NATIONAL WEATHER SERVICE

Building a Weather-Ready Nation

Application of Recent Northeast Cool Season CSTAR Conceptual Models to Three March 2018 Snowstorms Impacting Eastern New York and Western New England

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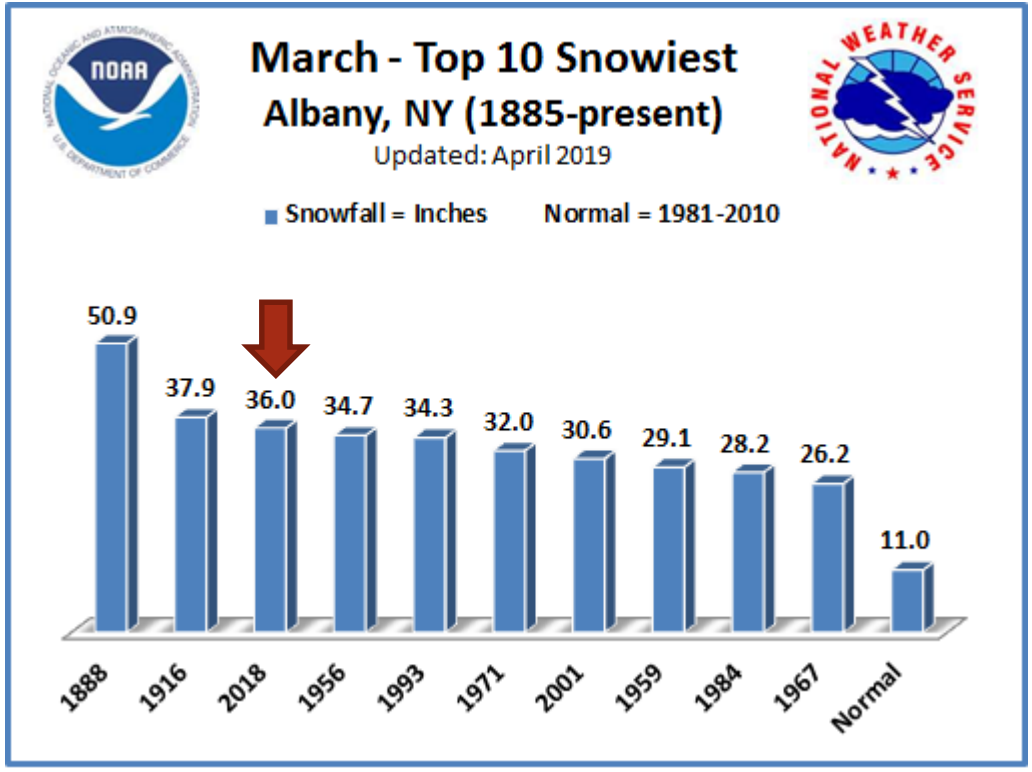
NOAA/NWS at Albany

100th AMS Annual Meeting - Boston, MA

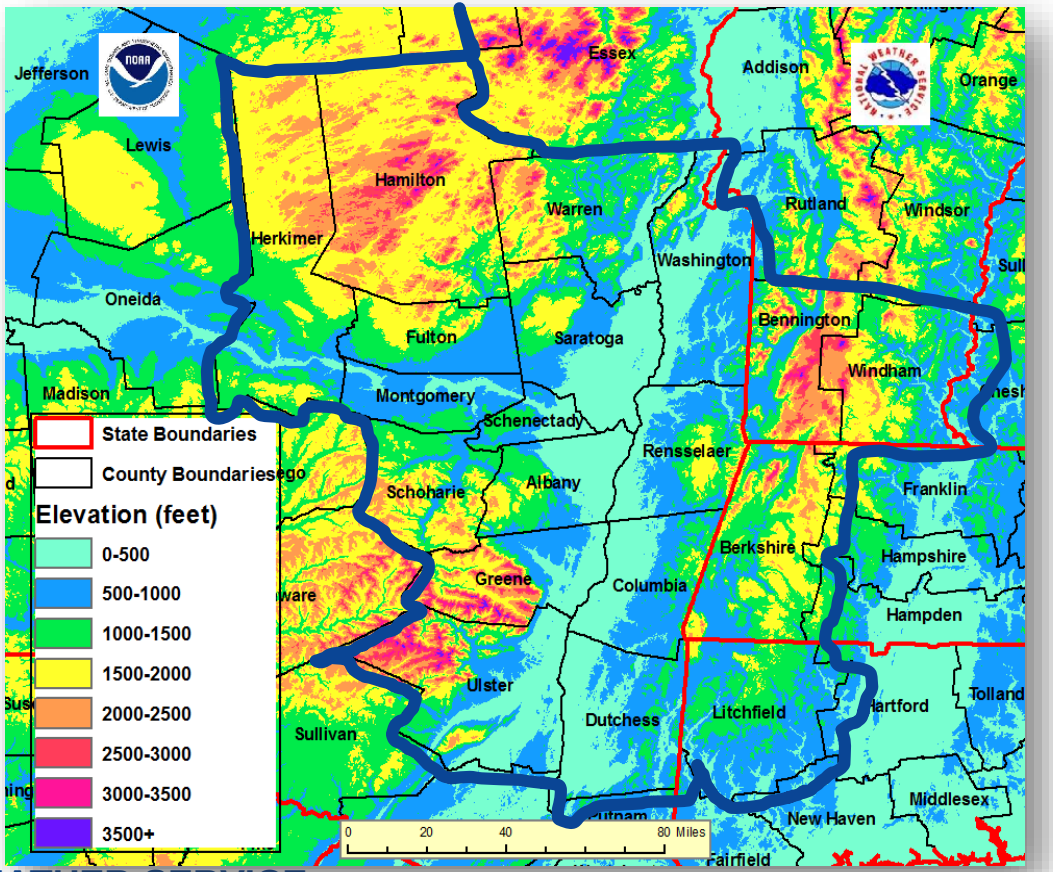
January 14, 2020

Historic March Snowfall for Albany, NY



- 3rd greatest all-time in 2018
- Mar 2nd: 11.9” (30.2cm)
- Mar 7-8th: 11.9” (30.2 cm)
- Mar 12-14th: 12.0” (30.5 cm)
- March Total: 36” (91.4 cm)

Local Topography – Albany Forecast Area



Motivation

- 3 transitional season/early spring snowstorms impacted eastern NY and western New England with heavy snowfall in the first 2 weeks of March 2018
- To compare the synoptic and mesoscale similarities between the three storms yielding the heavy snow
- Apply recent cool season SUNYA Collaborative Science, Technology and Applied Research (CSTAR) results and conceptual models to the cases (R20)

CSTAR V with SUNYA (2013-2016):
NOAA Grant # NA13NWS 46800004

Outline

- Brief Synoptic, Mesoscale, Radar Analysis for 2, 7-8, 13-15 March 2018 Snowstorms
- CSTAR Cool Season Conceptual Models
  - Steeves (2017) – Multiscale Analysis of Major Transition Season Northeast Snowstorms
  - Novak et al. (2004) – Cold Season Mesoscale Precip Bands
  - Kenyon (2013) – Motion of Mesoscale Snowbands
  - Augustyniak (2008) – Surface Flow Convergence in the Mohawk and Hudson Valley
  - Payer (2010) – Forecasting Precipitation Distributions with cool season 500-hPa Cutoff Cyclones

CSTAR I (Novak et al. 2004): Mesoscale Snowband Flow Charts &Conceptual Models

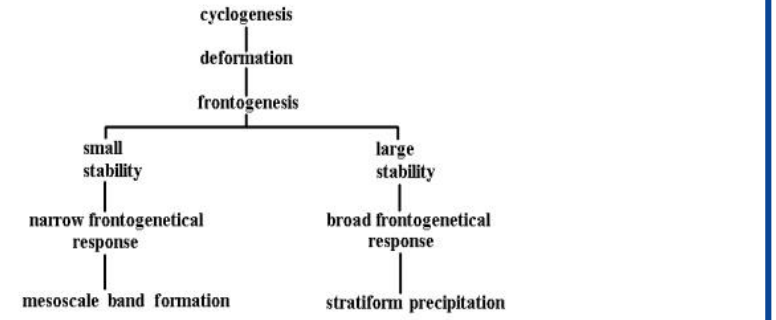


Fig. 4.7. Flow chart of the key components and interactions involved in band formation.

Frequently cited in NWS Area Forecast Discussions, refereed literature & used in the warning decision making

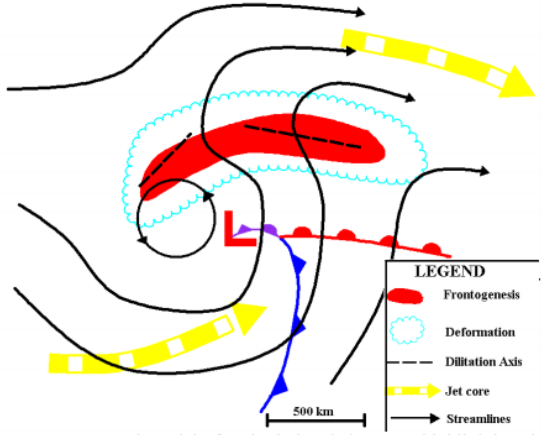
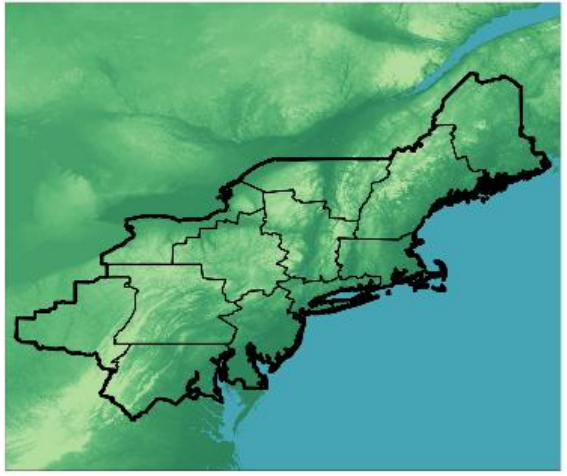


Fig. 4.1. Conceptual model of a single-banded system highlighting the key parameters. Features drawn include 700 hPa frontogenesis (shaded), 700 hPa deformation zone (encompassed by scalloped line) and associated primary dilatation axes (dashed line), 700 hPa streamlines (black lines), and 300 hPa jet cores (wide dashed arrows).

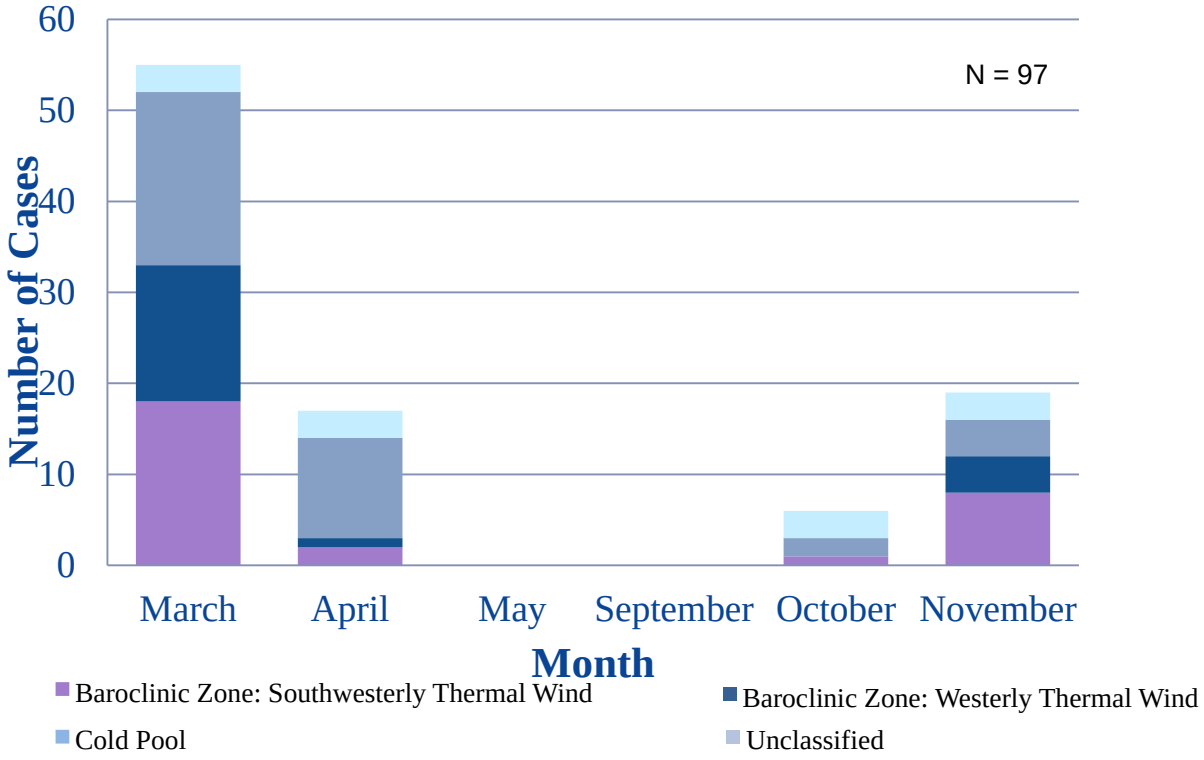
Transition Season Northeast Snowstorm Objective Definition (Steeves 2017)

- To be objectively defined as a major transition season Northeast snowstorm, an event in Storm Data must have at least three separate county warning areas (CWAs) report:
  - “Heavy Snow” (HS)
  - “Winter Storm” (WS)
  - “Blizzard” (B)
  - A combination of any of the three
  - WS and B must meet 12-h snow warning criterion for the reporting CWA



