



WWE NBM Evaluation

New England Snow
February 23rd 00z - February 24th 00z

Robert Haynes - Forecaster BTV





- Synoptic Overview
- Observations + Forecast Challenges
- Evaluation of the NBM
- Key Messages and Probabilistic Utilization



Regional Focus





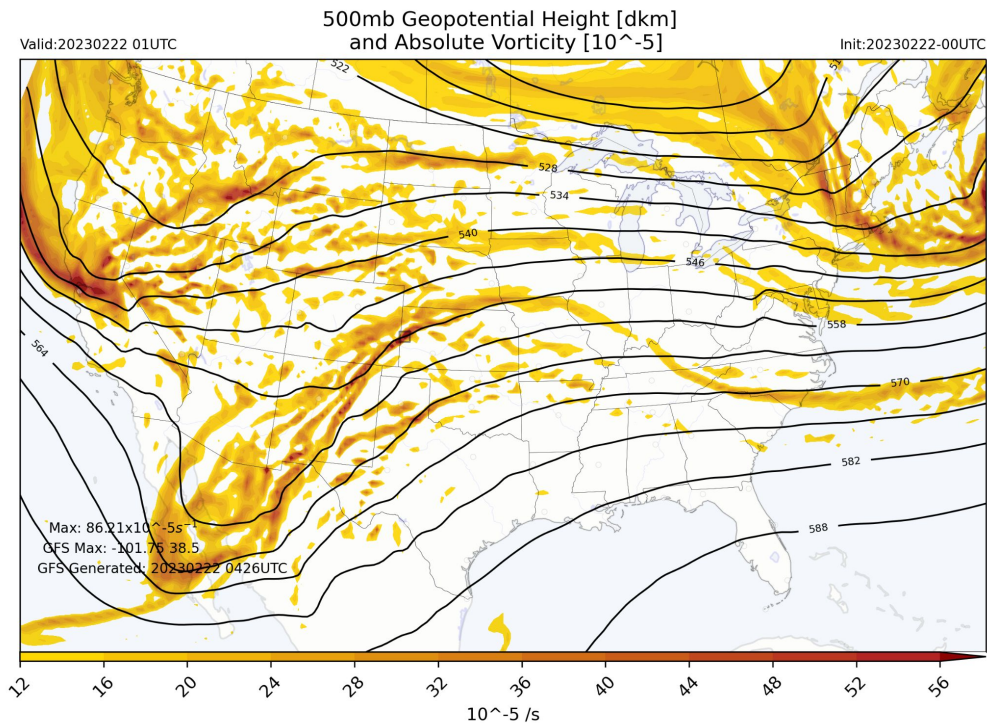
Synoptic Overview





Synoptic Overview - GFS Forecast Valid 2023 Feb 22 01 UTC

Two troughs to impact New England off the Baja entering California about 24 hours prior.



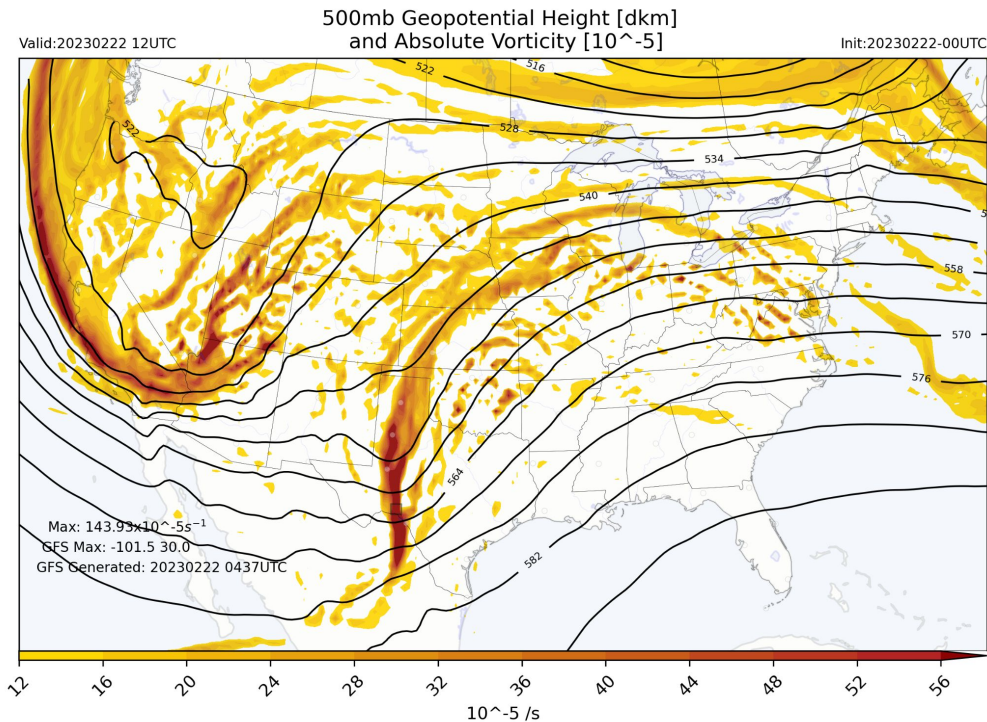
Downstream, fast zonal flow between an upper low in Canada and a building upper high near the Florida Peninsula.





Synoptic Overview - GFS Forecast Valid 2023 Feb 22 12 UTC

The trough over the Baja began to eject northeast. The western trough over California would be responsible for heavy snow in the Northern Plains.



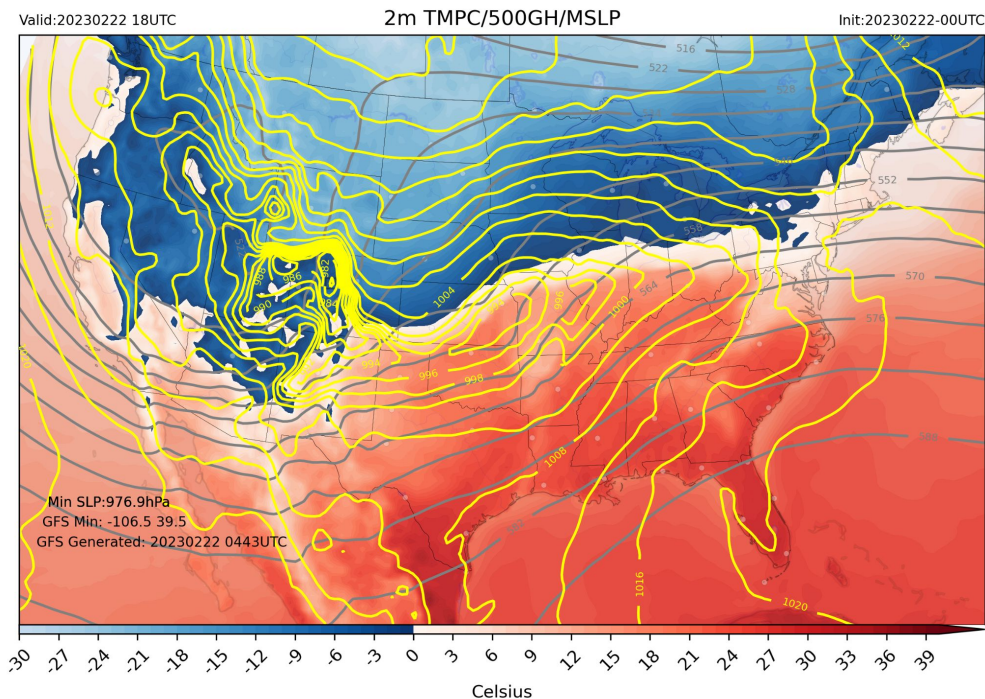
Warm, subtropical air (record breaking in the Southeastern US) would begin to advance north ahead of these systems.





Synoptic Overview - GFS Forecast Valid 2023 Feb 22 18 UTC

Somewhat out of the domain, is a 1036 hPa moving from Alberta Province in Canada. This would be critical to maintaining cold, dry air advecting into New England.



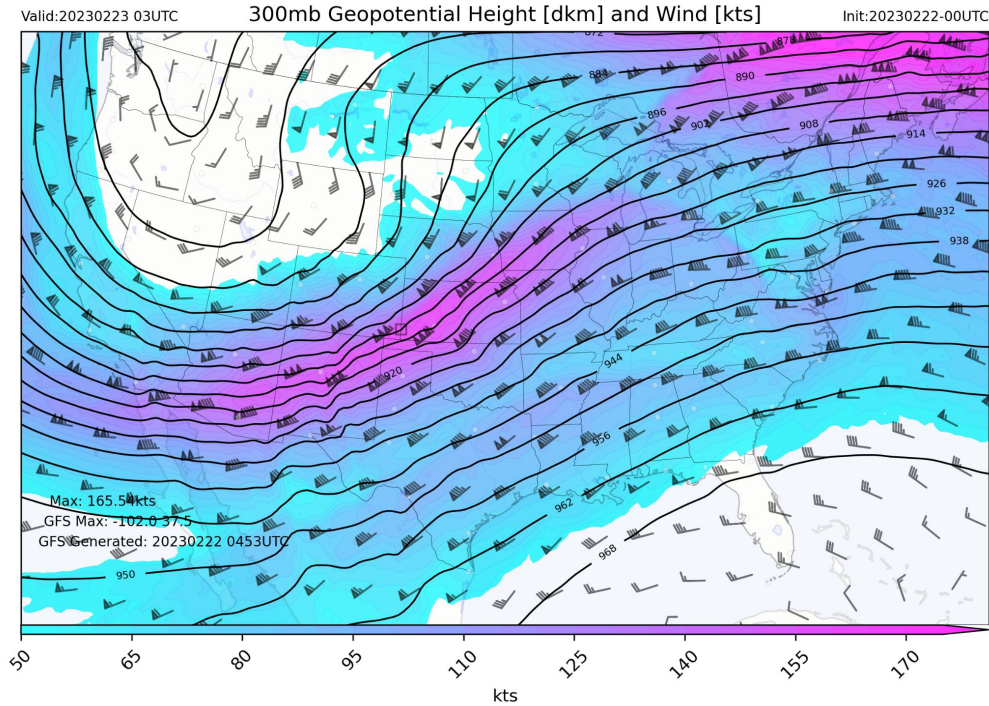
While temperatures would remain cool enough at the surface, warm temperatures were observed aloft, which would impact precipitation type and dendrite characteristics.





Synoptic Overview - GFS Forecast Valid 2023 Feb 23 03 UTC

Generally favorable jet configuration along the extensive warm front.

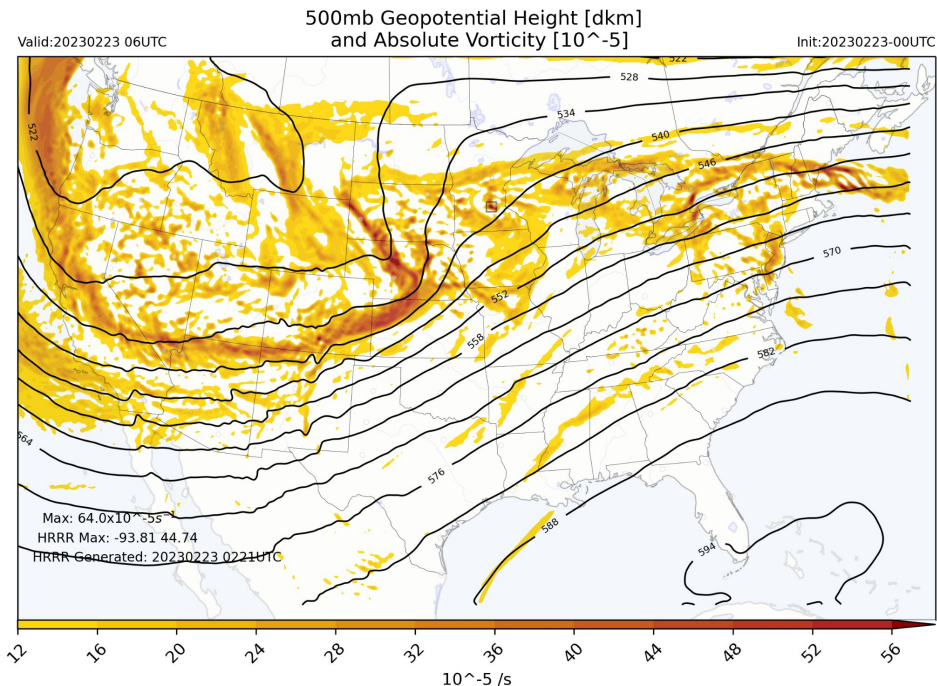
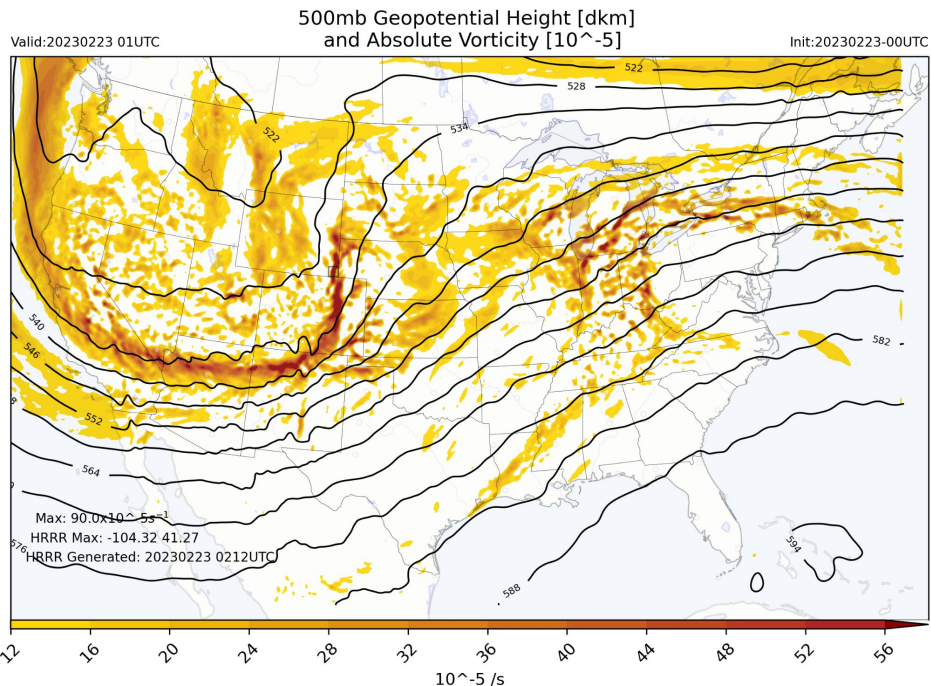


Anticyclonic flow aloft with southwest winds aloft north of Montreal and west to west southwest off the Atlantic pointed to some upper diffluence.





