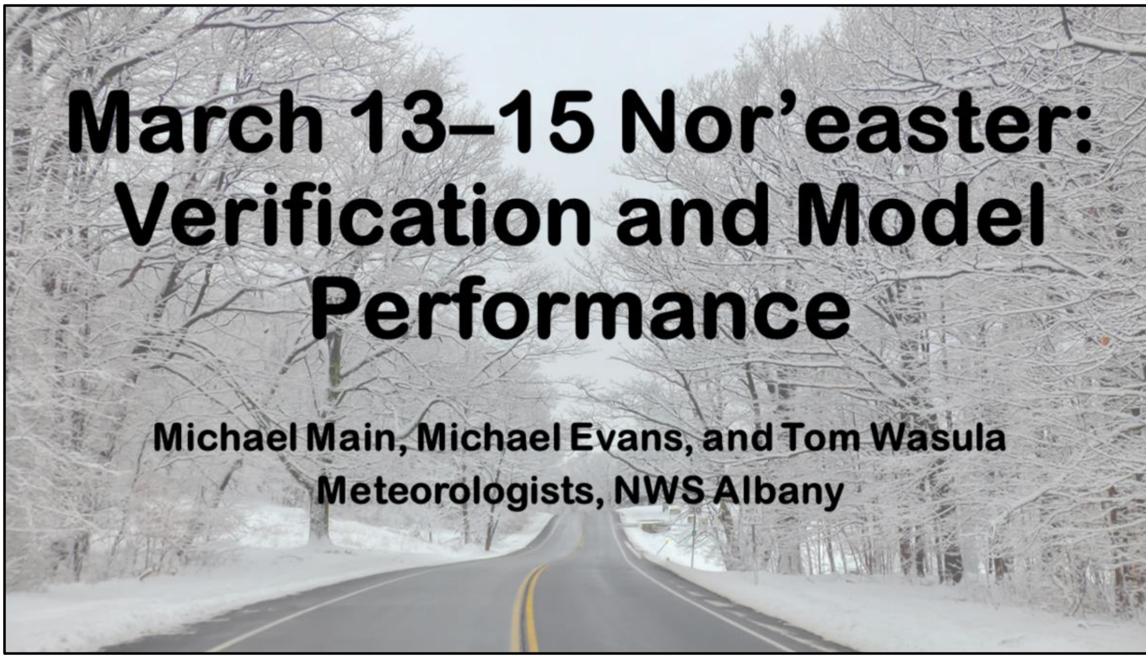
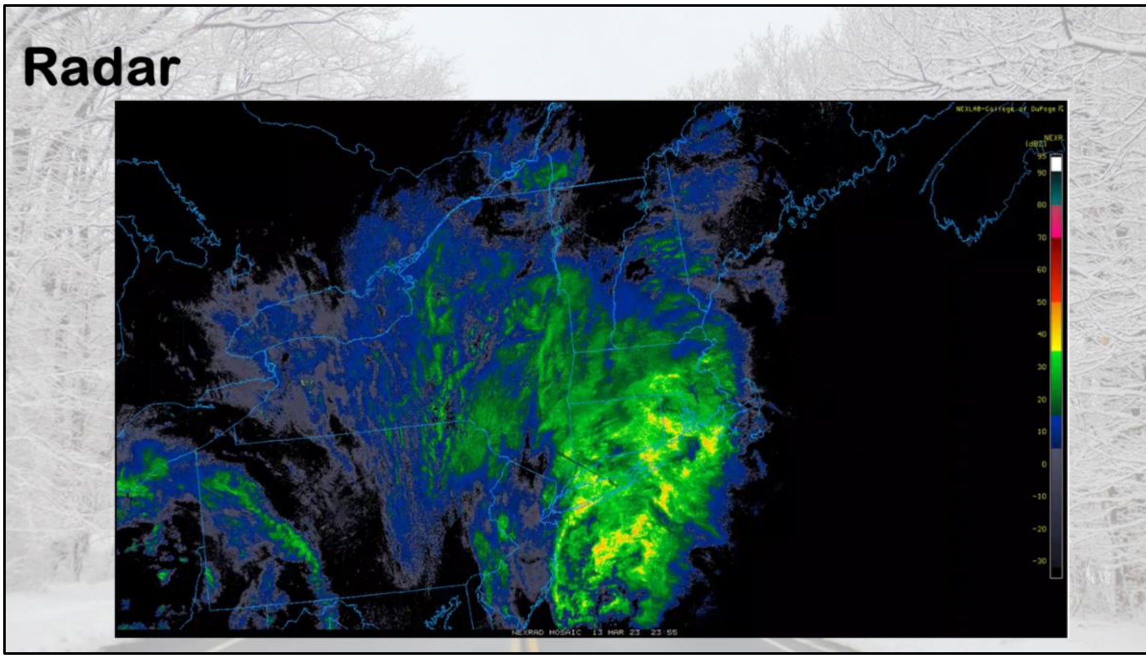
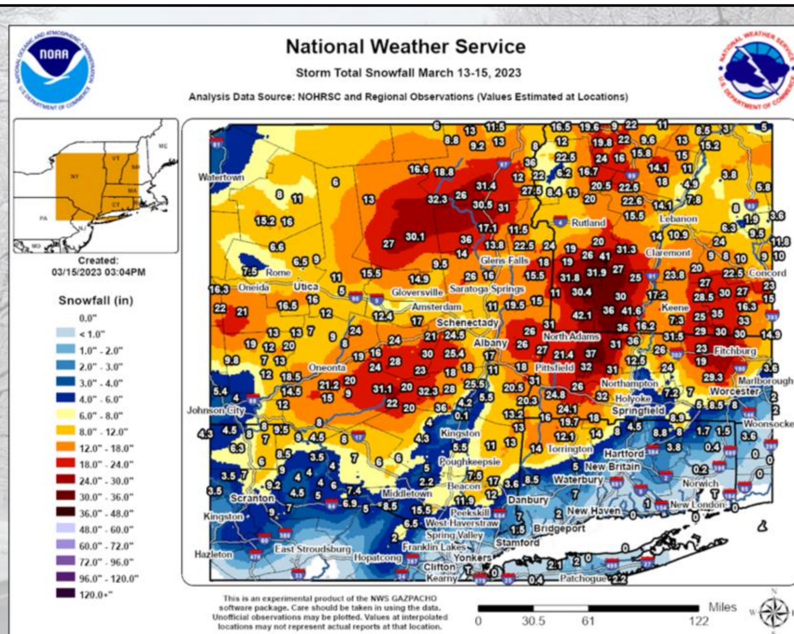

March 13–15 Nor'easter: Verification and Model Performance
Michael Main, Michael Evans, and Tom Wasula
Meteorologists, NWS Albany

