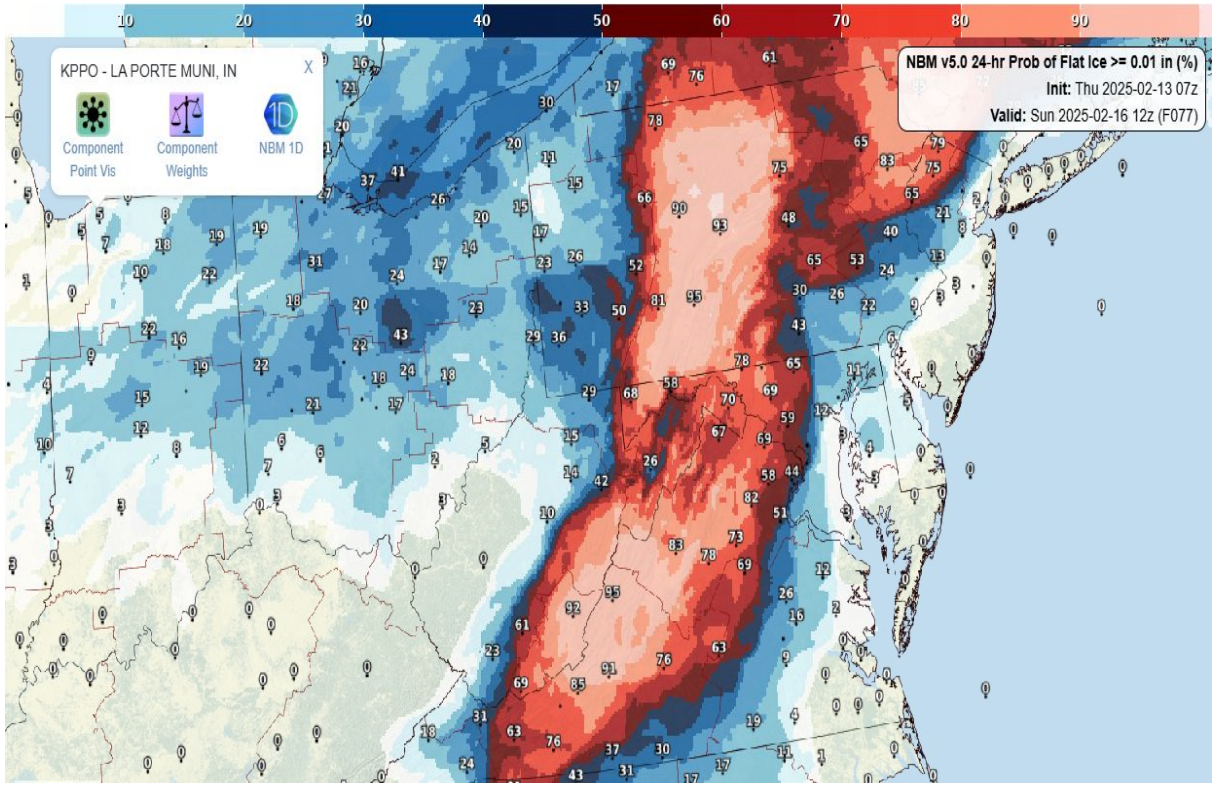




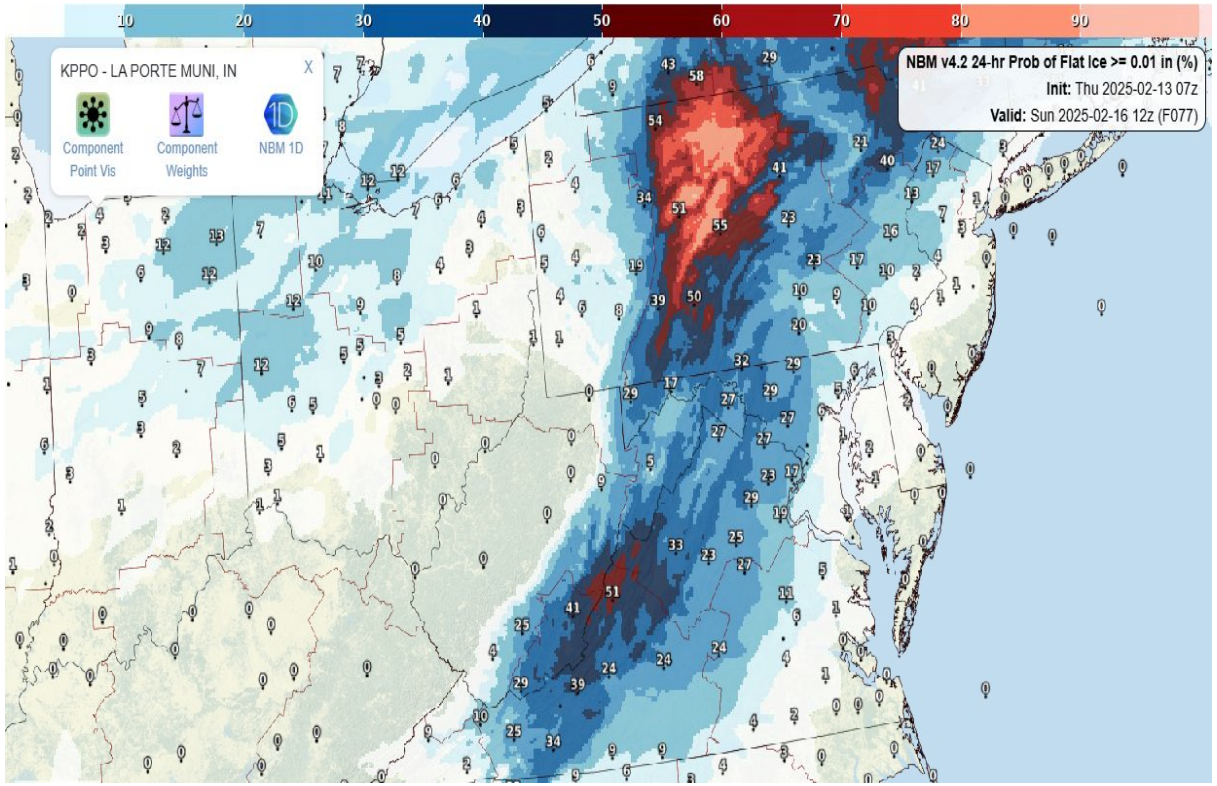
Initial example noted by WR, showing low ops NBM probs for ZR in a favorable setup

5.0 forecast, following changes to preserve inversions

ZR Case 2-16-25



NBM V5.0



NBM V4.2

- concern is whether this change will increase ZR probs too much

Challenges with Terrain

- As previously noted, when computing downscaled dry bulb Temperature (DsT) in v5.0, if an inversion near the surface is detected, and DMO 2m Temp is colder than the computed DsT, the DMO 2m Temp is used instead of DsT.
  - Intended to help inversion scenarios retain freezing rain signals
- Alaska Region noted problems with DMO snow being changed to rain too easily in complex terrain east of Anchorage (in the ops and parallel NBM)
- We have experimented with **changing the Ice/Snow flagging routine threshold to 38℉ from 33.8℉** AND **using downscaled wet bulb temperature (DsTw) instead of DsT**
  - DsTw <= DsT, by definition
  - This theoretically allows Cobb melting code to do the heavy lifting to melt snow
  - We are still assessing