Synoptic Overview - GFS Forecast 2023 Feb 23 at 01 UTC and 06 UTC



500 hPa trough begins to flatten as it moves into fast zonal flow



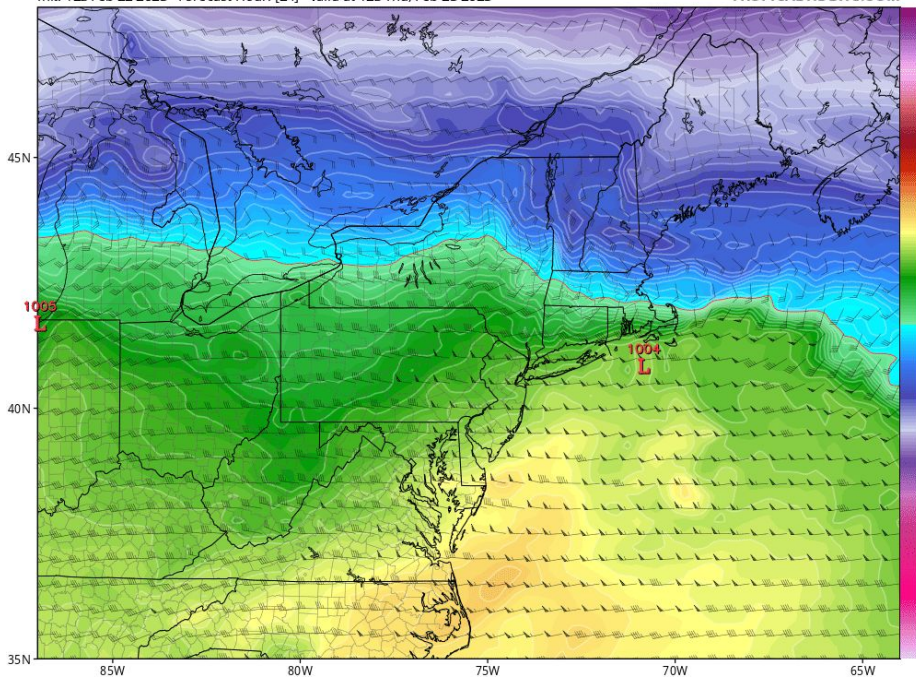


Synoptic Overview - NAM and GFS Forecast Valid 2023 Feb 23 12 UTC

GFS 850 hPa Air Temperature (°C, shaded), Isotherms (white), Wind (kt), and MSLP Centers (hPa)

Init: 12z Feb 22 2023 Forecast Hour: [24] valid at 12z Thu, Feb 23 2023

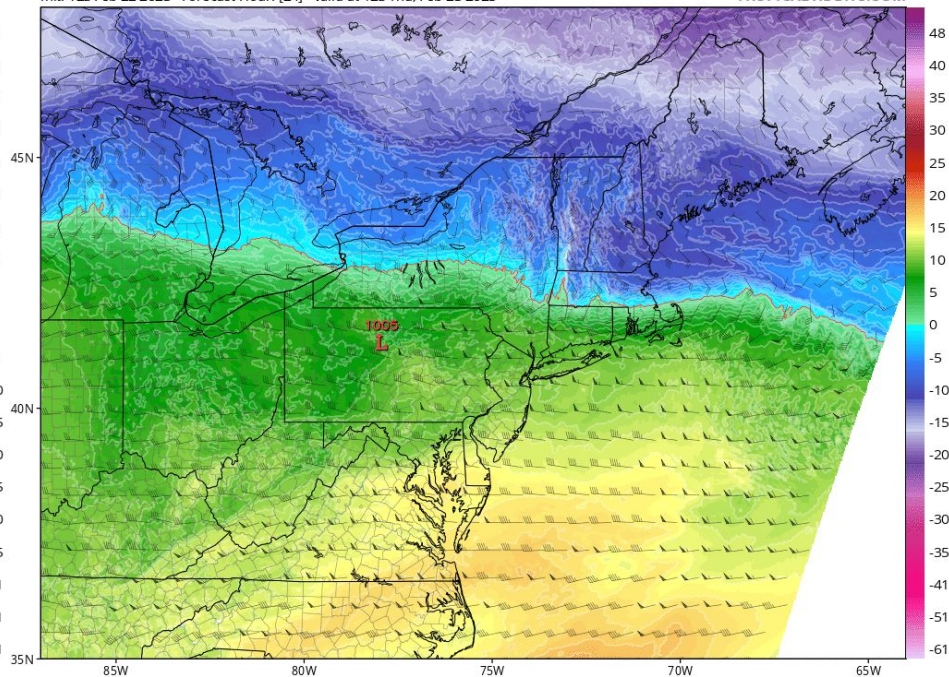
TROPICALTIDBITS.COM



NAM-3km 850 hPa Air Temperature (°C, shaded), Isotherms (white), Wind (kt), and MSLP Centers (hPa)

Init: 12z Feb 22 2023 Forecast Hour: [24] valid at 12z Thu, Feb 23 2023

TROPICALTIDBITS.COM



Forecast 850hPa winds showed low-level convergence along the sharp boundary.



National Oceanic and
Atmospheric Administration

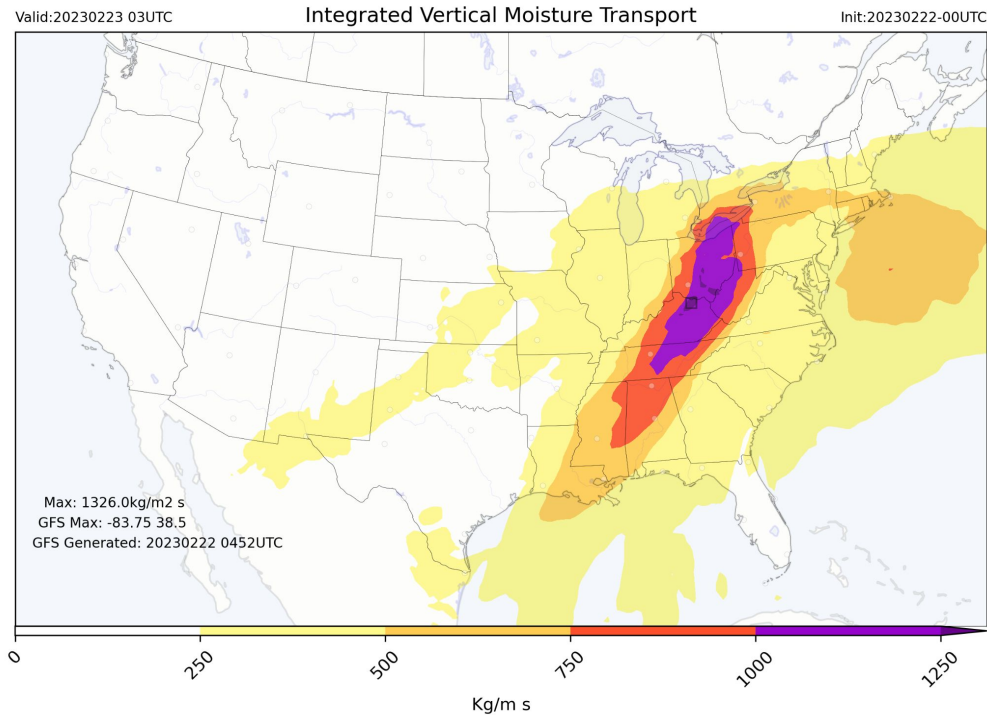
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Synoptic Overview - GFS Forecast Valid 2023 Feb 23 03 UTC

A strong feed of moisture from the Gulf of Mexico was expected to overrun cold, northerly flow across New England.



NAEFS climatology suggested forecast PWATs near the 90th percentile over southern New England (not shown).

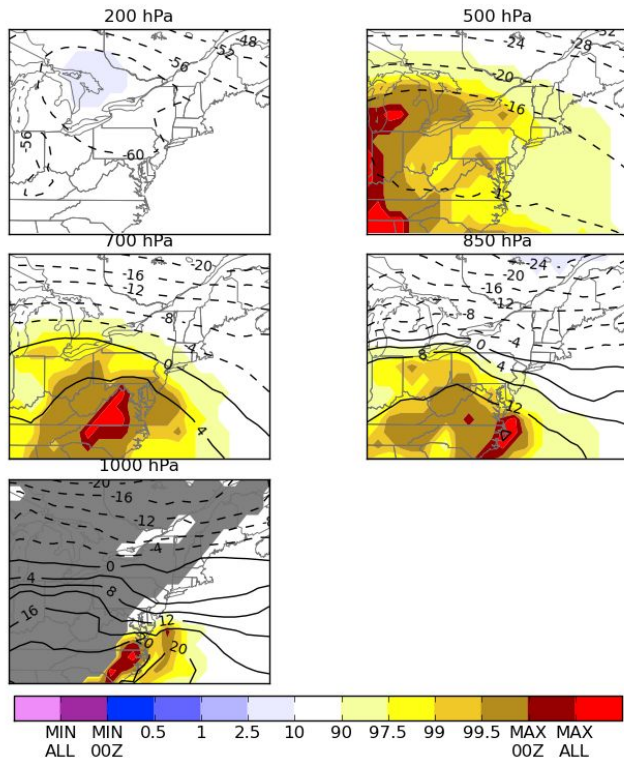




Thermodynamics from NAEFS Valid 2023 Feb 23 00 UTC

NAEFS climatological probabilities showed that lower level warm anomalies would not be an issue.

NAEFS Mean Temperature (C) and Climatological Percentile
HOUR 012 - VALID 00:00 UTC Thu Feb 23 2023



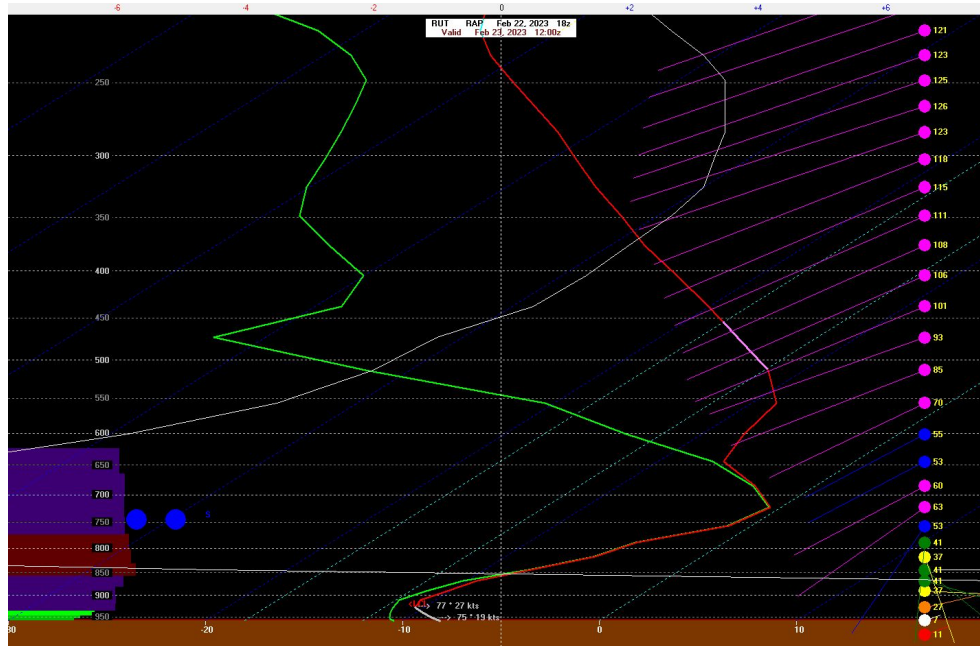
Aloft, conditions would be much warmer than usual. The 0 C layer was near 700 hPa - unusually high.





Synoptic Overview - Thermodynamics

KRUT RAP Forecast Sounding Valid 2023 Feb 23 at 00 UTC



KRUT RAP Forecast Sounding Valid 2023 Feb 23 at 12 UTC

This is about 00 UTC, near the onset of the event at KRUT. This is a favorable profile, with deep layer ascent, and moist forecast sounding. Though it is somewhat drier in the boundary layer.

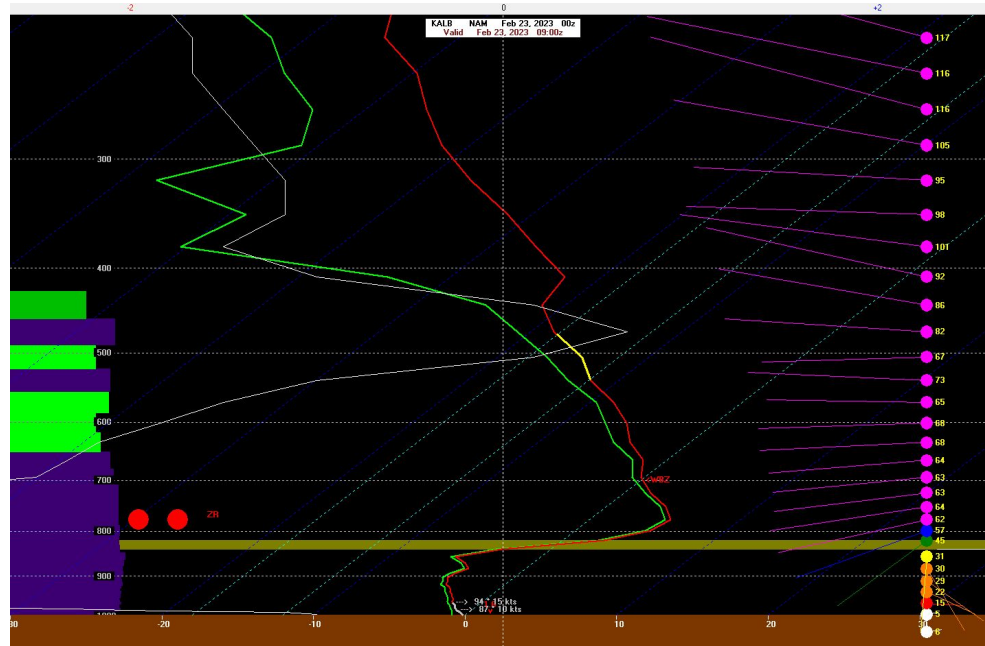
One can see the fast flow aloft, indicative of the jet stream near and just south of the area and the veering profile with height. The warm front has arrived.





Synoptic Overview - Thermodynamics

KALB NAM Forecast Sounding Valid 2023 Feb 23 at 09 UTC



As the event evolved, warming aloft and dry air entrainment would desaturate the dendritic growth zone.

Subfreezing temperatures were expected heading towards southern New England down into NY's capital district.