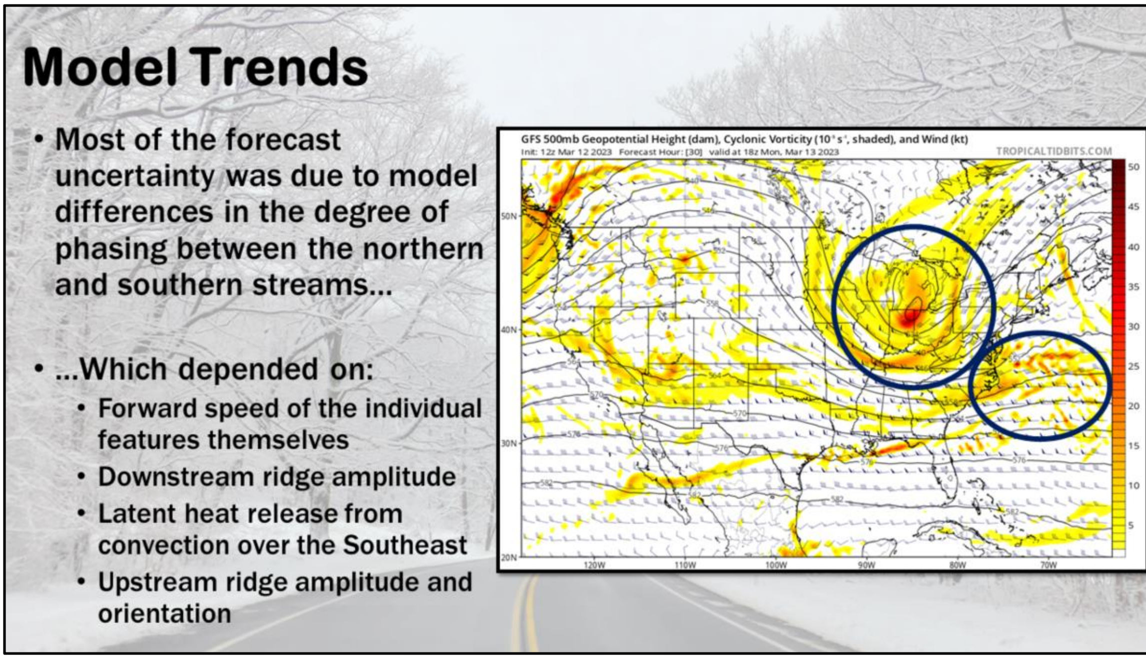


This radar loop shows moisture streaming northwards into the Northeast as the surface low approaches from the south. Initially, laterally translating bands are present, but a pivoting band develops to the west of the Hudson River during the morning of March 14. The pivoting band sat here for several hours, then finally slides eastwards as the storm pulls away to the northeast.

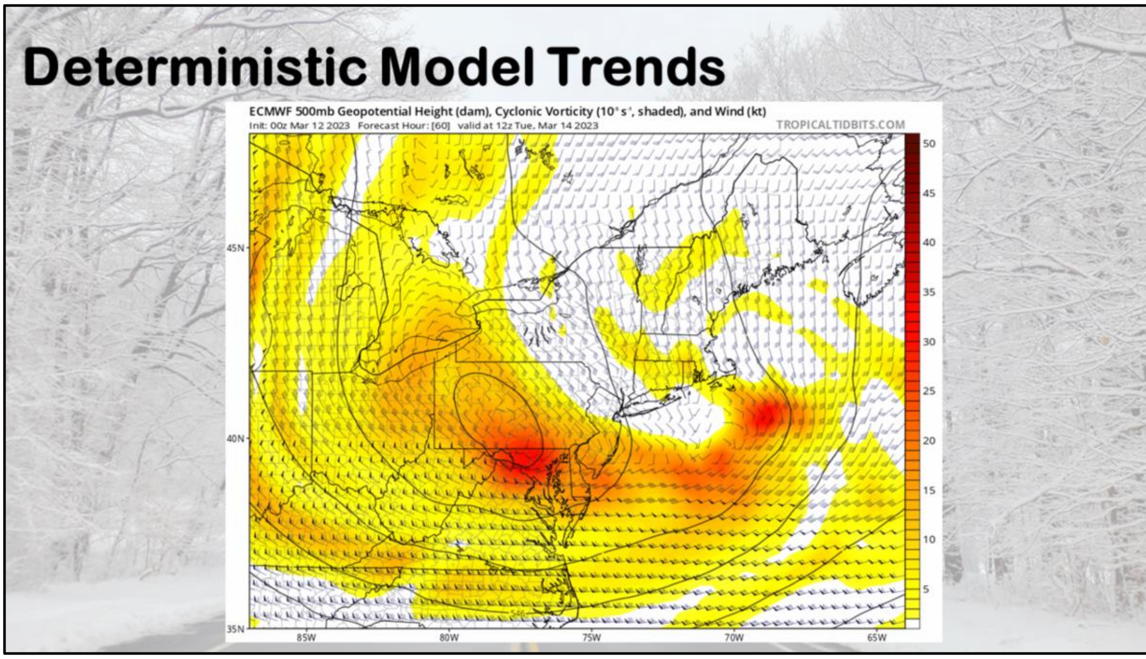
Verification

- Heaviest Snow:
  - Catskills
  - Eastern ADKs
  - Southern VT
  - Berkshires
  - Worcester Hills
- Lowest Snow Totals
  - Mid Hudson Valley
  - I-95 Corridor

