

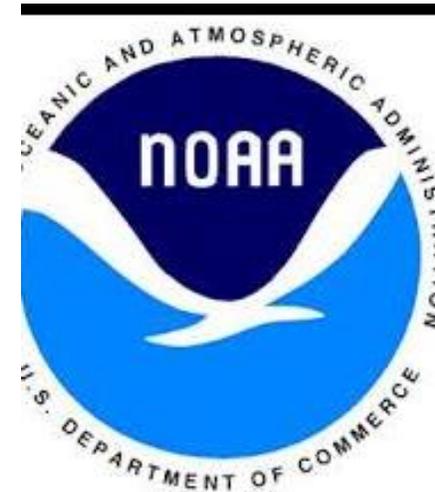


December 15th-17th 2022 Winter Storm Eastern New York

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U.S. National Weather Service
Albany, NY



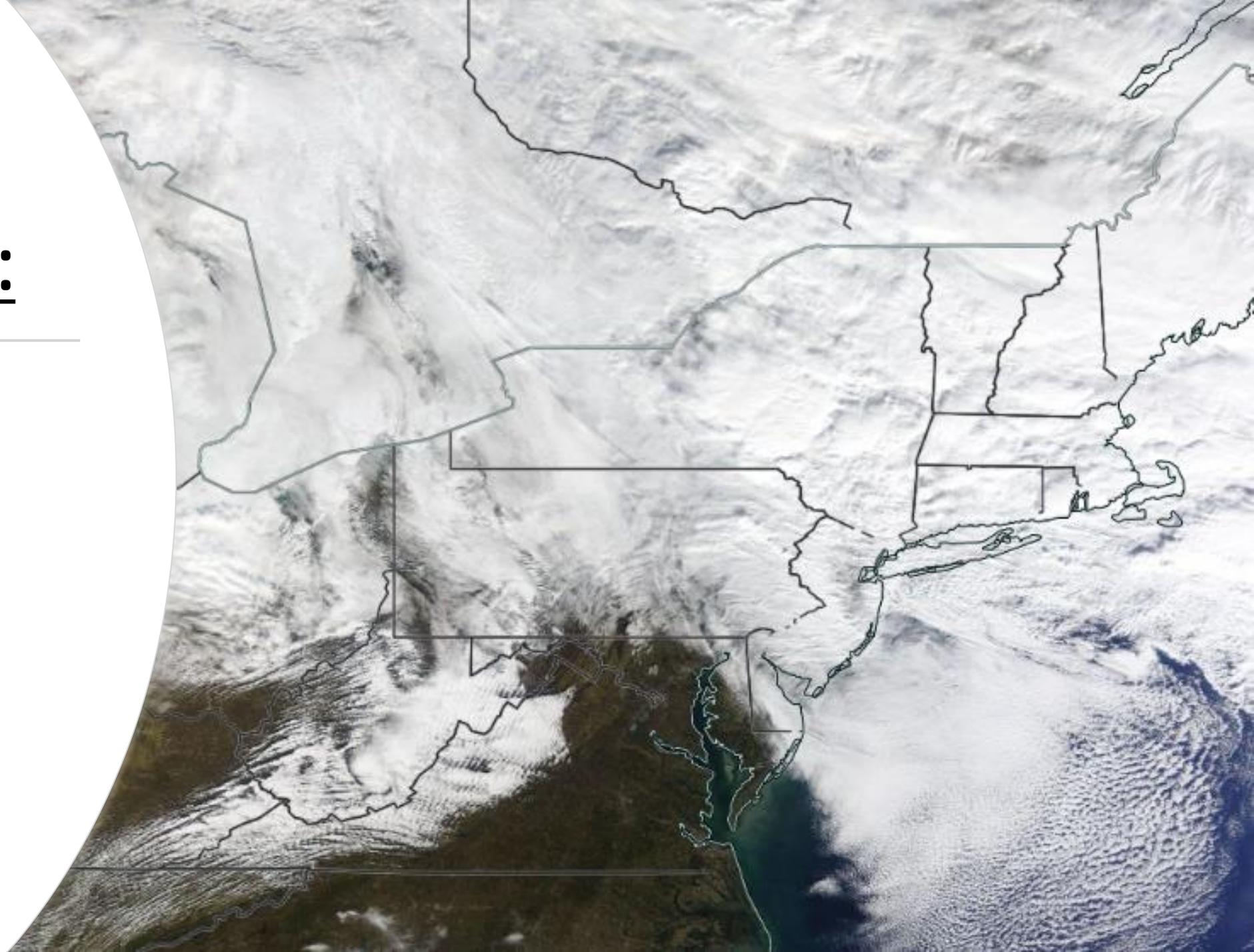
UNIVERSITY AT ALBANY





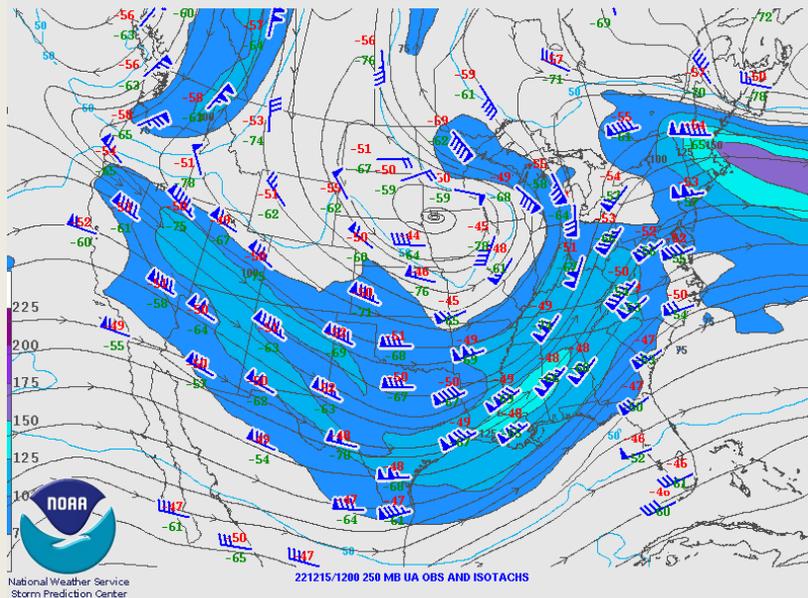
Brief Overview:

- Synoptic Overview
- Mesoscale Analysis
- NBM/NWS Forecasts
- Verification
- Concluding Thoughts

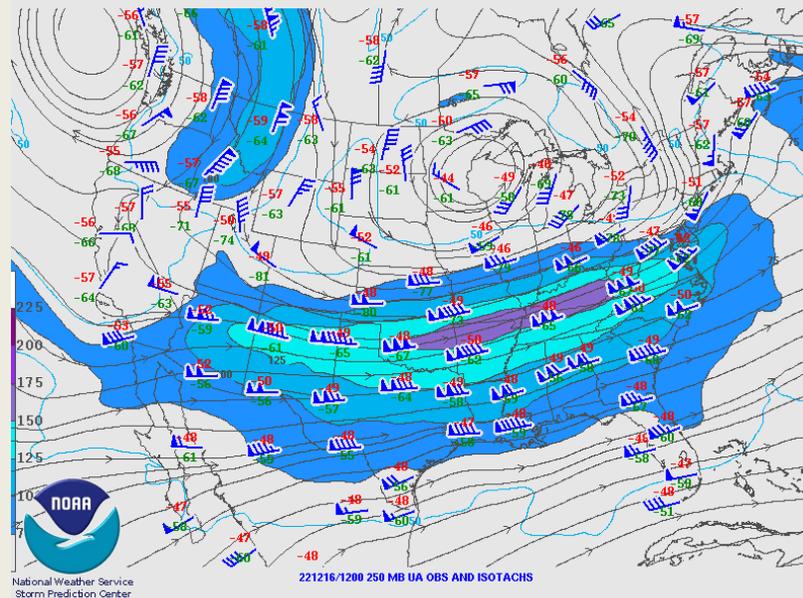


Synoptic Set-Up: 250mb

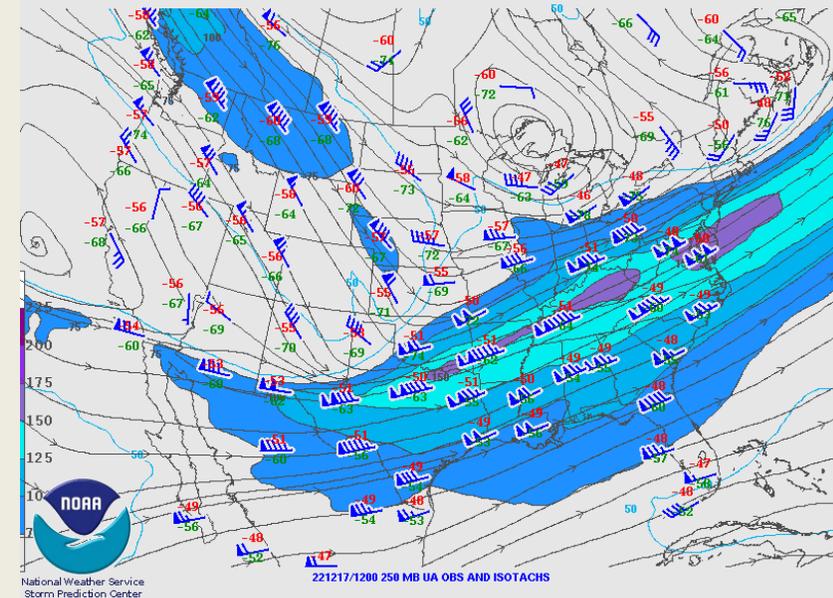
- A vertically stacked surface low is centered over the Central United States (U.S.), slowly moving north into the Upper Great Lakes Region. Initially, large-scale forcing is found between coupled jets, but becomes consolidated in the poleward exit region of a rapidly strengthening jet streak across the Central U.S. Winds at 250mb reach 150-175 knots (kts) in the jet streak just southwest of Albany, NY.



12z 12/15



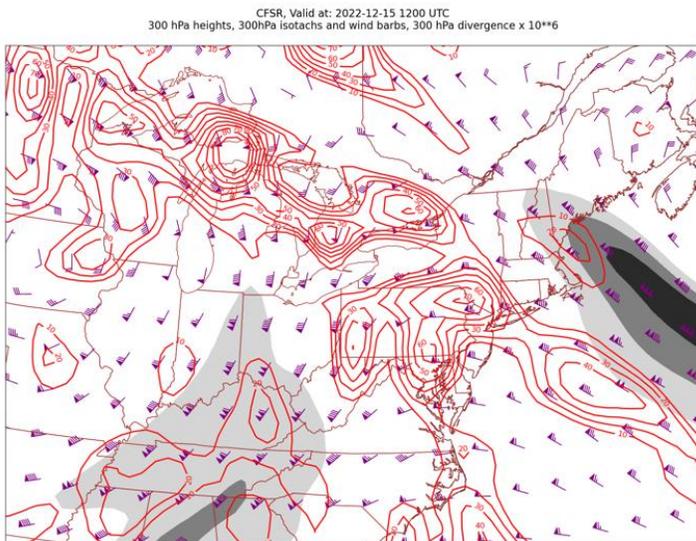
12z 12/16



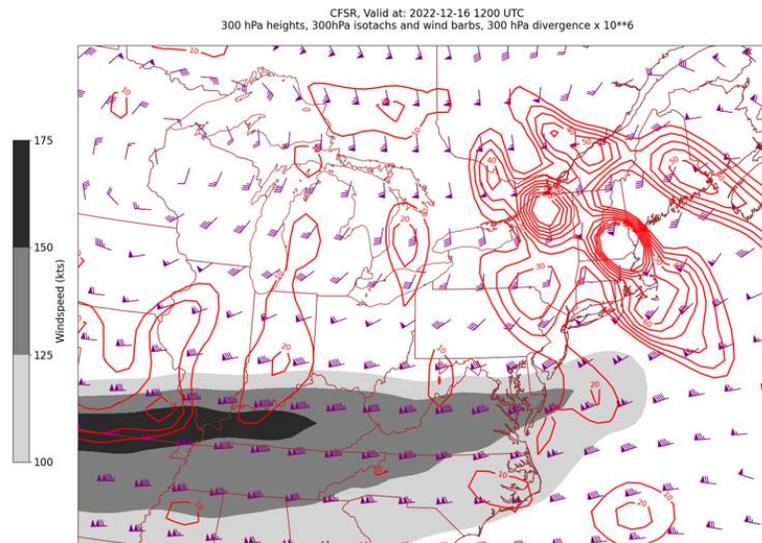
12z 12/17

300 hPa Divergence:

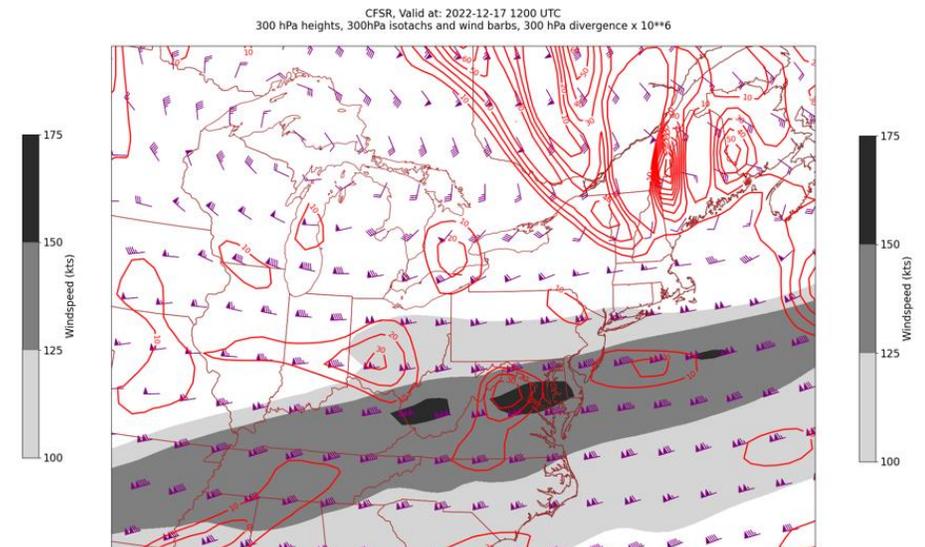
- As described at 250mb, upper-level divergence is found between a coupled jet near the Capital Region at 12z on 12-15. The area of greatest divergence shifts to the north and east of Albany, NY on 12-16 and 12-17 as the main jet streak strengthens to the south of NY.



12z 12-15



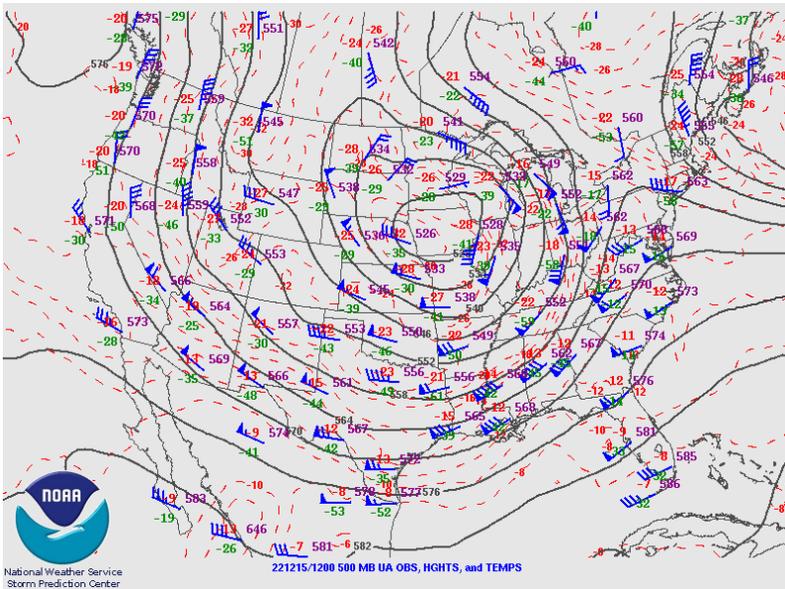
12z 12-16



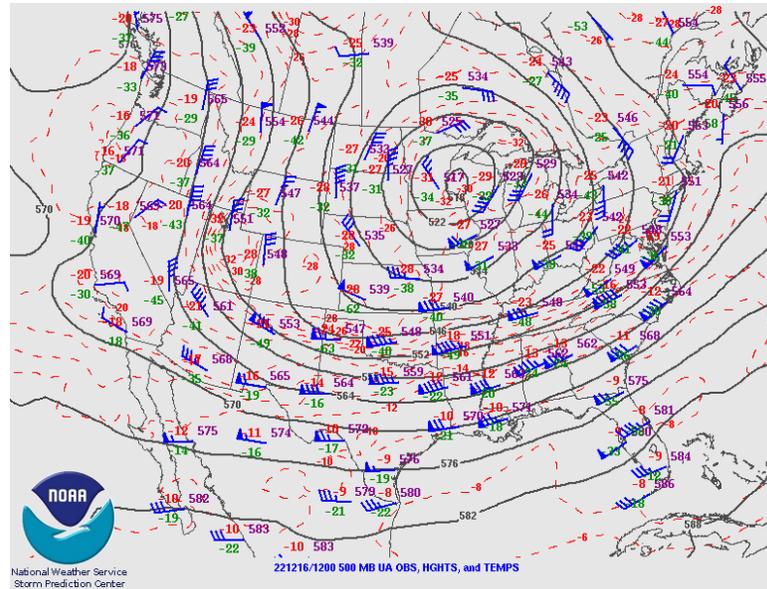
12z 12-17

Synoptic Set-Up: 500mb

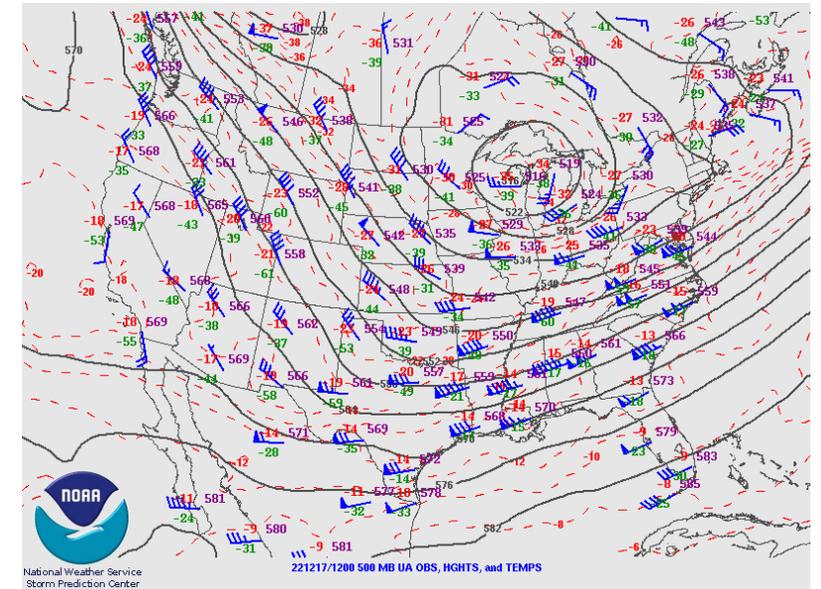
- A view at 500mb shows the lowest heights near the weakening surface low, with notably higher heights near the strongest mid-level winds (within the jet streak across the Central U.S.) and southward. Mid-level winds and heights moderate considerably across the Capital Region.



12z 12/15



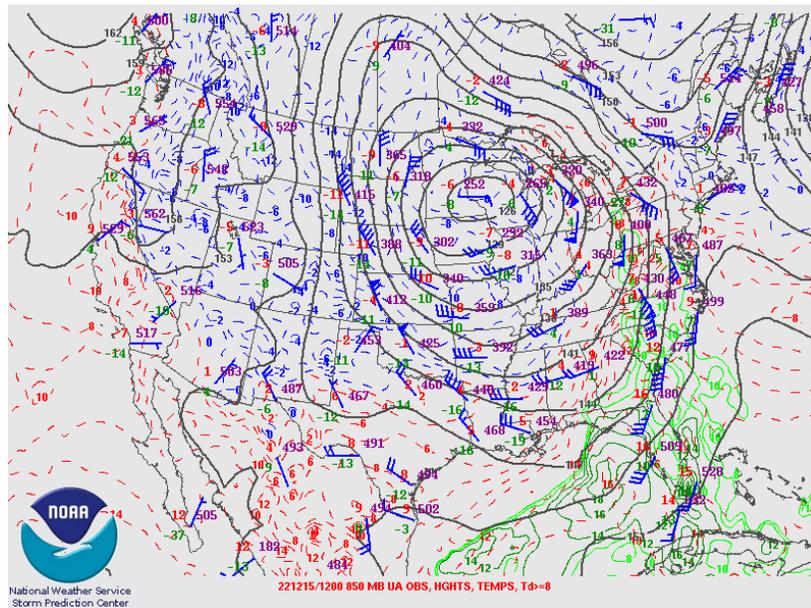
12z 12/16



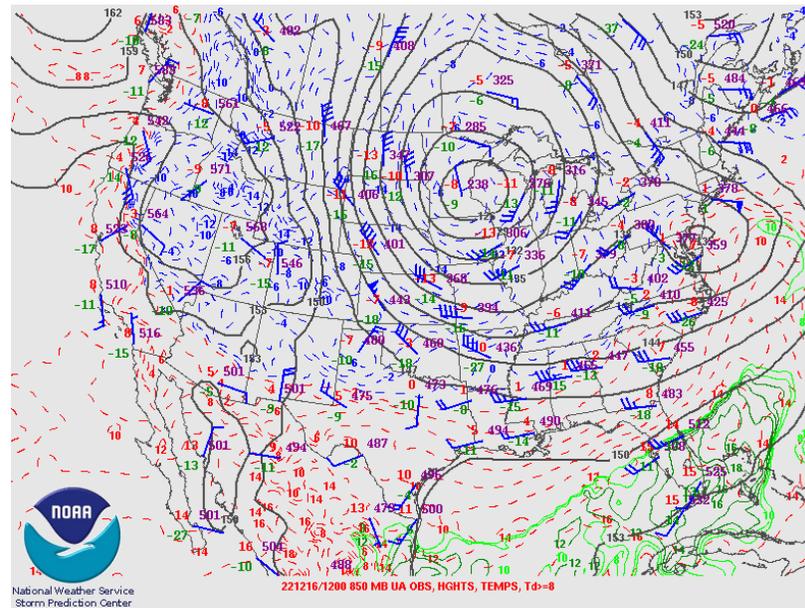
12z 12/17

Synoptic Set-Up: 850mb

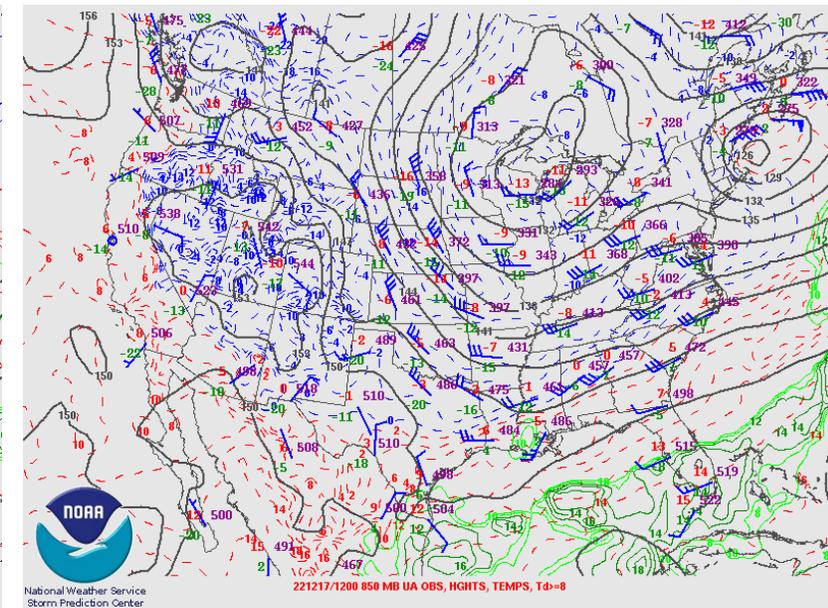
- Heights at 850mb continue to show the vertically stacked surface low across the Western Great Lakes, but also highlights the development of a secondary surface low that will eventually impact the Capital Region of NY. The green contours show 850 mb dew point, and indicate a conveyor belt of moisture from the southeastern U.S. stretching up into the northeastern U.S. on 12-15 and 12-16.