v5.0 Winter Changes

- Probabilistic vs. Deterministic
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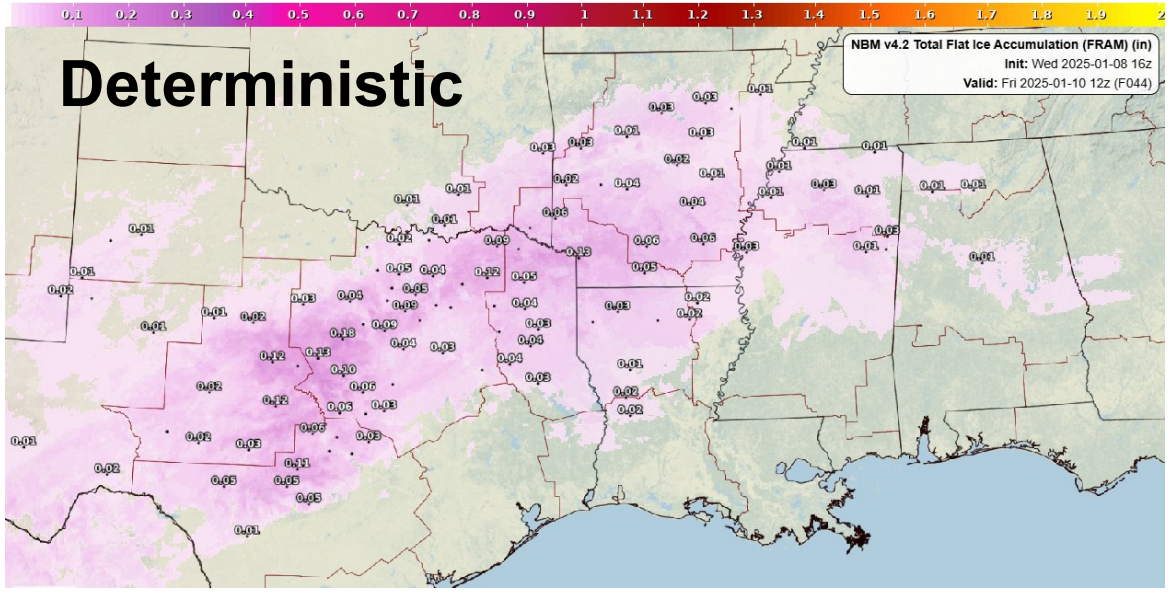
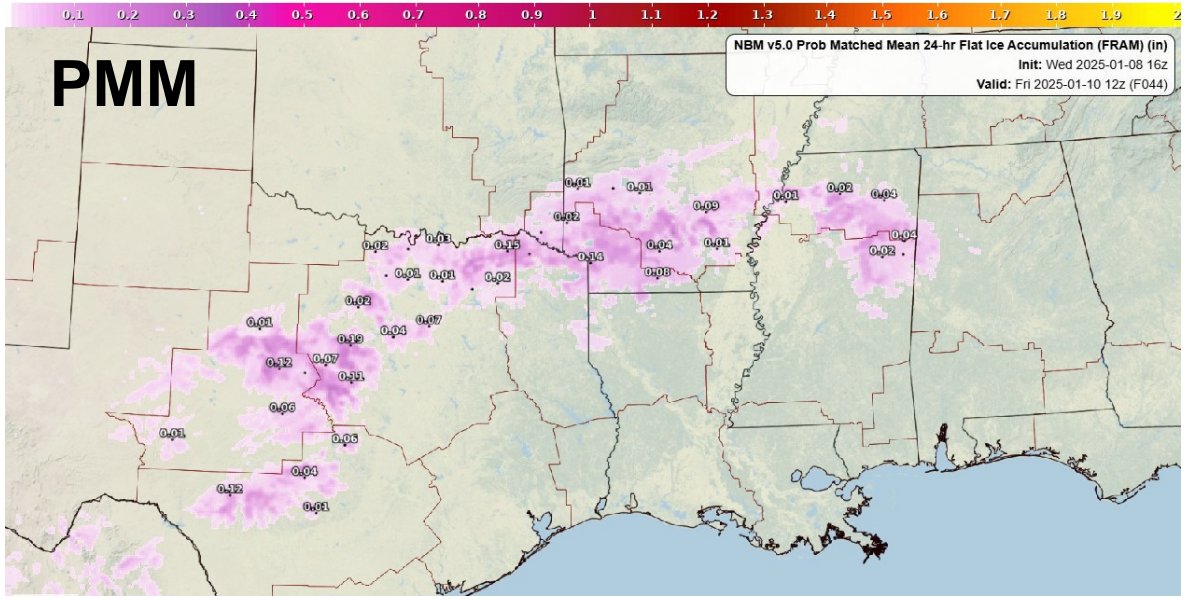
Probability-Matched Mean for ZR