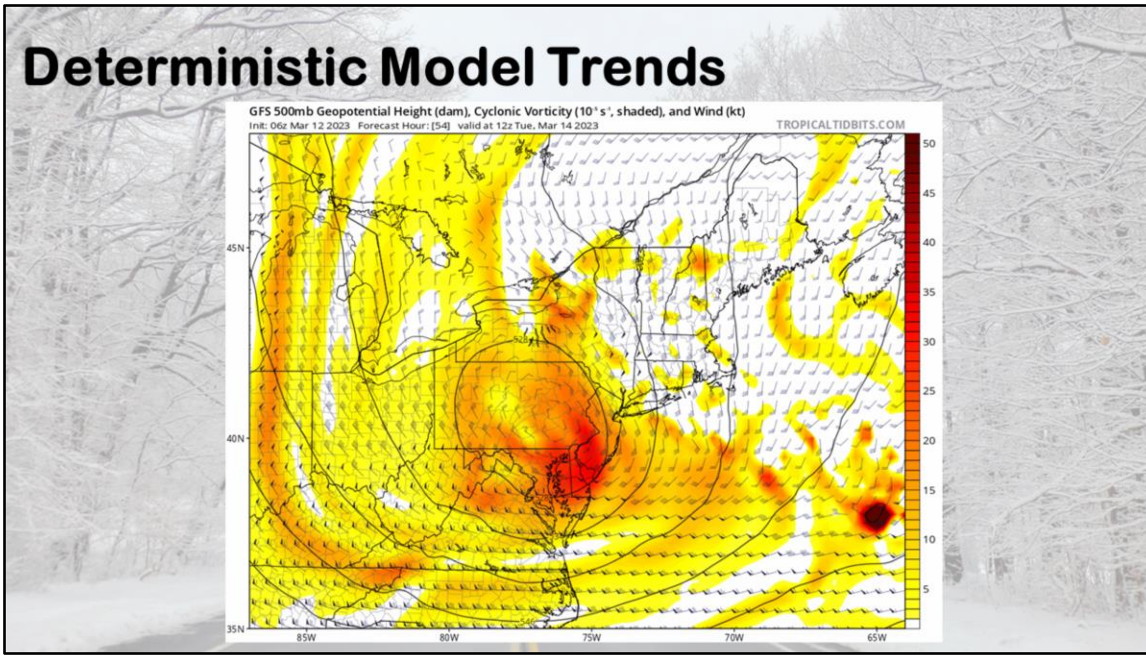




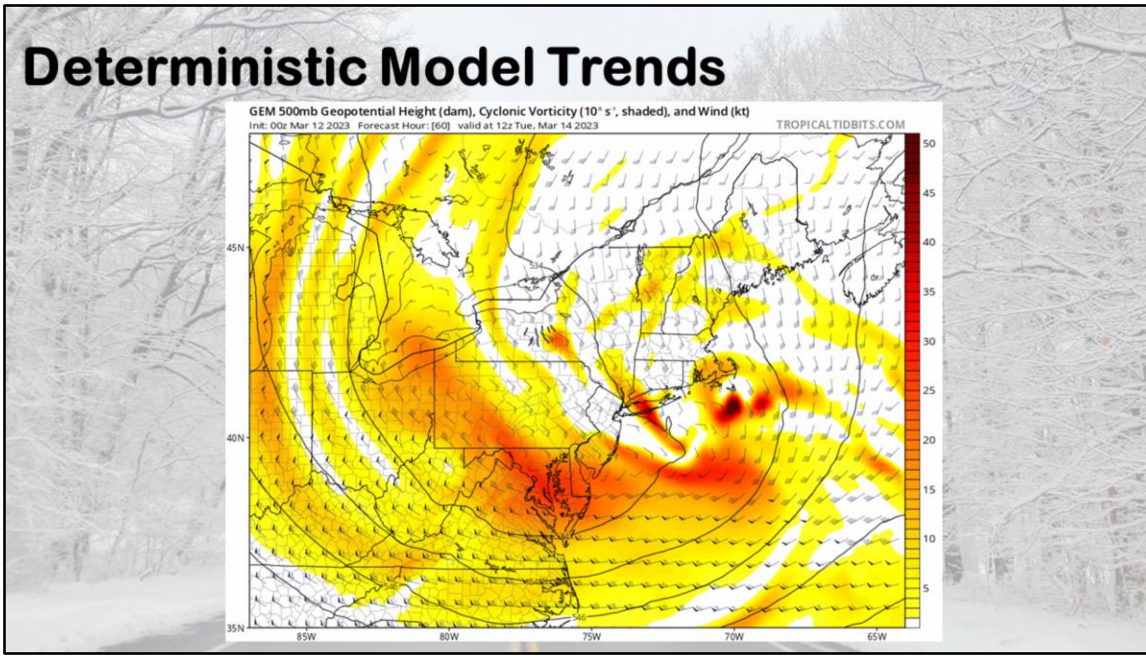
The northern stream trough would phase with the southern stream shortwave as these features moved off the east coast. However, there were several factors impacting the interaction of these two features. Uncertainty in the amount of latent heat release and downstream ridge amplification associated with the southern stream shortwave proved to be a large source of forecast uncertainty. Ultimately, these features did not end up fully phasing until after the upper low had already moved off the east coast, which resulted in the double-barrel low that was observed as opposed to a single, wrapped up surface low that was show by some guidance several days before the event.



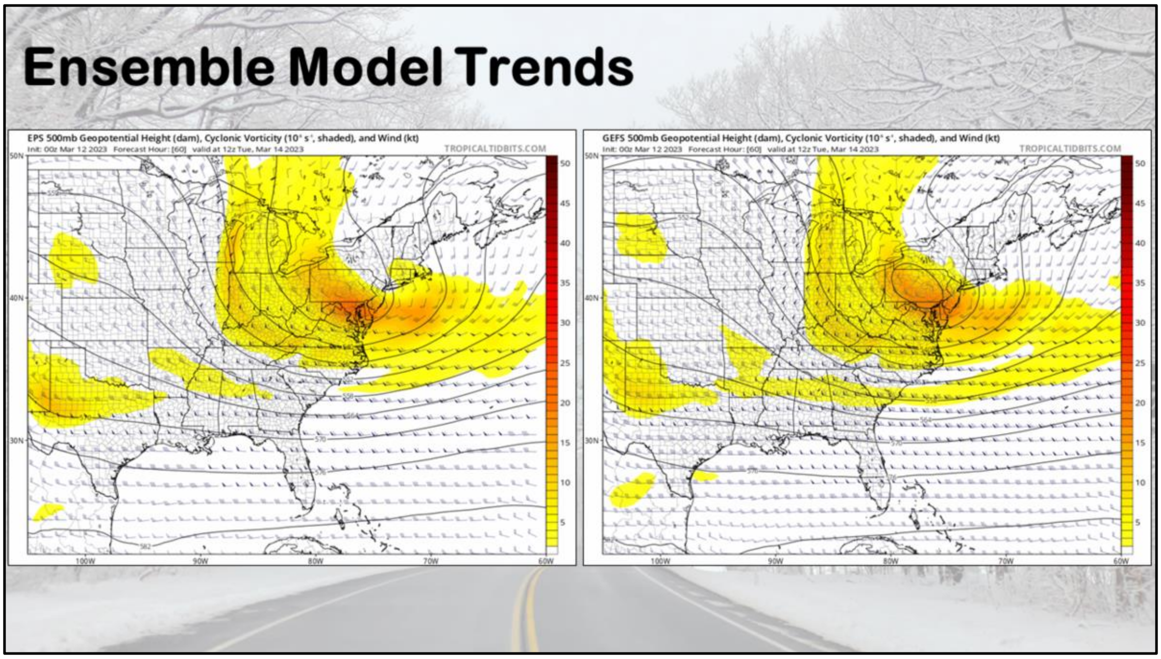
Model trend loop of 500 mb heights, winds, and vorticity shown by the deterministic ECMWF model. This loop shows that there is not a lot of variation in the position of the northern stream closed upper low, but there is some variability in the position of the southern stream shortwave that can be seen phasing with the northern stream trough.



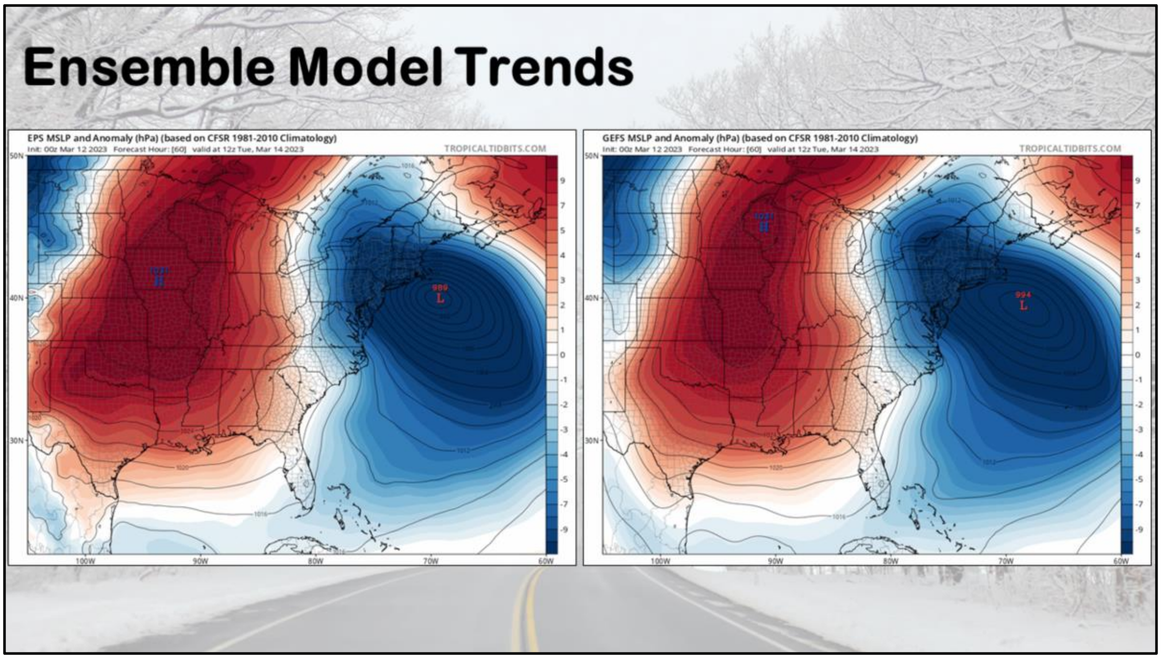
Model trend loop of 500 mb heights, winds, and vorticity shown by the deterministic GFS model. This loop shows a trend in the southern stream feature closer to the coast as forecast lead time decreases.