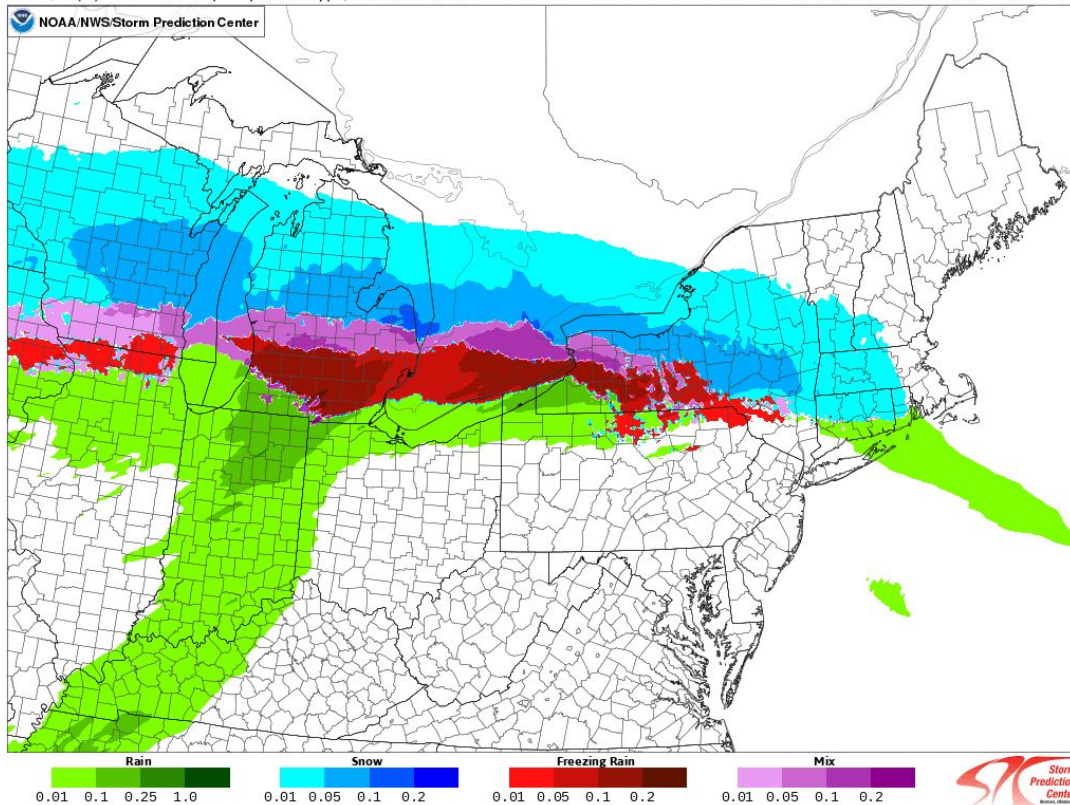
HREF 1-hr QPF and P-type Loop 2023 Feb 00 UTC thru 15 UTC

HREF

Run: Thu 2023-02-23 00:00 UTC

1-hr QPF (in) and dominant precipitation type, ensemble mean

Valid: Thu 2023-02-23 01:00 UTC



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Synoptic Summary

- **Precipitation was tied to an expansive warm front, with an embedded trough advecting a warm, moist air mass.**
- **Overrunning of record warmth in the SE US over cold, dry northerly winds would put sections of New England in the most favorable position for precipitation.**
- **Deep forcing for ascent would produce at least moderate snow, with embedded heavy snow.**
- **Dry air from surface high pressure to the north, and warm air aloft would impact precipitation type.**





Observations + Forecast Challenges

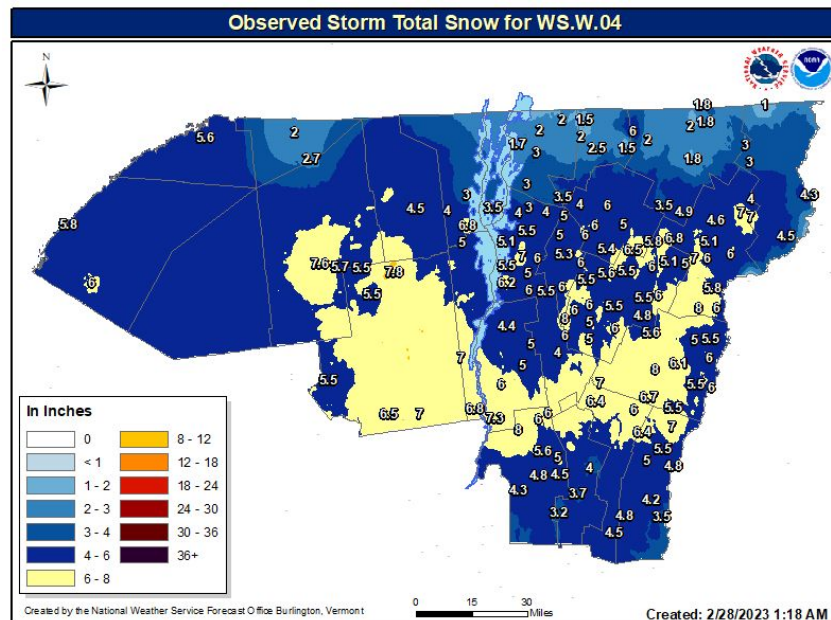
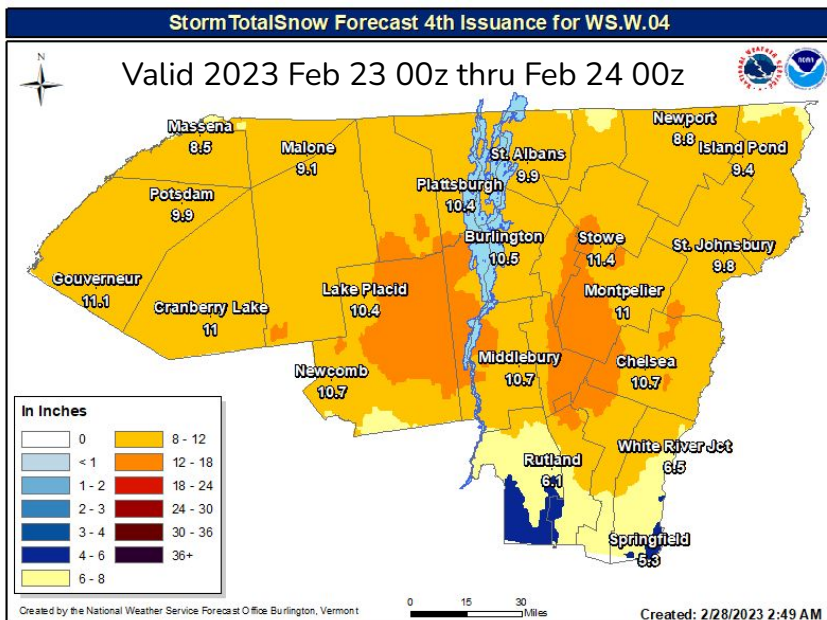




Observations + Forecast Challenges

- Forecasts by humans noted these favorable conditions and raised the forecast above the NBM 4.1 forecasts

[MAE based on received reports \(includes public data\)](#)

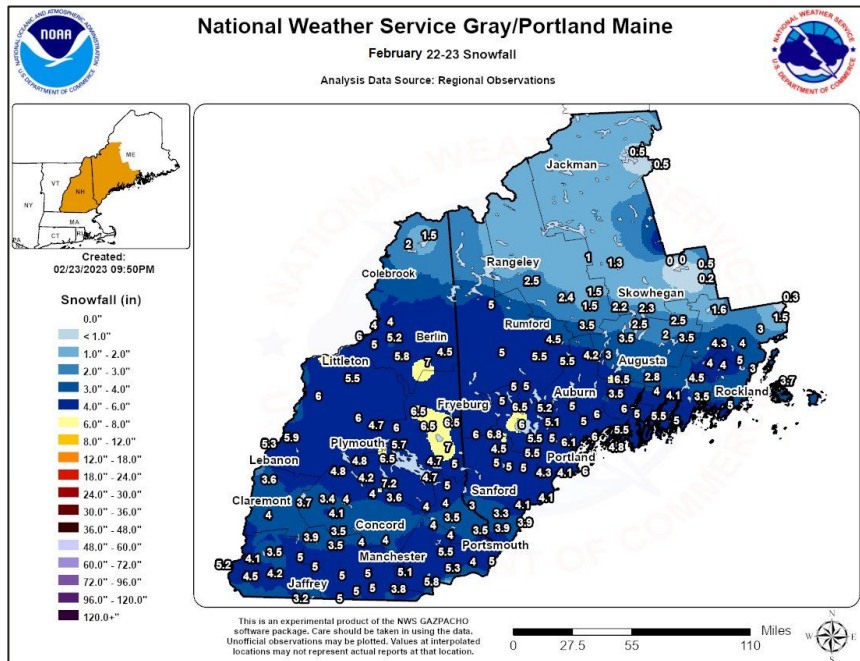
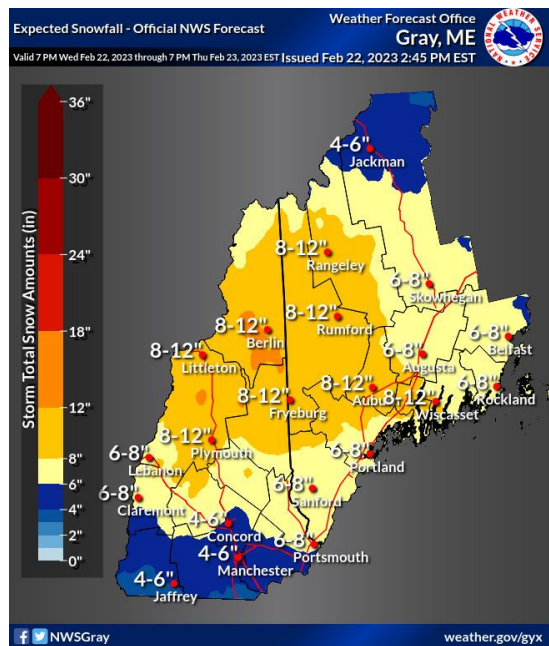




Observations + Forecast Challenges

- Forecasts by humans noted these favorable conditions and raised the forecast above the NBM 4.1 forecasts

Valid 2023
Feb 23 00z
thru Feb
24 00z



Observed
12z 22 Feb
2023 to
12z 23 Feb
2023



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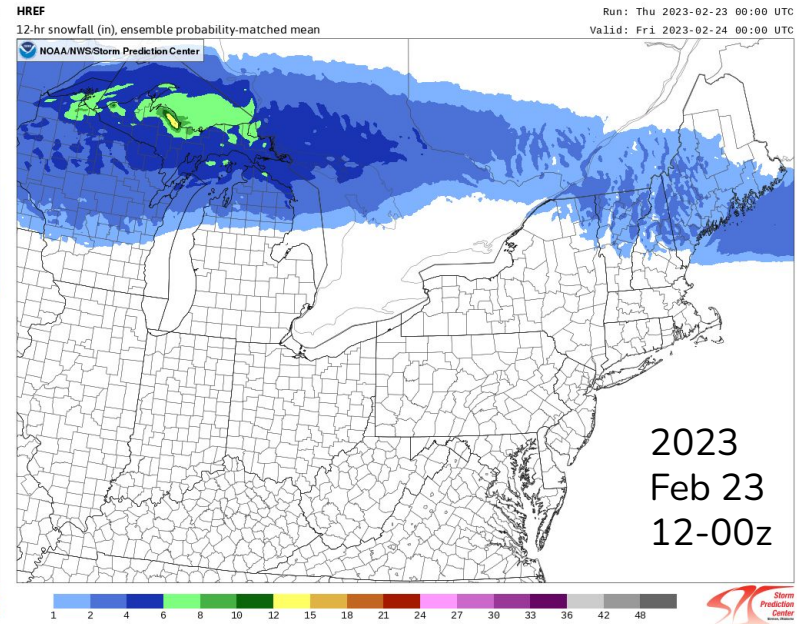
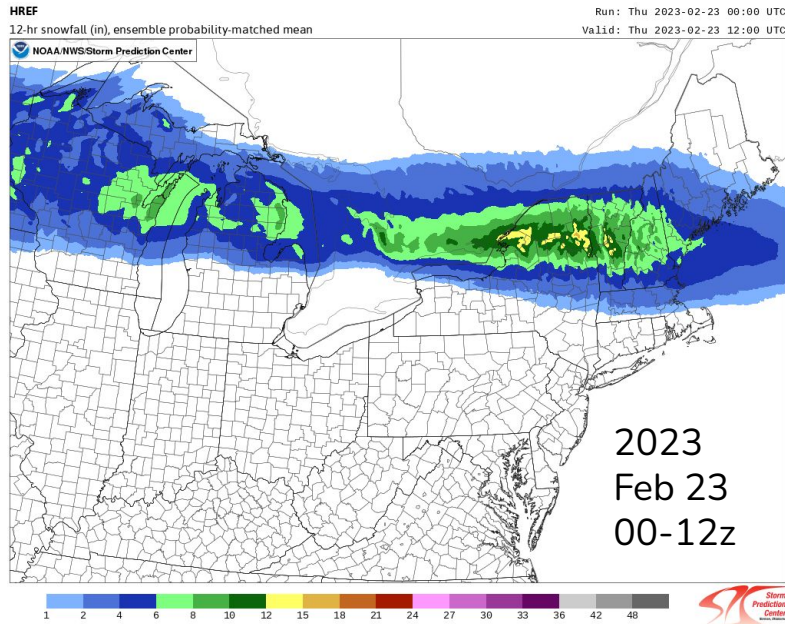
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Observations + Forecast Challenges

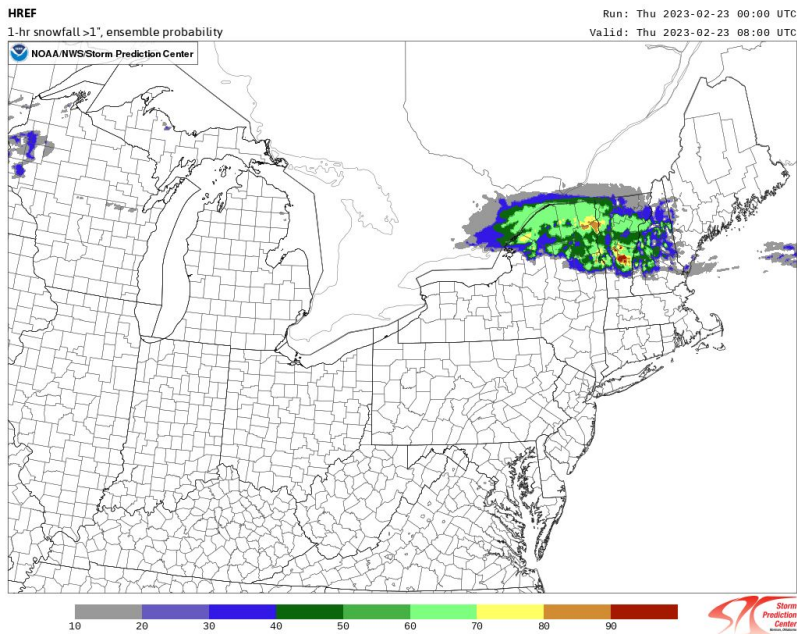
- HREF probability matched means were higher, and forecasters noting the favorable synoptic scale conditions leaned higher





Observations + Forecast Challenges

- Based on an event confined mostly to 12 hours and snowfall forecasts of 8-12", snowfall rates of 1/hr or greater were part of the messaging.