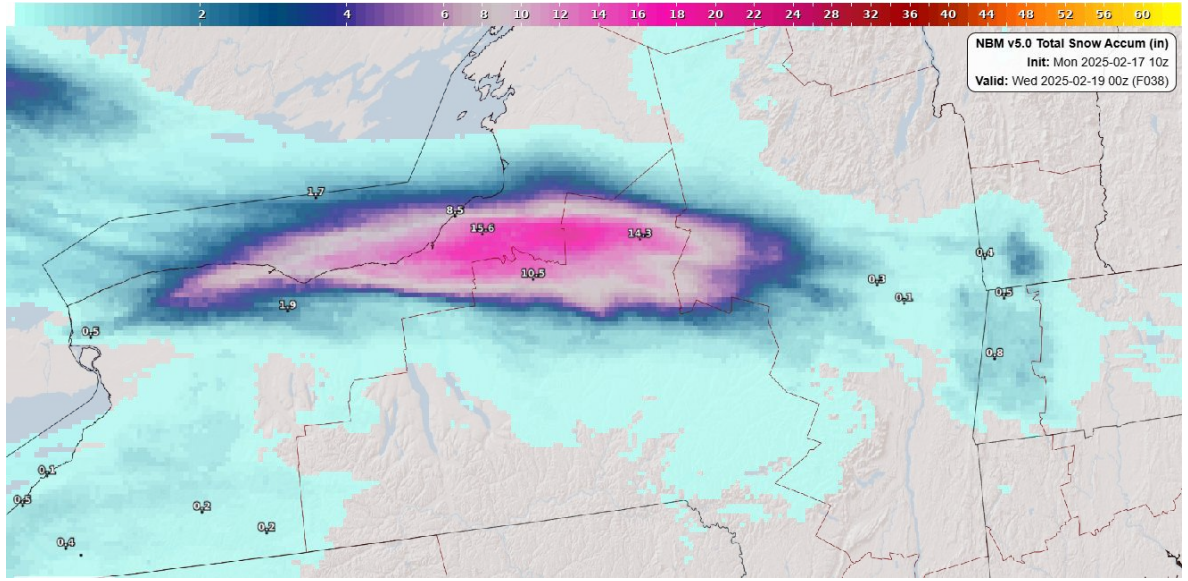


- The PMM attempts to highlight the corridors with the most likely opportunity to accumulate freezing rain