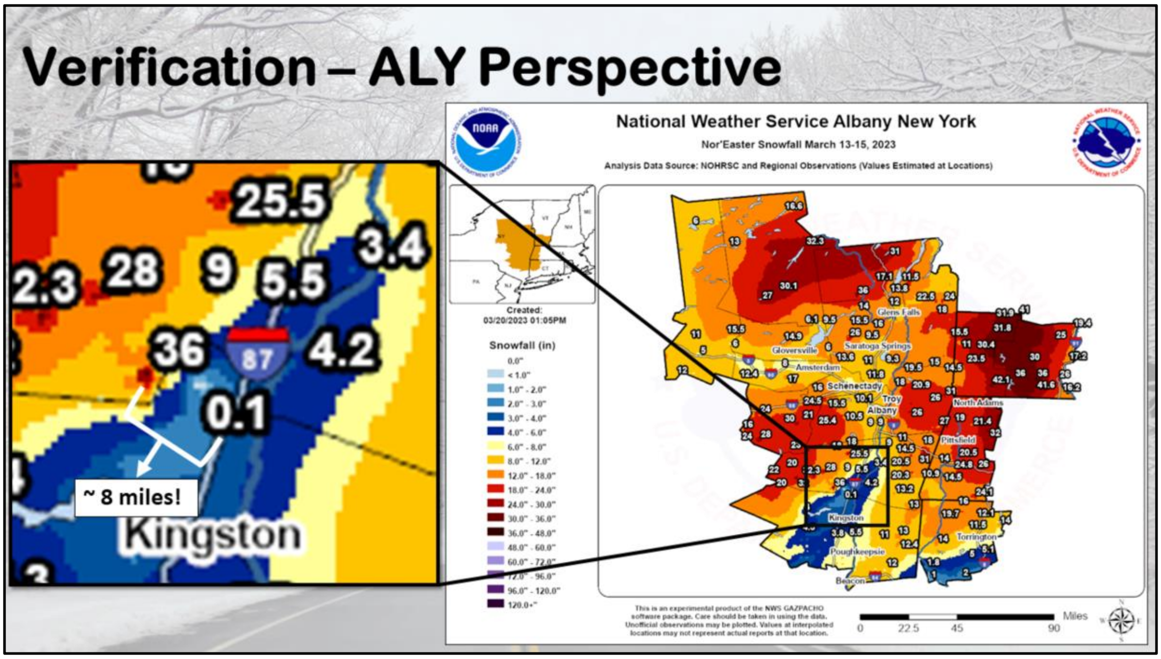
Model trend loop of 500 mb heights, winds, and vorticity shown by the deterministic Canadian model. This loop does not show quite as much variability in the position of the southern stream shortwave as was seen in the GFS. However, the trend with this model was the opposite of the GFS, as the model originally had the southern stream wave tucked in too close to Cape Cod. Ultimately, the models all ended up converging on a similar solution, but not until around 24 hours before the storm.



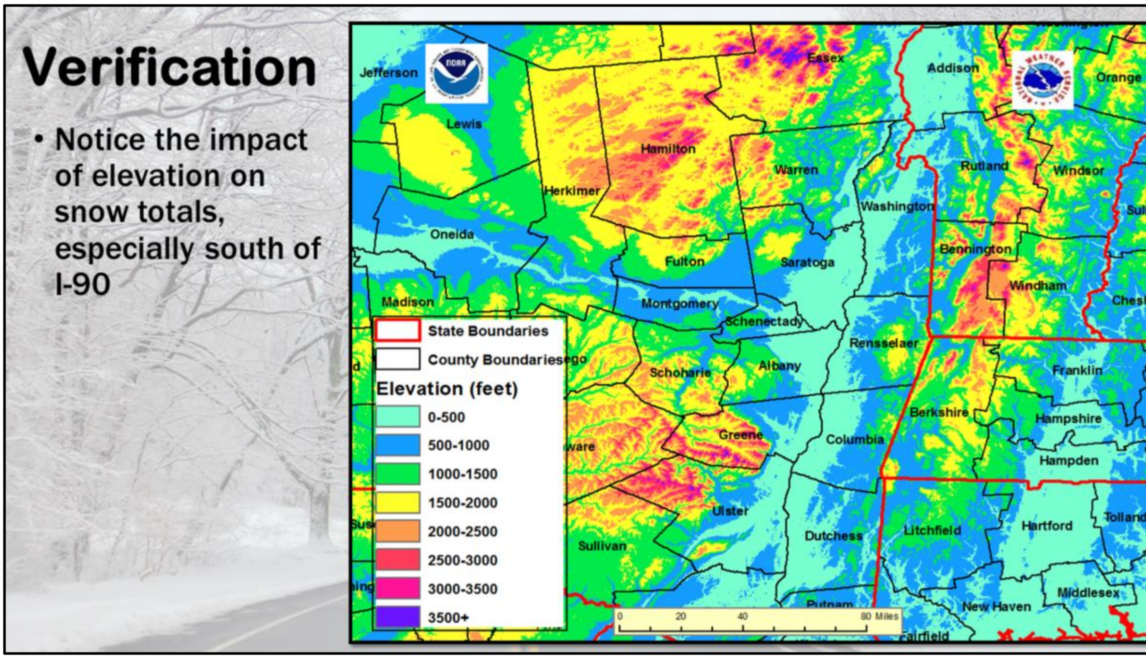
Model trend loops of 500 mb heights, winds, and vorticity for the ensemble mean of the EPS and GEFS. These loops show slight changes in the position of the lead shortwave, but the run-to-run changes are smaller than any of the deterministic models. Use of the ensemble models proved useful in creating a consistent forecast.



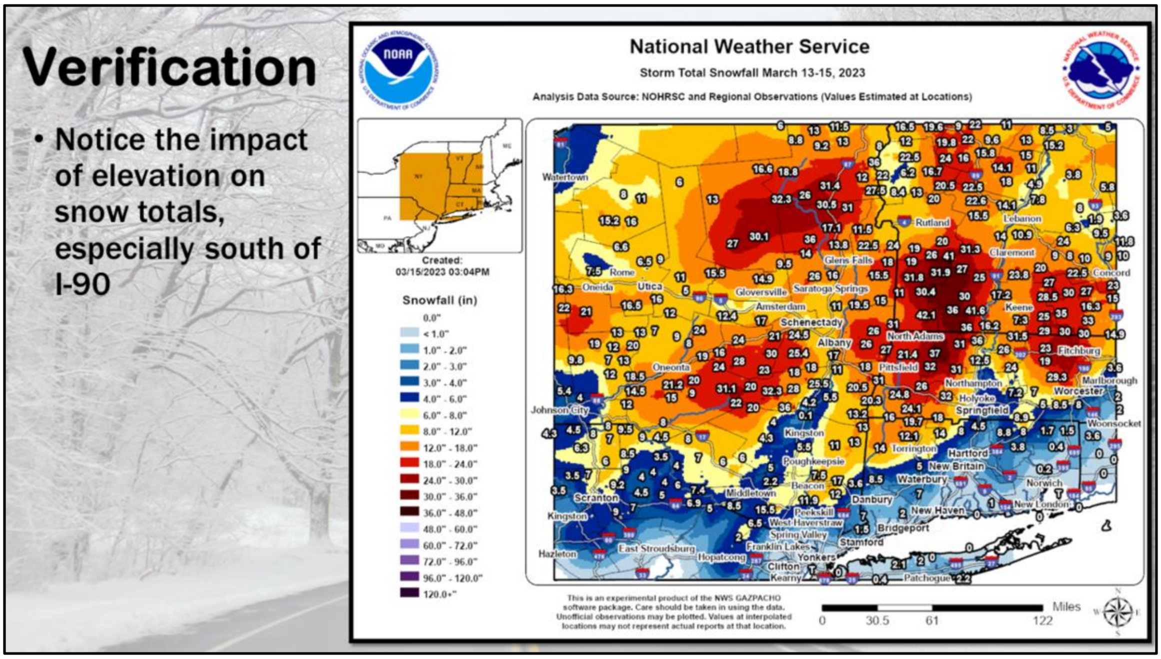
Loops of model trends in MSLP as seen in the ensemble mean for the EPS and GEFS leading up to the storm. There is a clear trend away from a single, consolidated low towards a more strung out, double-barrel low feature with an inverted trough extending back to the northwest across the NWS Albany forecast area.