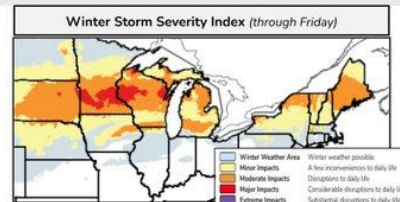


Key Messages for Coast-to-Coast Major Winter Storm

Updated 02/22/2023
4:30 PM CST

Blizzard conditions across the Plains; Heavy snow and ice in the Midwest to interior Northeast

- The major winter storm will continue to impact areas from the Plains to the Northeast through Thursday night. Expect widespread impacts to travel, infrastructure, livestock, and recreation.
- Heavy snow will impact areas from the Northern Plains to the Upper Midwest through Thursday morning. Plan on heavy snow rates of 1-2"/hr and wind gusts of 40-50 mph, which will create blizzard/whiteout conditions, nearly impossible travel, power outages, and scattered tree damage.
- A stripe of freezing rain is also expected across parts of the Upper Midwest and Great Lakes. Some localized ice accumulations greater than 0.25" are possible, especially from eastern Iowa through southern Wisconsin, northern Illinois, and southern Michigan. This will lead to treacherous travel conditions and scattered power outages in the region of heaviest freezing rain.
- Across the interior Northeast and New England, a quick burst of heavy snow is expected followed by a period of mixed precipitation including sleet and freezing rain. Heavy snow and ice accumulations up to 0.25" are likely to create difficult travel conditions and scattered power outages.



Additional Snow and Ice accumulation forecasts (through 6PM Fri CST)



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For more information go to:
www.nwsrncmp.noaa.gov and www.weather.gov

Weather Prediction Center
College Park, MD



National Oceanic and Atmospheric Administration
U.S. Department of Commerce

Burlington Weather Forecast Office

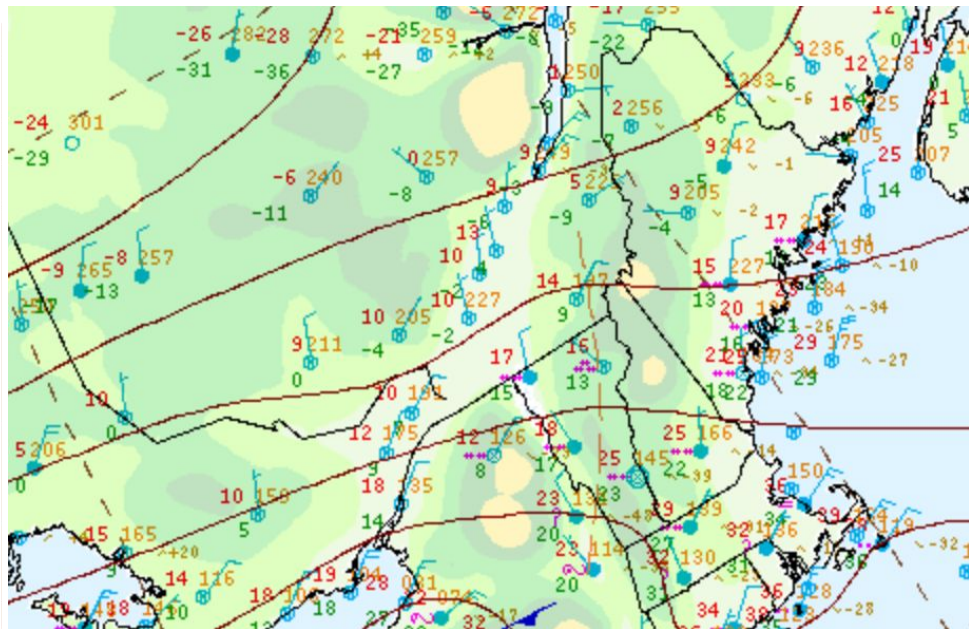
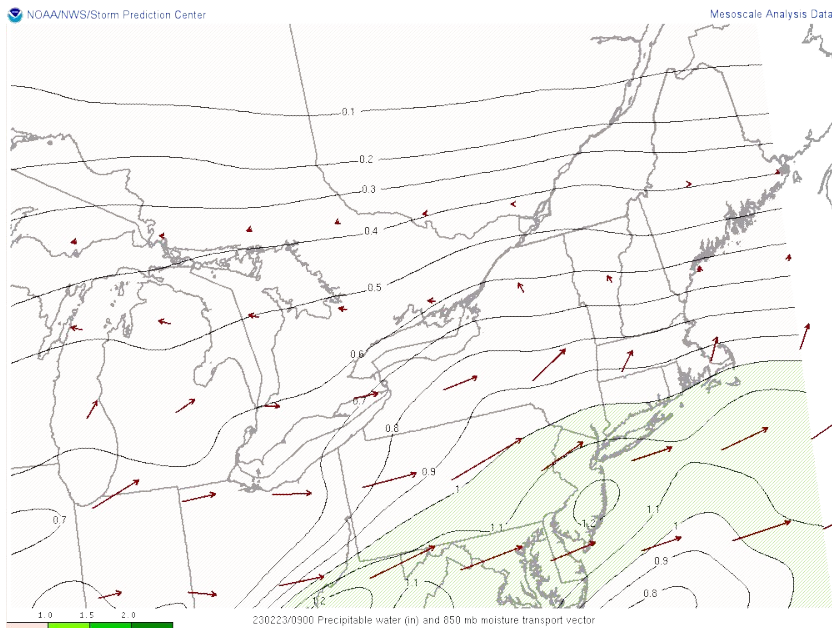


Observations + Forecast Challenges

- Dry air and more zonal moisture transport resulted in greater sublimation**

PWAT and moisture transport RAP Mesoanalysis 2023
Feb 23 09 UTC

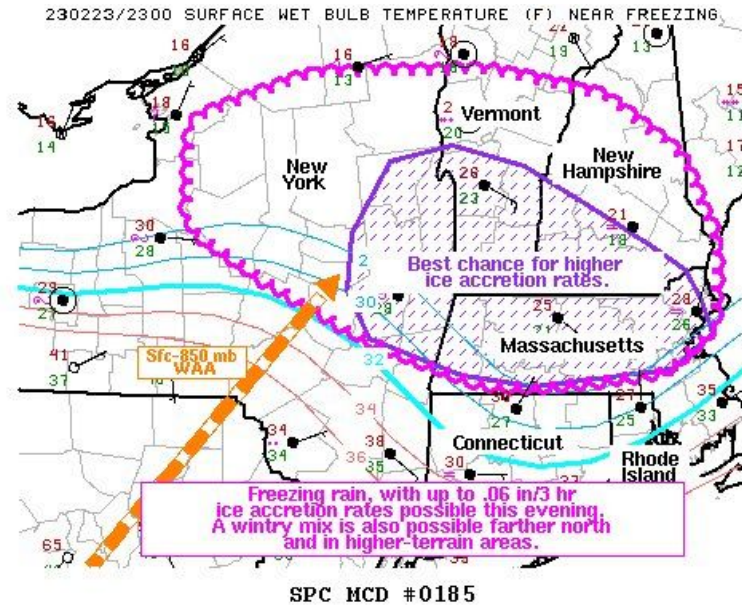
Surface observations at 2023 Feb 23 09 UTC





Observations + Forecast Challenges

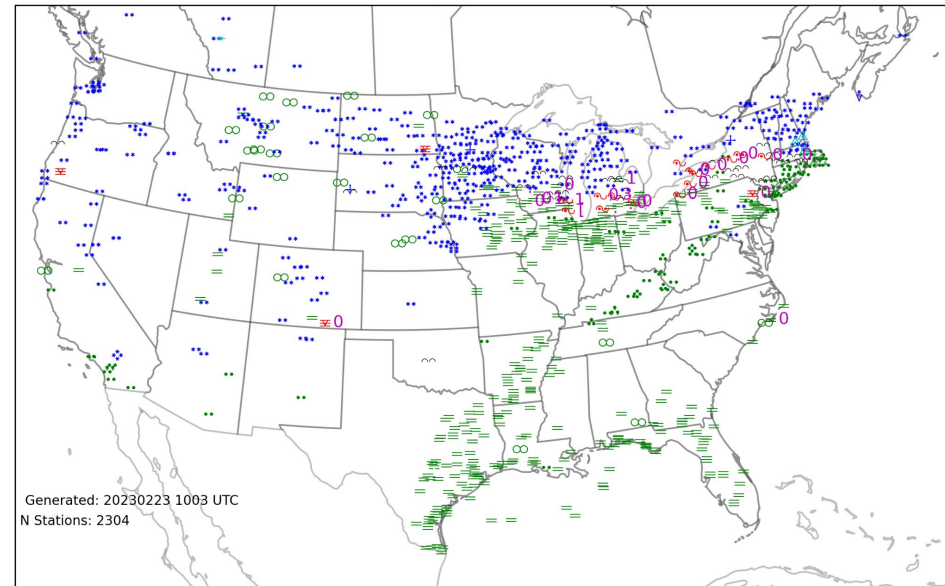
- Sleet and Freezing Rain across central NY, southern VT and into Massachusetts**



Valid: 20230223 0900UTC

Precip Types & LSRs

SFC METAR/LSRs



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Observations + Forecast Challenges

- Ice Reports from NWS Albany (left) and NWS Boston (right)

*****STORM TOTAL ICE*****

LOCATION	TOTAL ICE (inches)	TIME/DATE MEASURED	COMMENTS
CONNECTICUT			
...Litchfield County...			
Norfolk	0.38	1150 AM 2/23	Co-Op Observer
New Hartford	0.25	1250 PM 2/23	Flat ice accretion
MASSACHUSETTS			
...Berkshire County...			
Pittsfield Municipal	0.27	100 AM 2/24	Storm Total Ice
Harriman-and-west-Ai	0.14	100 AM 2/24	ASOS
NEW YORK			
...Albany County...			
Albany Intl AP	0.22	100 AM 2/24	Storm Total Ice
Albany	0.20	347 PM 2/23	NWS Albany Office
...Herkimer County...			
2 SSW Salisbury	0.20	1200 PM 2/23	Flat ice accretion
...Montgomery County...			
Amsterdam	0.12	917 PM 2/23	Trained Spotter
...Warren County...			
Floyd Bennett Memori	0.24	100 AM 2/24	Storm Total Ice

...FREEZING RAIN REPORTS...

Location	Amount	Time/Date
...Connecticut...		
...Hartford County...		
2 WSW Burlington	0.30 in	1247 PM 02/23
Bradley AP	0.03 in	1251 PM 02/23
Hartford-Brainard AP	T in	0653 AM 02/23
...Tolland County...		
5 E Rockville	0.15 in	1030 AM 02/23
...Massachusetts...		
...Essex County...		
Lawrence AP	0.04 in	0135 PM 02/23
Beverly AP	T in	1135 AM 02/23
...Franklin County...		
Orange AP	0.03 in	1137 AM 02/23
...Hampden County...		
Westfield-Barnes AP	0.22 in	0142 PM 02/23
...Norfolk County...		
Norwood AP	T in	0653 AM 02/23
...Worcester County...		
Worcester AP	0.35 in	0114 PM 02/23
Fitchburg AP	0.02 in	1239 PM 02/23

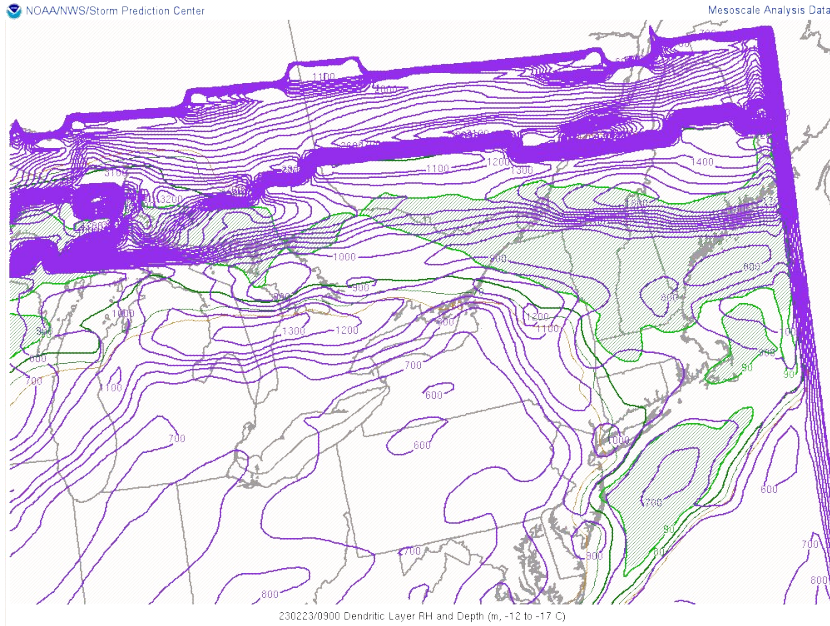




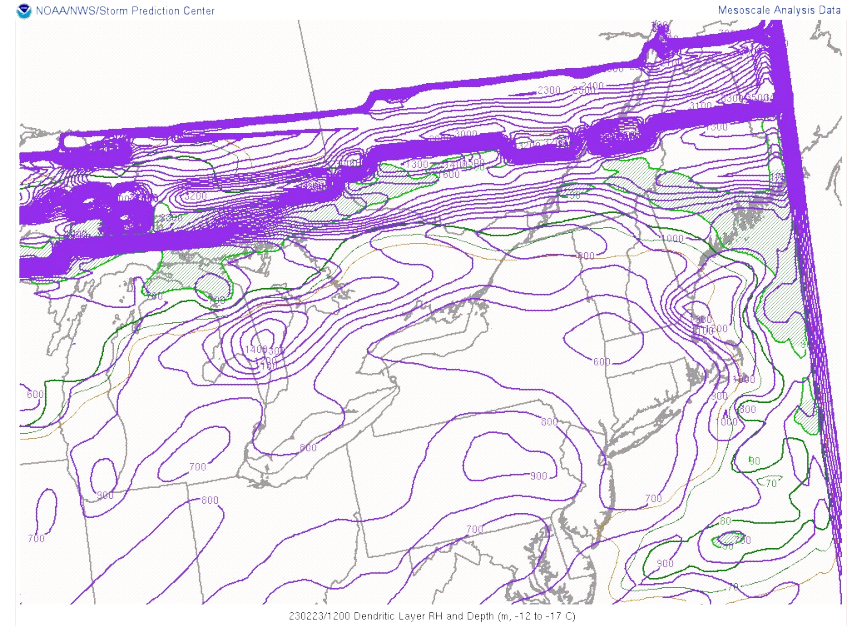
Observations + Forecast Challenges

- Drying in the dendritic growth zone cut into SLR values (09z vs 12z)**

Dendritic Layer and RH 2023 Feb 23 09 UTC



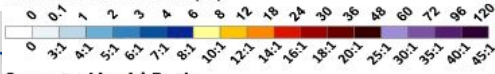
Dendritic Layer and RH 2023 Feb 23 12 UTC