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

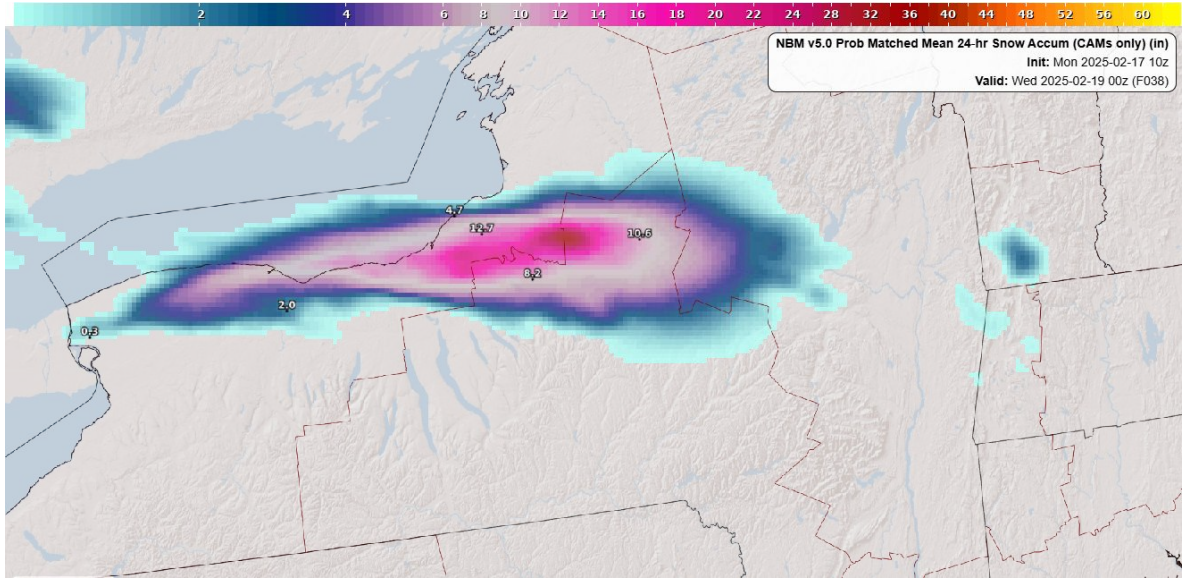
Probability-Matched Mean for Snow

Total Snow Accumulation



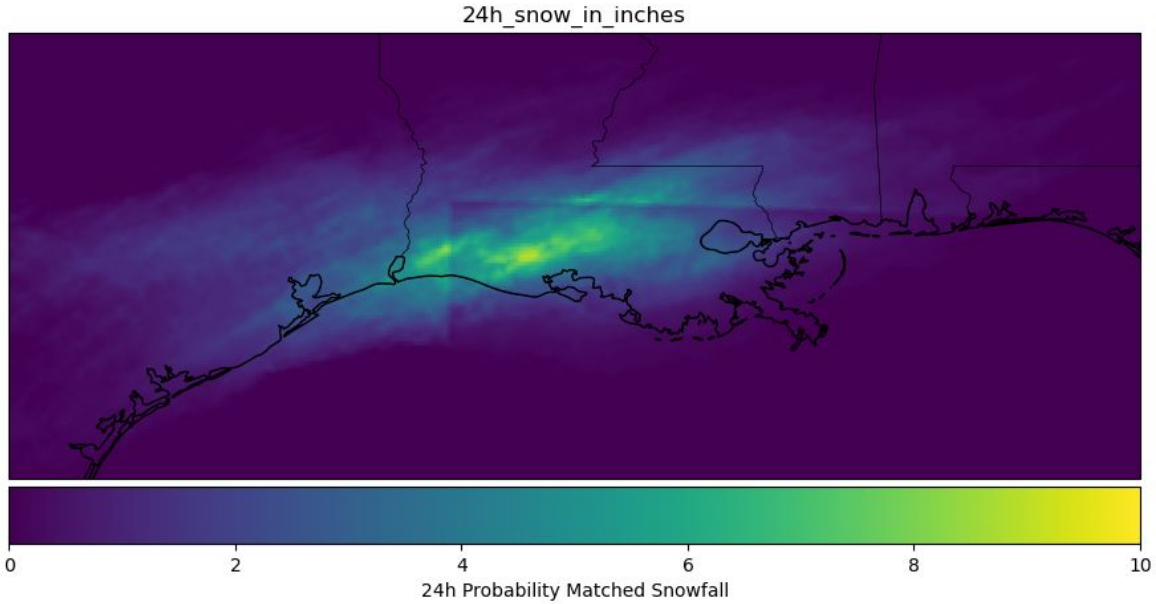
Max: 19”

Probability-Matched Mean

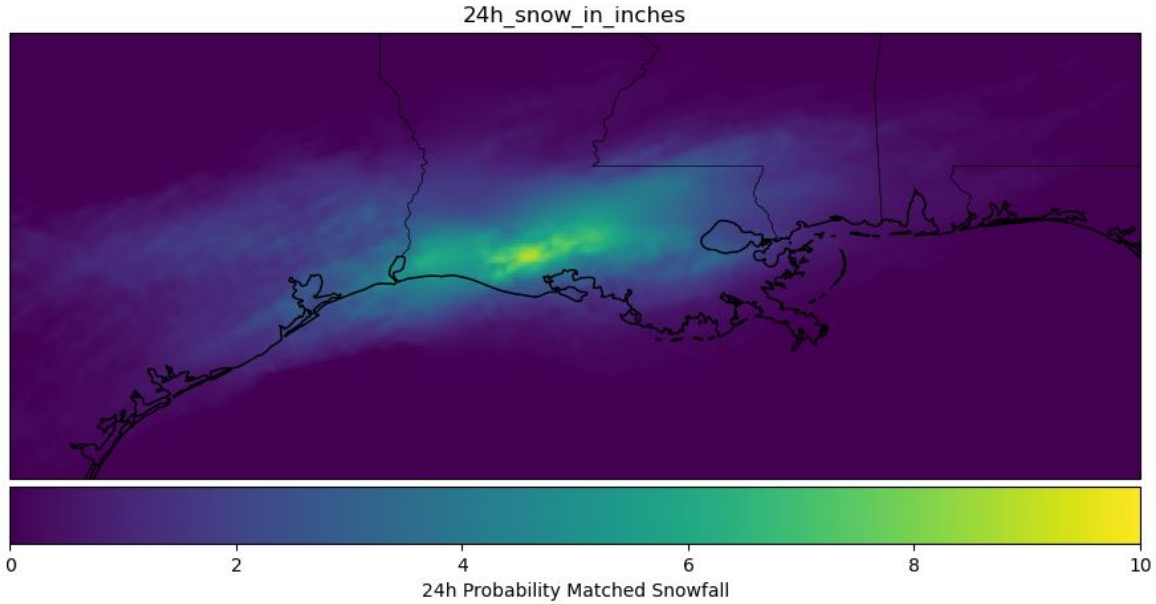


Max: 32”

Probability-Matched Mean for Snow



Original



Revised

- Artifacts initially in the PMM products, driven by the regional boundaries, have been removed by smoothing the values along the boundaries