12z 12/15



12z 12/16

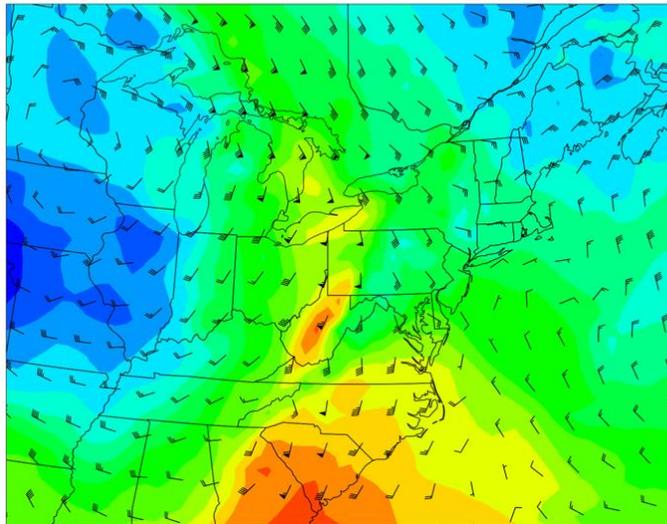


12z 12/17

850 hPa Temperatures(°C):

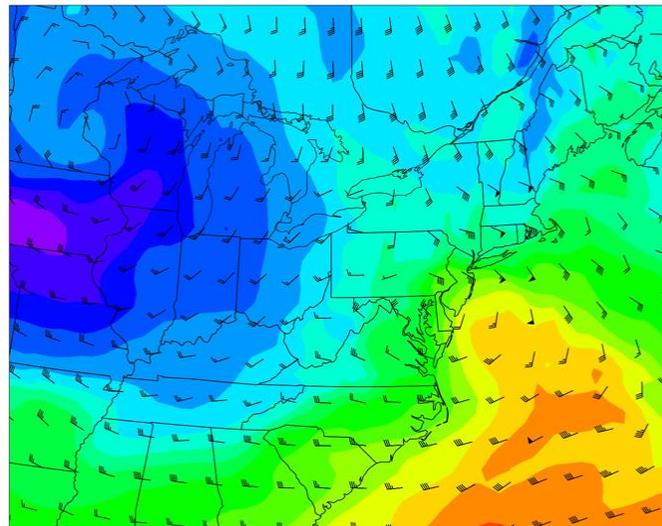
- Low-level southeasterly flow over the Capital Region supports 850 hPa temperatures slightly below or near freezing prior to this event. Flow remains stagnant throughout the next 24-36 hours before a trough builds in from the west, supporting cold air advection and a change to northwesterly flow.
- *With temperatures near freezing throughout most of the event, precipitation-type was greatly dependent on elevation.*

CFSR 850 hPa temperature (°C, filled contours) and winds (kts, barbs)
Valid at: 2022-12-15 1200 UTC



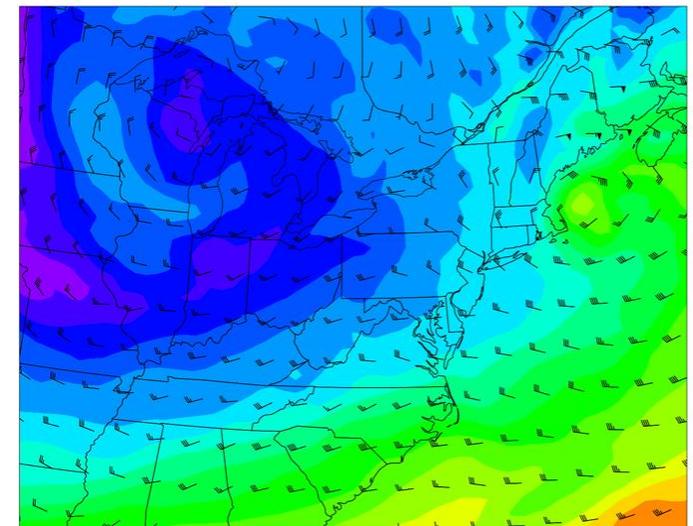
12z 12-15

CFSR 850 hPa temperature (°C, filled contours) and winds (kts, barbs)
Valid at: 2022-12-16 1200 UTC



12z 12-16

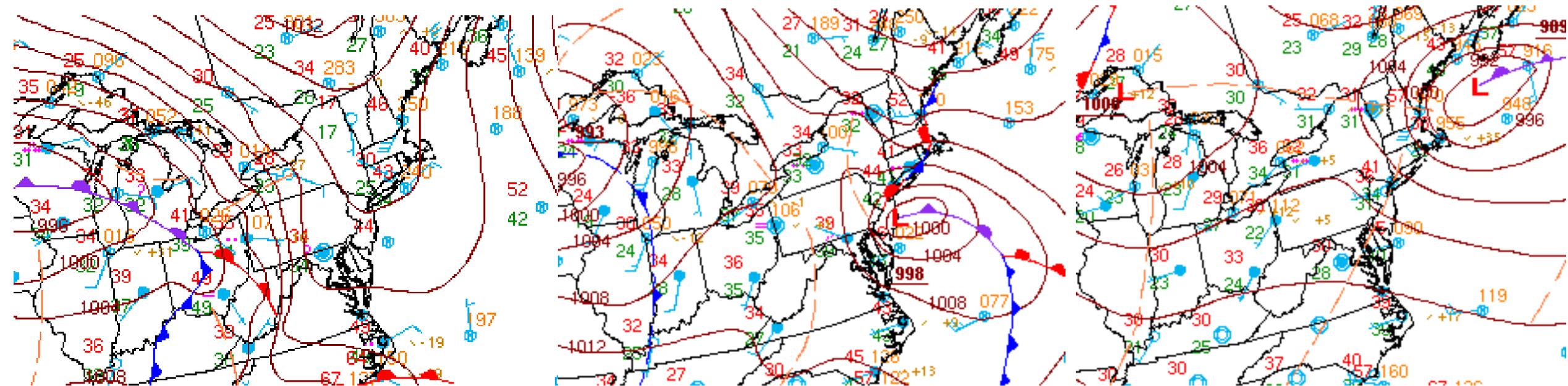
CFSR 850 hPa temperature (°C, filled contours) and winds (kts, barbs)
Valid at: 2022-12-17 1200 UTC



12z 12-17

Surface Analysis:

- A vertically-stacked surface low is centered over the Western Great Lakes. It's associated warm, cold, and occluded fronts meet over Central Ohio where plentiful surface convergence is present. This localized area of convergence (and fronts) will spawn a secondary low of 1000mb over eastern New Jersey. Eventually, the surface low intensifies to 989mb and moves off the eastern seaboard.



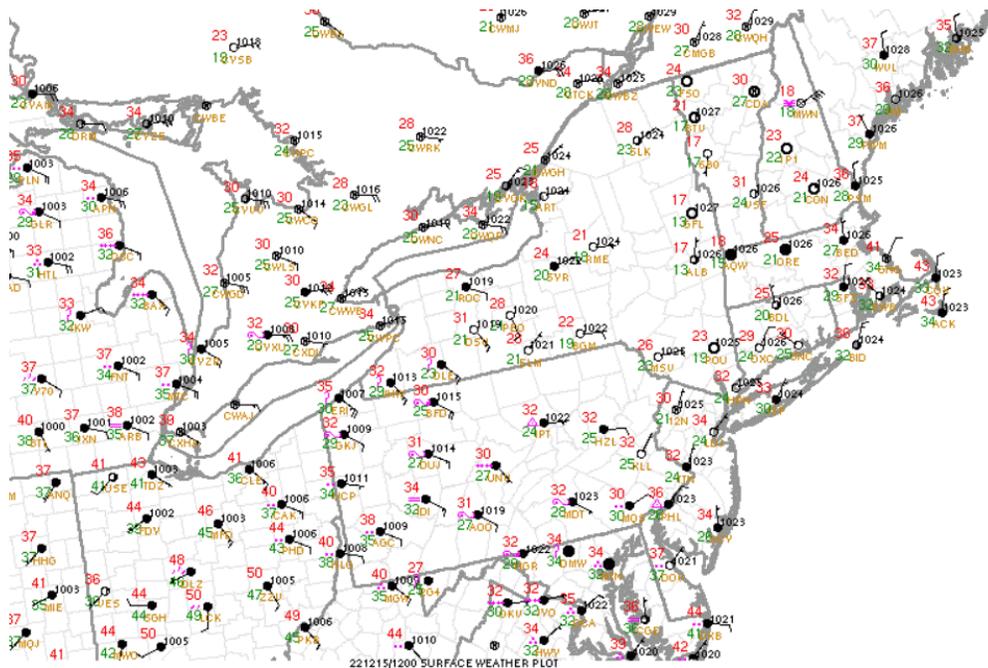
12z 12/15

12z 12/16

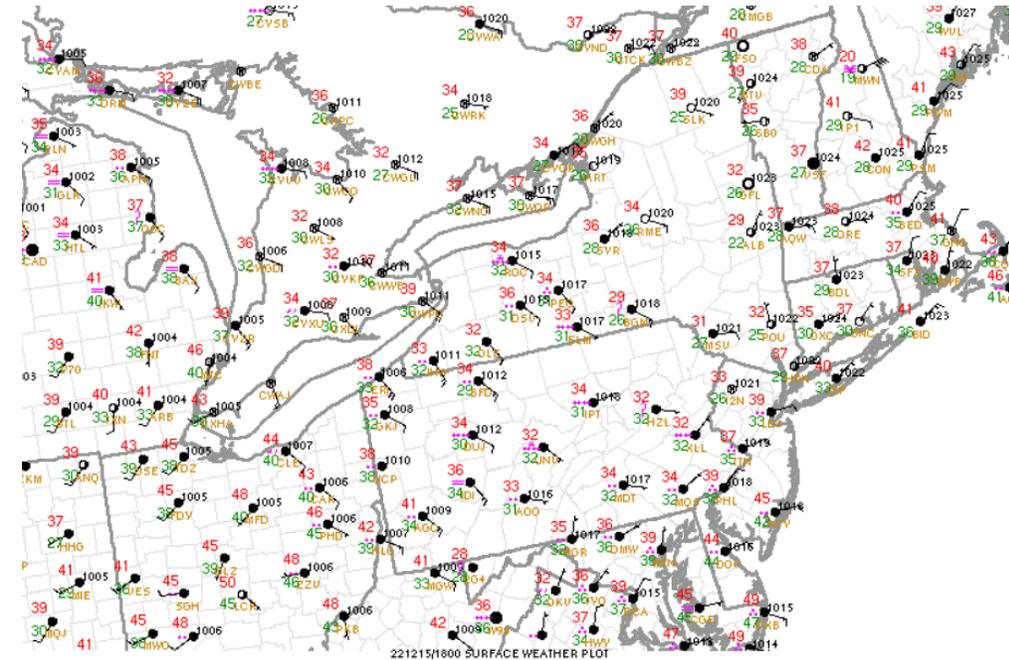
12z 12/17

Surface Observations Prior To the Event:

- Flow at the surface is north northeasterly at both 12z and 18z on 12-15. This resulted in some cold air damming within the Hudson and Mohawk Valleys. In other words, cold, dense air held on longer in valley locations such as Albany, NY while surrounding higher terrain was affected by warm air advection occurring around parts of the developing low.