Evaluation of the NBM

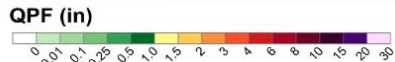
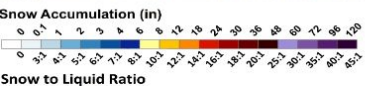
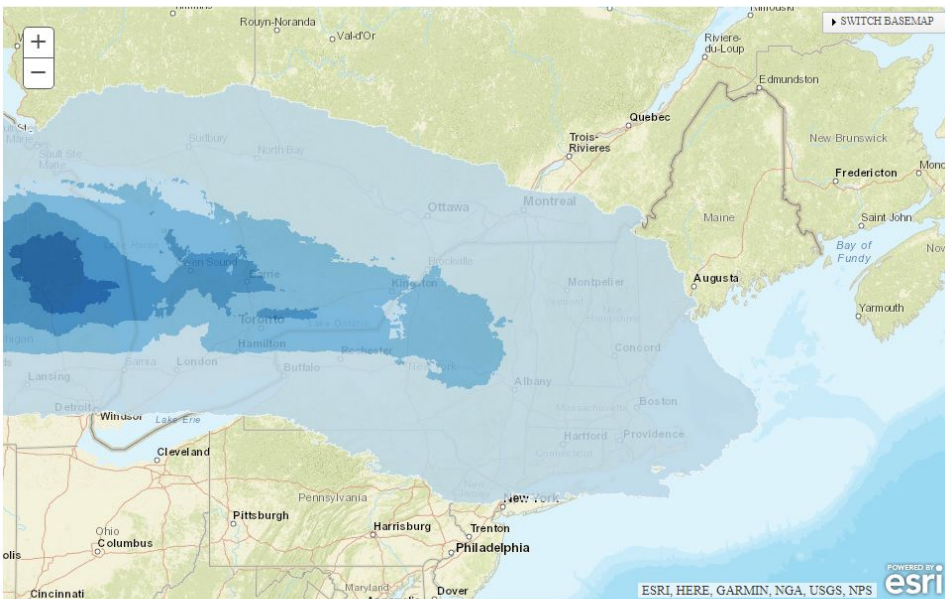




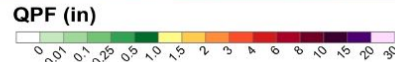
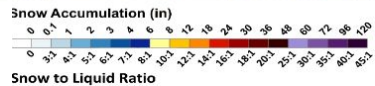
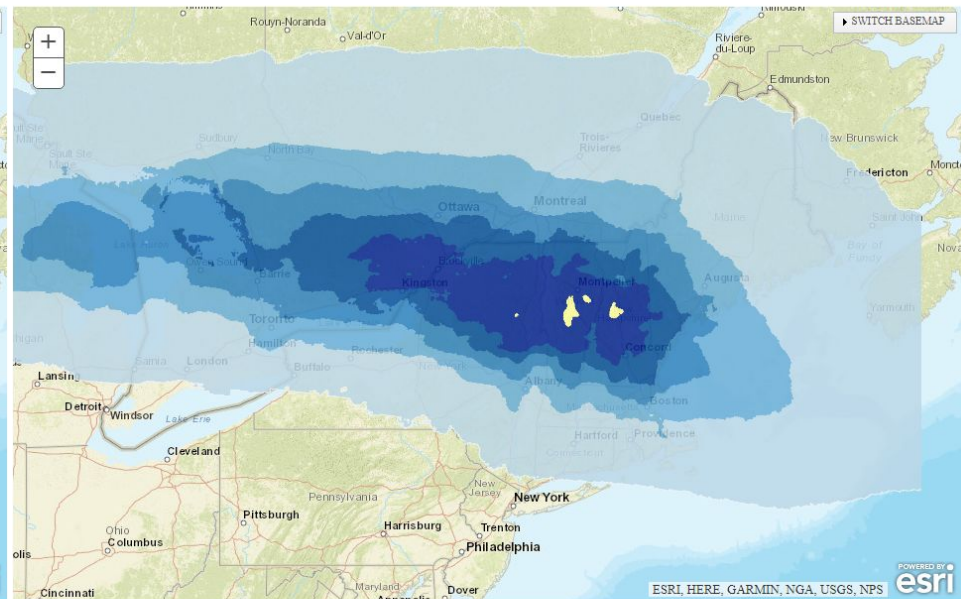


NBM Deterministic Day 3 - 6 HRLY

Forecast Period Ends: 06Z Thu 23 Feb, 2023



Forecast Period Ends: 12Z Thu 23 Feb, 2023

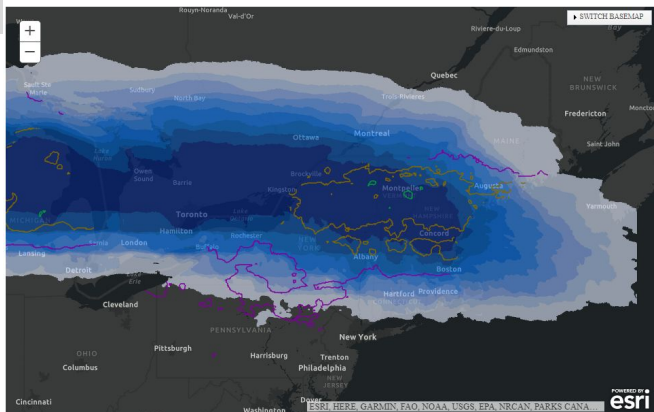




NBM Probabilistic Day 3

1 inch
prob
with ob

Forecast Period Ends: 12Z Thu 23 Feb, 2023 | Forecast Hour: 84

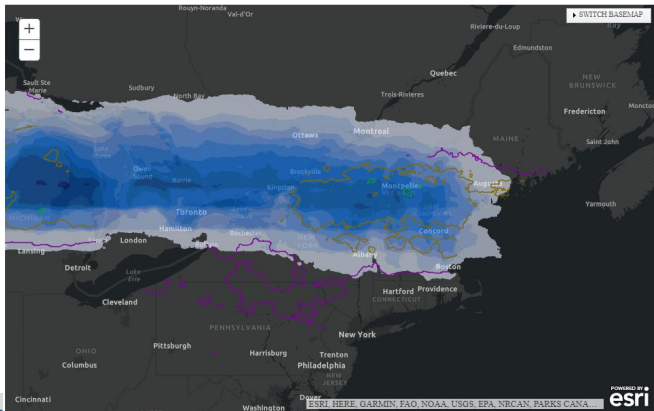


Probability



Forecast Period Ends: 12Z Thu 23 Feb, 2023 | Forecast Hour: 84

4 inch
prob
with ob

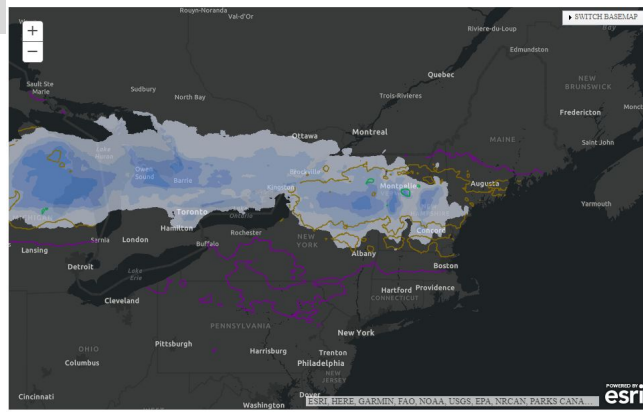


Probability



8 inch
prob
with ob

Forecast Period Ends: 12Z Thu 23 Feb, 2023 | Forecast Hour: 84

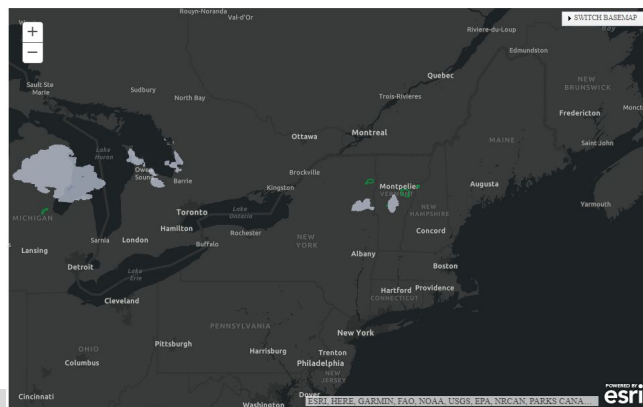


Probability

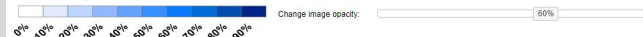


Forecast Period Ends: 12Z Thu 23 Feb, 2023 | Forecast Hour: 84

12 inch
prob
with 8
inch
contour



Probability



National
Atmos
U.S. Depar

gton Weather Forecast Office



How would you message the event?

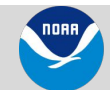
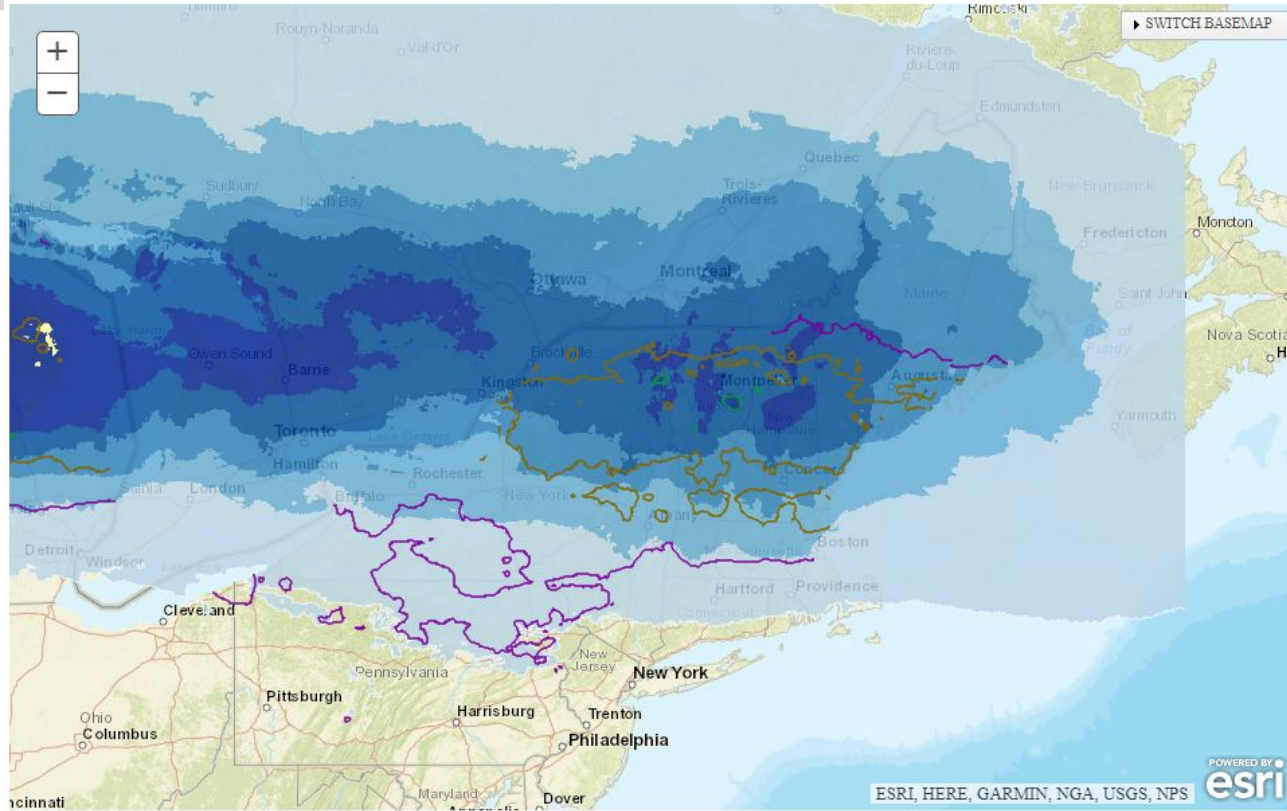
- **What snowfall ranges would you be comfortable with?**
- **Based on the deterministic, would heavy snowfall rates be a potential concern?**
- **Would you think warning/watch/advisory decisions will be necessary down the road?**
- **How do you feel about the location of greatest snowfall accumulations?**
- **Do the deterministic and probabilistic data match in your view?**





NBM Deterministic Day 2 - Total

Forecast Period Ends: 12Z Thu 23 Feb, 2023



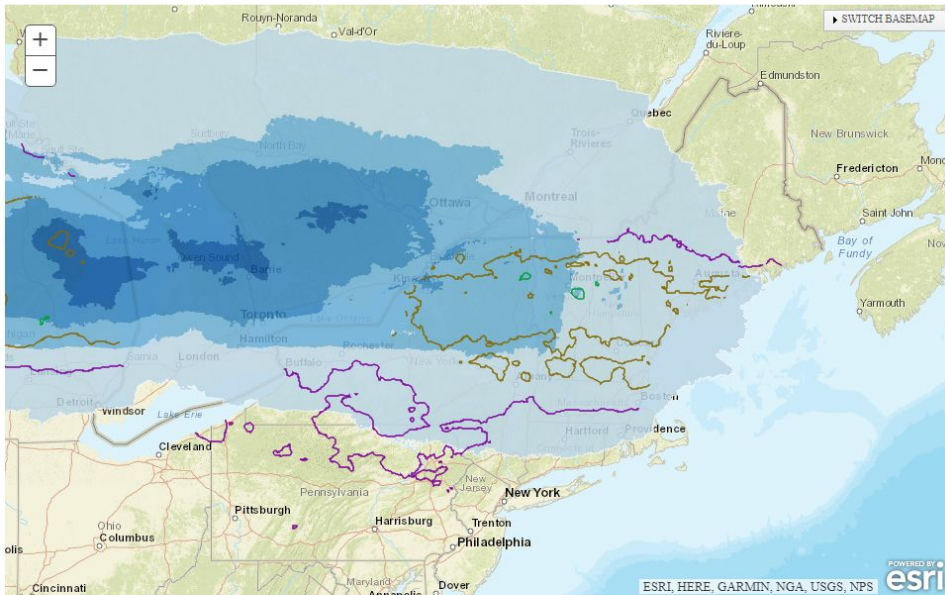
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Atmospheric Admin
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NBM Deterministic Day 2 - 6 HRLY