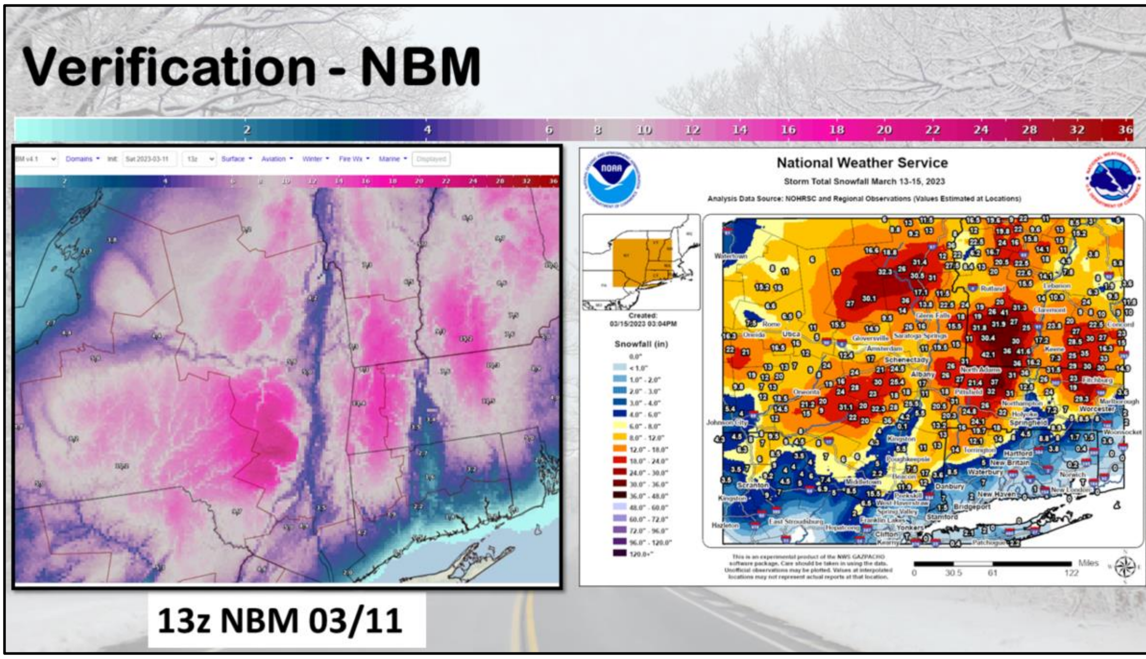
This is the verification map for the NWS Albany forecast area. This map was shown before, but a closer look shows sharp snowfall gradients across the region. The highest snowfall totals were in the Catskills, Southern Greens, Berkshires, and Adirondacks, but locally higher amounts were also observed along the spine of the Taconics and in the Hudson Highlands. Lower amounts were seen in valley areas, especially south of I-90. The most notable snowfall gradient was in the Mid Hudson Valley where there was a difference of 36” of snow over an 8 mile distance. This are near Saugerties and Kingston that had almost no snow from this storm also saw very little snow from the March 2, 2018 storm that took a similar track to this storm and also dropped multiple feet of snow in the higher elevaitons.



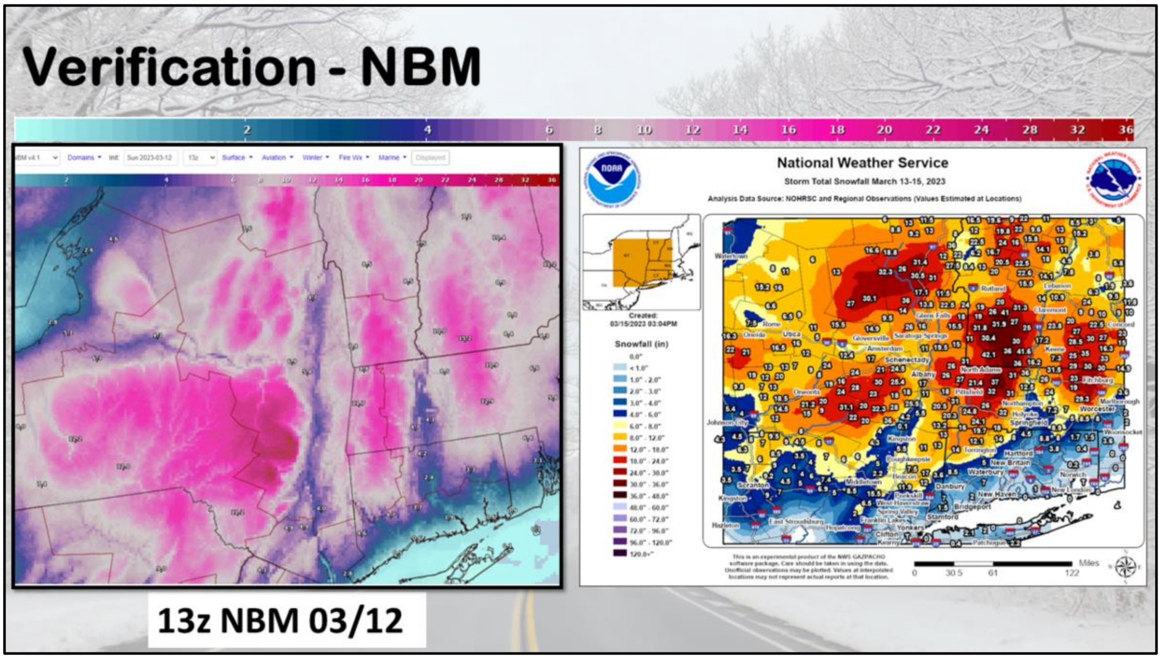
Comparing this terrain map to the snowfall accumulation map on the next slide, it is clear the impact of elevation on snowfall totals. Also, note that there is a very sharp elevation rise going from the valley areas near Saugerties to the higher peaks of the Catskills in southern Greene County, which is where the sharp snowfall gradient was also located.