Northeast domain outlined in dark black with thin black CWA borders

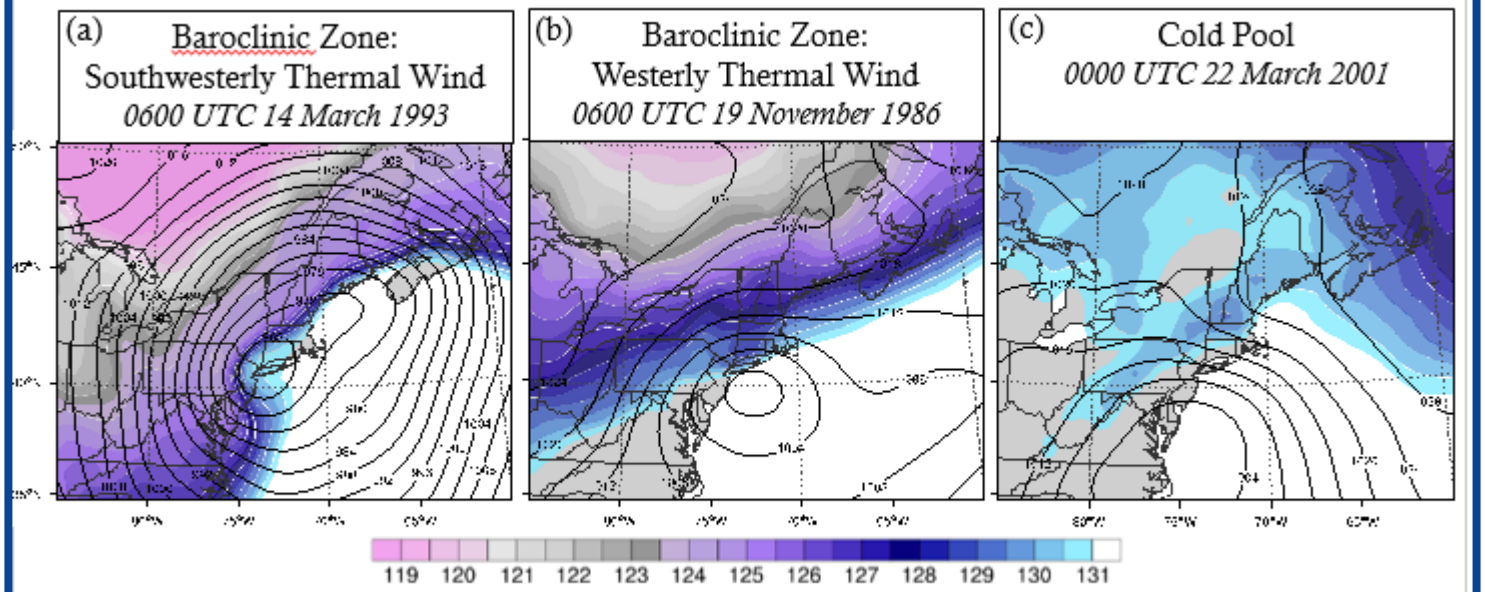
1983-13 Climatology: Monthly Distribution (Steeves 2017)



Monthly distribution of major transition season Northeast snowstorms by lower-tropospheric cold air pattern

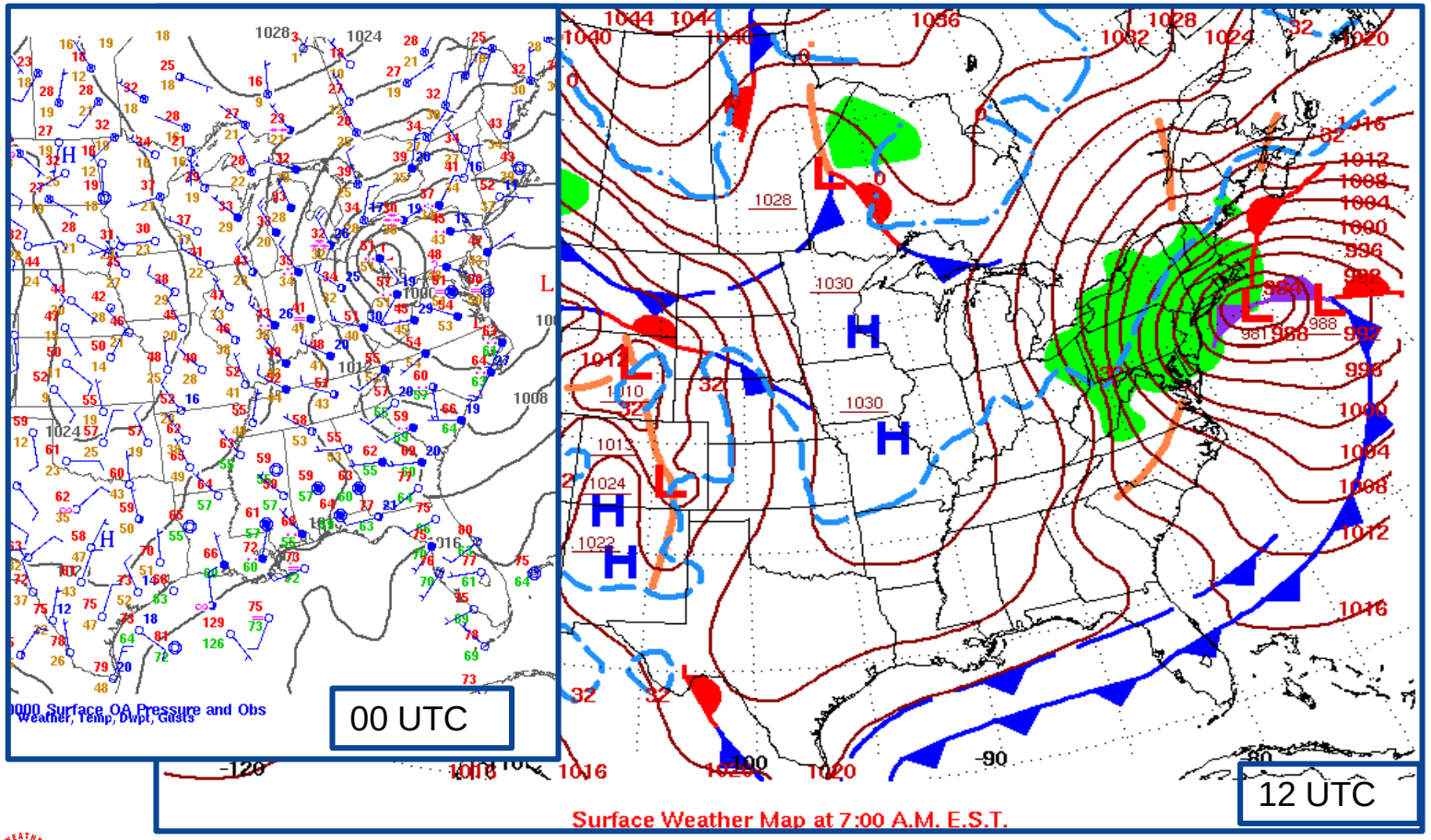
Transitional Season Storms: 3 Categories

Steeves (2017)



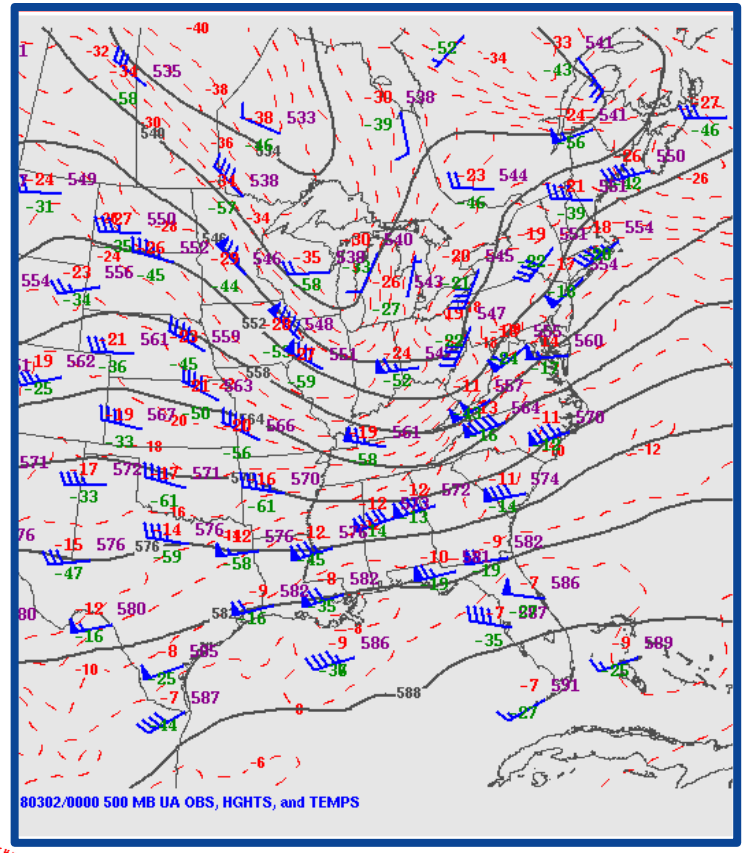
1000–850-hPa thickness (shaded, dam) and MSLP (contoured, hPa) at (a) 0600 UTC 14 March 1993, a Baroclinic Zone: Southwesterly Thermal Wind case; (b) 0600 UTC 19 November 1986, a Baroclinic Zone: Westerly Thermal Wind case; and (c) 0000 UTC 22 March 2001, a Cold Pool case

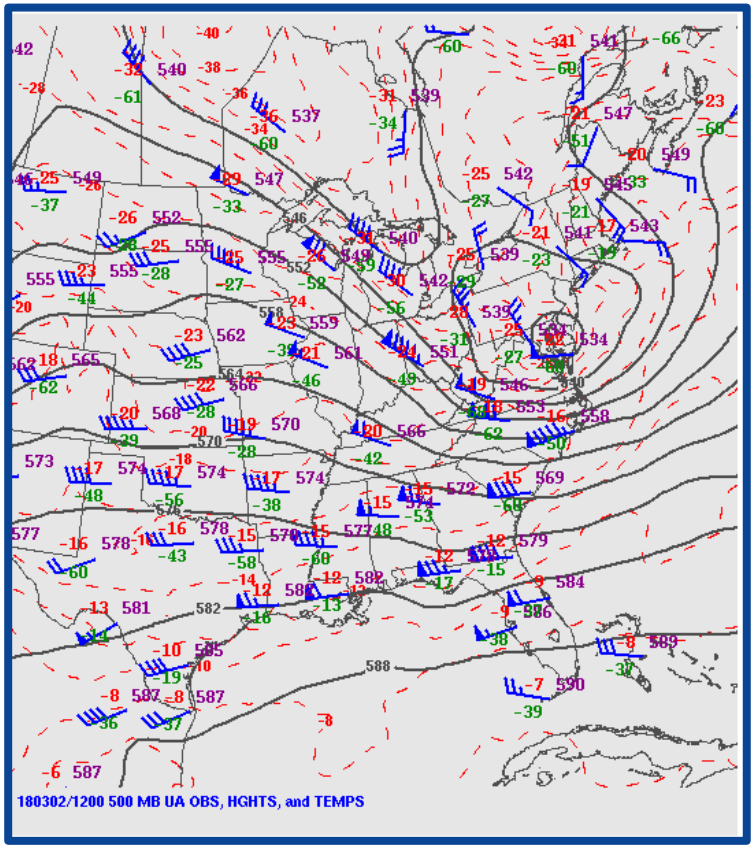
0000 & 1200 UTC 2 March 2018 Surface Maps



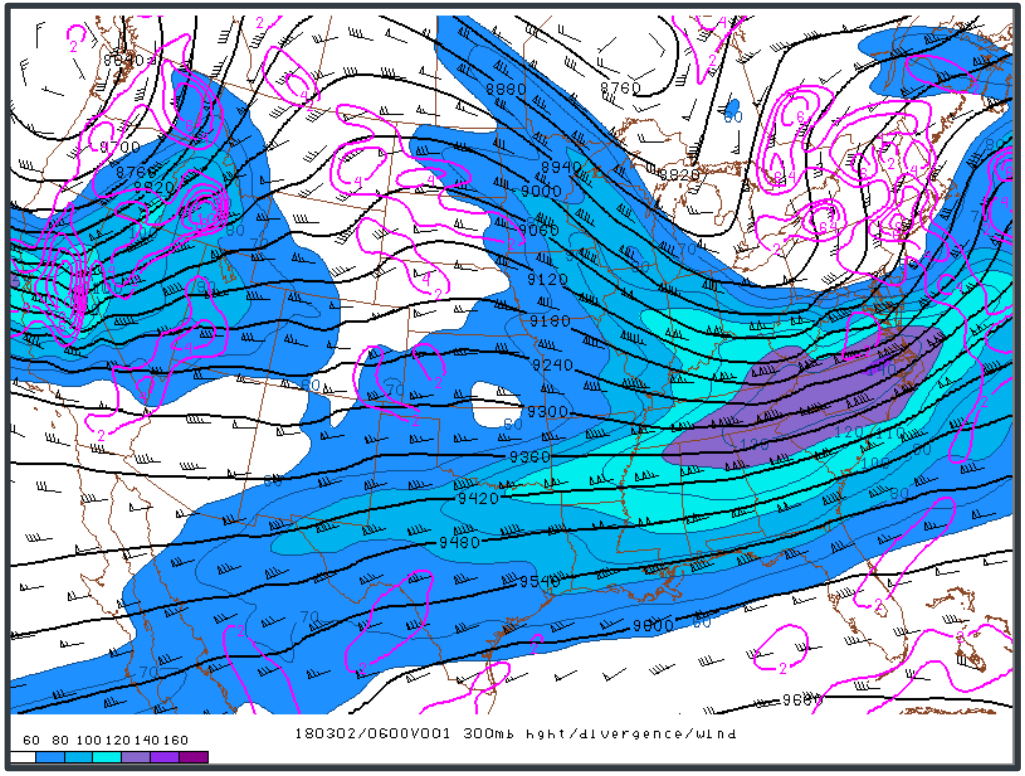
M

00 & 12 UTC 2 MAR 2018 500 hPa Upper Air Analysis





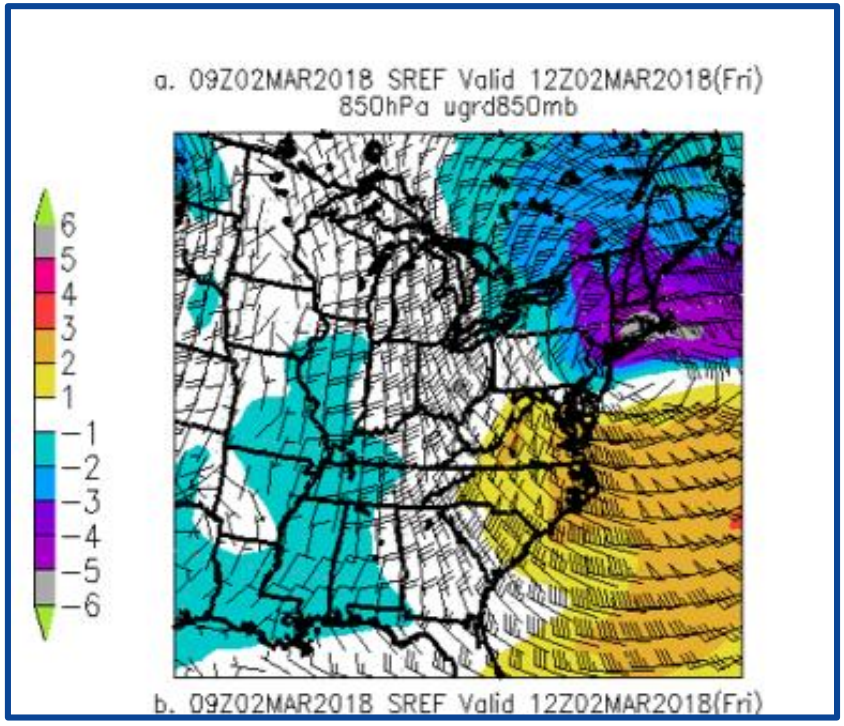
0600 UTC 2 MAR 2018 Rapid Refresh
300 hPa Heights, Divergence and Winds (kts)