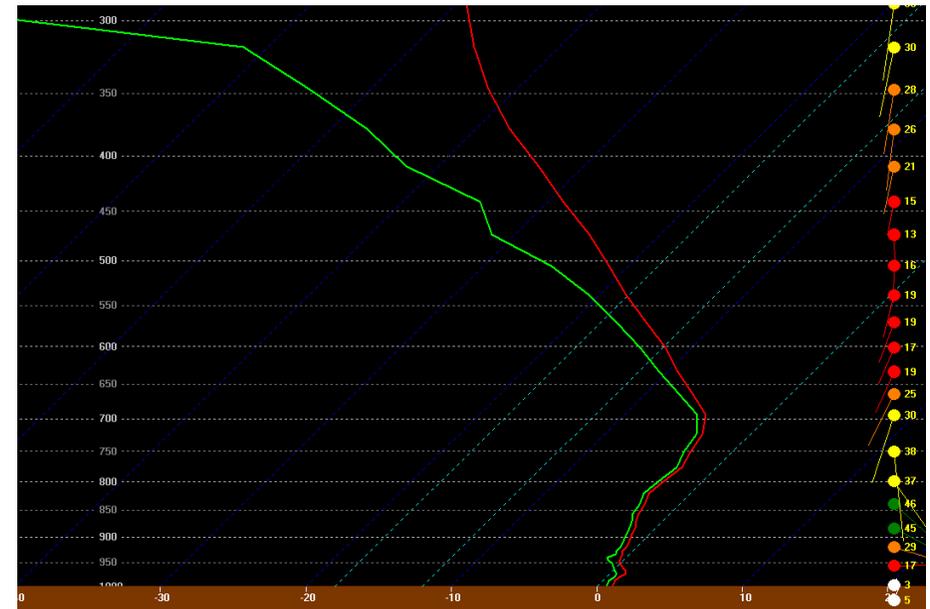
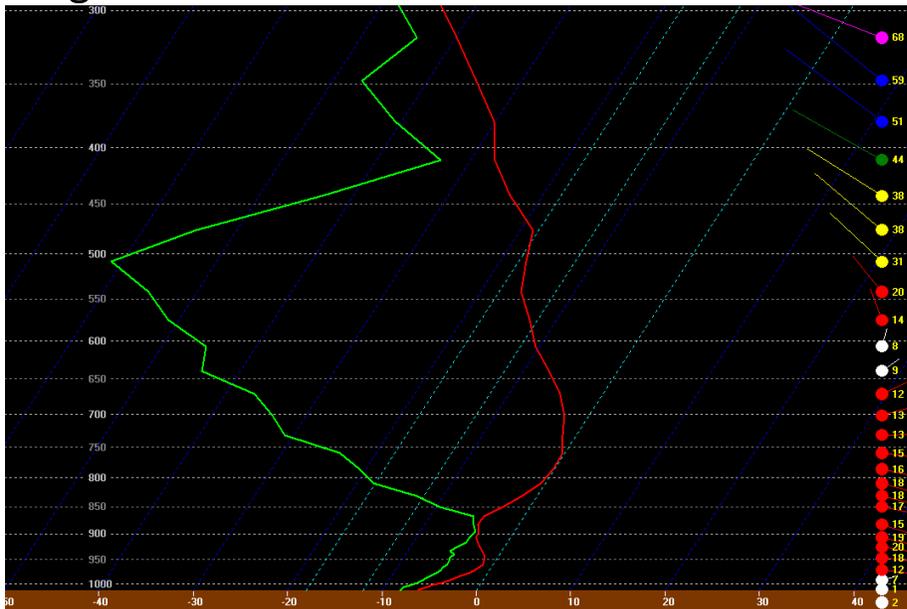
12z 12-15



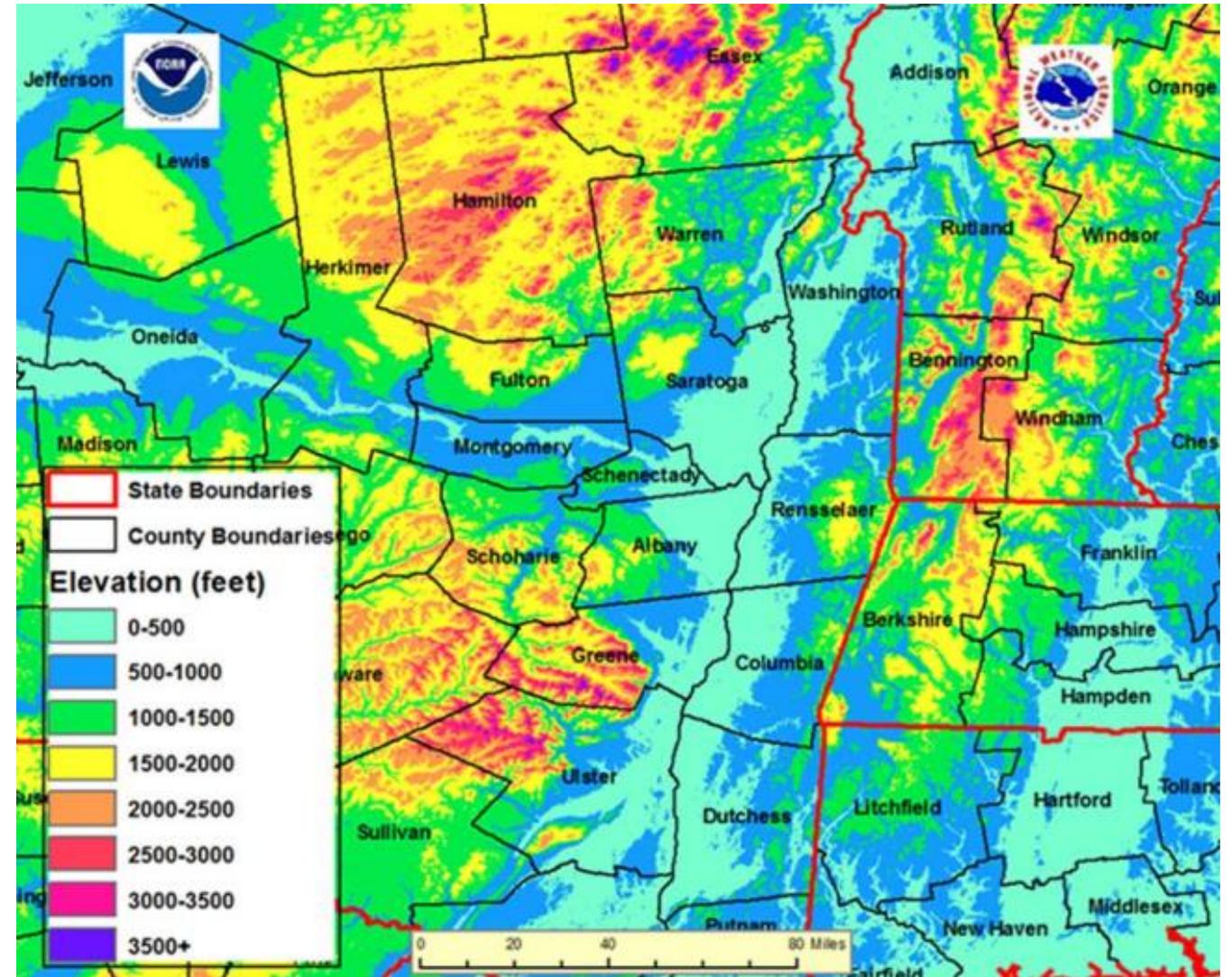
18z 12-15

NAM BUFKIT (ALB) Soundings:

- No observed soundings were available in Albany, NY during this event, so BUFKIT soundings are used. The profile on 12-15, prior to the onset of precipitation, shows very dry air in the mid-to-upper layers, with more moisture in the low-levels. The dewpoint and temperature remains well-below freezing with relatively light winds through 500mb. Our second sounding (12-16) was taken with precipitation ongoing, so the column is saturated from the surface to 500mb. There is a small inversion present at or below 950mb as temperatures warm just above freezing at the surface. Winds are much stronger throughout the profile as well. Rain was falling at the ALB sounding site, but most higher elevations were reporting snow at this time.



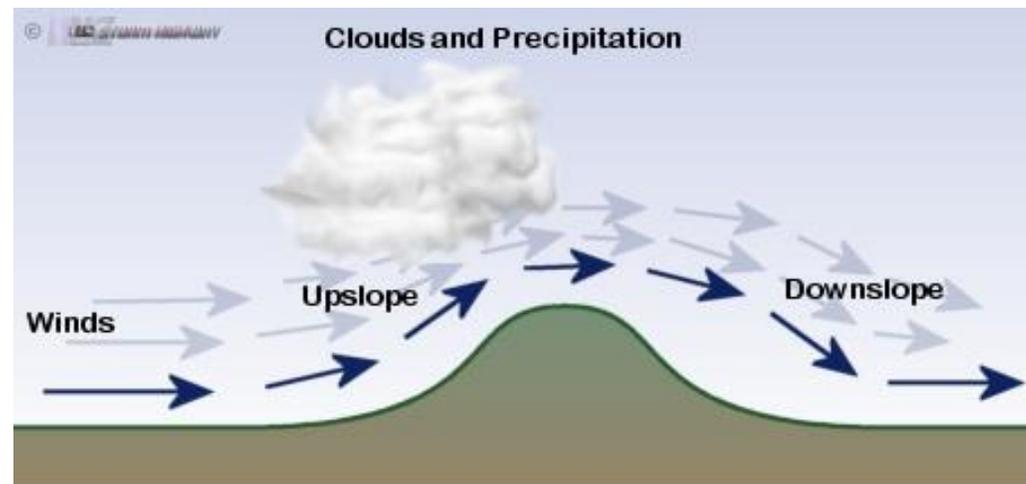
Capital Region Topography:



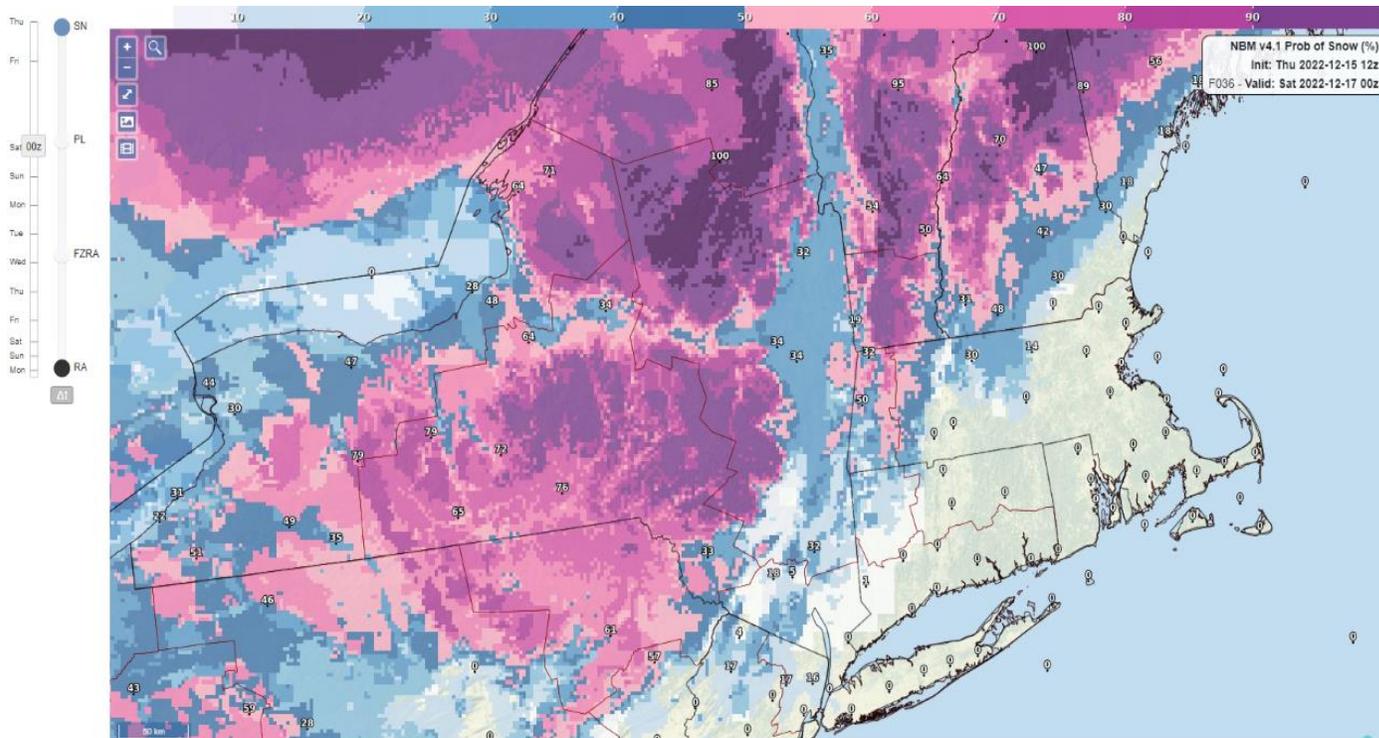
- The county warning area (cwa) of the National Weather Service (NWS) office in Albany, NY has large fluctuations in topography. Elevation would become crucial to where snow or rain fell.

What is Upsloping/Downsloping?

- Elevation fluctuations also enhance something known upslope and downslope precipitation. The National Weather Service (NWS) defines upsloping as “air that flows toward higher terrain and is forced to rise. The added lift often results in widespread low cloudiness and stratiform precipitation”. Downsloping is the direct opposite of this, as air will sink towards the surface, resulting in clearing or decreasing precipitation rates.
- In this winter storm, upsloping occurred across the Adirondacks, Catskills, and Taconic’s, while downsloping occurred across the Hudson and Mohawk Valley’s.