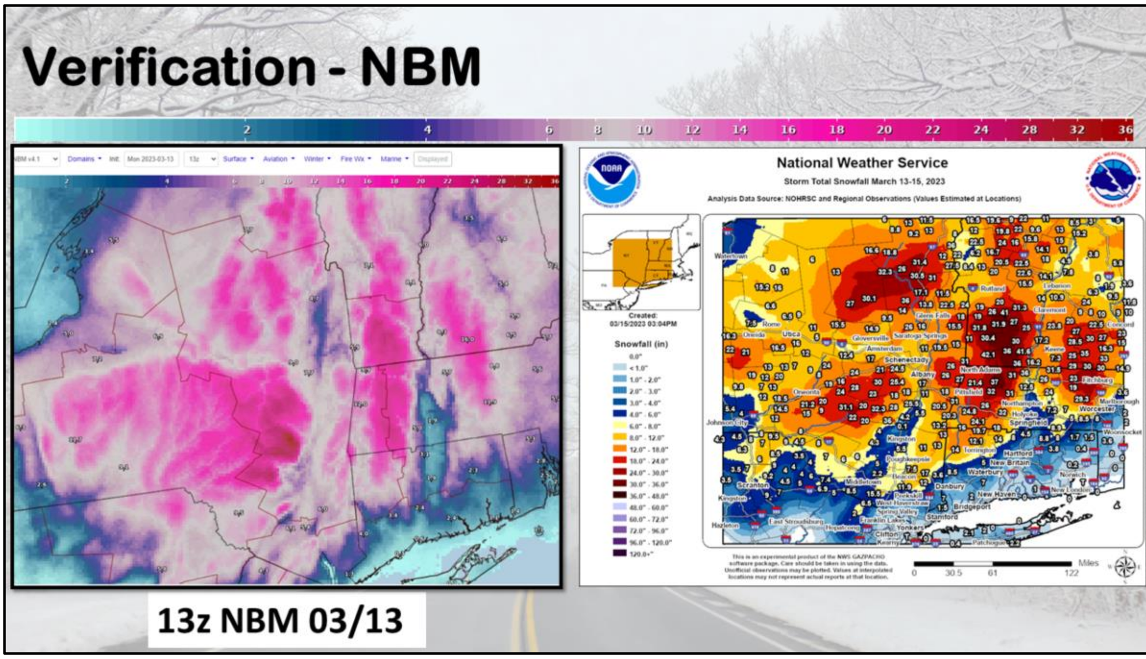
A broader view of snowfall totals for comparison with the terrain map on the previous slide.



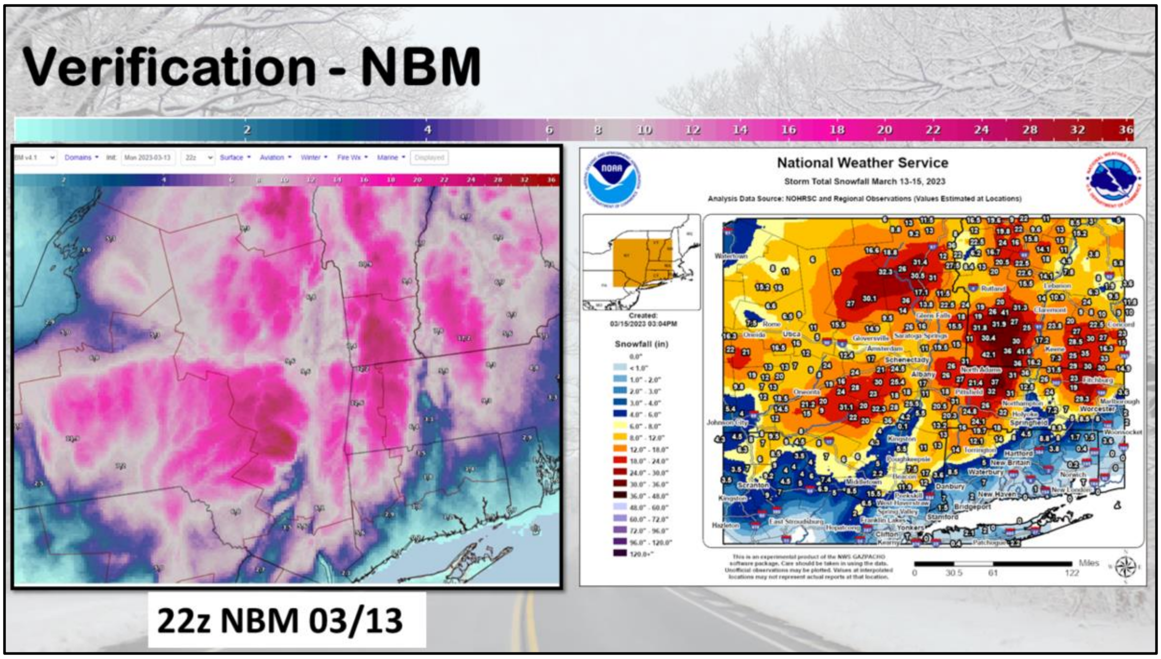
The NBM forecast from the morning of March 11th showed the highest forecast snowfall amounts across the Catskills and the high terrain of western New England. However, it showed much lower snowfall mounts in valley areas than actually fell, especially north of I-90.



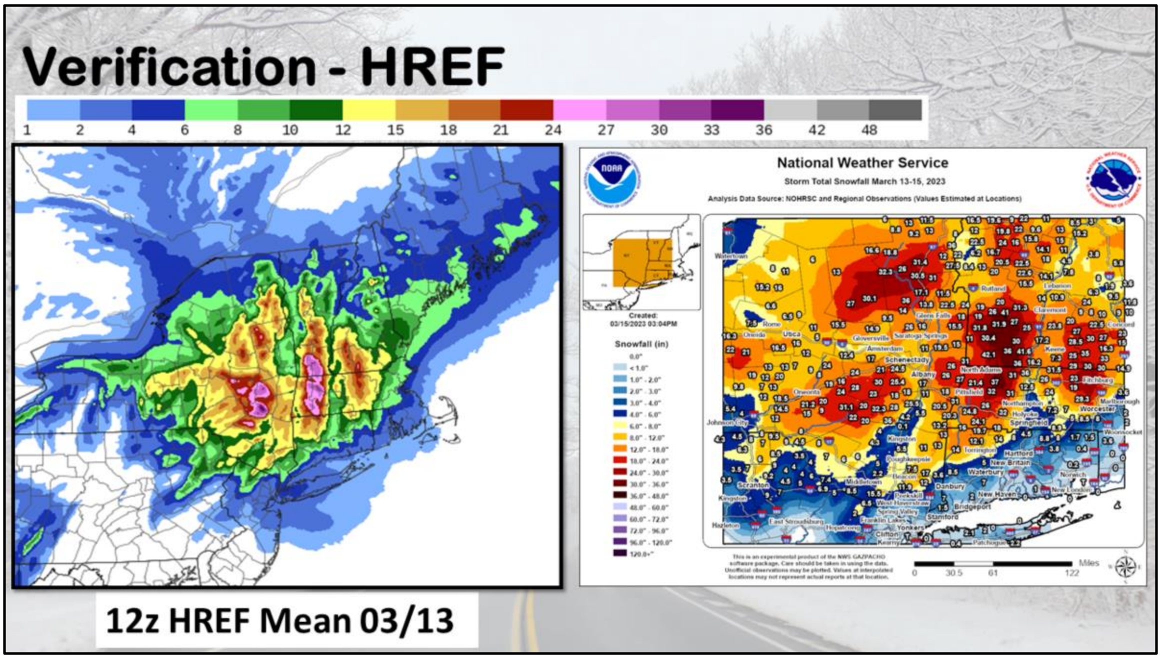
The NBM snowfall forecast from the following day brought amounts up in all of the higher elevation areas, which was a step in the right direction. However, snowfall amounts were still too low for valley areas north of Albany.