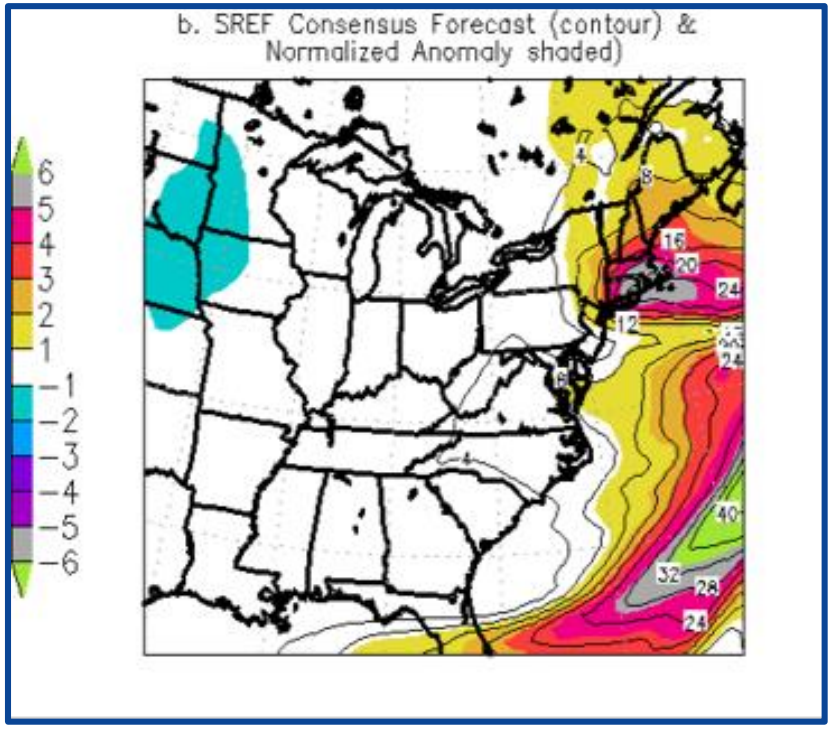
Poleward jet streak lifting out (equatorward entrance region) while dominate 120-140 kt poleward left exit region jet streak is approaching Northeast

0900 UTC SREF F1200 UTC 2 MAR 2018

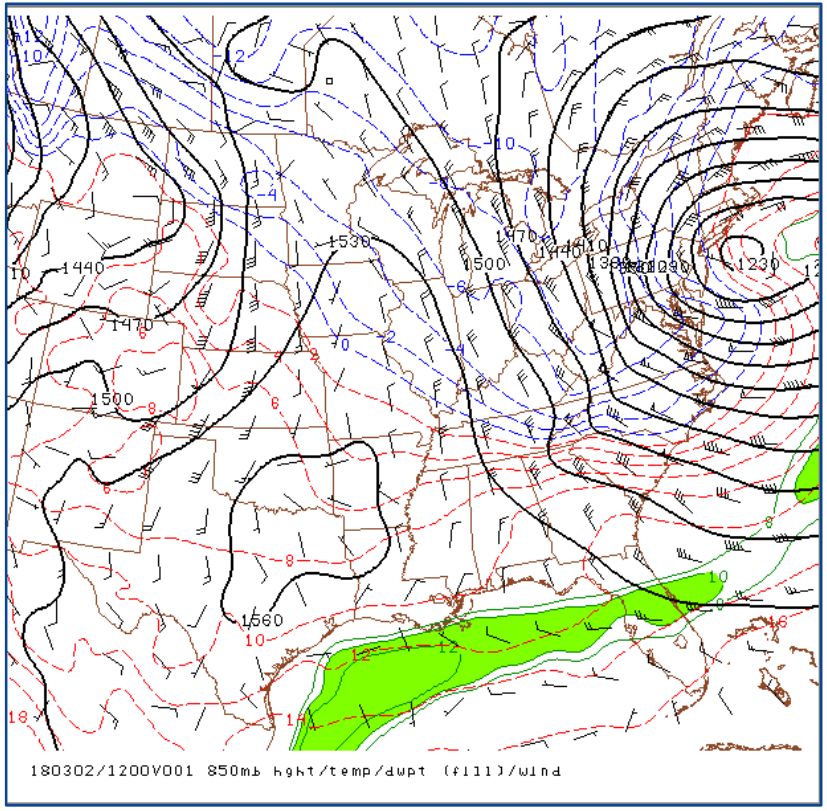
850 hPa u-wind anomalies (easterlies)



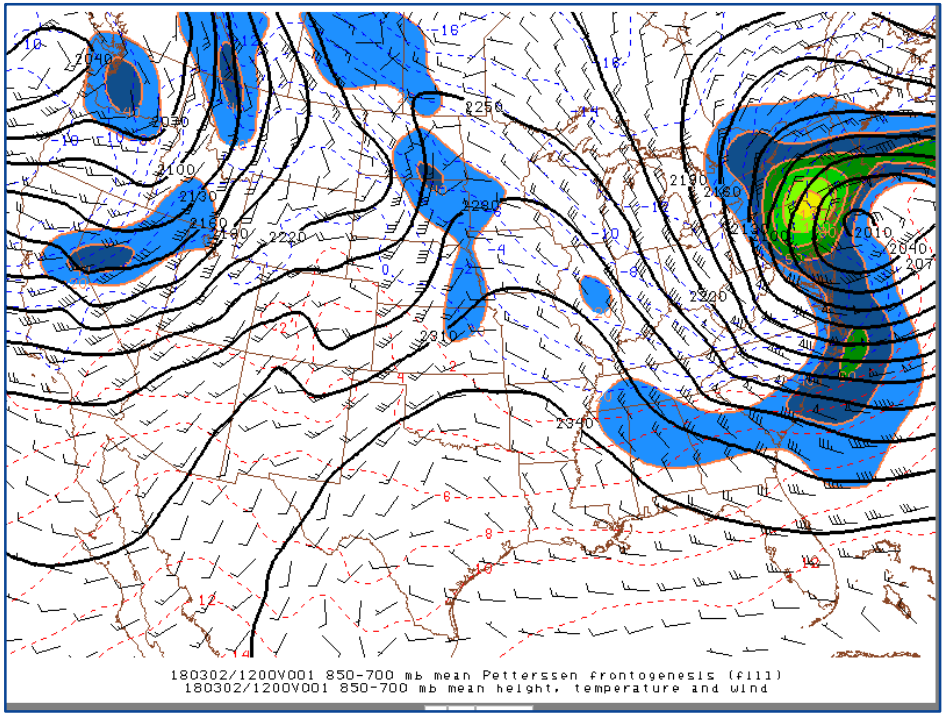
850 hPa Moisture Flux anomalies



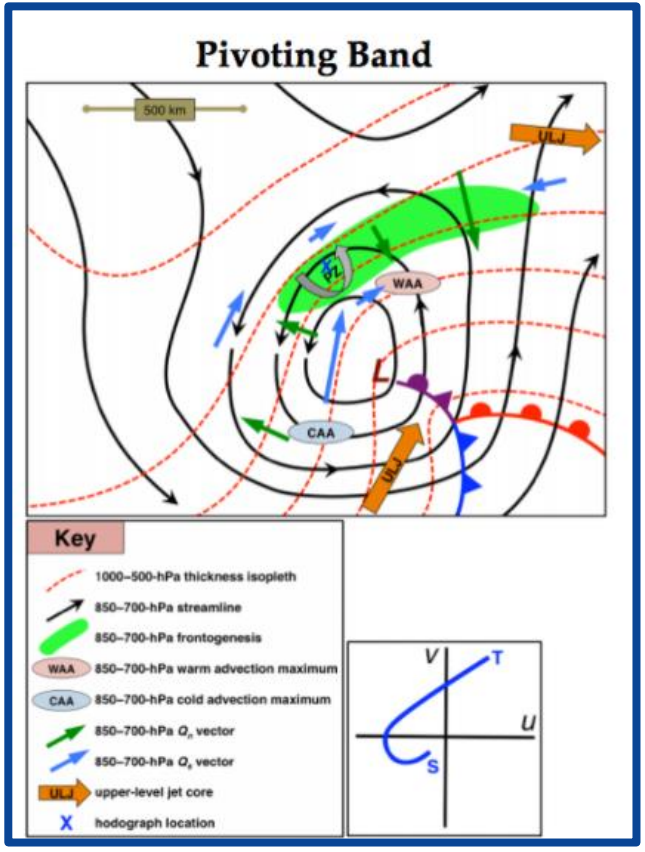
1200 UTC 2 MAR 2018: 850 hPa Height,Temps (˚C) and Winds (kts)



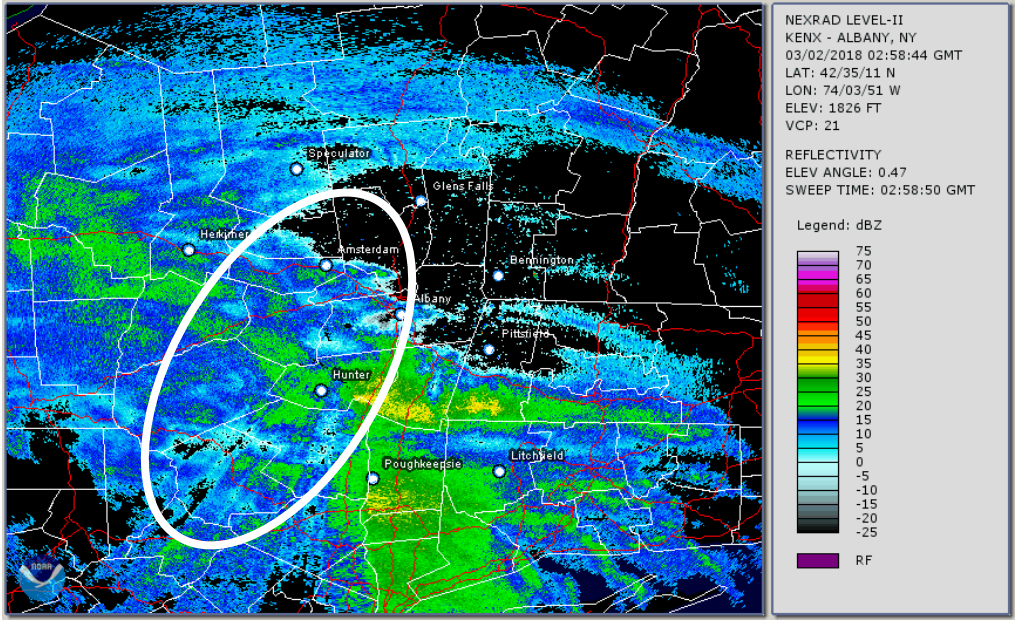
1200 UTC 2 MAR 2018: 850 – 700 hPa Rapid Refresh 2-D Petterssen Mean FGEN & Heights



Kenyon Pivoting Band Conceptual Model (2013)

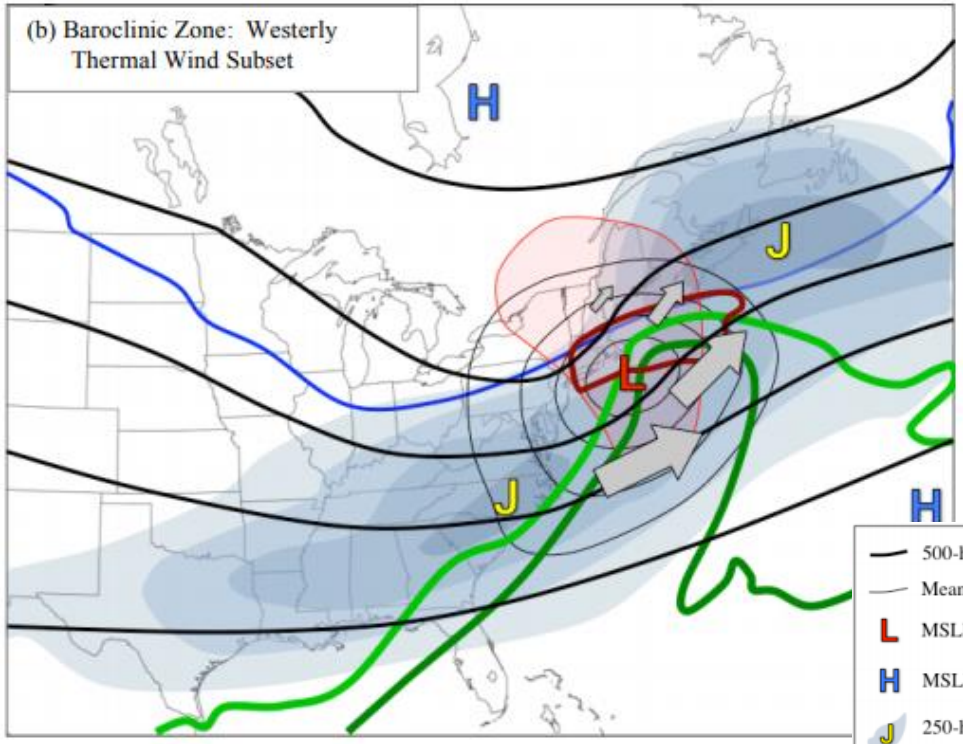


0600 UTC 2 MAR to 0000 UTC 3 MAR 2018



Mega-Band with Hourly Snowfall rates 2-4+”/hr

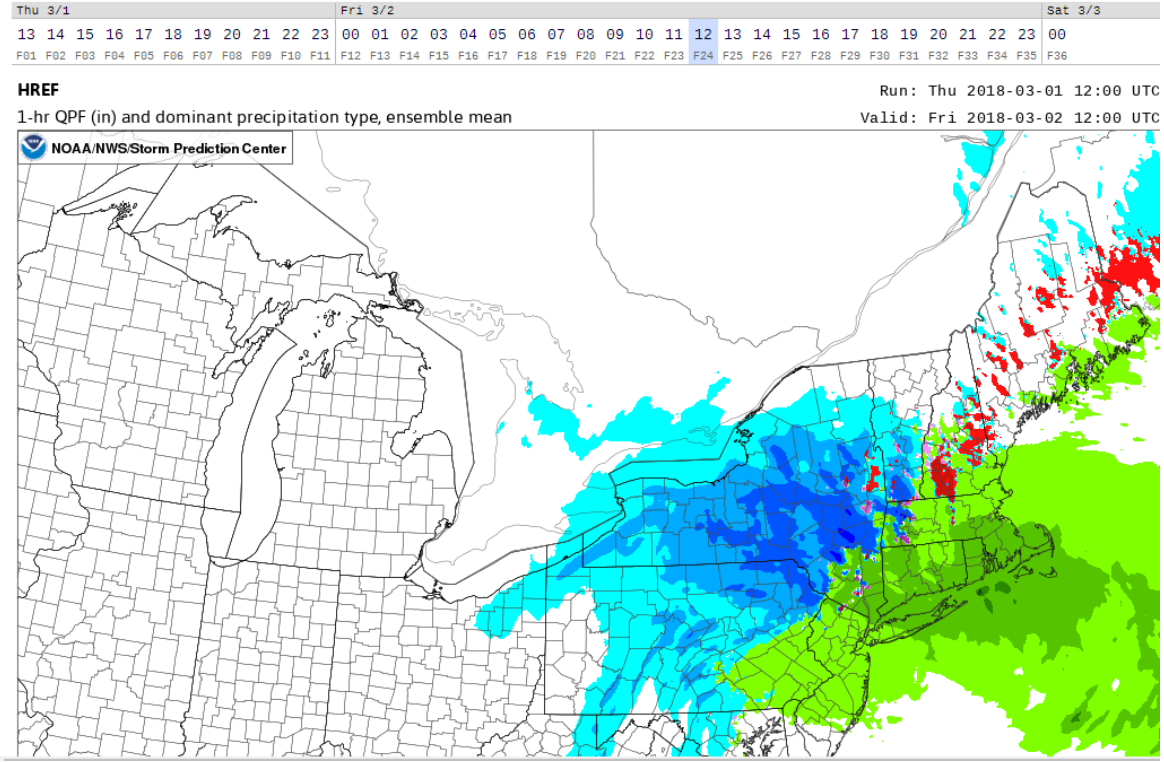
2 March 2018 Snowstorm Conceptual Model



Steeves (2017)