Forecast Period Ends: 06Z Thu 23 Feb, 2023



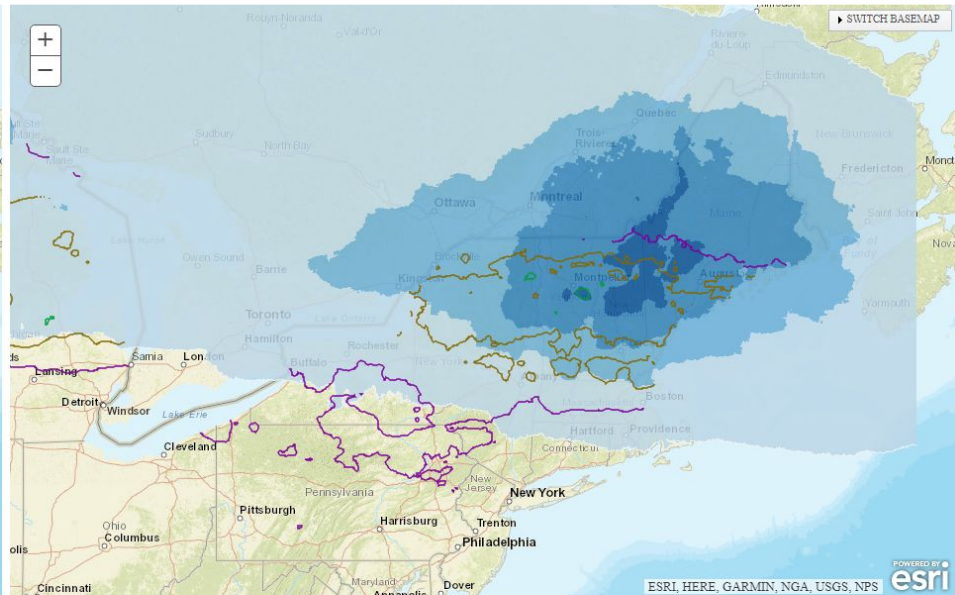
Snow Accumulation (in)

0 0.1 0.25 0.5 1.0 1.5 2 3 4 6 10 15 20 30

Snow to Liquid Ratio

0 0.1 0.25 0.5 1.0 1.5 2 3 4 6 10 15 20 30

Forecast Period Ends: 12Z Thu 23 Feb, 2023



Snow Accumulation (in)

0 0.1 0.25 0.5 1.0 1.5 2 3 4 6 10 15 20 30

Snow to Liquid Ratio

0 0.1 0.25 0.5 1.0 1.5 2 3 4 6 10 15 20 30



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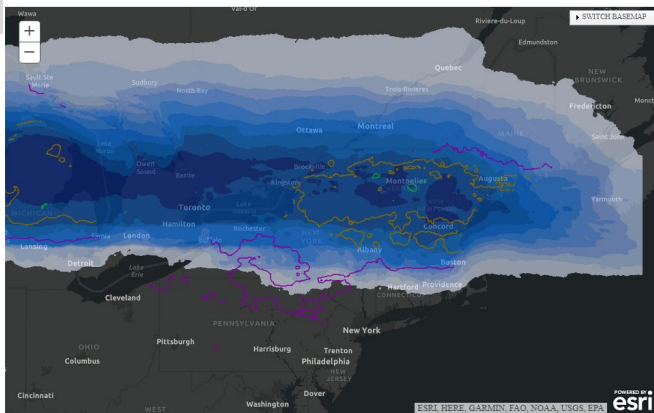
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NBM Probabilistic Day 2

1 inch
prob
with ob

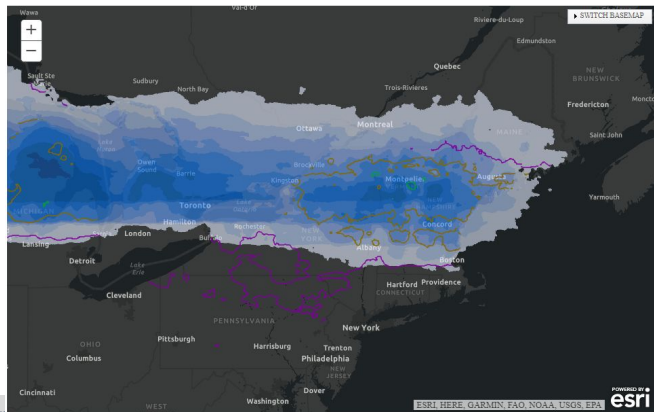
Forecast Period Ends: 12Z Thu 23 Feb, 2023 | Forecast Hour: 60



Probability



4 inch
prob
with ob

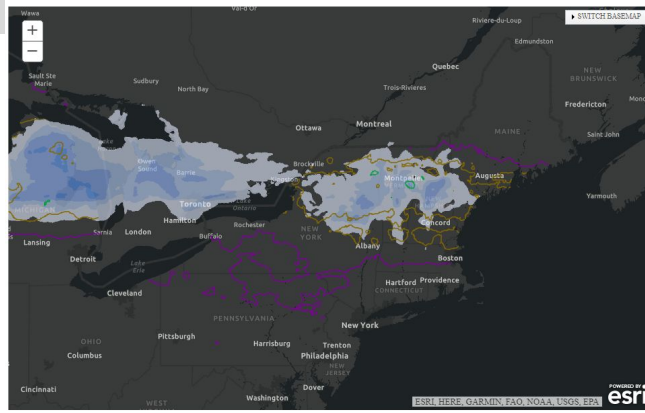


Probability



8 inch
prob
with ob

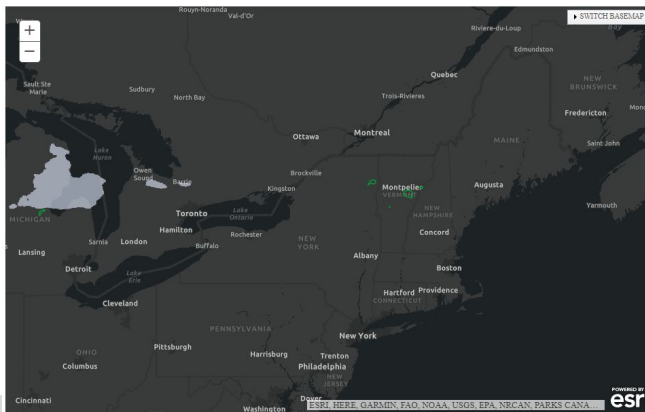
Forecast Period Ends: 12Z Thu 23 Feb, 2023 | Forecast Hour: 60



Probability



12 inch
prob
with 8
inch
contour



Probability



National
Atmos

U.S. Depart

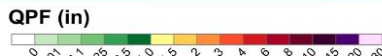
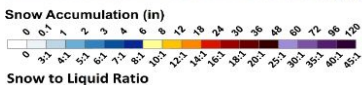
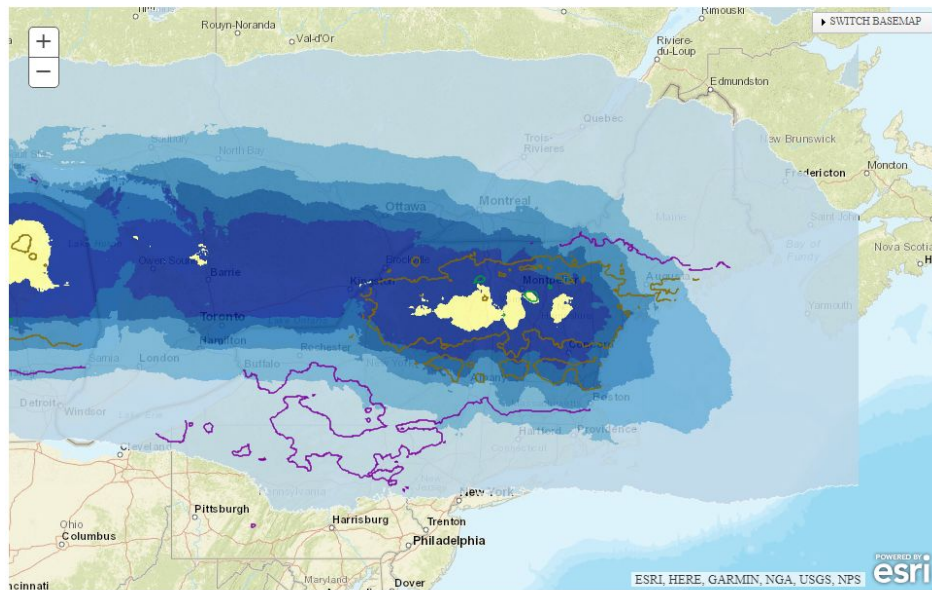
ton Weather Forecast Office



NBM Deterministic Day 3 vs Day 2

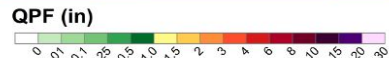
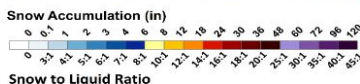
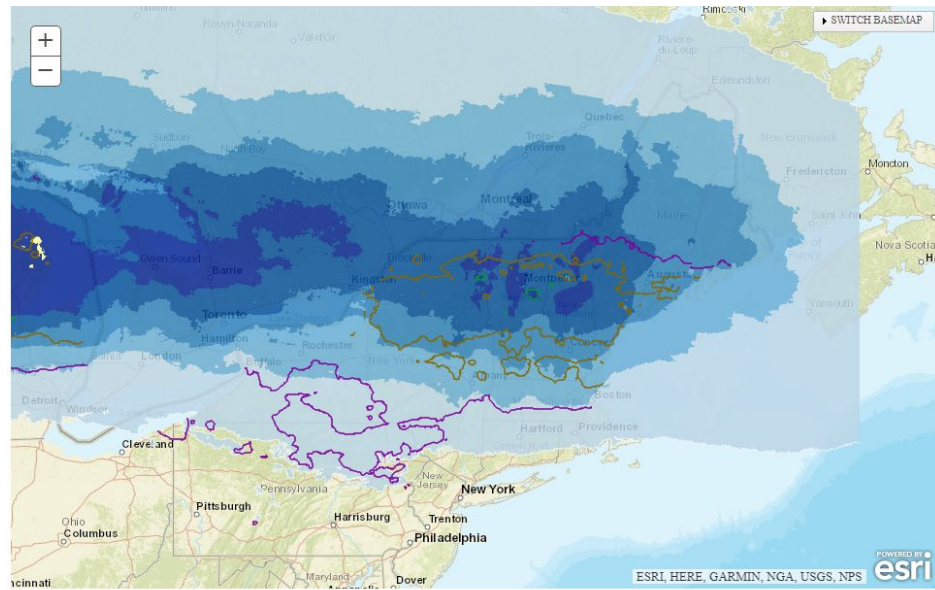
Day 3

Forecast Period Ends: 12Z Thu 23 Feb, 2023



Day 2

Forecast Period Ends: 12Z Thu 23 Feb, 2023



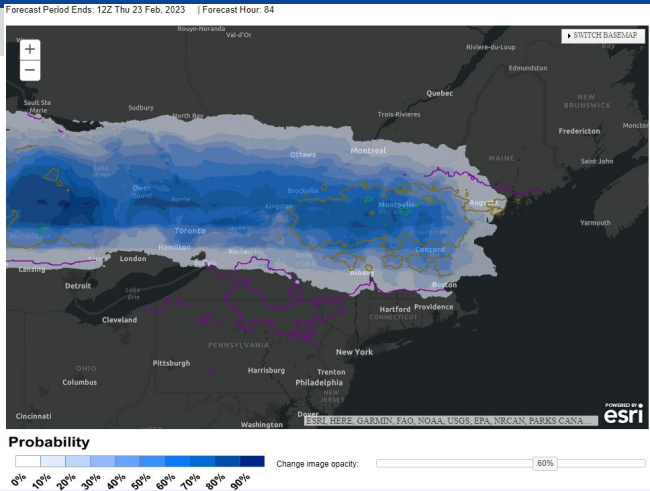
**National Oceanic and
Atmospheric Administration**
U.S. Department of Commerce

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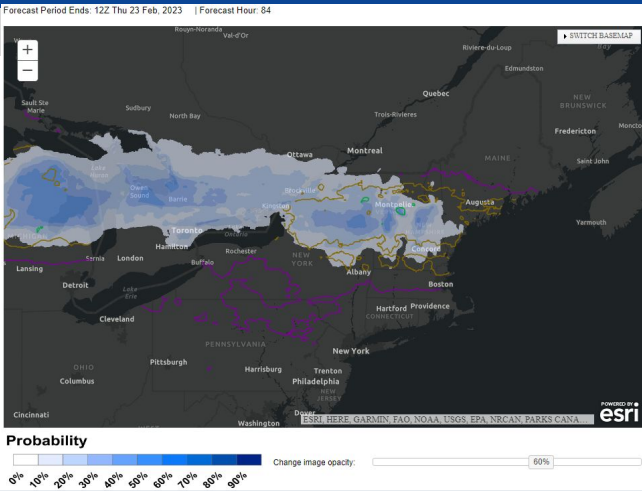


NBM Probabilistic Comparing Day 3 and Day 2

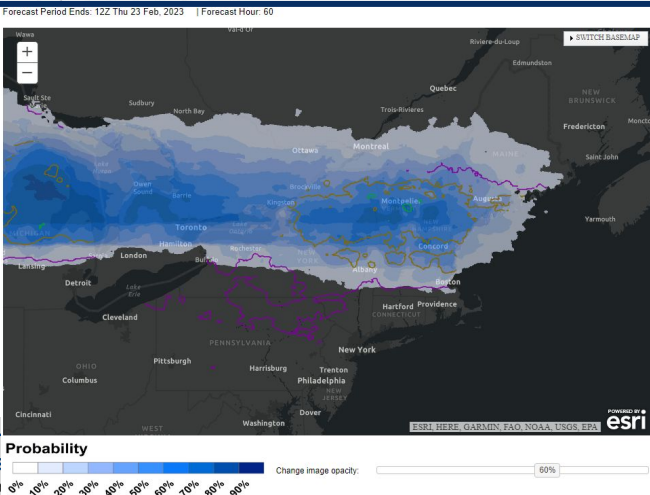
4 inch
prob
Day 3



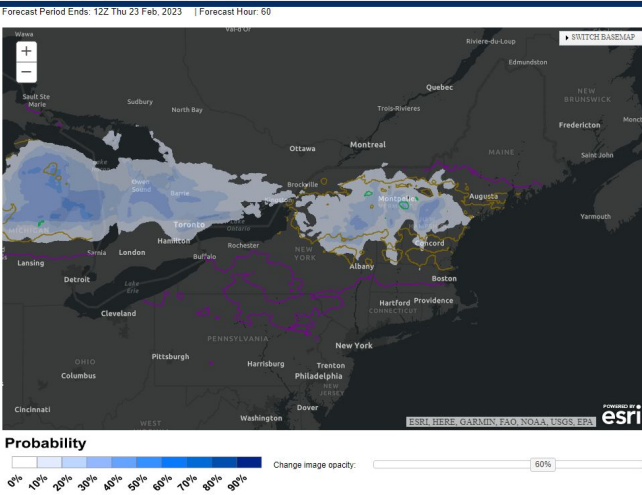
8 inch
prob
Day 3



4 inch
prob
Day 2



8 inch
prob
Day 2



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How would you message the event?