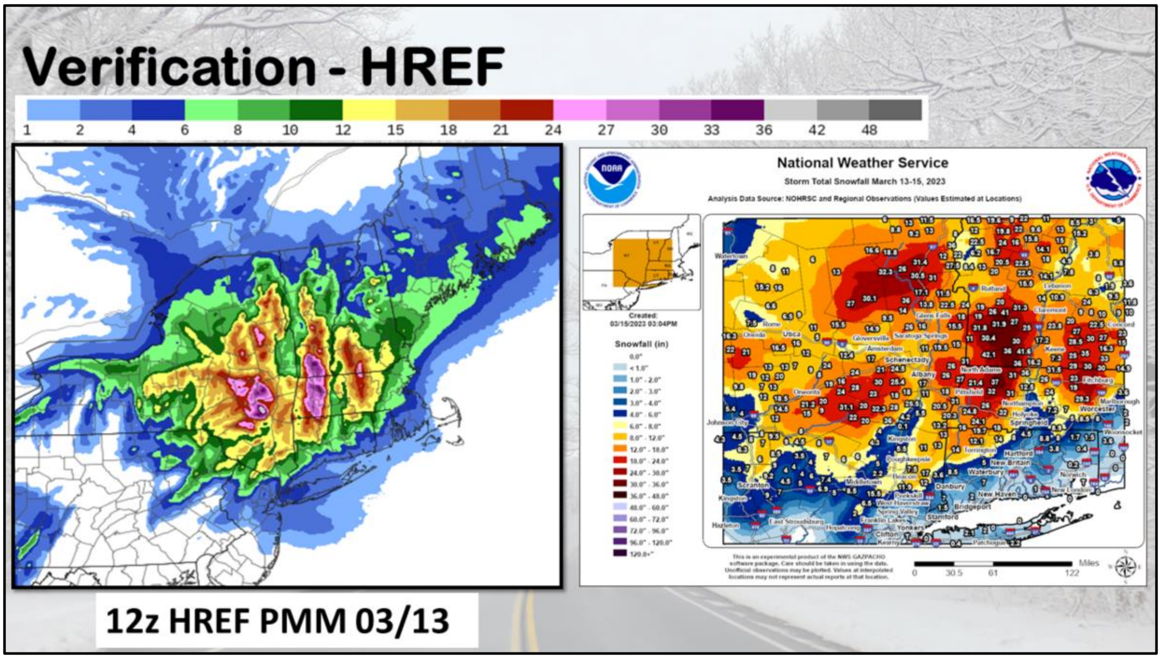
The NBM snowfall forecast from the 13th, which now had more hi-resolution guidance included, had even higher snowfall amounts in the high terrain than the previous run, especially in western New England. Amounts in the Adirondacks also increased, but still were too low. It is concerning that this forecast, only 12 hours before the snow was expected to begin, was still significantly underdone in the Hudson Valley north of Albany. Meanwhile, amounts were too high in the Mid Hudson Valley.



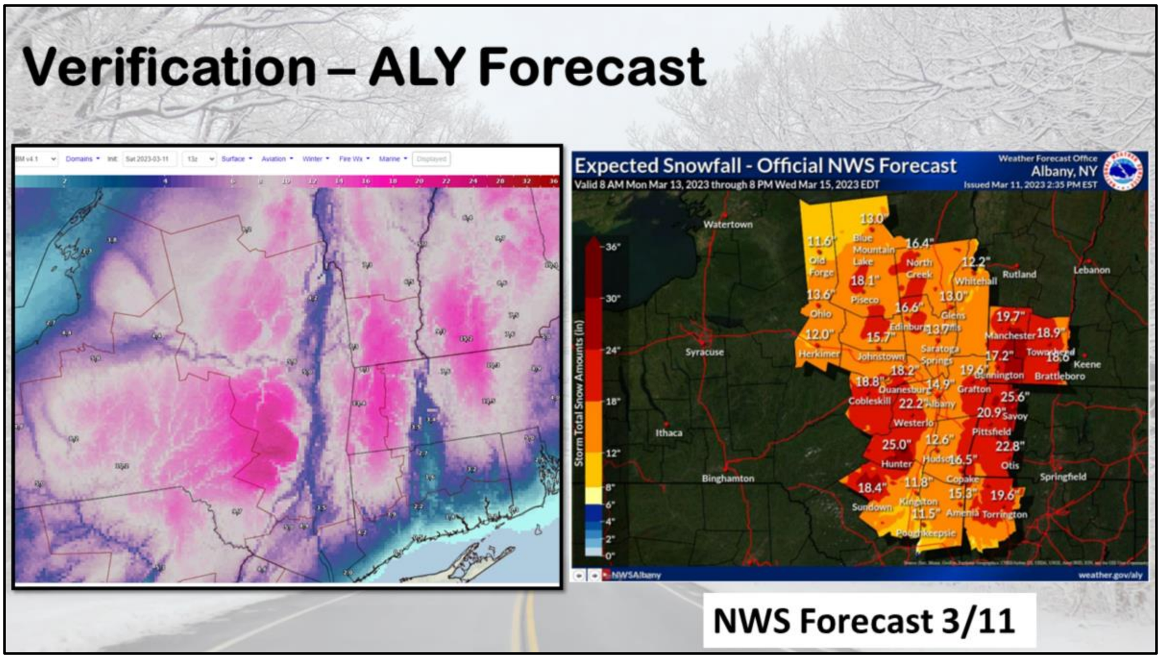
The NBM snowfall forecast from the afternoon on the 13th. At this point, snow had already started in the high elevations and would begin in the next several hours for valley areas. Snowfall amounts increased in the southern Greens and finally came up in the Hudson Valley north of Albany, but were still on the low side here. The NBM did a good job capturing the local minimum in the Mid Hudson Valley as well. However, this good forecast from the NBM was essentially too little too late as the NWS had already sent out several forecasts and our partners had been preparing for the event for several days at this point.



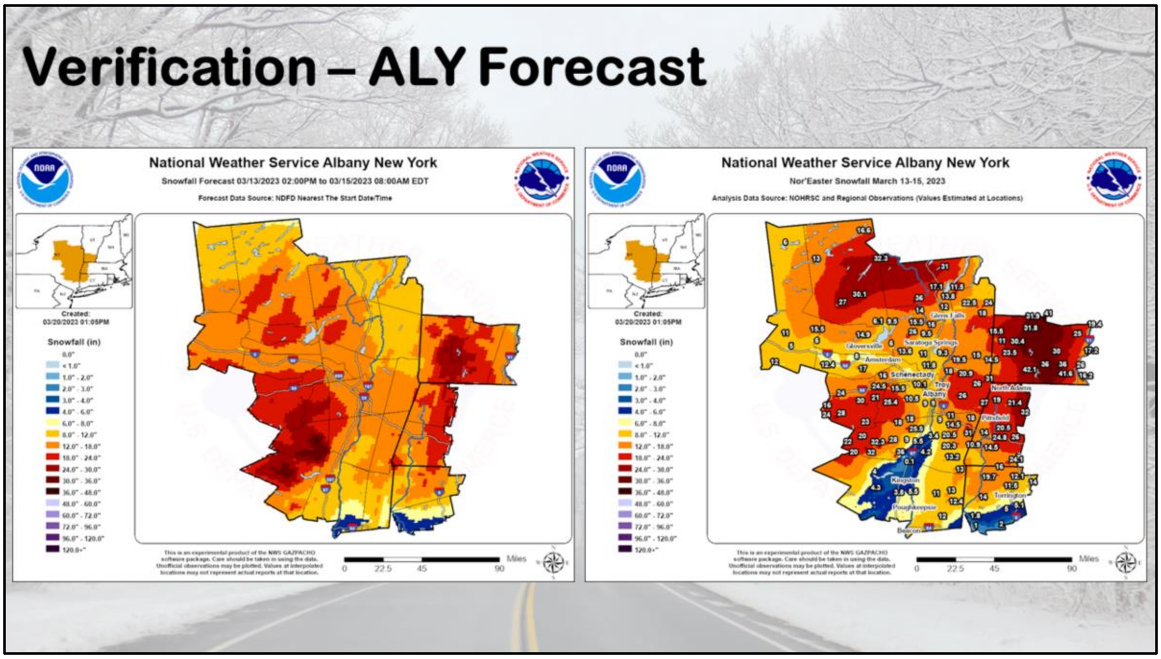
HREF verification versus the observed snowfall. Overall, the HREF did a good job highlighting the terrain dependence. It too was too low with snowfall amounts in the Hudson Valley north of I-90, but was slightly better than the 13z NBM. It also captured the local minimum (relative to surrounding areas) near Saugerties, but the snowfall amounts here were too high. It did, however, do an excellent job capturing the enhanced snowfall totals along the Taconics and in the Hudson Highlands, where it outperformed the NBM.