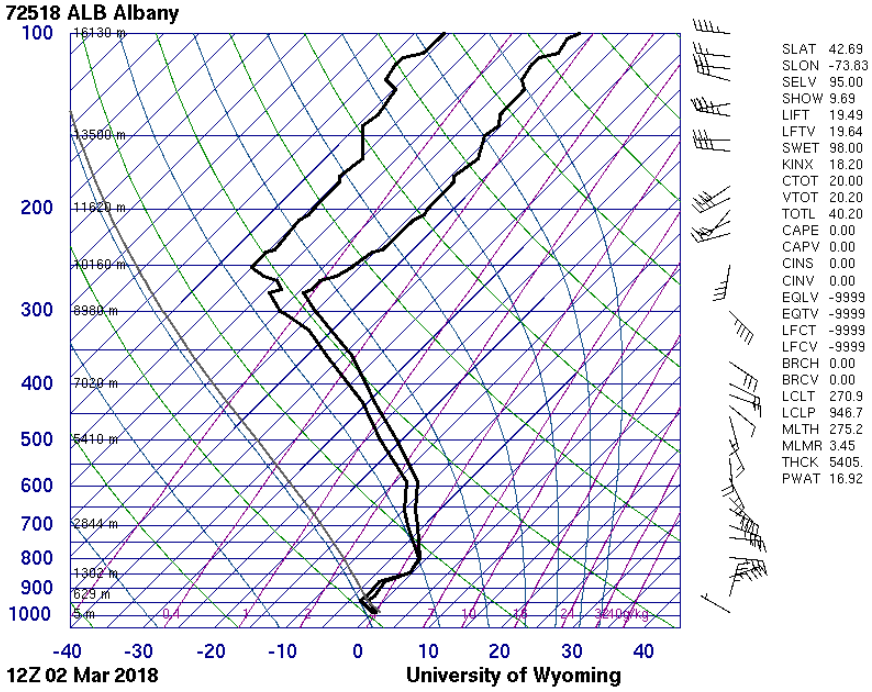
500-hPa geopotential height
Mean sea level pressure (MSLP)
L MSLP minimum
H MSLP maximum
J 250-hPa jet streak
Integrated water vapor transport (IVT); Arrow size denotes IVT magnitude
Ridge of high MSLP
20 mm precipitable water contour
25 mm precipitable water contour
925–850-hPa frontogenesis
Q-vector forcing for ascent
1290 m 1000–850-hPa thickness contour
CP Lower-tropospheric cold pool

1200 UTC 1 MAR 2018 HREF P-type valid 1200 UTC 2 MAR 2018

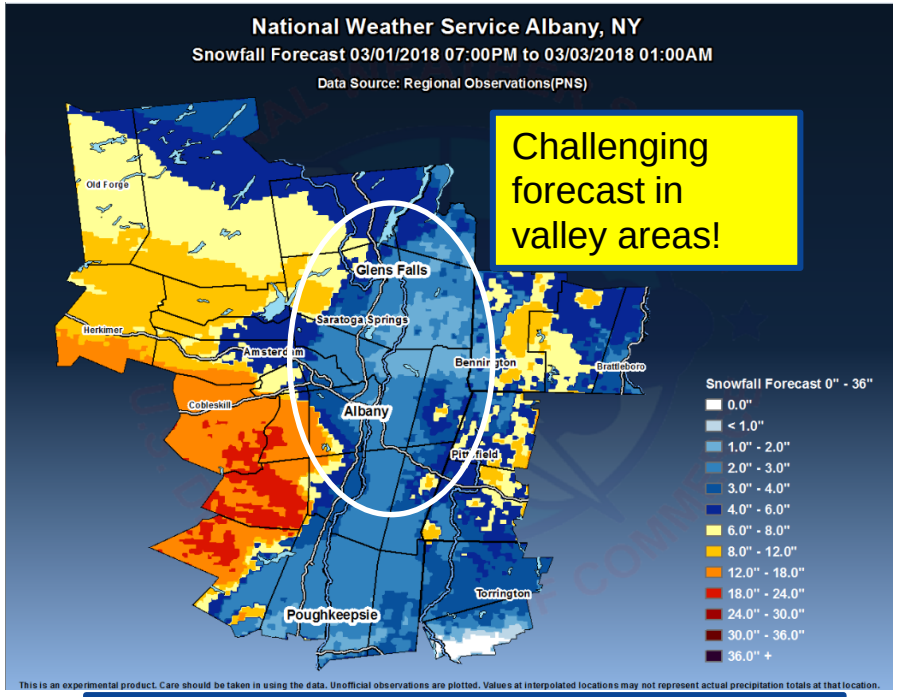


1200 UTC 2 MAR 2018 KALB Sounding

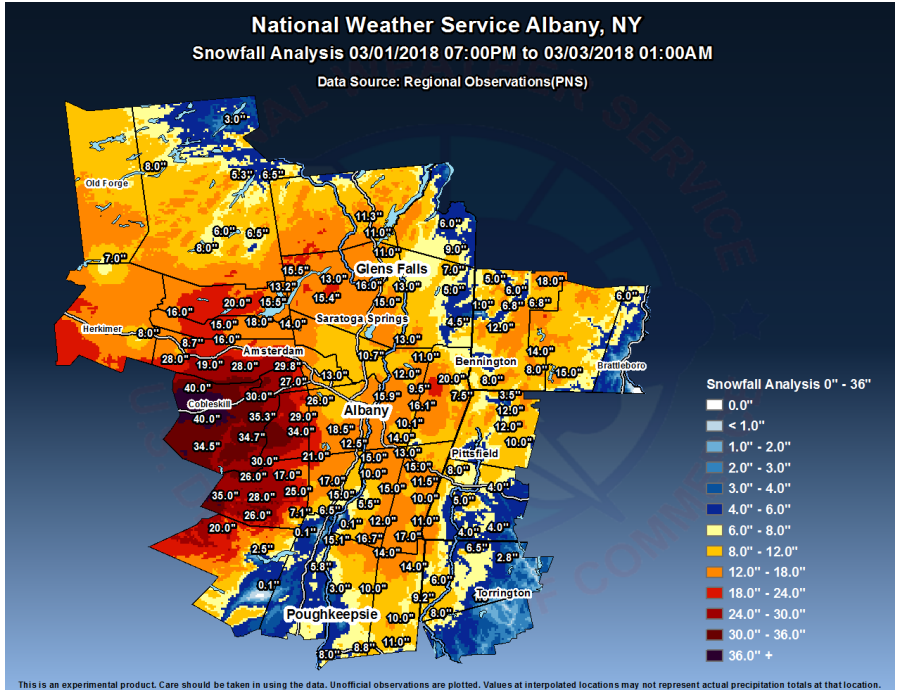
Let it snow at Albany!!!