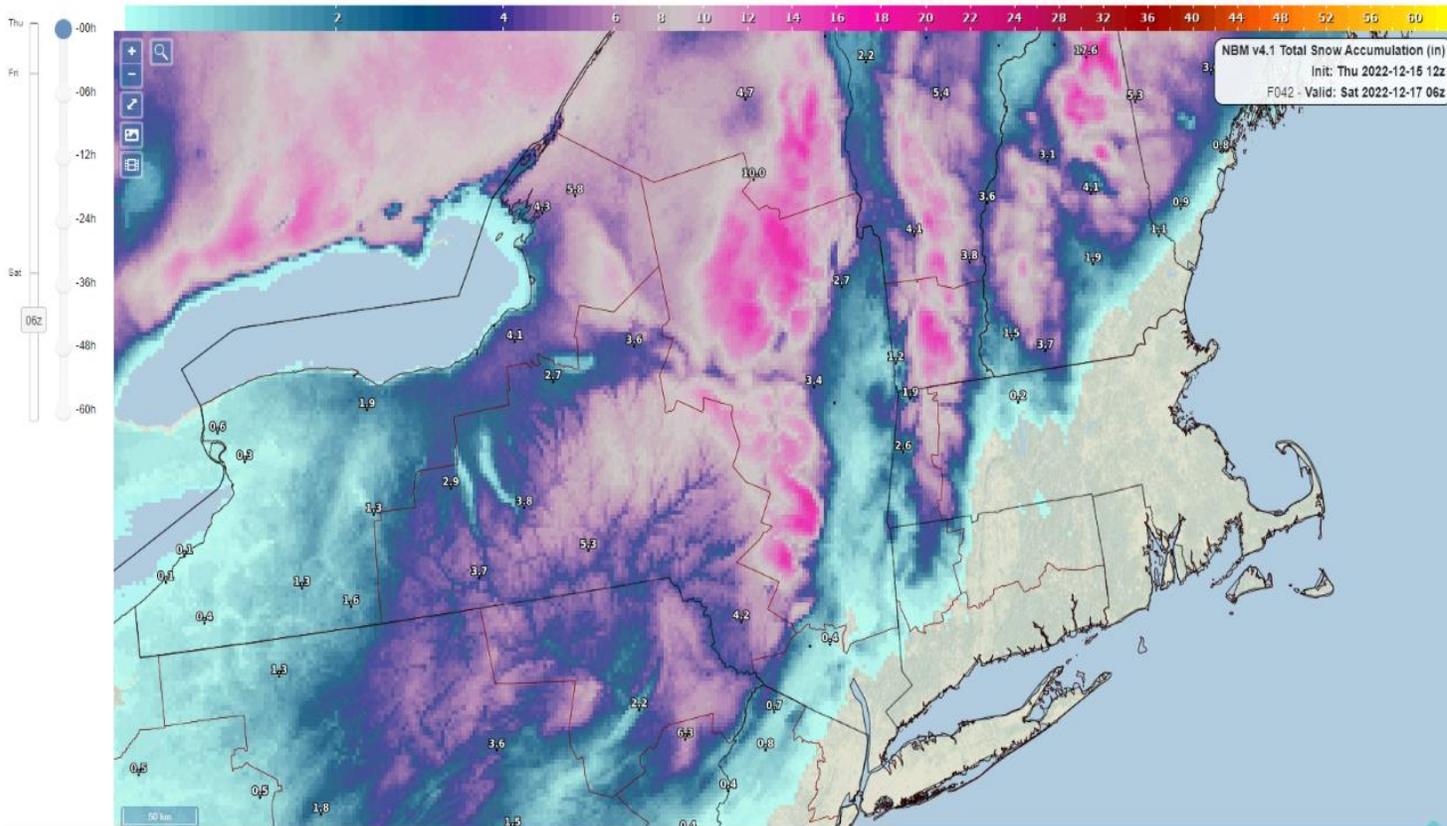
National Blend of Models (NBM) Probability of Snow(%):



Initialized: 12z 12-15

- The NBM highlights high probabilities of snow across the steepest elevations, especially the Adirondacks, Catskills, and Taconic Mountains.
- The Hudson and Mohawk Valley's have substantially lower snowfall probabilities.

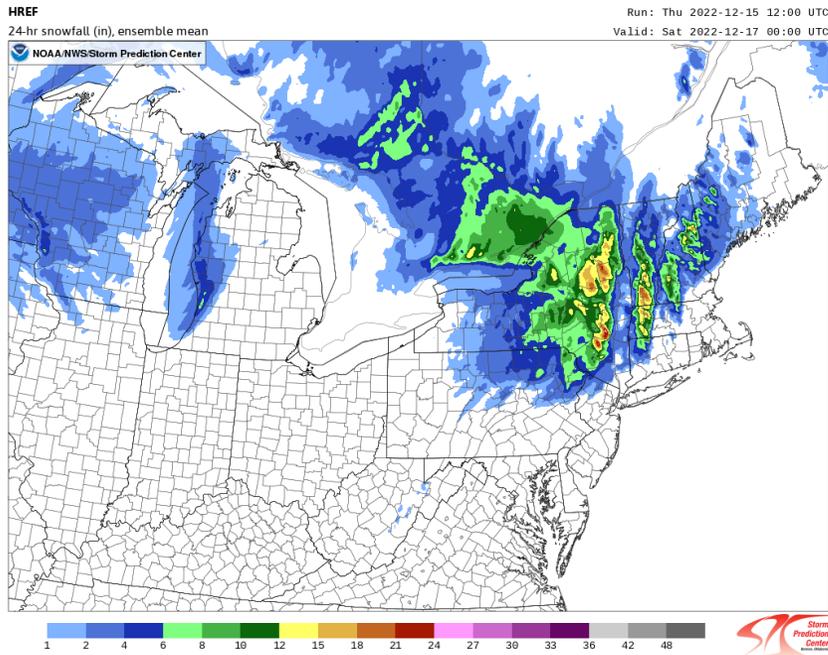
NBM Total Snow Accumulation Forecast:



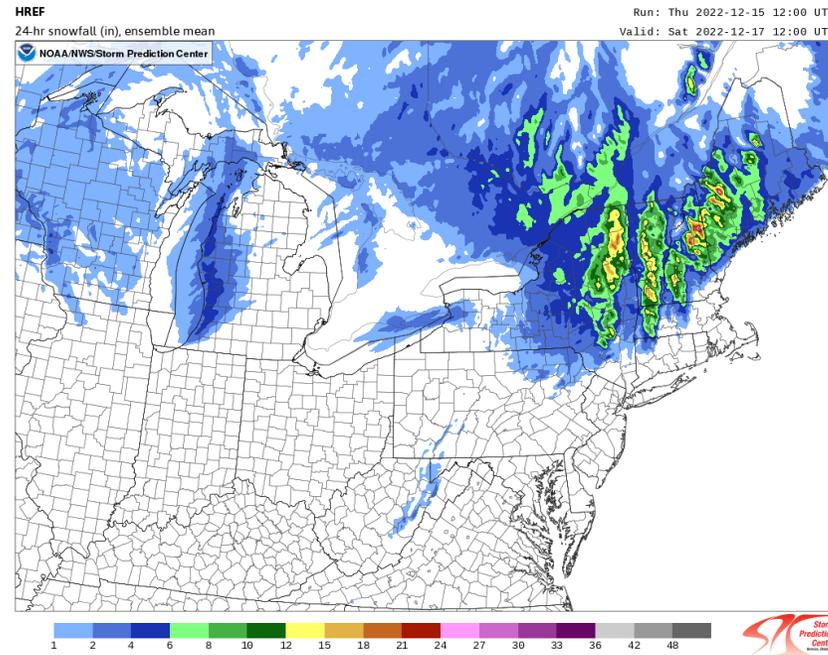
- Similar to the NBM snow probabilities, accumulation is heavily-reliant on elevation.
- 1-2 feet of snow was forecasted across portions of the Catskills and Adirondacks, with slightly less in the Taconic Mountains.
- 1-3” was forecasted within the Hudson Valley while 4-8” was forecasted within the Mohawk Valley

Initialized: 12z 12-15 through 06z 12-17

High Resolution Ensemble Forecast (HREF) 24-Hour Snowfall:



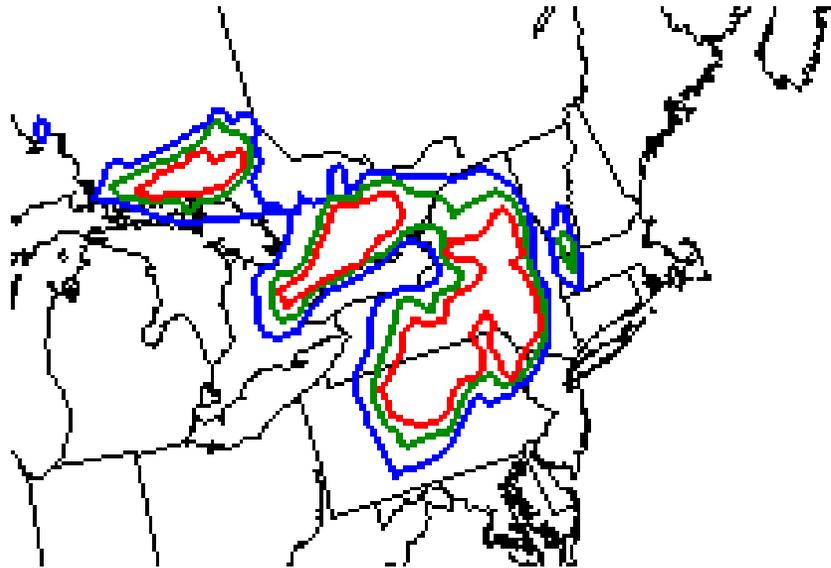
Initialized 12z 12-15 through
00z 12-17



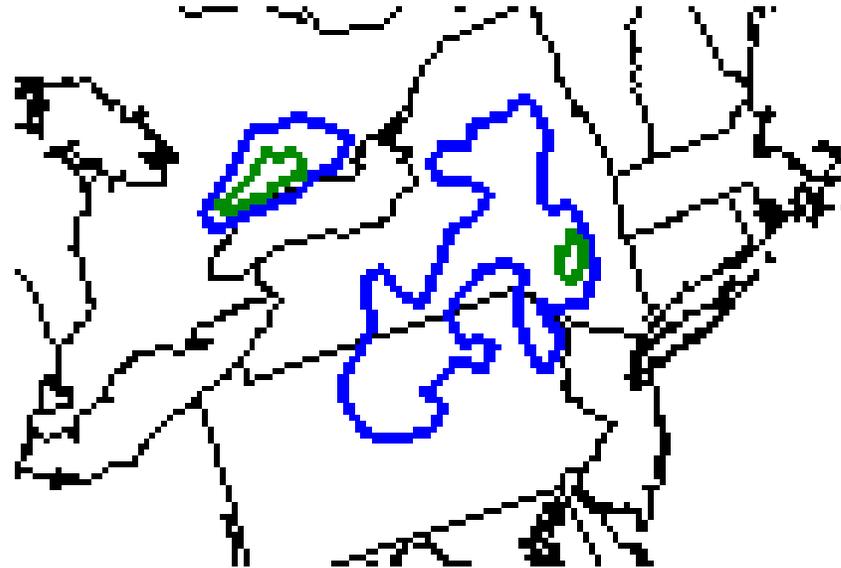
Initialized 12z 12-15 through
12z 12-17

- The HREF places the greatest snow accumulation in the Catskills and Adirondacks once again.
- Two-day totals top 1-2 feet (locally 2.5 feet) in these regions.
- The Hudson Valley receives significantly lower totals (1-3").