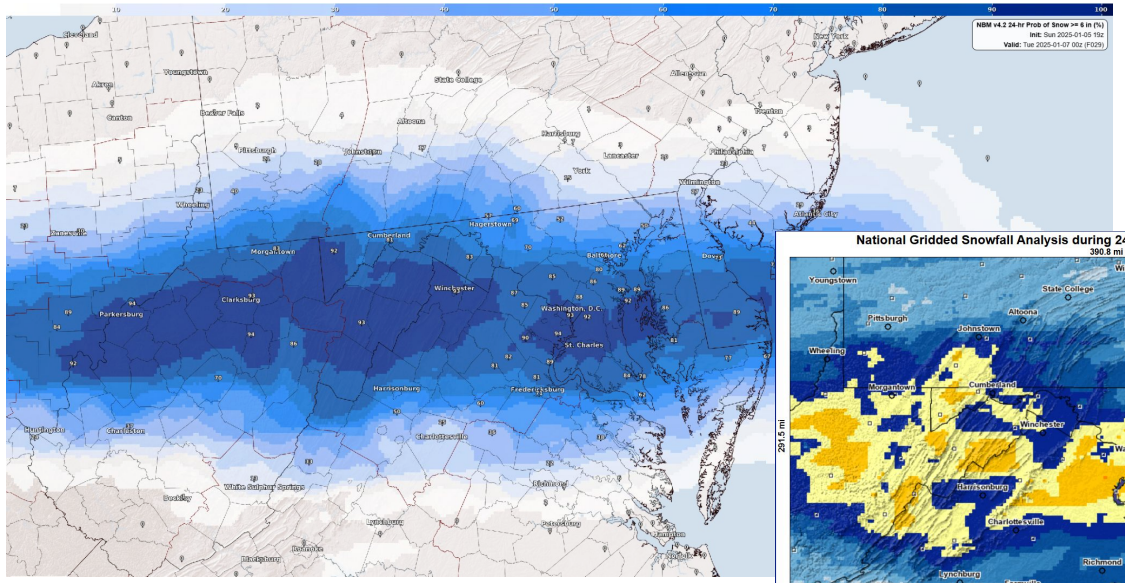
Calibrating Snow Exceedance Probs

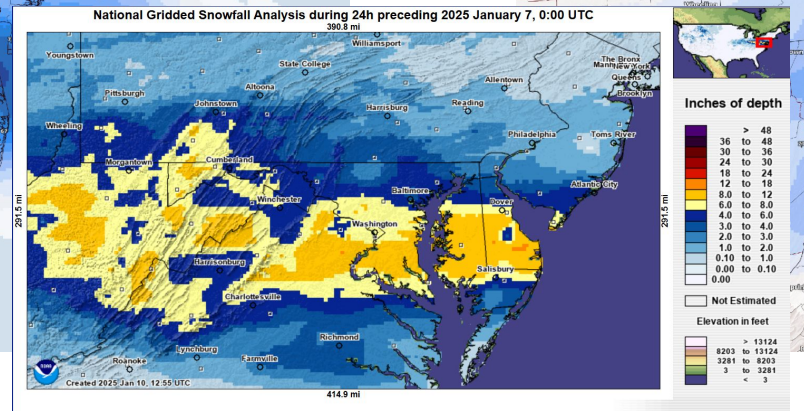
- Work by Dave Rudack to improve NBM Snow Exceedance Probabilities