NWS forecast (12-24 hrs before) vs. observed snowfall

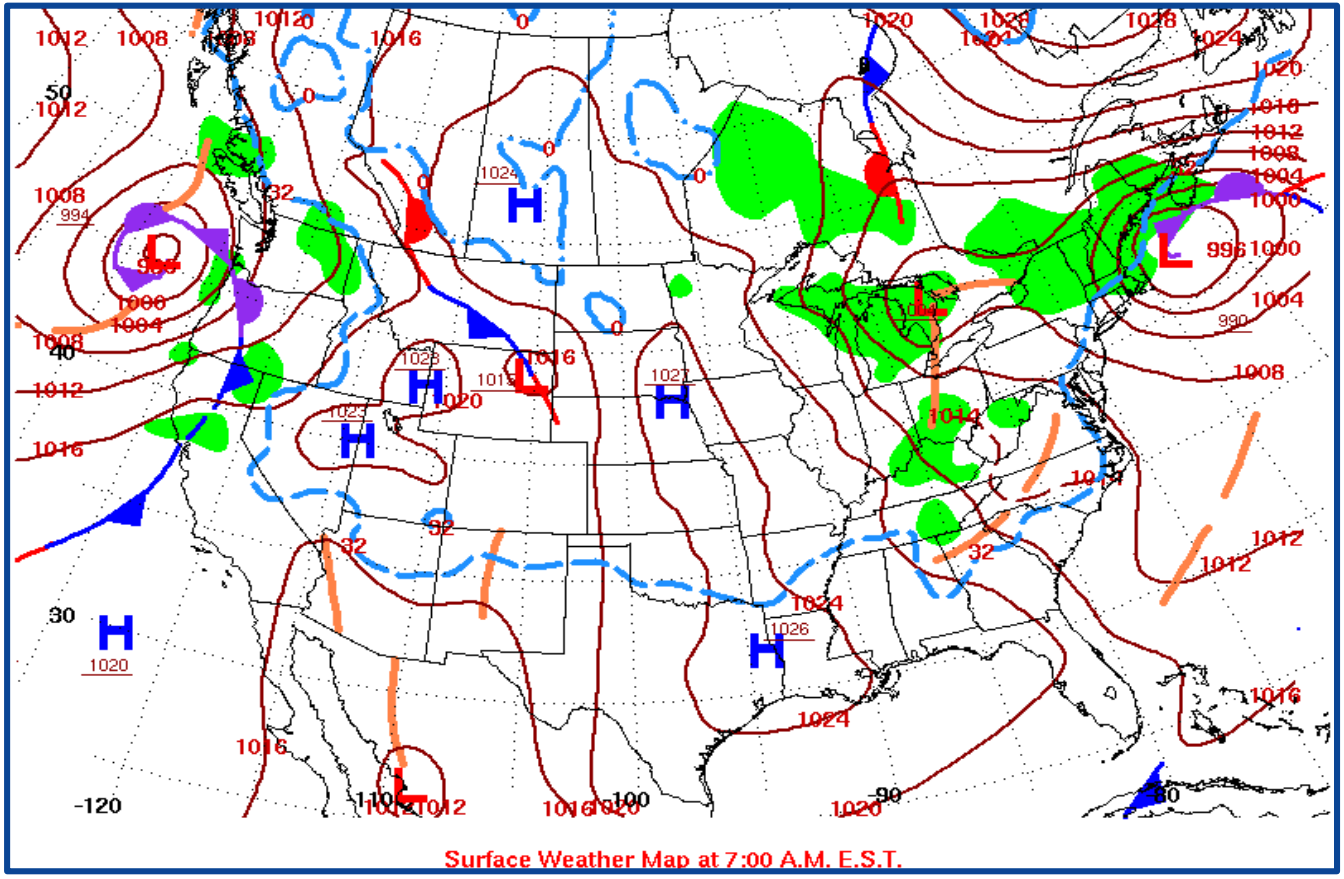


1 March 2018 4 pm Initial Forecast Totals

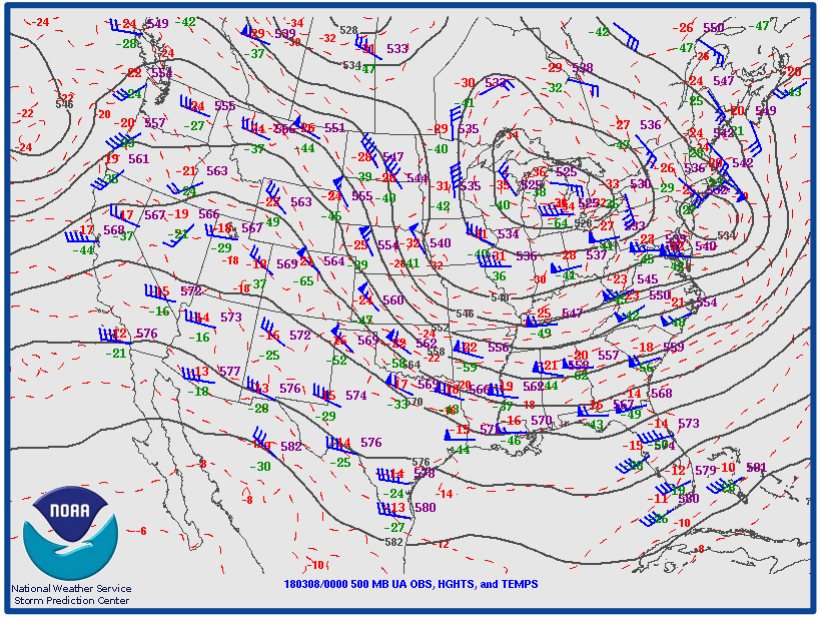


2 March 2018 Observed Snowfall Amounts

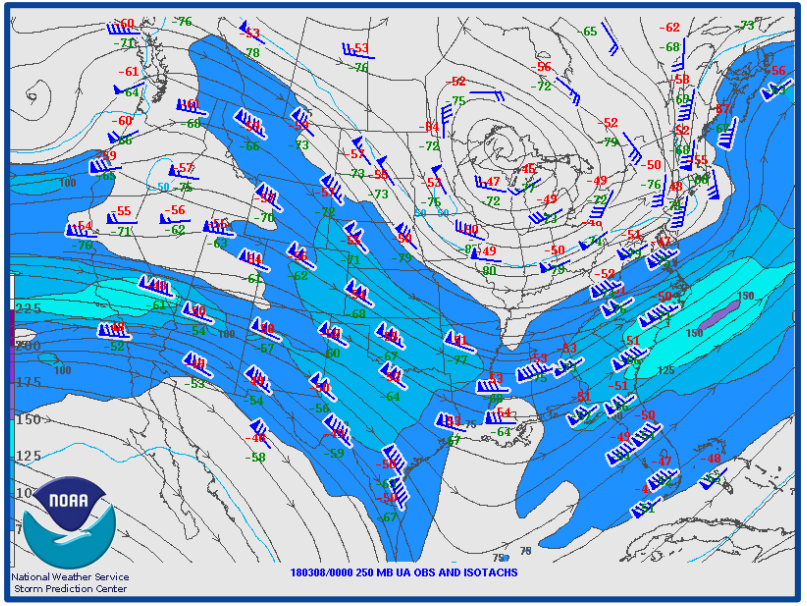
1200 UTC 8 March 2018 Surface Map



0000 UTC 8 March 2018: 500 hPa and 250 hPa Analysis

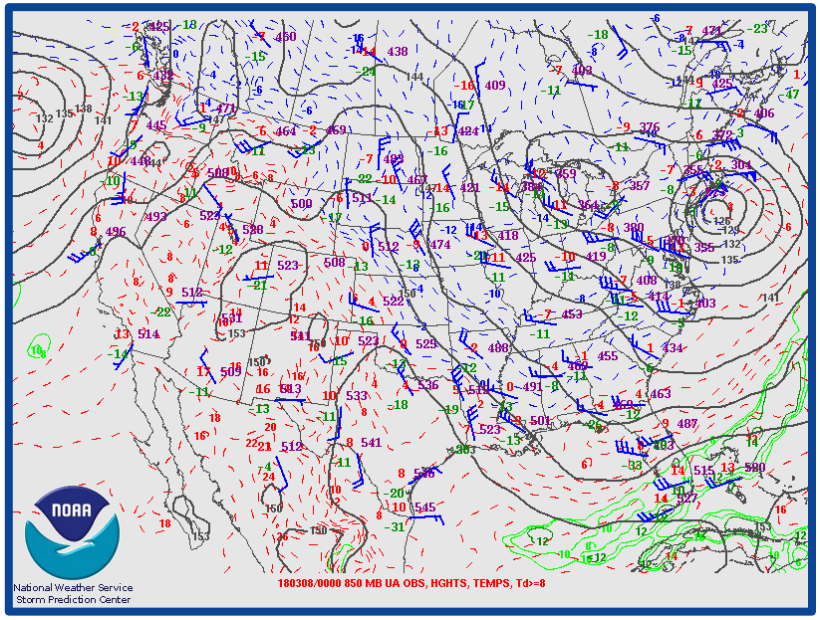


500 hPa Raobs, Heights (dam) & Temps (°C) Analysis

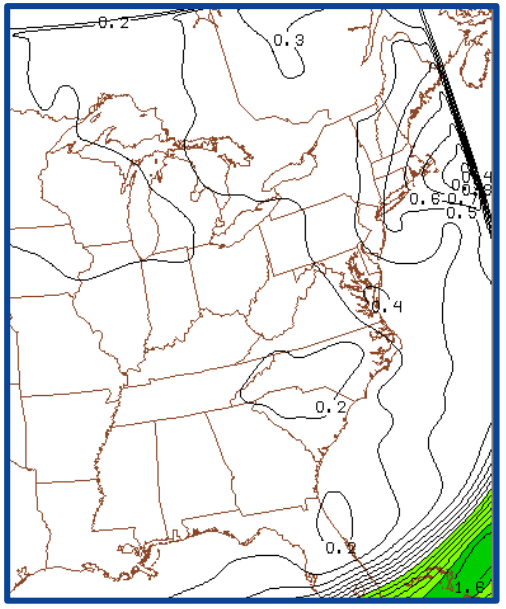


250 hPa Raobs, Heights (dam), Temps (°C) and Isotach Analysis

0000 UTC 8 March 2018 850 hPa & PWATs

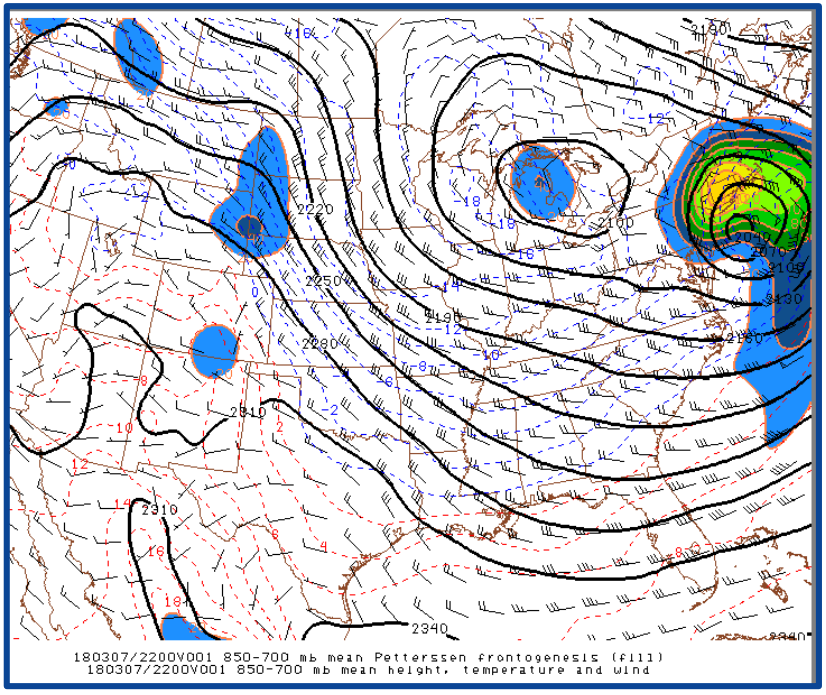


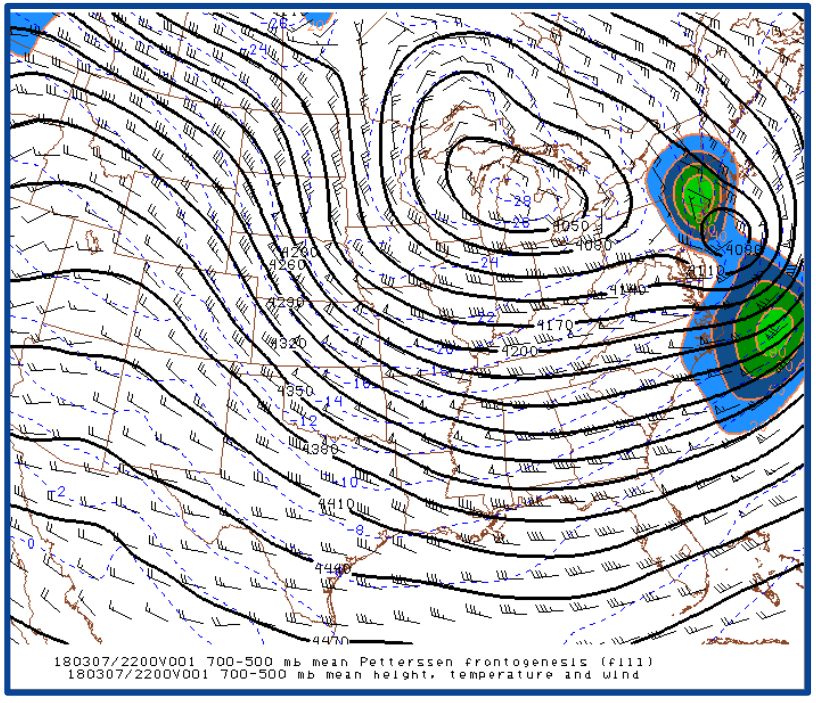
850 hPa Raobs, Heights (dam), Temps (°C) and Dewpts(°C) Analysis



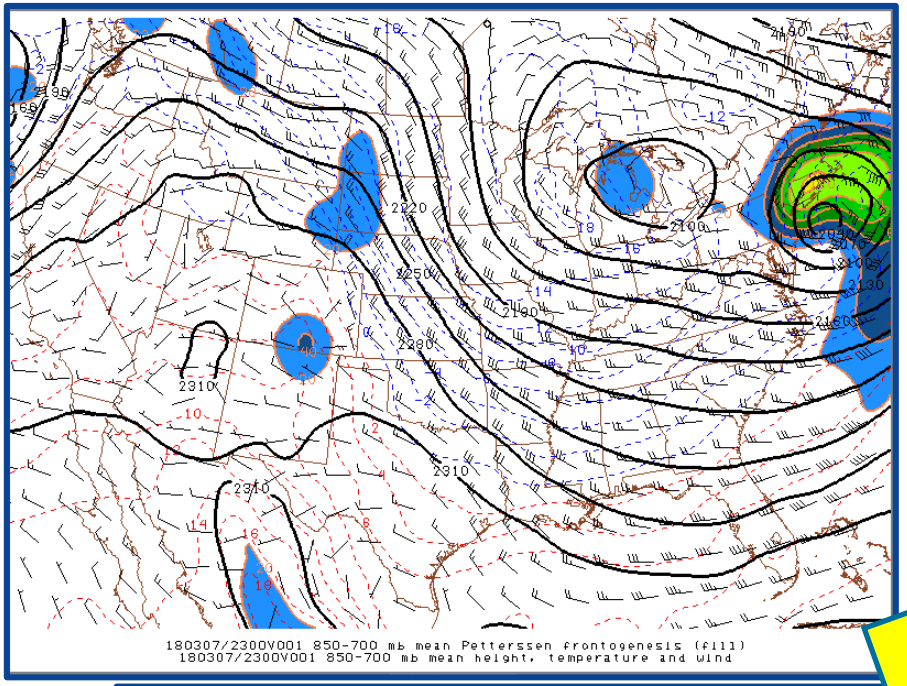
Rapid Refresh PWAT SPC Mesoanalysis

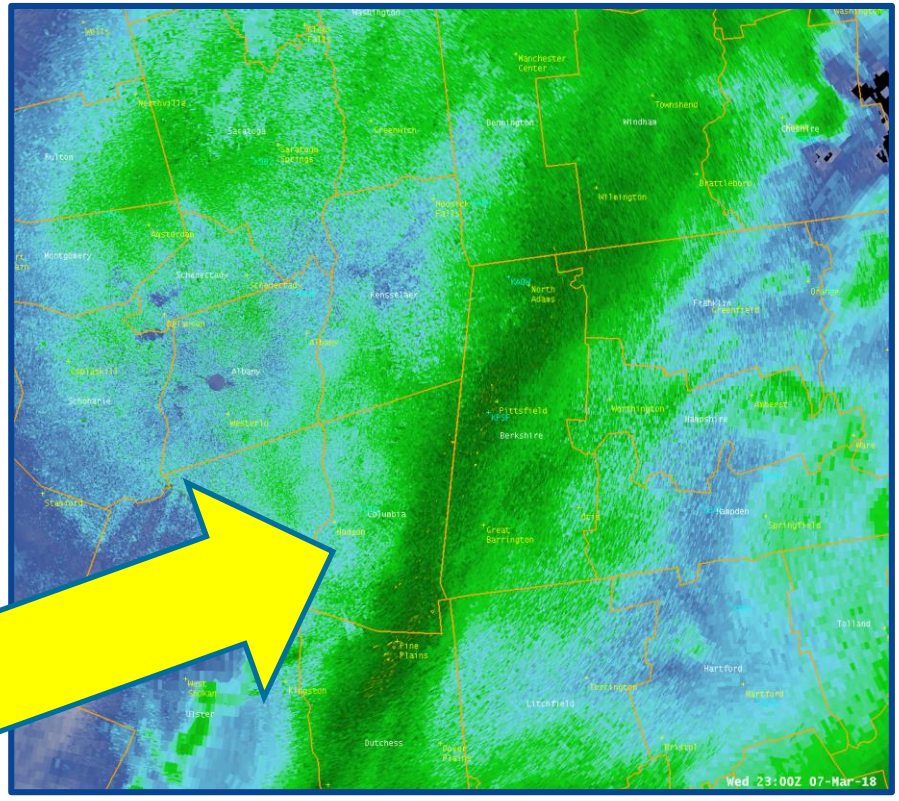
2200 UTC 7 March 2018 2-D FGEN





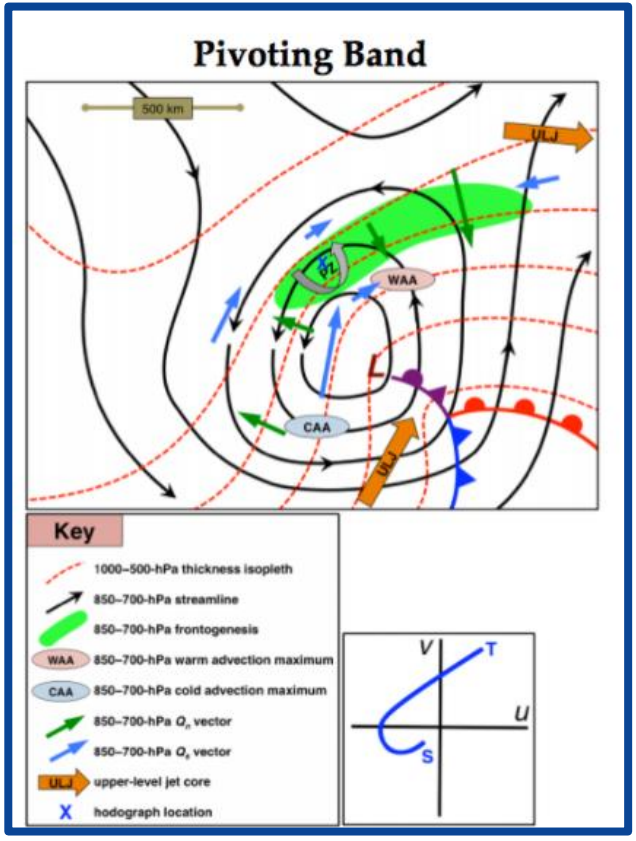
2300 UTC 2-D 850-700 hPa Mean 2-D FGEN, Heights and Temps (°C)