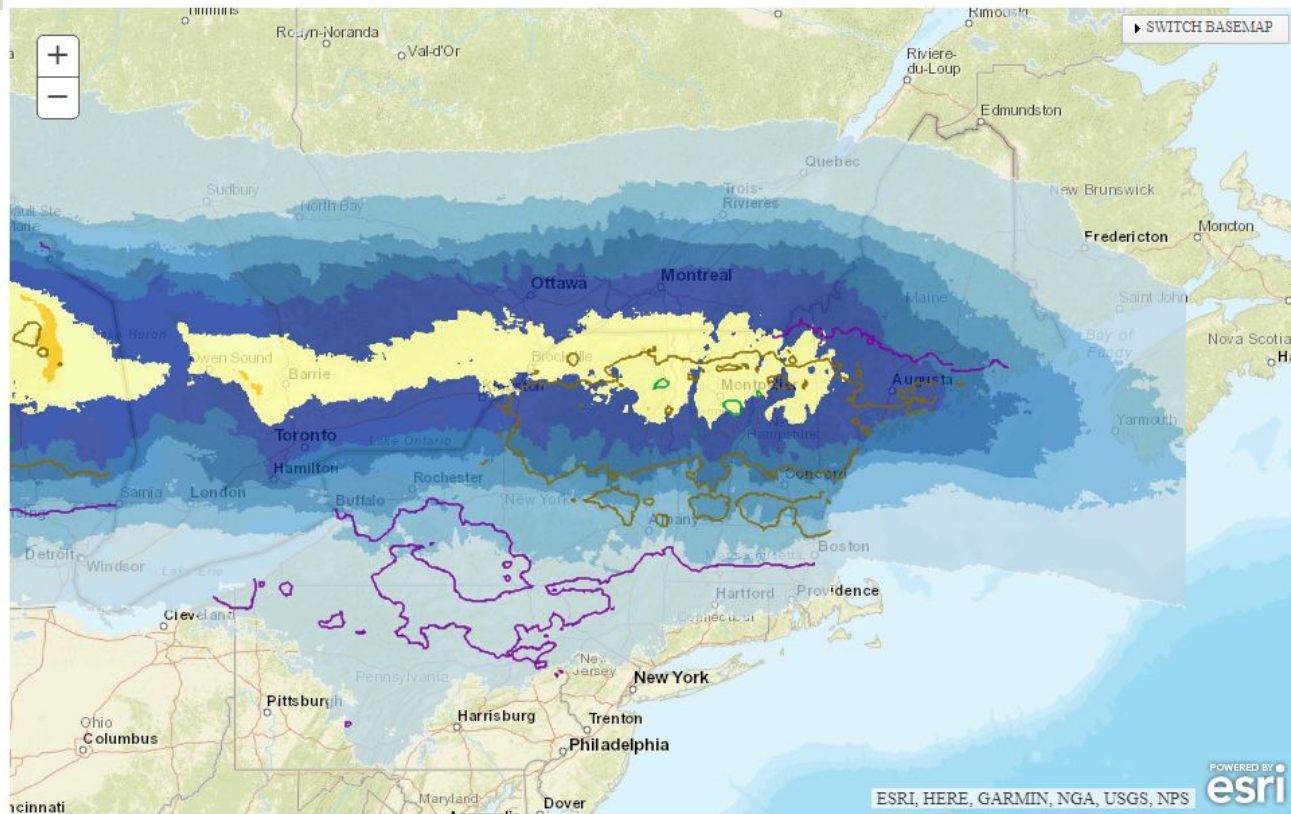
- **What snowfall forecast range would you be comfortable with?**
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- **Would you tell partners the forecast is on track or changing?**
- **Would you make warning/watch/advisory decisions?**
- **How do you feel about the location of greatest snowfall accumulations?**
- **Do the deterministic and probabilistic data match in your view?**
- **Do you feel more or less confident about the forecast?**



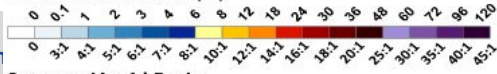


NBM Deterministic Day 1 - Total

Forecast Period Ends: 12Z Thu 23 Feb, 2023



Snow Accumulation (in)



Snow to Liquid Ratio

POF (in)



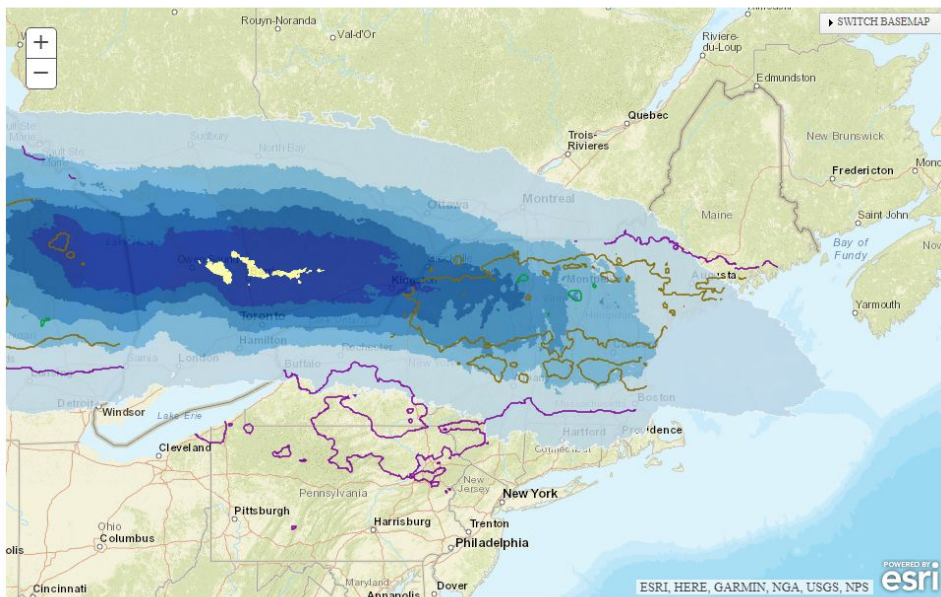
National Oceanic
Atmospheric Administration
U.S. Department of Commerce

Weather Forecast Office



NBM Deterministic Day 1 - 6 HRLY

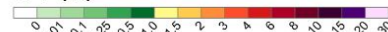
Forecast Period Ends: 06Z Thu 23 Feb, 2023



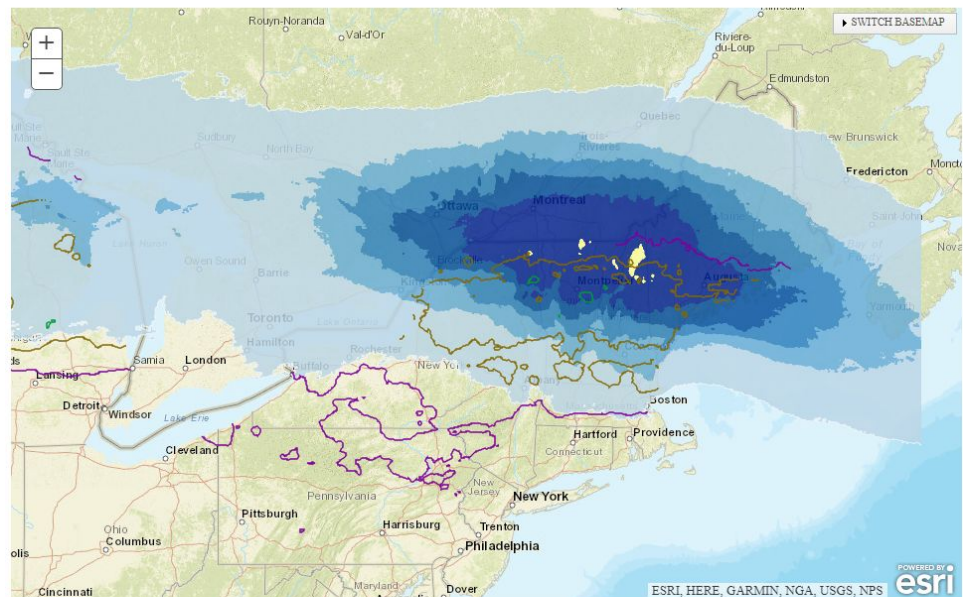
Snow Accumulation (in)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

Snow to Liquid Ratio

QPF (in)



Forecast Period Ends: 12Z Thu 23 Feb, 2023



Snow Accumulation (in)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

Snow to Liquid Ratio

QPF (in)



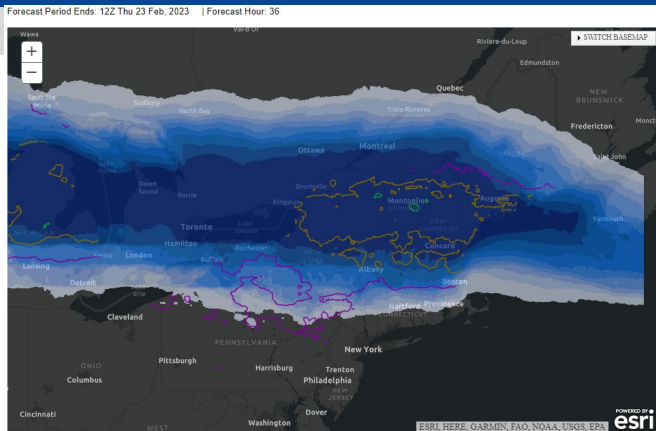
National Oceanic and
Atmospheric Administration
U.S. Department of Commerce

Burlington Weather Forecast Office

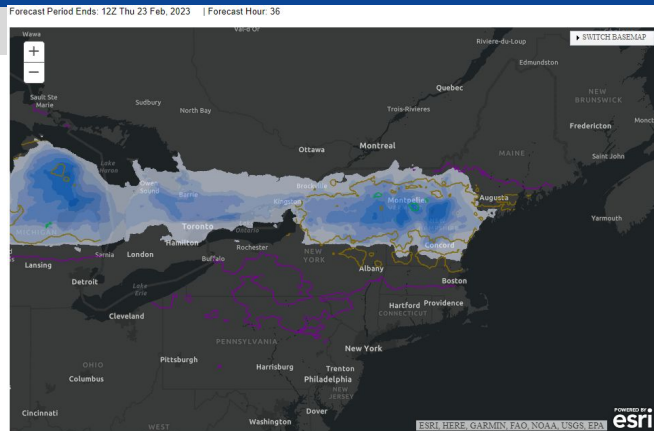


NBM Probabilistic Day 1

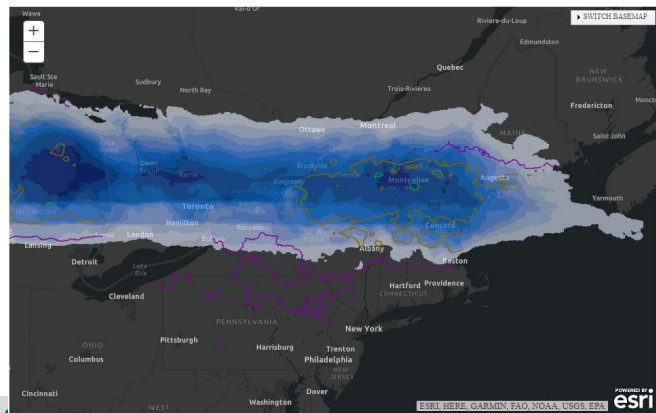
1 inch
prob
with ob



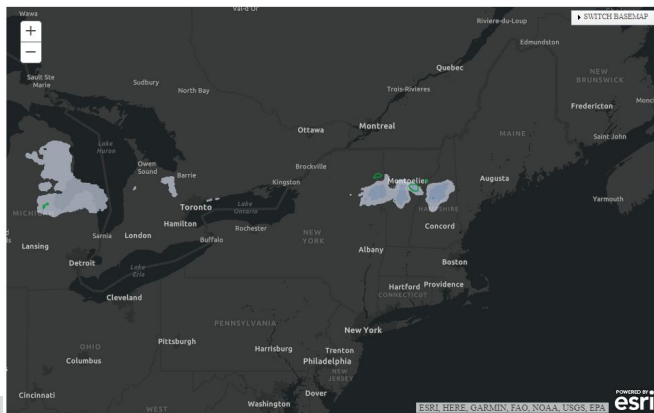
8 inch
prob
with ob



4 inch
prob
with ob



12 inch
prob
with 8
inch
contour



National
Atmospheric
U.S. Department of

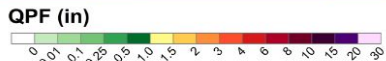
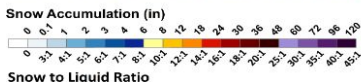
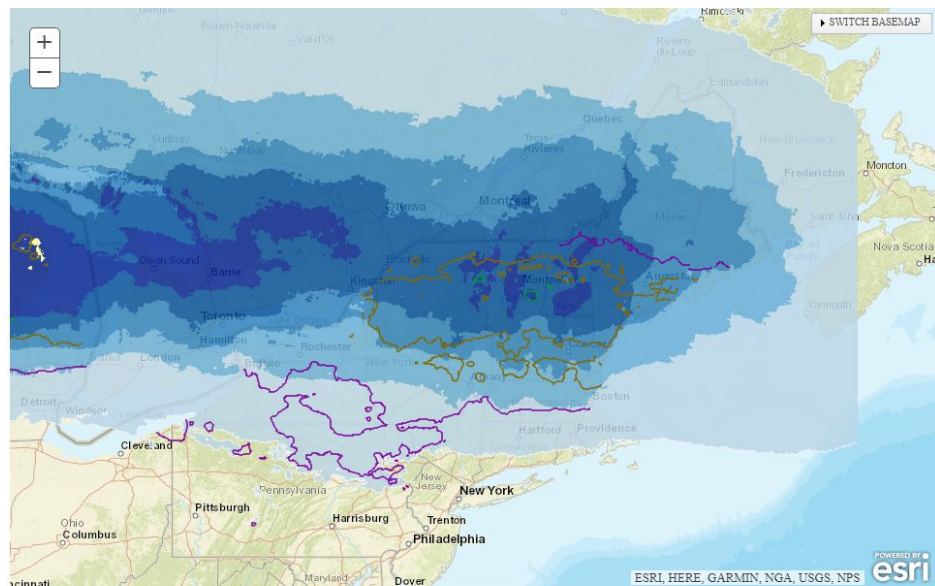
gton Weather Forecast Office