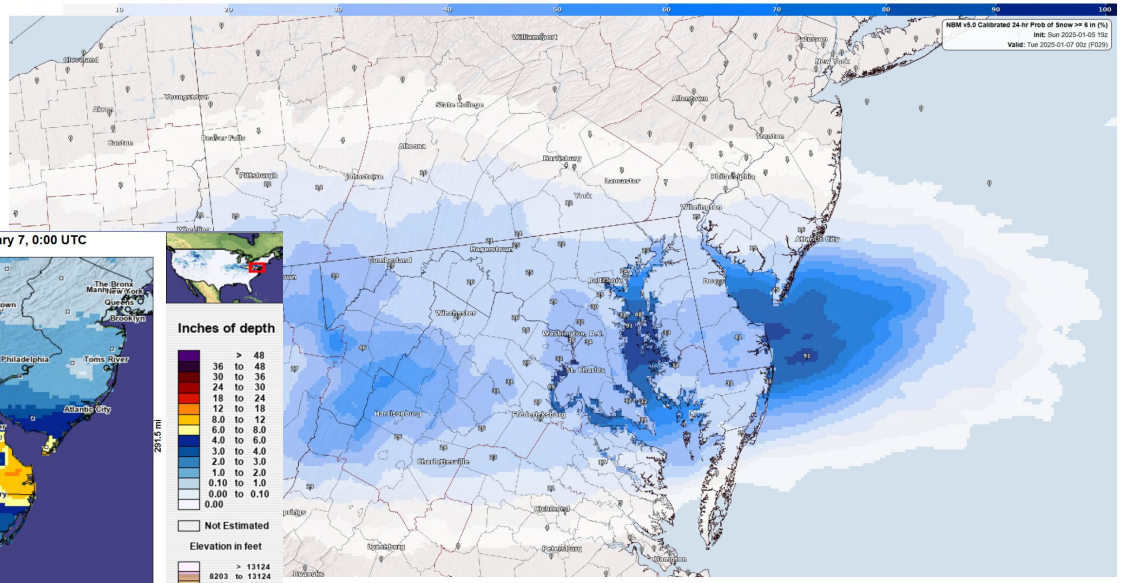
- Uses these NBM 24h snow exceedance probabilities in the regression predictors:
  - **Exceedance amounts greater than a Trace:**
    - > Trace, > 1.0 inch, > 2.0 inches, > 4.0 inches, daily snowfall climatology.
  - **Exceedance amounts greater than one inch:**
    - > Trace, > 1.0 inches, > 2.0 inches, > 4.0 inches, > 6.0 inches, > 8.0 inches, daily snowfall climatology.
  - **Exceedance guidance for > 2.0, > 4.0 inches, > 6.0 inches, > 8 inches, > 12 inches, > 18 inches, > 24 inches:**
    - > Trace, > 1.0 inch, > 2.0 inches, > 4.0 inches, > 6.0 inches, > 8 inches, > 12 inches, > 18 inches, > 24 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.

Calibrated Snowfall Exceedance Probs







Regular Probability > 6”

Calibrated Probability > 6”

- The development was done on a winter with limited snow in the Eastern U.S., so a redevelopment for the East, using snow data from the current winter, is underway

Active Winter Changes in NBMv5.0

- High Resolution ECMWFE data
  - 0.2 deg for all 50 members, hourly resolution through 72 hours
- Removal of SREF inputs, replaced with 11 various Canadian members
  - Combination of GDPS, GEPS, RDPS, REPS
- GEFS surface variables increased resolution to 0.25 deg through 240 hrs (vertical profile still at 0.5 deg) (not discussed during presentation)
  - Tmp, RH, Ugrd, Vgrd, MSLP, ****PTYPE****
- QMD QPF modifications impact winter suite
  - Supplemental locations (CONUS only), setting amounts <0.254 mm per 6 hr to 0, hi-res ECMWF, removal of SREF, removal of 9 point stencil

- When computing downscaled Temperature (DsT), if an inversion near the surface is detected, and DMO 2m Temp is colder than the computed DsT, use DMO 2m Temp instead of DsT
  - Intended to help inversion scenarios retain freezing rain signals
- Ice/Snow flagging routine threshold changed to 38F from 33.8F AND uses DsTW instead of DsT
  - DsTW <= DsT, by definition
  - Theoretically allows Cobb melting code to do the heavy lifting to melt snow

Extra Slides

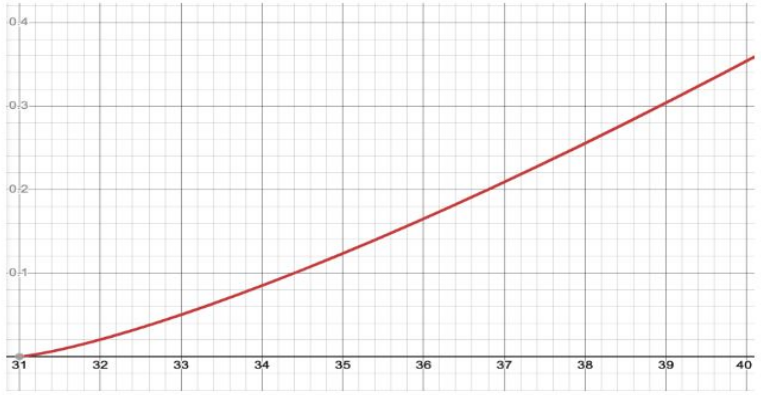
Cobb Methodology

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.

Note: v4.1 set SLR to 0 when T > 33

NBM SLR

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