Weather Prediction Center (WPC) Snowfall Probabilities (12/15):



Issued 09z for $\geq 4''$
of snow

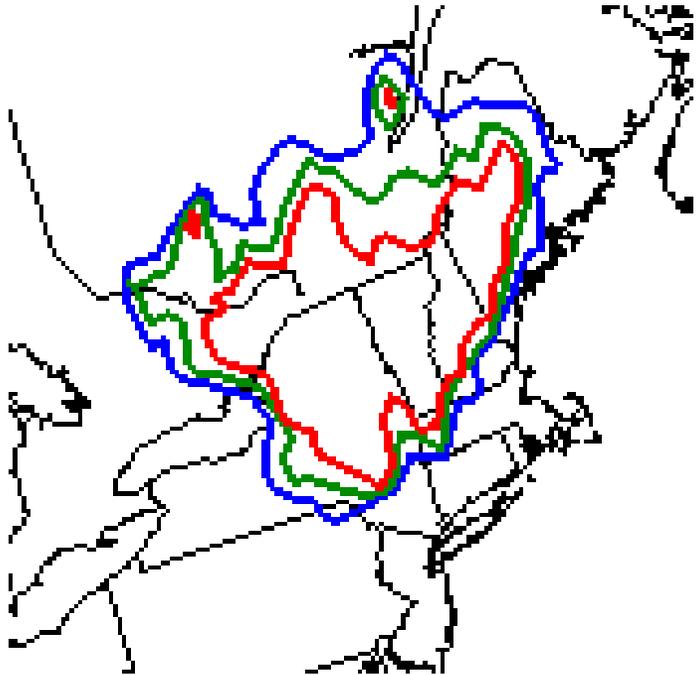


Issued 09z for $\geq 8''$
of snow

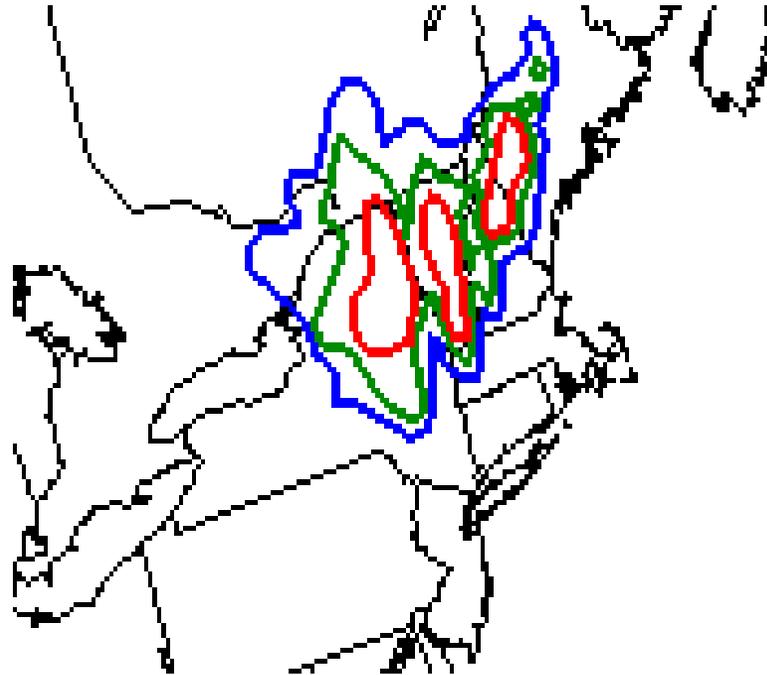
- The WPC day one forecast supported most model guidance with the highest probabilities centered over the Catskills.
- Even with the rough sketched contours, the Hudson Valley remains evident on the $\geq 4''$ graphic.

WPC Snowfall Probabilities (12/16):

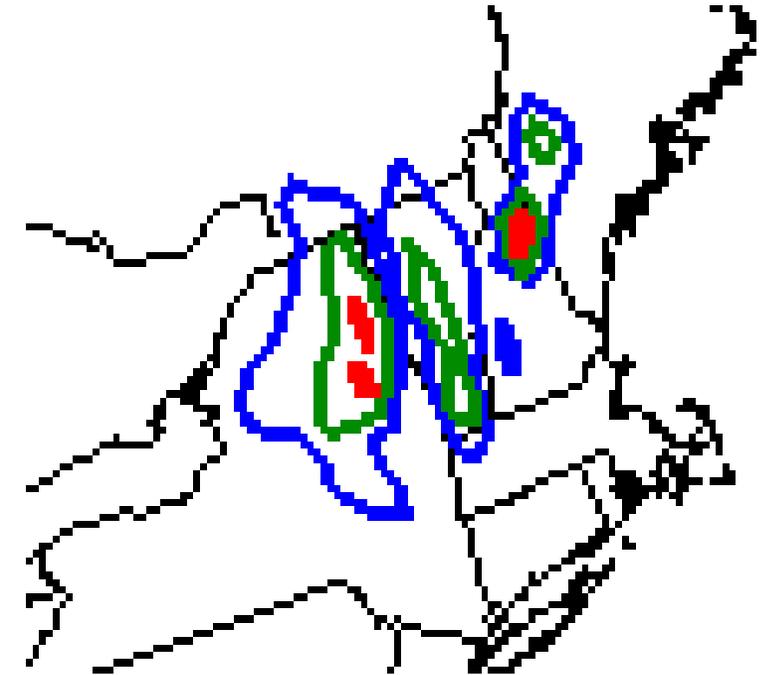
- The second WPC one day outlook was a little different in that higher snow probabilities existed in the Mohawk/Hudson Valley's. However, the theme of high elevation snow is reflected once again, especially in the Adirondacks.



Issued 09z 12/16
for ≥ 4 " of snow

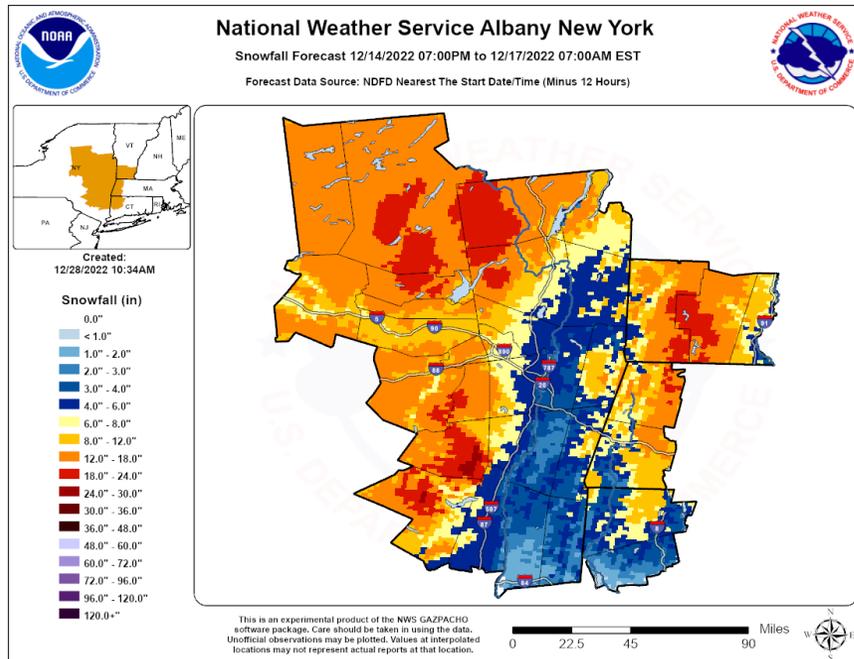


Issued 09z 12/16
for ≥ 8 " of snow

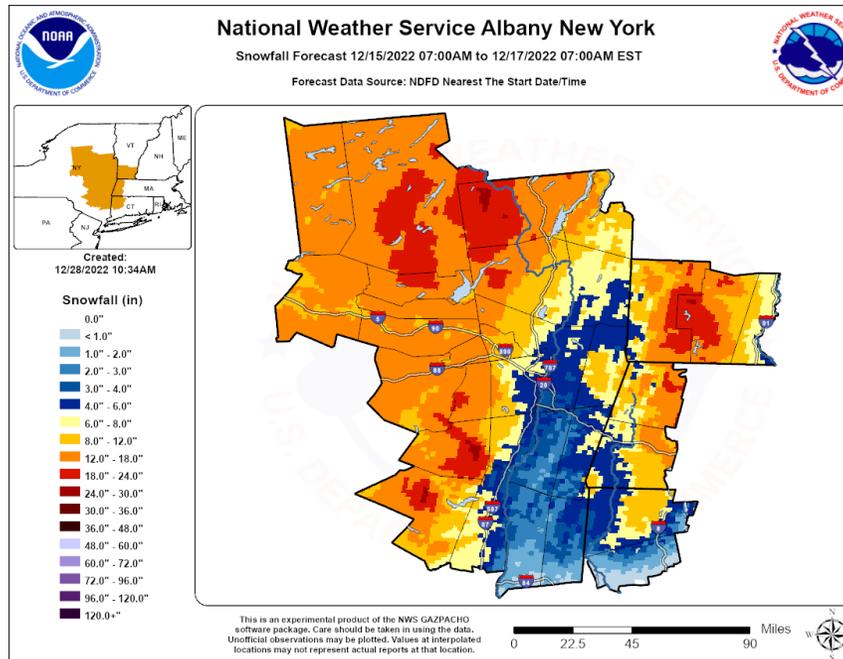


Issued 09z 12/16
for ≥ 12 " of snow

National Weather Service (NWS) office in Albany, NY Forecast:



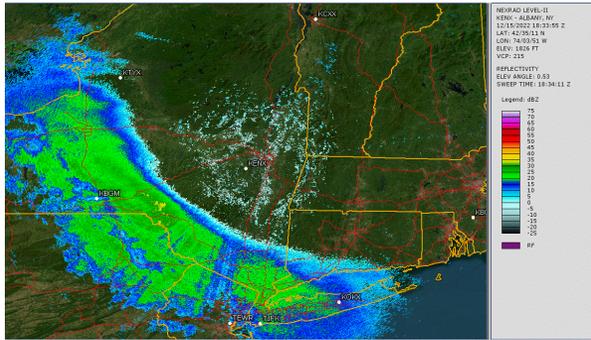
Forecast Issued
00z 12/15/22



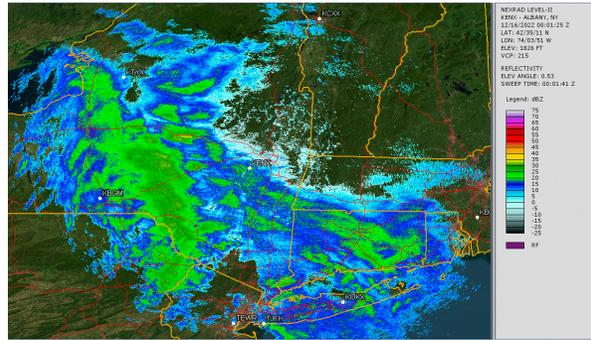
Forecast Issued
12z 12/15/22

- Similar to all the previous forecasts, the NWS in Albany had the greatest snowfall occurring in the Adirondacks and Catskills.
- Upwards of 1.5-2.5 feet of snow was forecasted across the highest terrain.
- The Hudson Valley was forecasted to receive 1-4" of snow.