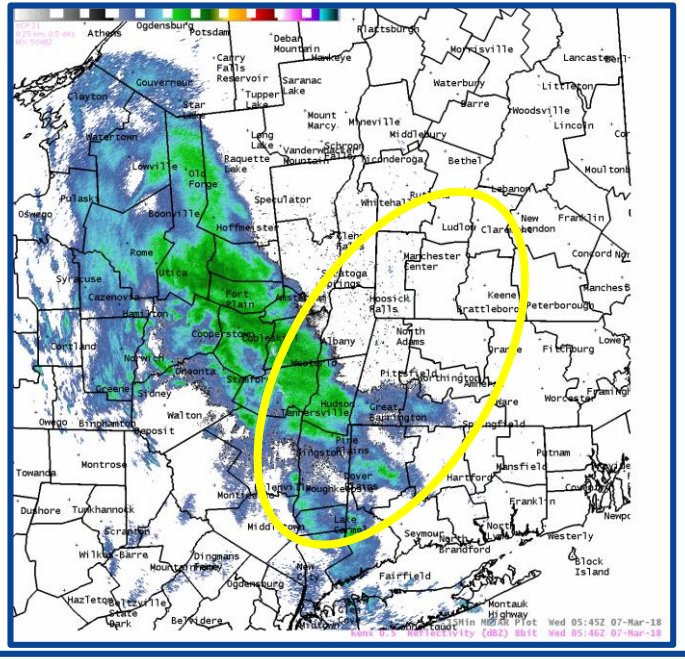


2300 UTC KENX radar shows impressive "Pivoting" single mesoscale band southeast of Albany and the Capital Region

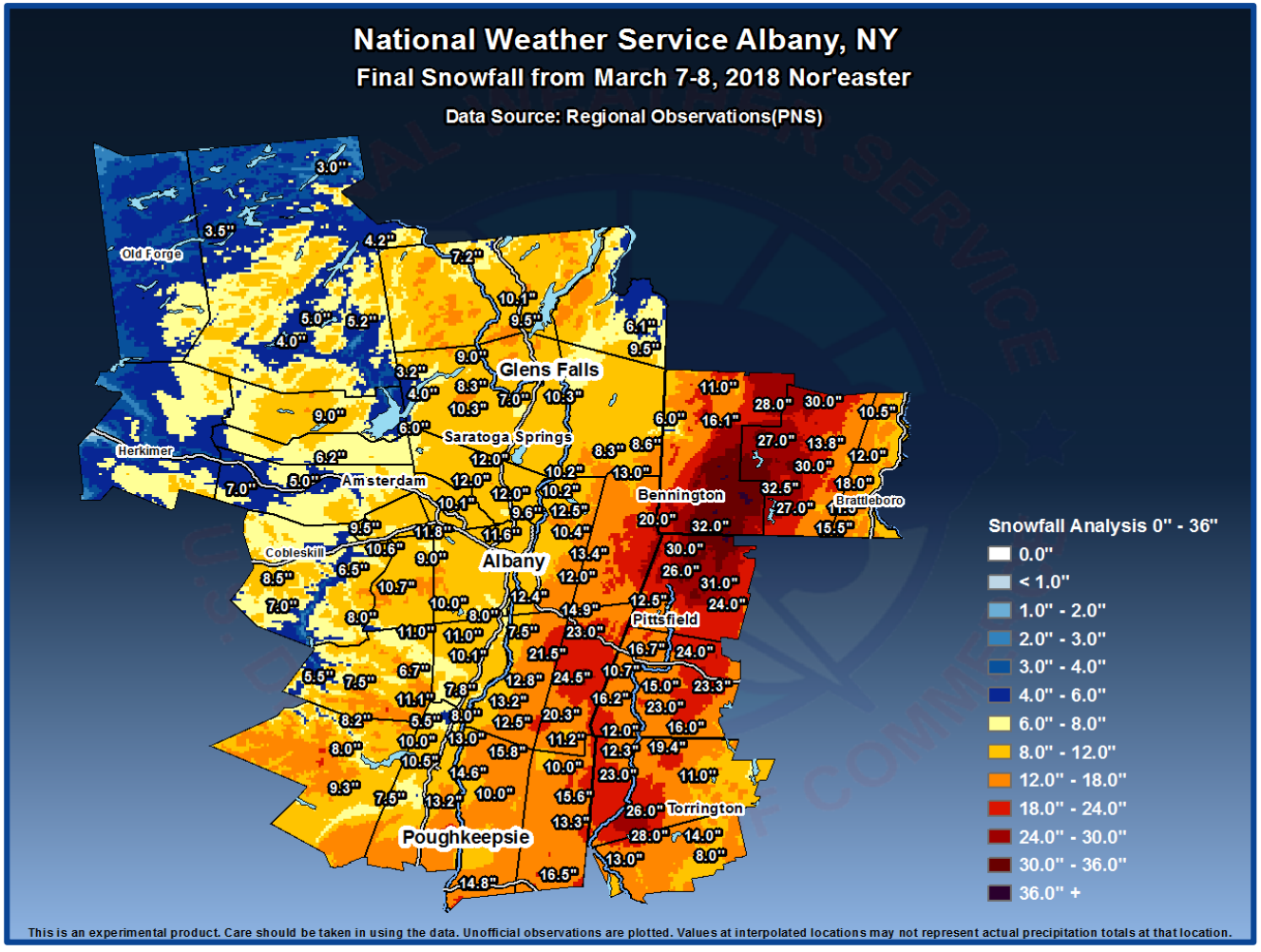
Kenyon Pivoting Band Conceptual Model (2013)



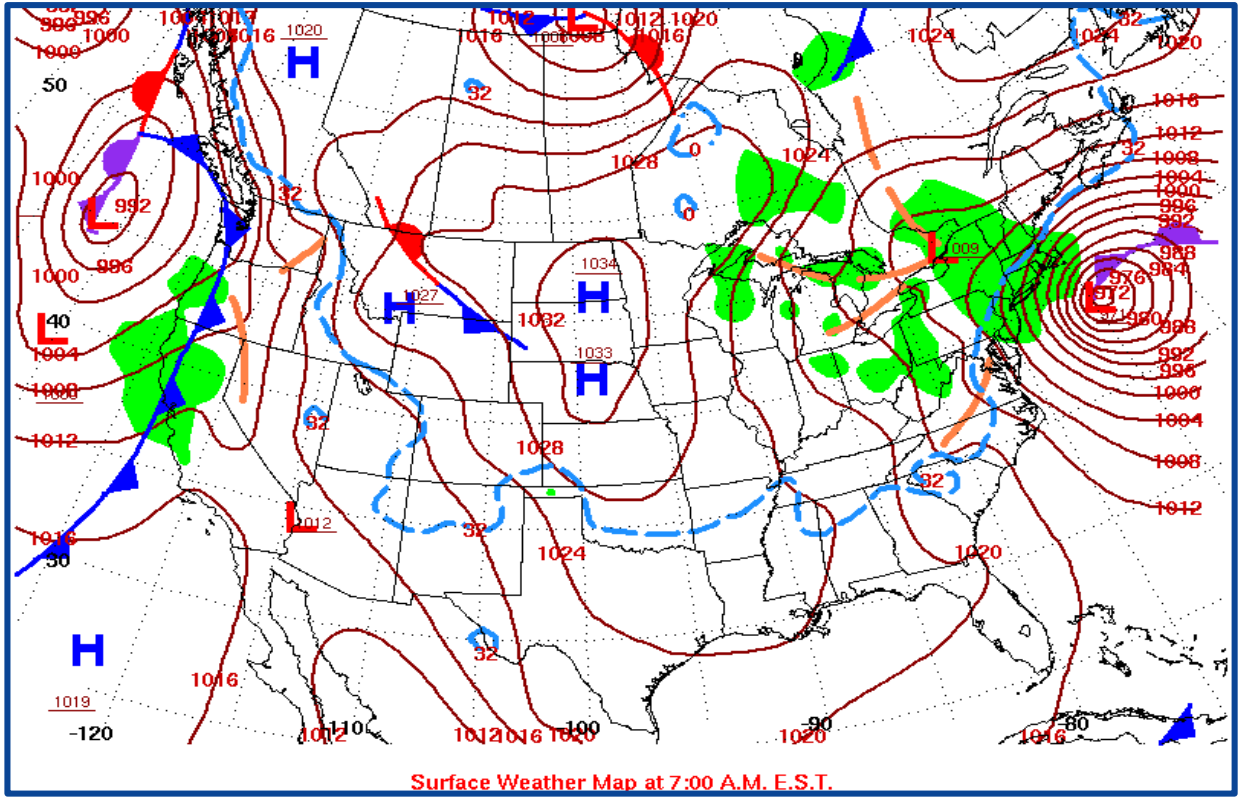
0600 UTC 7 MAR to 1300 UTC 8 MAR 2018



Impressive band with Hourly Snowfall rates: 1-3+”/hr

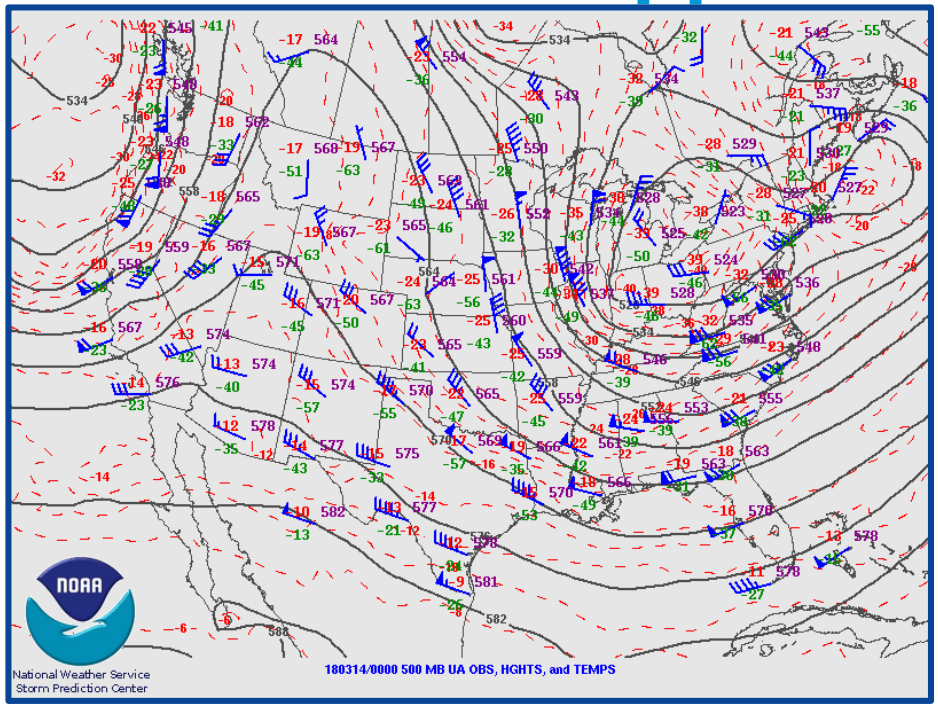

National Weather Service Albany, NY
Final Snowfall from March 7-8, 2018 Nor'easter
Data Source: Regional Observations(PNS)
Old Forge
Herkimer
Amsterdam
Glens Falls
Saratoga Springs
Cobleskill
Albany
Bennington
Brattleboro
Pittsfield
Torrington
Poughkeepsie
Snowfall Analysis 0" - 36"
0.0"
< 1.0"
1.0" - 2.0"
2.0" - 3.0"
3.0" - 4.0"
4.0" - 6.0"
6.0" - 8.0"
8.0" - 12.0"
12.0" - 18.0"
18.0" - 24.0"
24.0" - 30.0"
30.0" - 36.0"
36.0" +
This is an experimental product. Care should be taken in using the data. Unofficial observations are plotted. Values at interpolated locations may not represent actual precipitation totals at that location.