NBM Deterministic Day 2 vs Day 1

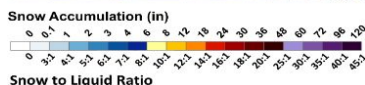
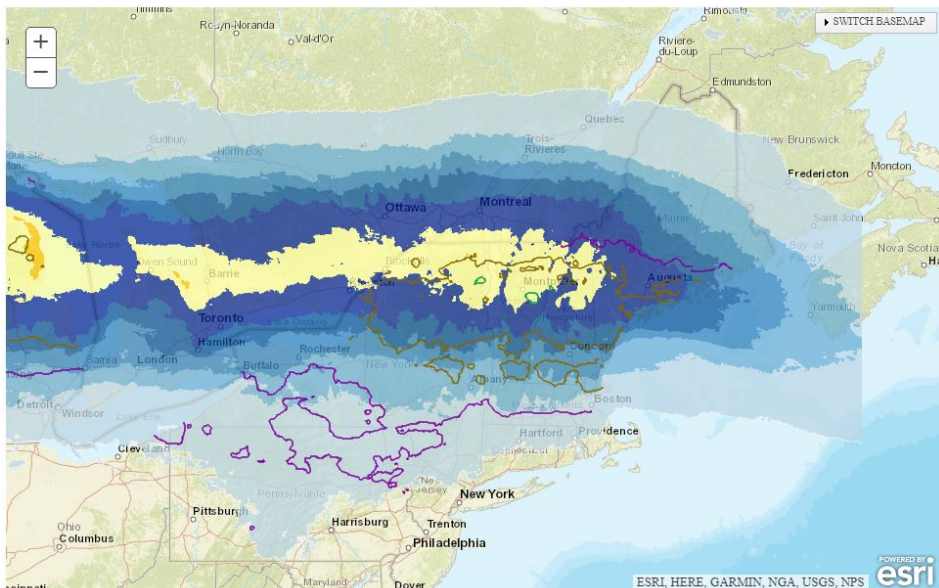
Day 2

Forecast Period Ends: 12Z Thu 23 Feb, 2023



Day 1

Forecast Period Ends: 12Z Thu 23 Feb, 2023

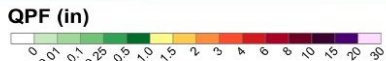
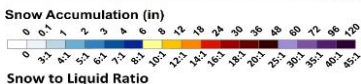
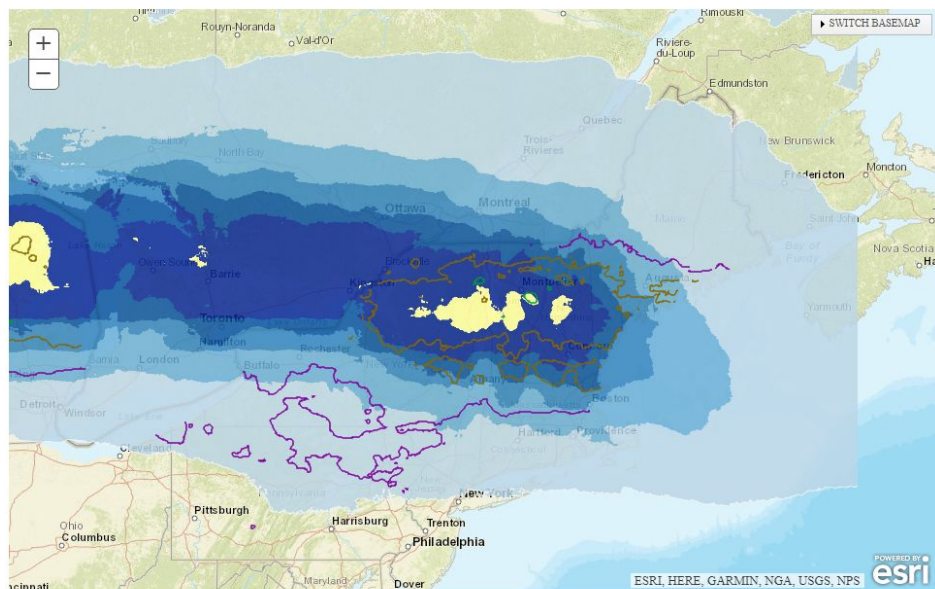




NBM Deterministic Day 3 vs Day 1

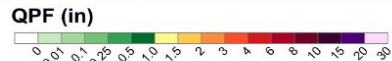
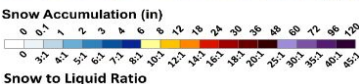
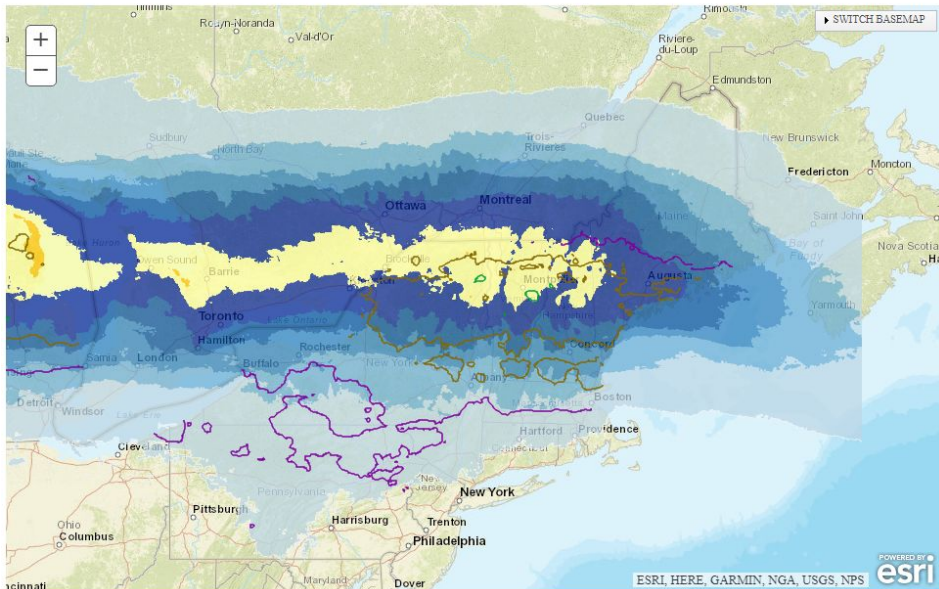
Day 3

Forecast Period Ends: 12Z Thu 23 Feb, 2023



Day 1

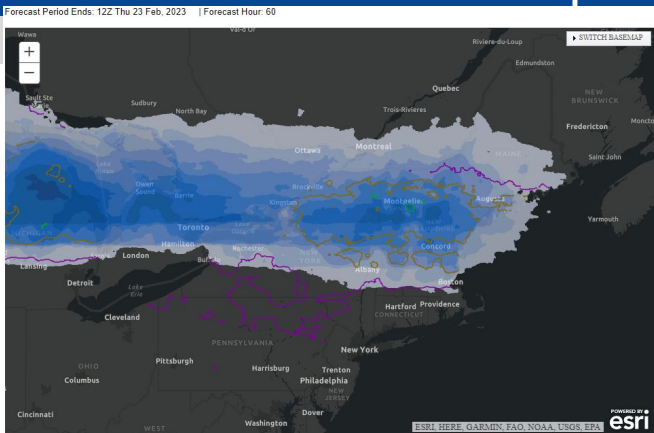
Forecast Period Ends: 12Z Thu 23 Feb, 2023



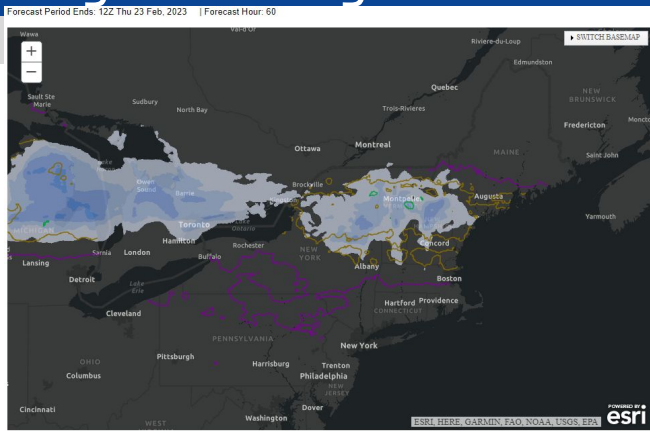


NBM Probabilistic Comparing Day 2 and Day 1

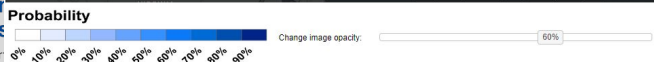
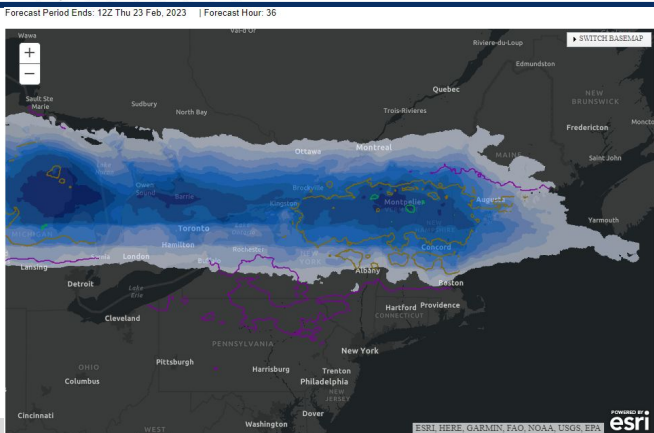
4 inch
prob
Day 2



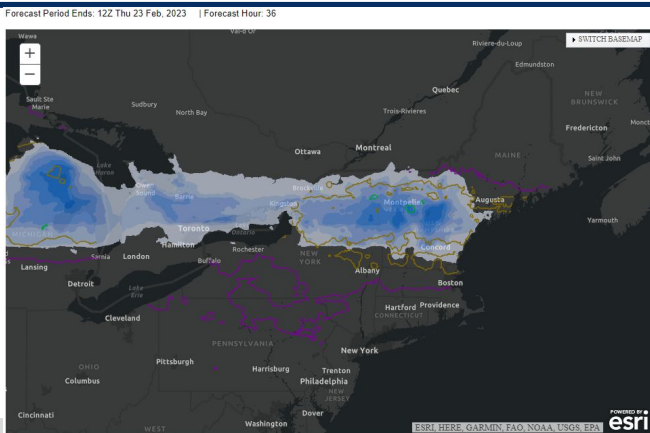
8 inch
prob
Day 2



4 inch
prob
Day 1



8 inch
prob
Day 1



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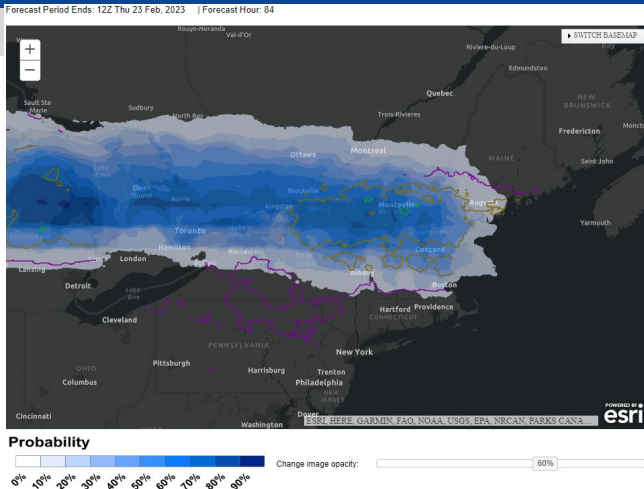
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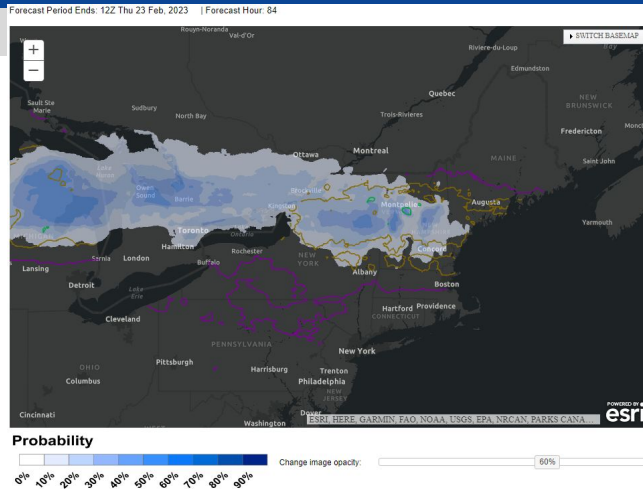


NBM Probabilistic Comparing Day 3 and Day 1

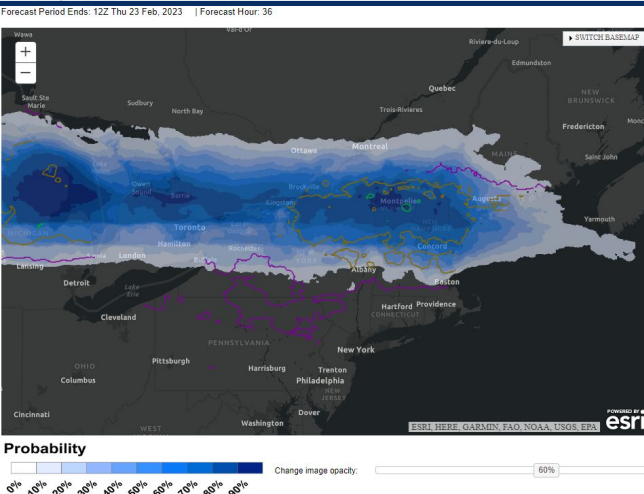
4 inch
prob
Day 3



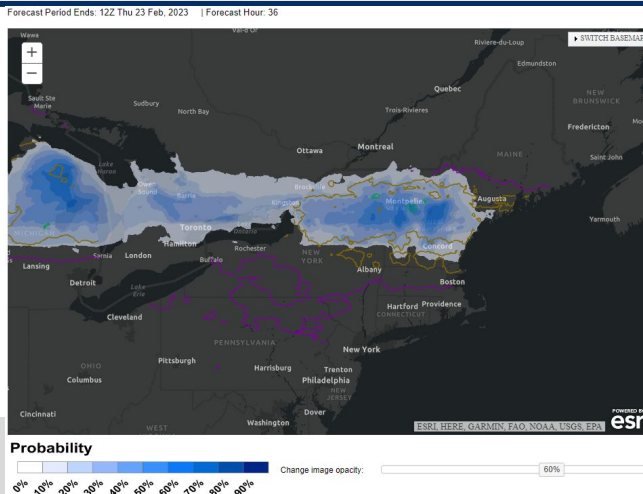
8 inch
prob
Day 3



4 inch
prob
Day 1



8 inch
prob
Day 1



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How would you message the event?

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Thanks for your attendance!

Robert Haynes (robert.d.haynes@noaa.gov)

Thanks to James Correia, Sarah Trojniak, and Kirstin Harnos for support during the LANTERN project!