KENX Reflectivity (Elevation: 0.53):



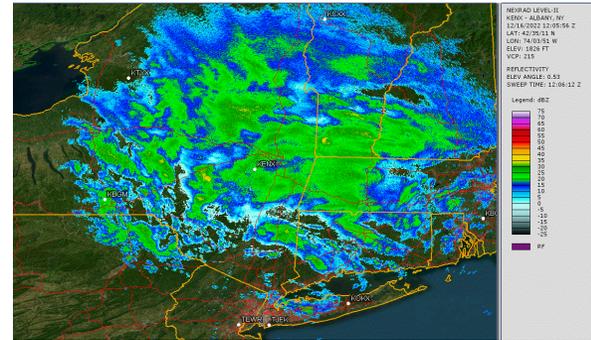
12-15 18z



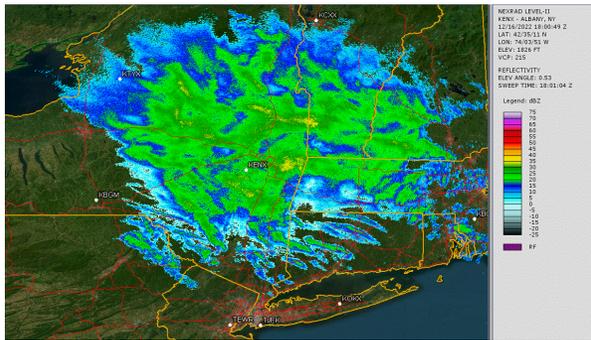
12-16 00z



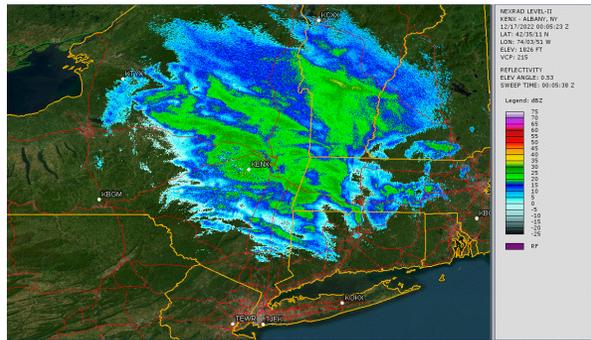
12-16 06z



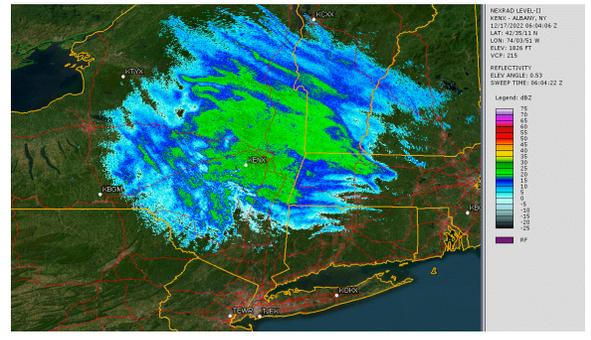
12-16 12z



12-16 18z



12-17 00z

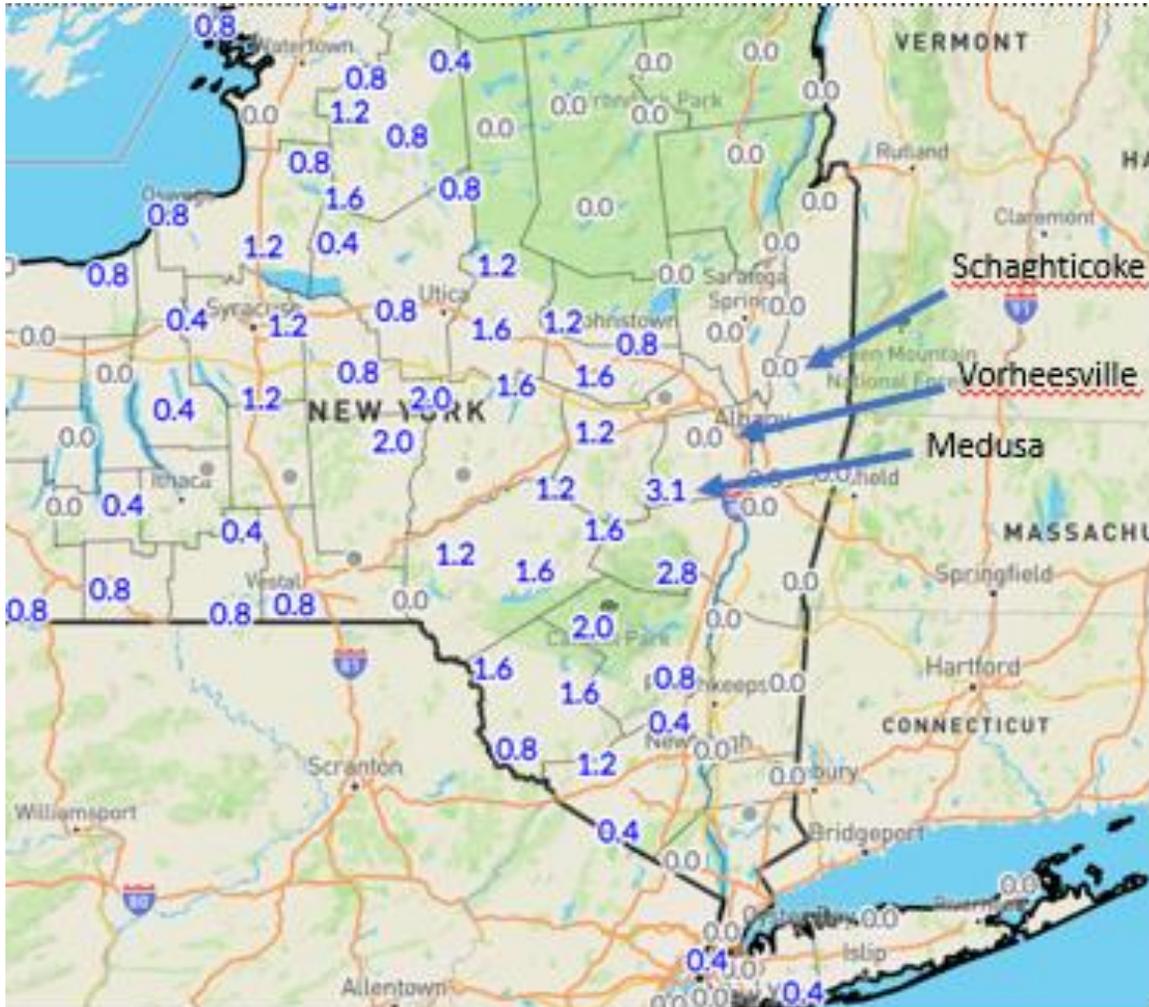


12-17 06z



12-17 12z

New York State (NYS) Mesonet:



- New York is home to an extensive Mesonet network that takes extensive measurements of select variables during intervals as little as 5 minutes.
- During this event, the NWS utilized several of these stations to determine the ongoing precipitation-type.
- For this case study, we looked at three sites with varying elevations. They are as mapped from south to north:
 - Medsua: 1,247 ft above sea level
 - Vorheesville: 378 ft above sea level
 - Schaghticoke: 323 ft above sea level

NY Mesonet Cameras/Data:

Medusa



Conditions as of 1:00 AM

Snow Depth	7"				
P-type	Rain				
	1-hr	3-hr	6-hr	12-hr	24-hr
Snow Accumulation	0.4"	1.6"	4.7"	4.7"	4.7"
Depth Change	0.4"	1.6"	4.7"	4.3"	4.3"
Liquid-Equivalent	0.06"	0.19"	0.48"	0.55"	0.55"
SLR	--	9	10	9	9

Voorheesville



Conditions as of 1:00 AM

Snow Depth	2"				
P-type	Snow				
	1-hr	3-hr	6-hr	12-hr	24-hr
Snow Accumulation	0.0"	0.8"	0.8"	0.8"	0.8"
Depth Change	-0.4"	0.4"	0.4"	0.4"	0.4"
Liquid-Equivalent	0.04"	0.17"	0.31"	0.31"	0.31"
SLR	0	0	3	3	3

Schaghticoke



Conditions as of 1:00 AM

Snow Depth	3"				
P-type	Rain				
	1-hr	3-hr	6-hr	12-hr	24-hr
Snow Accumulation	0.4"	1.6"	2.0"	3.5"	3.5"
Depth Change	0.4"	1.2"	1.2"	1.6"	0.8"
Liquid-Equivalent	0.04"	0.12"	-0.57"	0.48"	0.85"
SLR	--	--	--	--	--

- Our event began in the late afternoon/early evening hours on 12-15 with a burst of heavy, wet snow across the Capital Region.
- Site data is provided at 1am on 12-16 Eastern Standard Time (EST).
- Stations have trouble diagnosing precipitation-type despite all cameras showing falling snow.
- Snow accumulation at Schaghticoke and Voorheesville is limited as temperatures rise within the valley.
- Temperatures stay cooler within the higher terrain, as seen by greater accumulation at Medusa.

NY Mesonet Cameras/Data:

Medusa



Conditions as of 1:00 PM

Snow Depth	11"				
P-type	Rain				
	1-hr	3-hr	6-hr	12-hr	24-hr
Snow Accumulation	0.4"	1.2"	2.0"	4.3"	9.1"
Depth Change	0.4"	1.2"	1.2"	3.1"	7.5"
Liquid-Equivalent	0.04"	0.11"	0.23"	0.58"	1.13"
SLR	--	--	--	6	9

Voorheesville



Conditions as of 1:00 PM

Snow Depth	5"				
P-type	Rain				
	1-hr	3-hr	6-hr	12-hr	24-hr
Snow Accumulation	0.0"	1.2"	1.6"	2.8"	3.5"
Depth Change	0.0"	0.8"	1.2"	2.0"	2.4"
Liquid-Equivalent	0.10"	0.31"	0.43"	0.63"	0.94"
SLR	--	--	--	7	6

Schaghticoke



Conditions as of 1:00 PM

Snow Depth	2"				
P-type	Rain				
	1-hr	3-hr	6-hr	12-hr	24-hr
Snow Accumulation	0.0"	0.4"	0.4"	0.4"	0.4"
Depth Change	0.0"	0.0"	-0.4"	-0.8"	-1.6"
Liquid-Equivalent	0.04"	0.12"	0.21"	0.36"	0.48"
SLR	--	--	--	--	--

- Site data is provided at 1pm on 12-16 EST.
- Once again, stations struggle to diagnose precipitation-type. However, snow continues to accumulate at the Medusa site.
- The same cannot be said about the locations in the Hudson Valley such as Voorheesville and Schaghticoke. Precipitation has changed to rain or a mix of rain/snow.

NY Mesonet Cameras/Data:

Medusa



Conditions as of 1:00 AM

Snow Depth	11"				
P-type	--				
	1-hr	3-hr	6-hr	12-hr	24-hr
Snow Accumulation	0.0"	0.0"	0.0"	1.6"	5.9"
Depth Change	-0.4"	-0.8"	-0.4"	1.2"	4.3"
Liquid-Equivalent	0.00"	0.00"	-1.27"	0.17"	0.76"
SLR	--	--	--	--	6

Voorheesville



Conditions as of 1:00 AM

Snow Depth	6"				
P-type	Rain				
	1-hr	3-hr	6-hr	12-hr	24-hr
Snow Accumulation	0.0"	0.0"	0.4"	2.8"	5.5"
Depth Change	0.0"	0.0"	-0.4"	1.2"	3.1"
Liquid-Equivalent	0.01"	0.08"	-1.22"	0.67"	1.30"
SLR	--	--	--	--	7