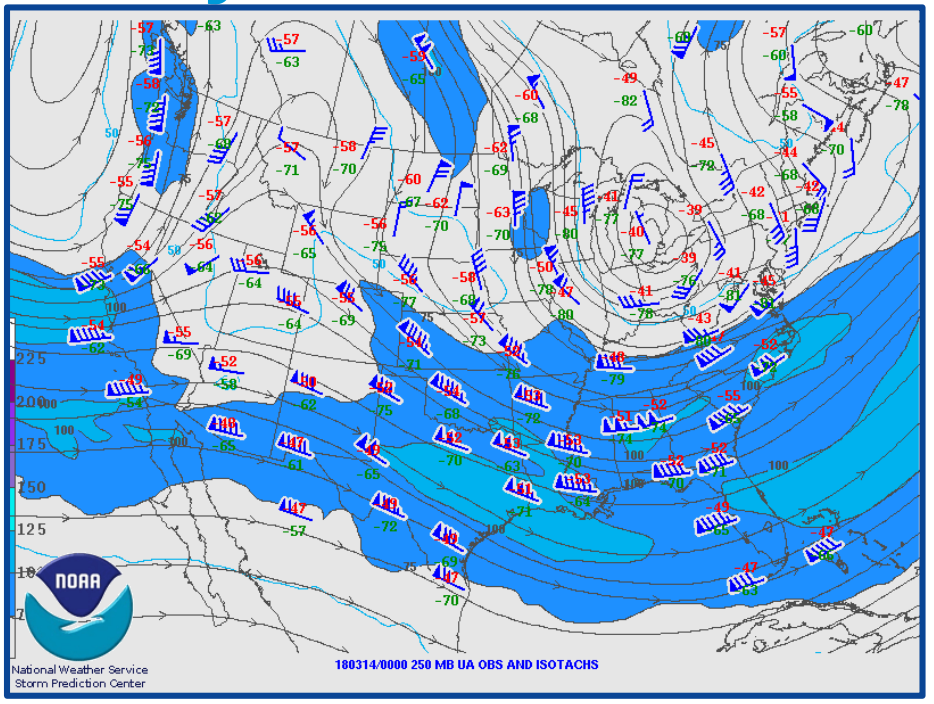
1200 UTC 13 March 2018 Surface Map



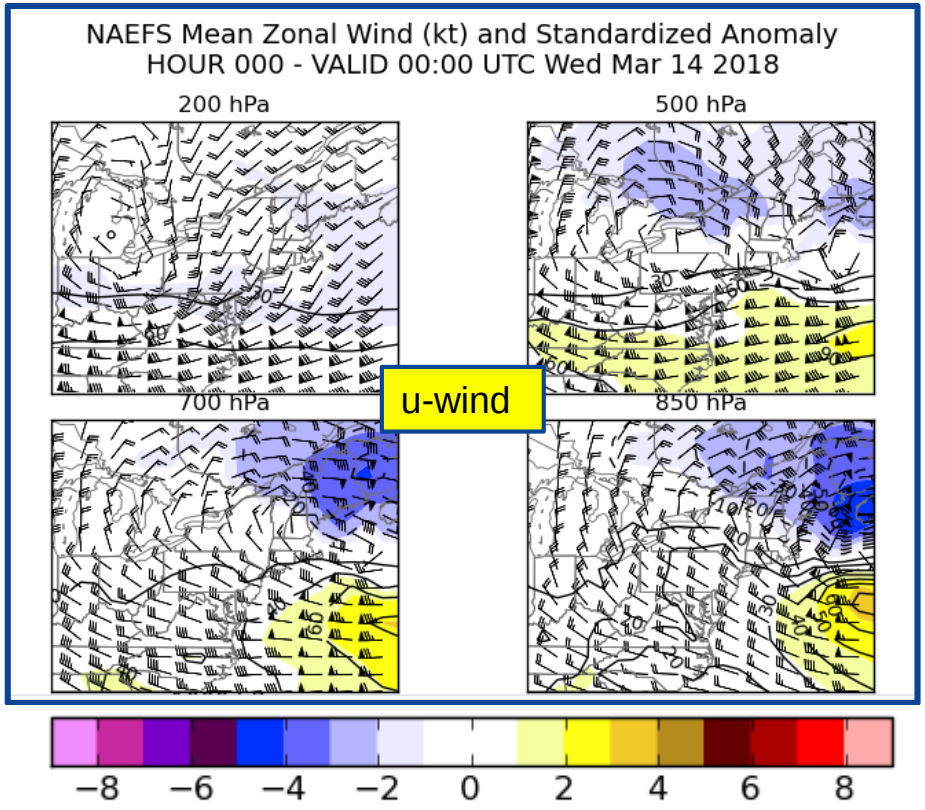
Miller Type B set-up again

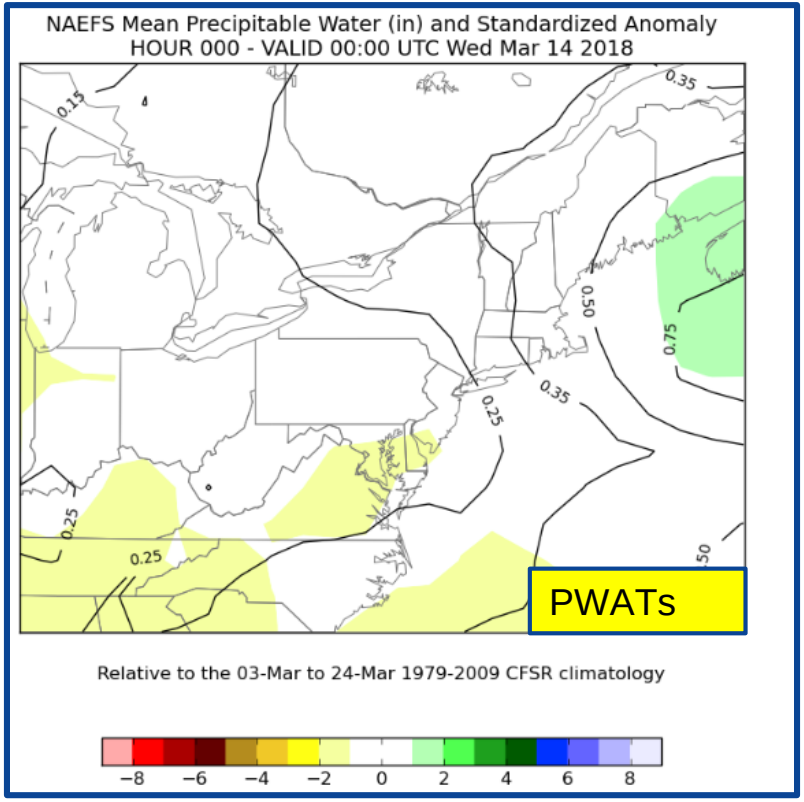
0000 14 March 2018 500 hPa and 250 hPa Upper Air Analysis





0000 UTC 14 MAR 2018 NAEFS Anomalies





Mohawk-Hudson Convergence (MHC) Event (Augustyniak 2008)

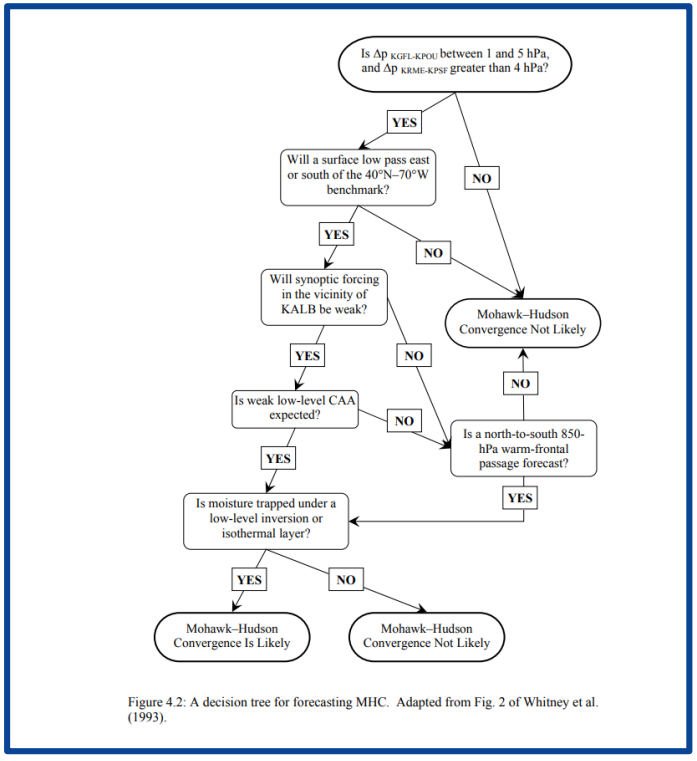
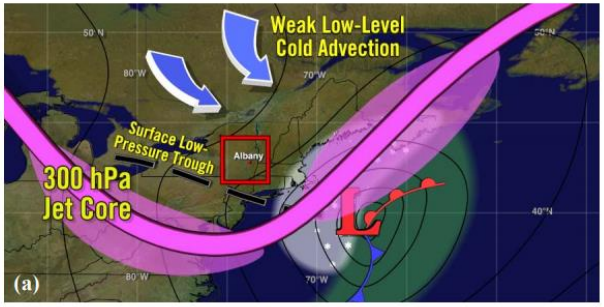


Figure 4.2: A decision tree for forecasting MHC. Adapted from Fig. 2 of Whitney et al. (1993).



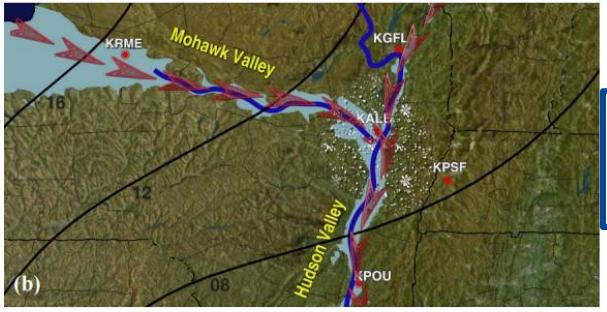
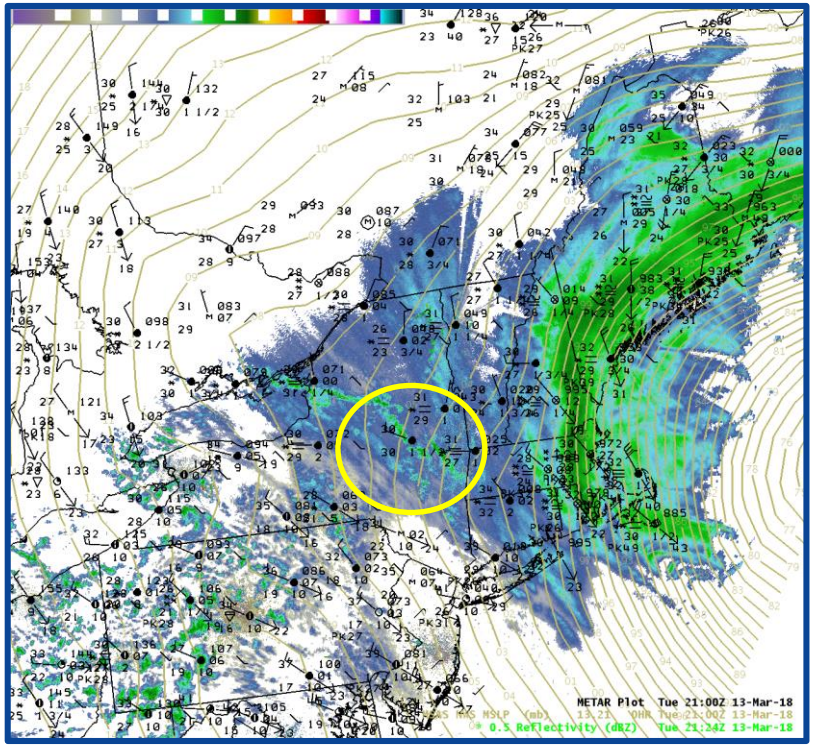


Figure 4.1: Schematic of the key features observed during a prototypical MHC event on the (a) synoptic-scale and (b) mesoscale. Shown in (a) are: an intensifying area of surface low pressure located southeast of 40°N, 70°W, and moving northeastward (red "L"); sea level isobars (solid black lines); a trough of surface low pressure; the attendant areas of synoptic-scale snow (white shading) and rain (green shading); the axis of 300-hPa maximum winds (heavy pink line) and jet streaks (pink shading); weak low-level cold advec-tion from the north; the area which bounds the MHC domain (red box). Shown in (b) are: the Mohawk and Hudson Rivers (royal blue line) and their associated valleys (light blue shading); low-level channeled flow (red arrows); sea level isobars with higher pressures indicated to the north and west (solid black lines); the approximate location of mesoscale snow forced by MHC effects (stippled shading); the locations of bellwether surface observation sites used in seven case studies (red circles and corresponding station codes.

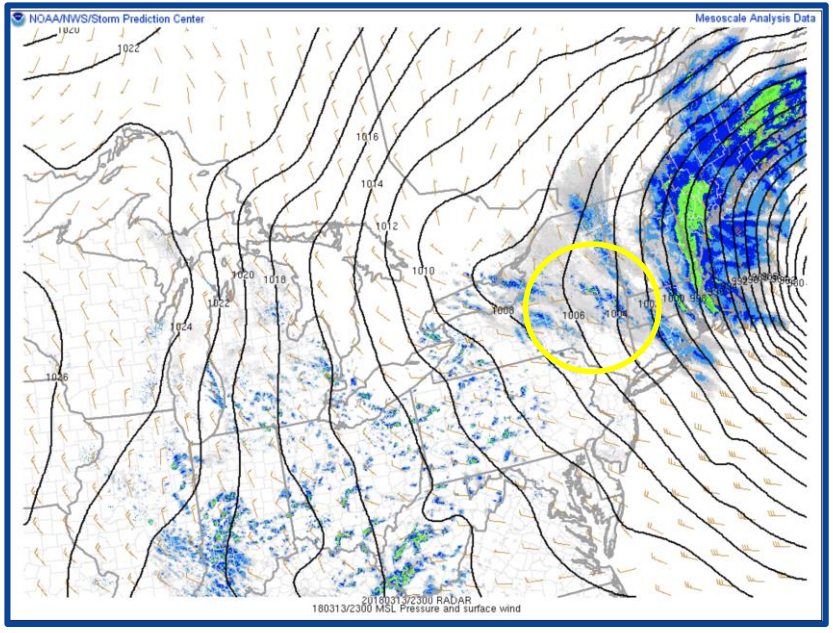
Synoptic Set-up

Mesoscale: Convergence of air parcels

2100 UTC & 2300 UTC 13 March 2018 Sfc Maps



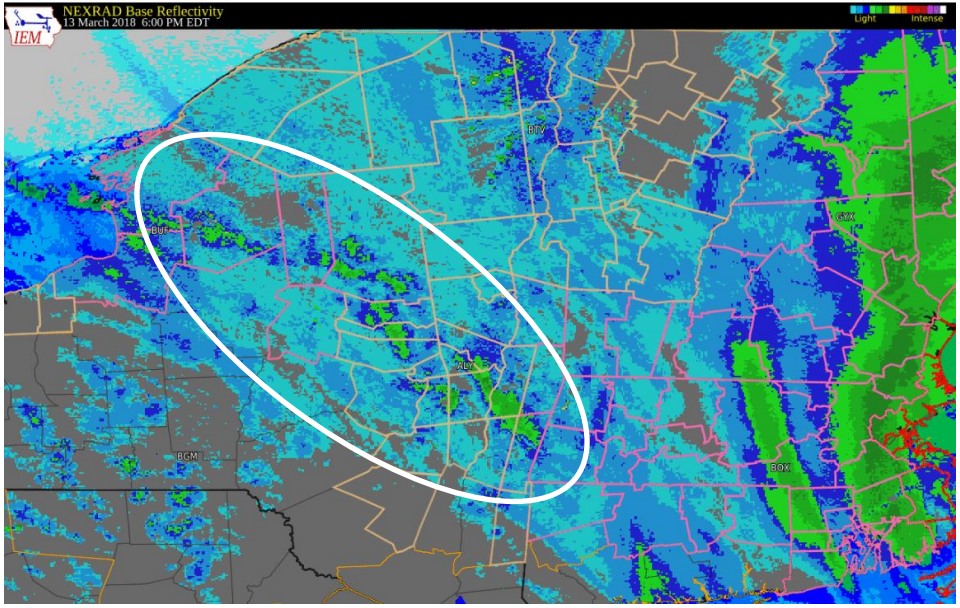
2100 UTC METAR, MSAS MSLP, and Regional Mosaic Overlay



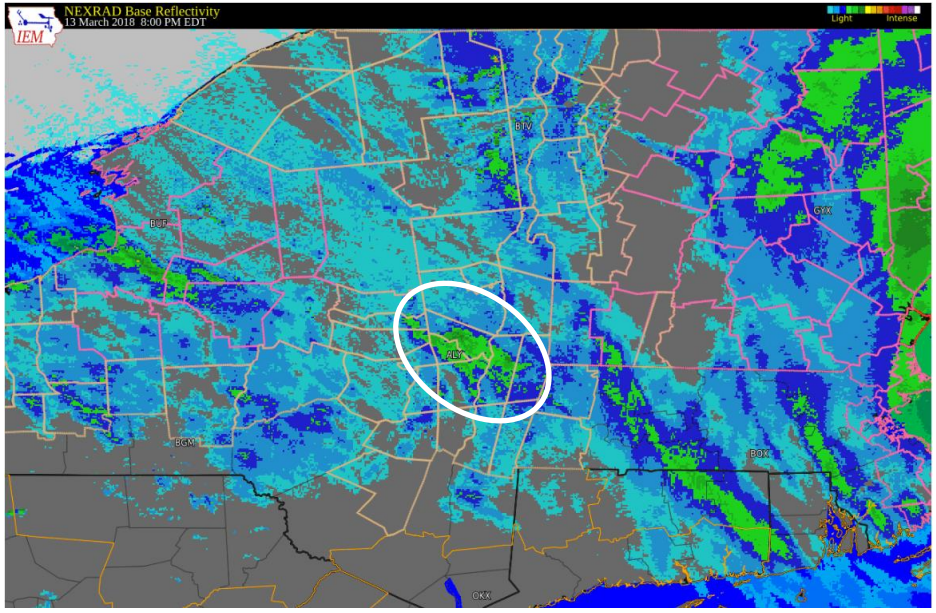
2300 UTC SPC Rapid Refresh Radar, MSLP, and Surface Wind Composite Overlay