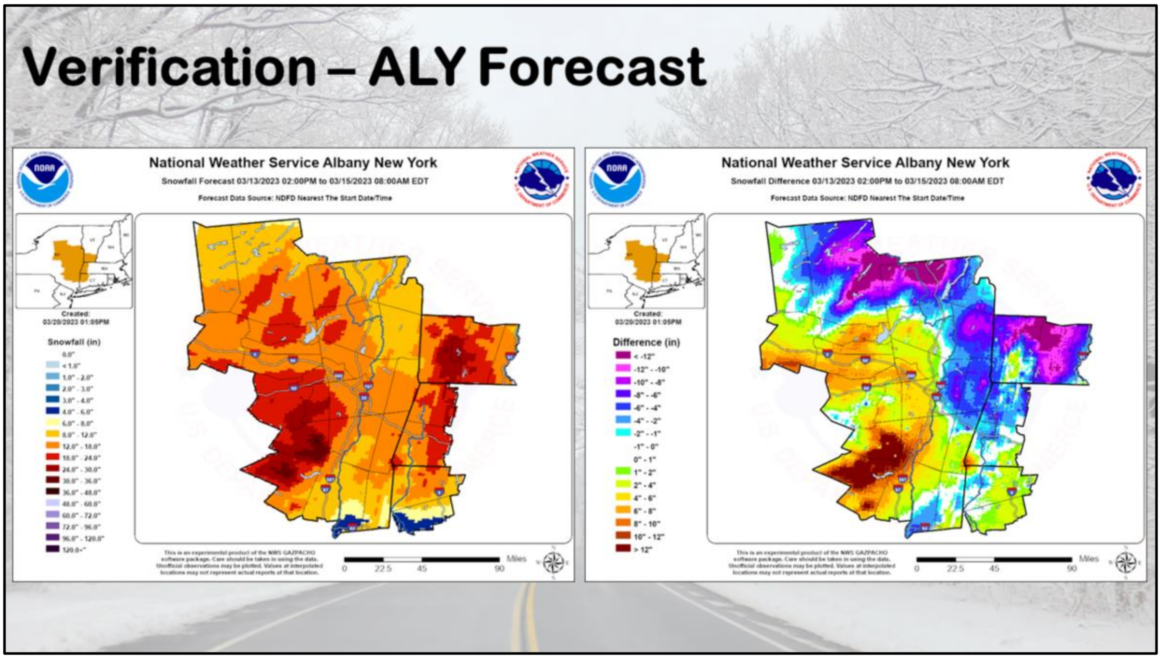
The same map as before, except using the probability matched mean, which retains some of the “extreme” snowfall values that can be washed out in a simple ensemble mean.



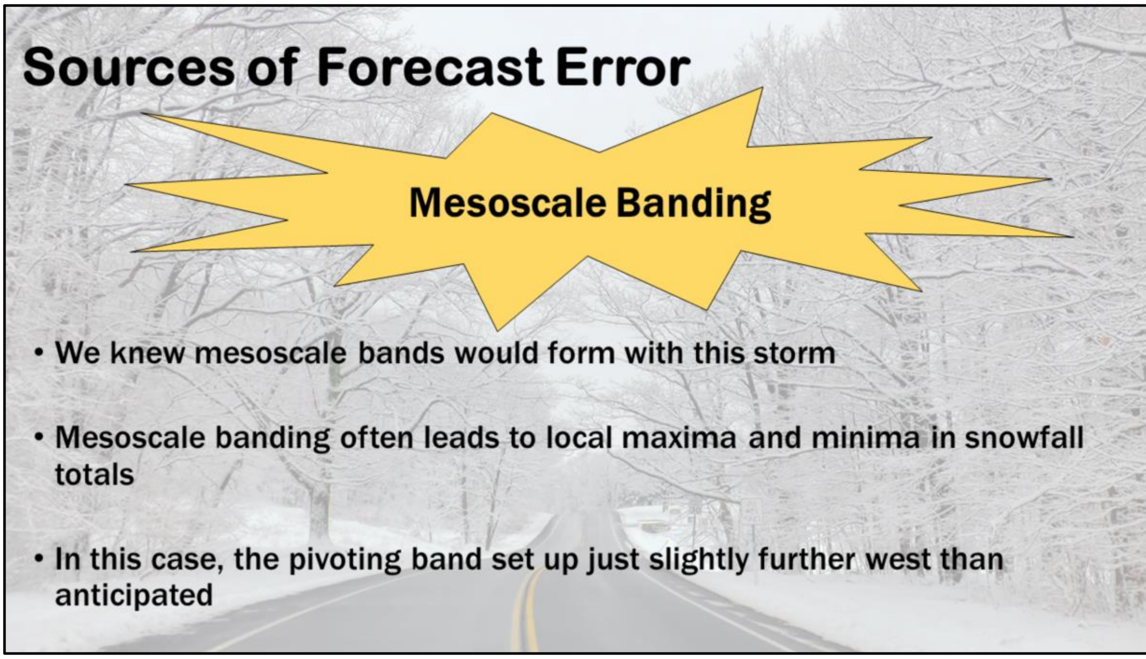
The NWS Albany forecast on March 11th compared to the NBM from the same day. NWS Albany forecasters correctly realized that the NBM was likely too low with snowfall amounts in the valley areas and bumped up the snowfall forecast accordingly to add value over the model. NWS forecasters also correctly had higher amounts in the Adirondacks and southern Greens than the NBM.



The NWS Albany forecast from the morning of March 13th compared to the verification map. Additional detail was added since the forecast shown on the last slide, but overall the general message of highest amounts in the terrain and lower, but still significant accumulations in the valleys was shown in both forecasts.



Now, the map on the left shows the forecast error in inches. The under-forecast in the southern Greens occurred where 2 to 3 feet of snow was expected and 36-42 inches of snow was observed. So, this did at least still fit with the message of the forecast. In the upper Hudson Valley, there was an under-forecast. With the NBM and HREF showing less snow here, there was some concern about downsloping leading to lowered snowfall totals. The under-forecast in the Adirondacks occurred where the mesoscale snow band set up and dropped several inches of snow per hour for multiple hours. There was an over-forecast in the Capital district and parts of the Mid Hudson Valley. Ultimately, it was expected that the mesoscale band would set up in this area, but it ultimately set up a few miles further west, leading to less snow here than forecast. Finally, the over-forecast in the Catskills shown here is likely an artifact of the interpolation algorithm that struggled with the sharp snowfall gradients and a lack of reports in this area. The map on the previous page shows numerous 30+ inch reports in the Catskills in the area highlighted dark red on this map, suggesting that the forecast here was actually much better than it appears from this graphic.



One of the primary sources of forecast uncertainty and forecast error was trying to nail down the exact location(s) that mesoscale snow bands would set up. We know that there would be mesoscale banding that would lead to local enhancement of snowfall totals, but ultimately this occurred just a tad further west than expected. More information on mesoscale banding is provided in the “banding” presentation linked on the case study website below the link for this presentation.

Conclusions

- This was a high impact storm for most of eastern NY and western New England, with heavy snow and significant power outages.
- Overall, this storm was well predicted several days in advance, with signals for a potentially significant snowfall accumulation in the high terrain areas.
- Model guidance struggled with the snowfall totals in the valleys, but NWS ALY forecasters correctly saw that the NBM was likely too low here and adjusted the official forecast accordingly.
- However, uncertainty in the evolution of mesoscale snow banding led to an under-forecast in the eastern Adirondacks and an over-forecast in portions of the Hudson Valley.