Schaghticoke



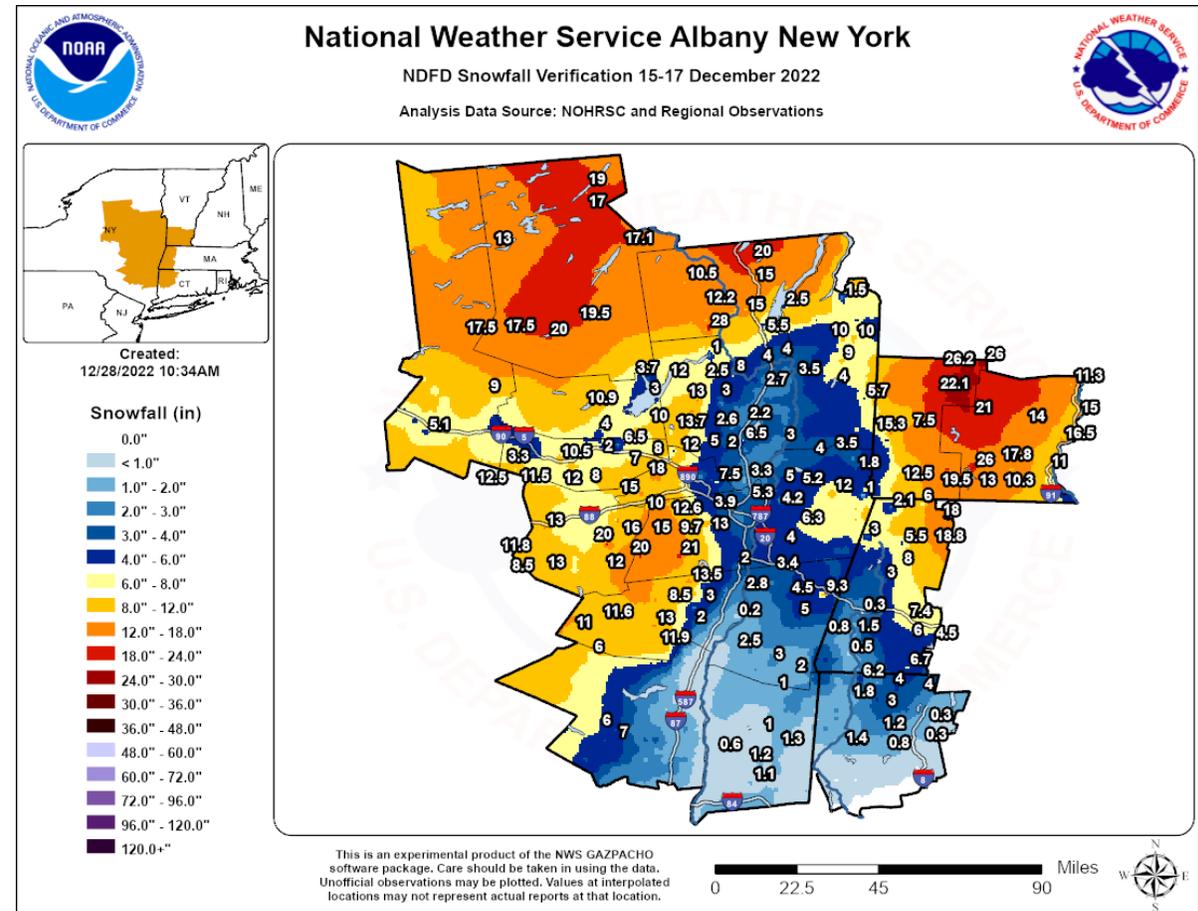
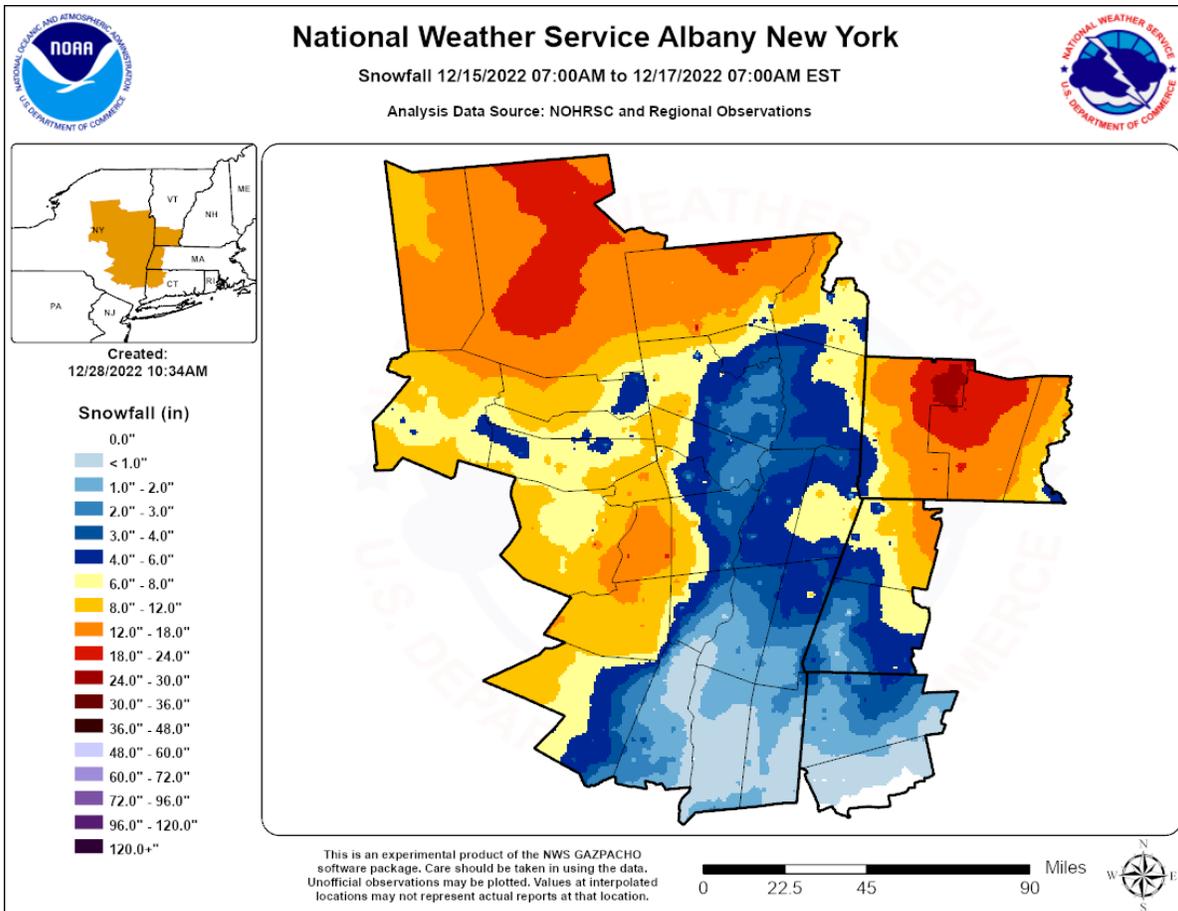
Conditions as of 1:00 AM

Snow Depth	2"				
P-type	Rain				
	1-hr	3-hr	6-hr	12-hr	24-hr
Snow Accumulation	0.0"	0.0"	0.0"	0.0"	0.0"
Depth Change	0.0"	-0.4"	-0.4"	-0.4"	-0.8"
Liquid-Equivalent	0.03"	0.11"	0.11"	0.11"	0.11"
SLR	--	--	--	--	--

- Site data is provided at 1am on 12-17
- The high-elevation site at Medusa continues to see falling snow (via the camera). Snowpack has begun to melt slowly, but overall snow depth has almost reached a foot.
- Precipitation-type at the two low-elevation stations have completely switched over to rain (via the cameras), helping to decrease the existing snowpack. Total snow depth never exceeded 6" at these sites, with Schaghticoke only receiving about 2" of heavy wet snow from the initial burst on 12-15.
- Summary: Mesonet stations supported the idea that high-elevation locations would see more snow accumulation whereas low-elevation sites saw a faster transition to rain. These sites become very useful to NWS forecasters throughout the event.

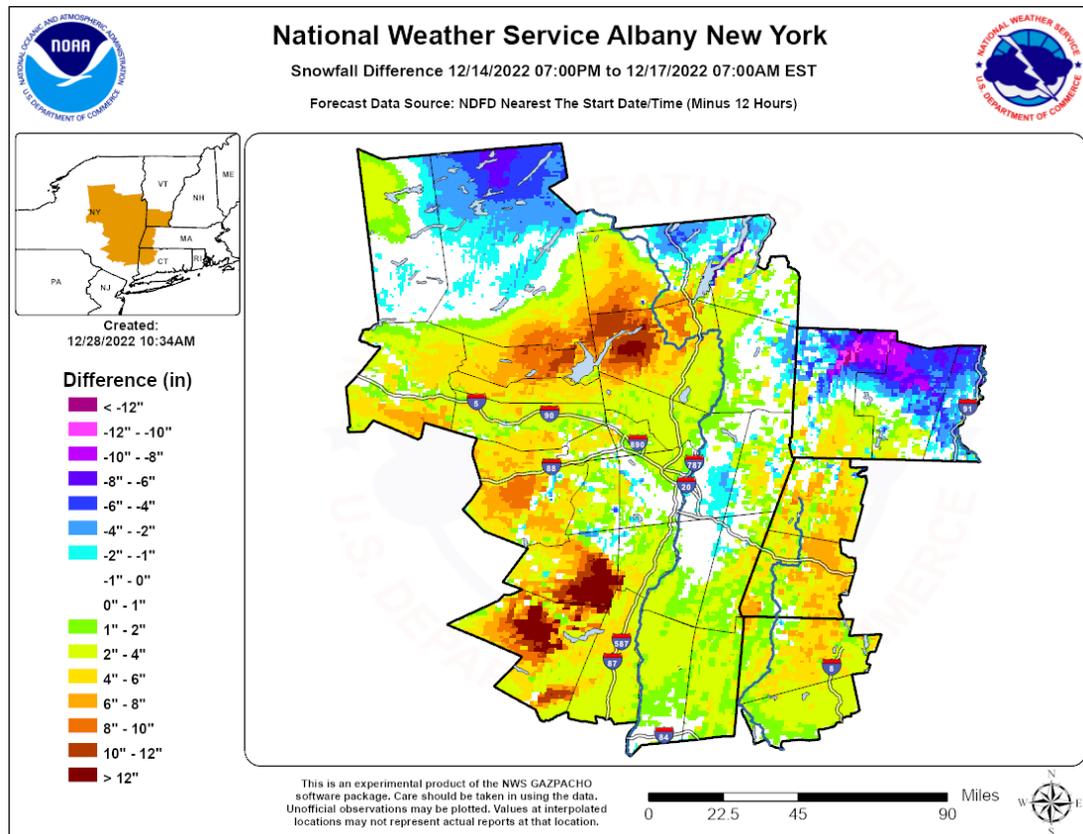
Observed Snowfall:

- Heavy snow fell across the greatest elevation as expected, with the highest totals (up to 2.5 feet) across the Adirondacks and Taconic Mountains. Snow totals in the Hudson Valley ranged from less than an inch in the southern portions of the valley to almost 5 inches in the northern parts of the valley. The Mohawk Valley saw a range between 4-12”.

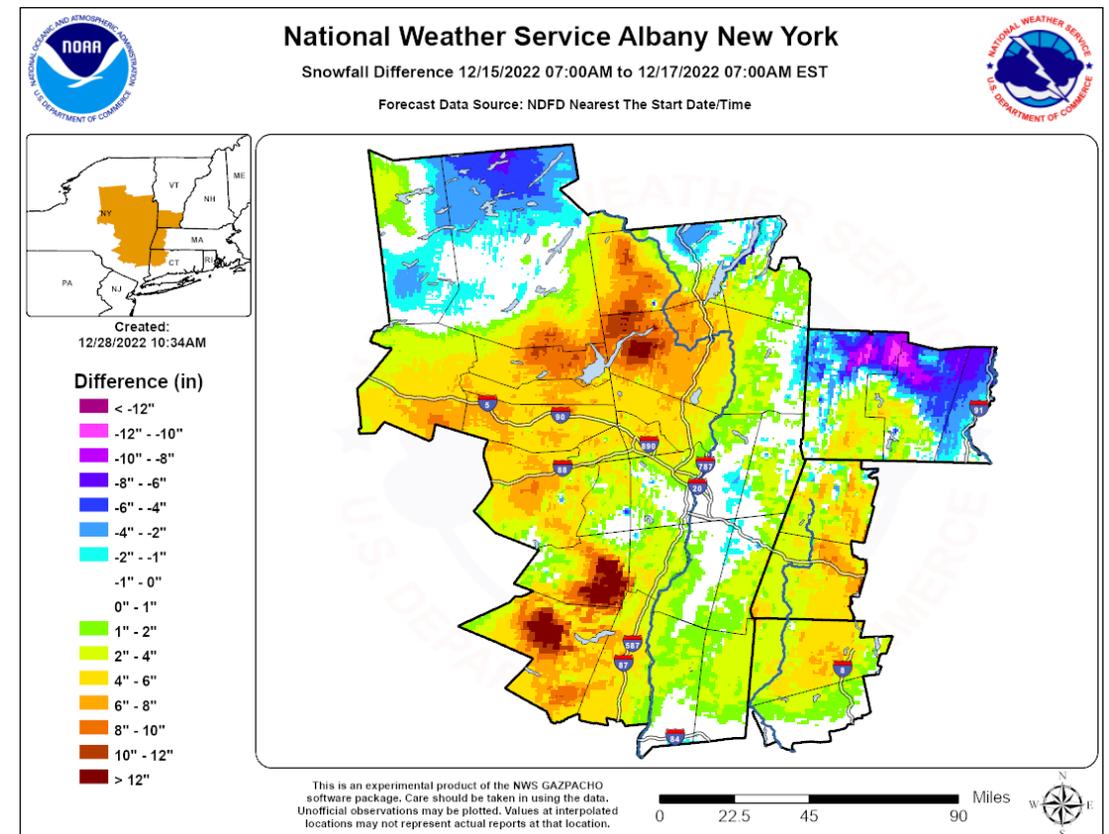


NWS Albany, NY Verification:

- The NWS forecast verification maps below highlight areas where the NWS forecast was overdone and underdone. The Adirondack and Taconic Mountain Ranges saw actual snowfall exceed forecasts by 6-12", whereas forecasts exceeded actual accumulation by 8-12" in the Catskills. The NWS did an excellent job within the Hudson Valley, with slight over-forecasting in the Mohawk Valley.



Valid for 00z 12/15/22
Forecast



Valid for 12z 12/15/22
Forecast

Conclusions:

- This was a classic early season event where precipitation-type is elevation-dependent.
- All models and organizations had a great handle on snow in the Adirondacks and Hudson Valley, but over-forecasted snow in the Catskills and under-forecasted snow in the Taconic's.
- The WPC day one forecast also had high snow probabilities in the Hudson Valley that never came to fruition.