Mesoscale Snowband focused by inverted trough

2200 UTC & 00 UTC: Evolution into MHC Snowband?



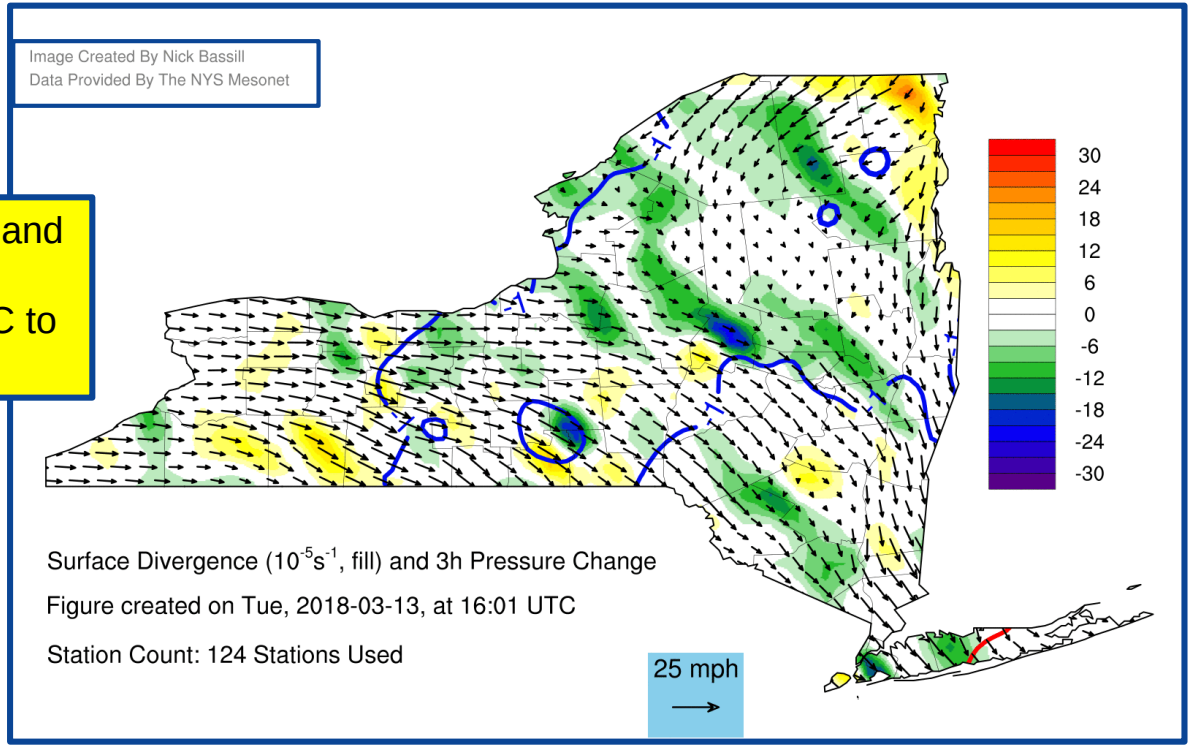
2200 UTC 13 MAR 2018: Reflectivity (dBZ)



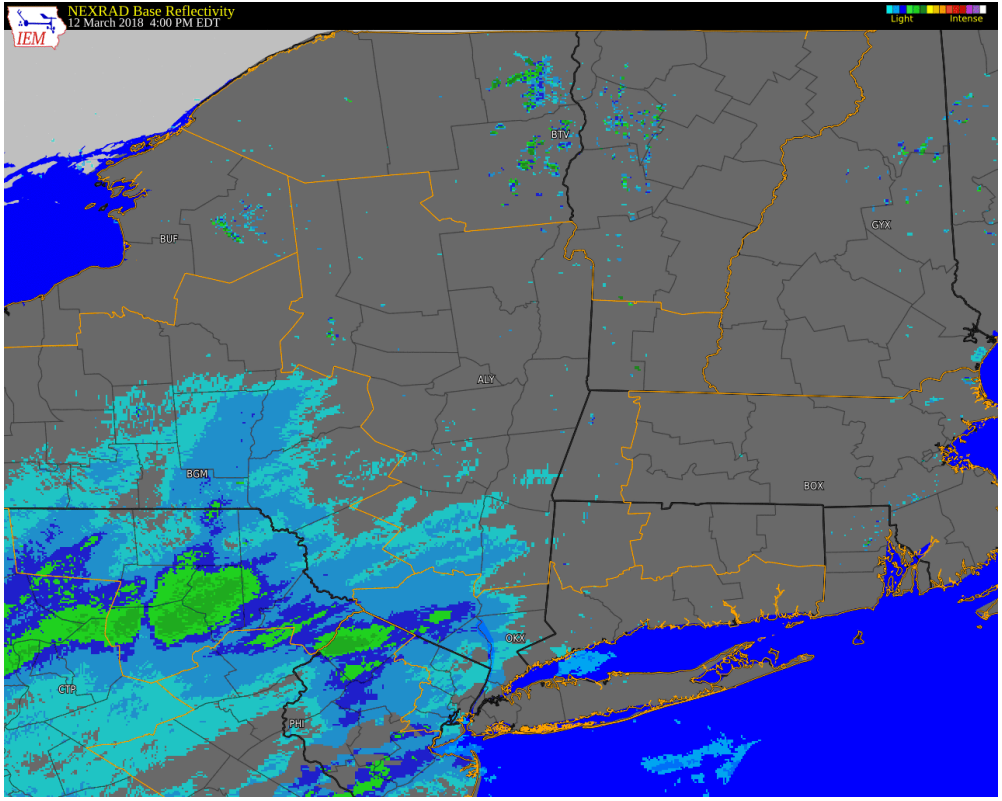
0000 UTC 14 MAR 2018: Reflectivity (dBZ)

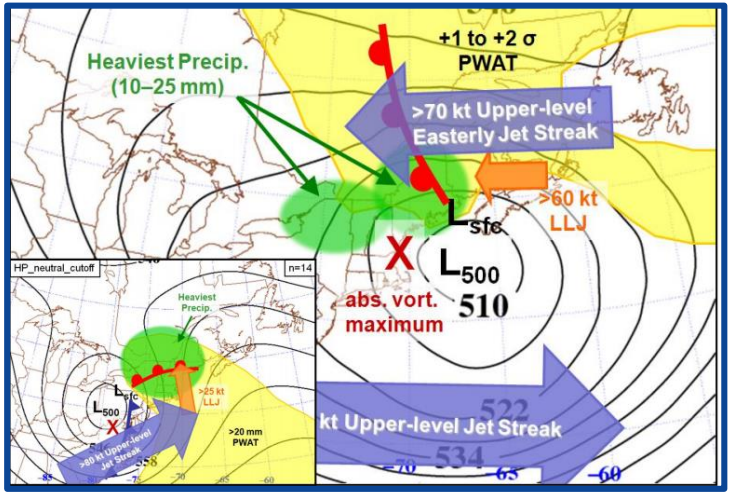
1600 UTC 13 MAR to 0400 UTC MAR 2018
Sfc Divergence (Convergence), Winds & 3-hr MSLP Change

Mesoscale snow band evolves into MHC between 0100 UTC to 0400 UTC



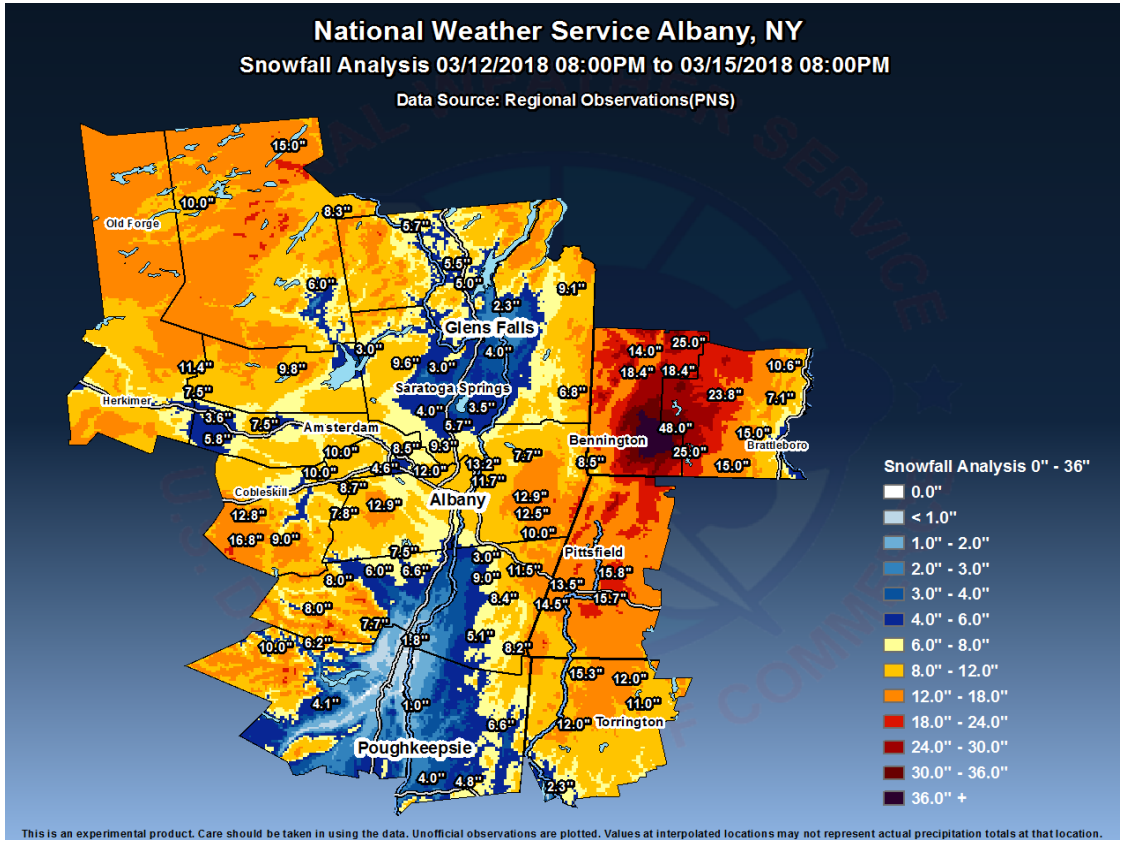
2000 UTC 12 MAR to 1100 UTC 15 MAR 2018 Radar Loop





Cut-off low and Westerly Upslope Flow (Payer 2010) provided additional heavy snows in the western New England higher terrain

12 – 15 March 2018 Snow Totals Amounts

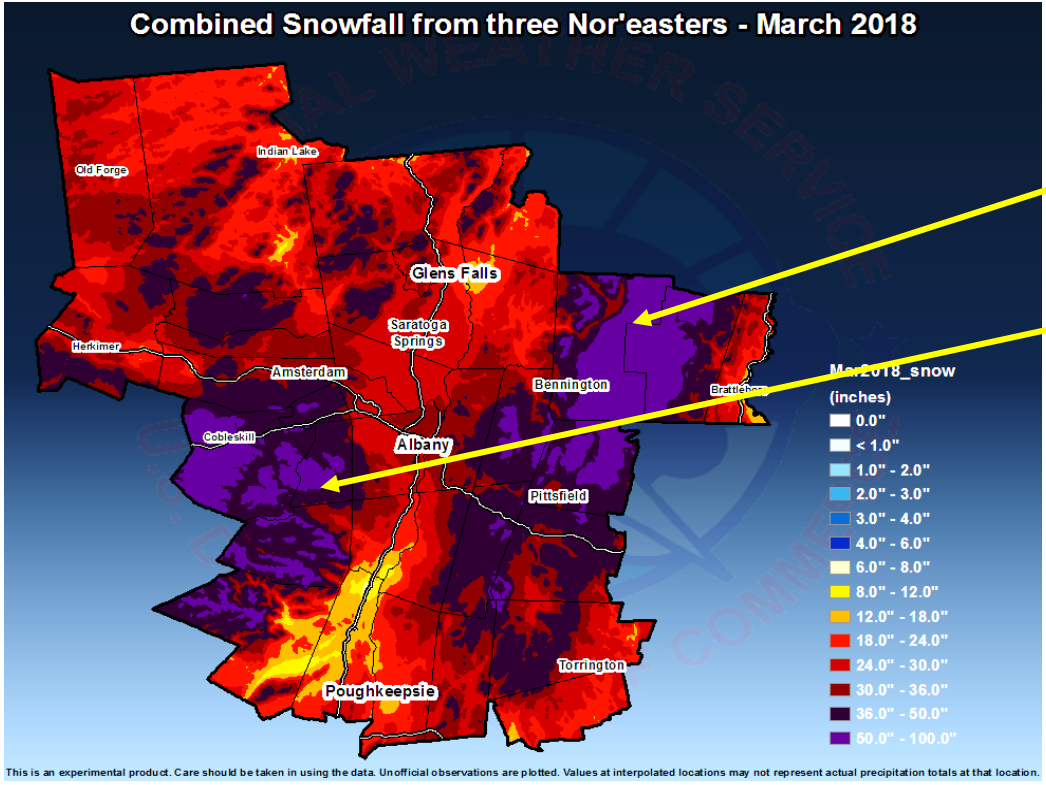


Woodford, VT March 15, 2018

48” of snow and close to 100” for all 3 storms!

Photo: Mike Evans, NWS Albany, NY

3 Storm Snow Totals: 1-15 March 2018



Southern Greens & eastern Catskills widespread 60-100”

Conclusions

- 3 high impact transitional season Northeast snowstorms with record snowfall
- Miller Type-B systems with decaying primary low and secondary coastal cyclogenesis
- Jet streaks, upper and lower wind anomalies coupled with moisture anomalies helped produce the heavy snowfall
- Mesoscale snow bands (pivoting bands) were dominate
- CSTAR conceptual models aided operational forecasters in the warning decision making and snowfall forecasts (https://vlab.ncep.noaa.gov/web/albany-cstar/home)

March in the Albany Forecast Area…

Came in like a Wampa….

…and went out like a TaunTaun

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