Applications of Winter Mesoanalysis: Lessons Learned From The February 16-17, 2024 Winter Storm

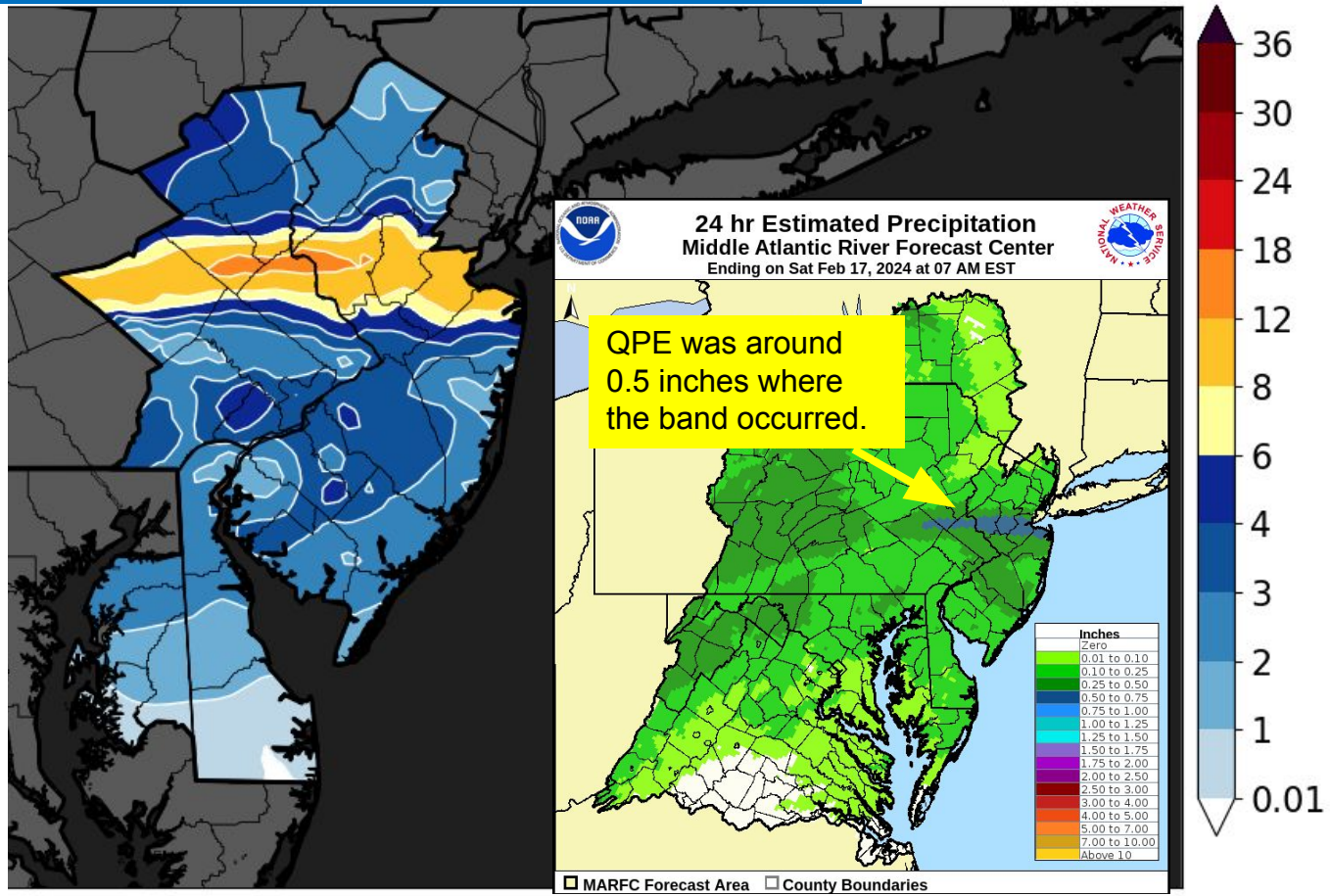
Heavy Banded Snow Throws Us a Curveball!

What Happened?

- Quick moving low tracks ENE from Texas Panhandle to Virginia then over southern Delmarva Friday night into early Saturday Feb 16-17, 2024

- Large swath of the PHI CWA sees 1-4 inches of snow with **a narrow heavy band of 6-12+ inches** falling just south of the I-78 corridor through eastern PA into NJ

- **Heavy snow band was narrower, more intense, and about 50 miles north of where model consensus had it placed;** max QPF close to what was forecast by the models however very high snowfall ratios (20:25/1) led to higher than forecast maximum amounts



Why Does This Matter?

- Core Partners were expecting a 2 to 4 inch snow event for the areas affected by the heavy snow band – they were not prepared for 6-12+ inches!

- This event occurred overnight but a similar future event occurring during the daytime could bring very high impacts! Similar past events noted below:
  - December 15, 2017 – traffic backed up for hours on 295
  - November 15, 2018 – Traffic snarled over northern NJ, NYC metro – children stranded at schools, commuters spent 8+ hours getting home!

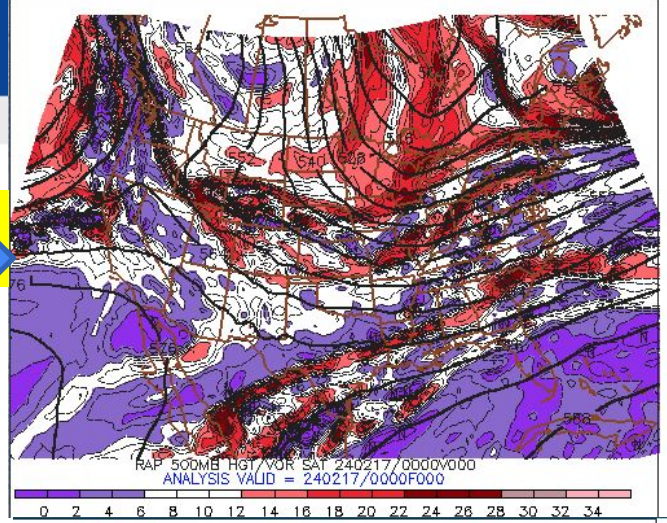
- **If we can message these events effectively and respond to signals in the near term we can <u>improve warning lead time and better prepare our partners!</u>**

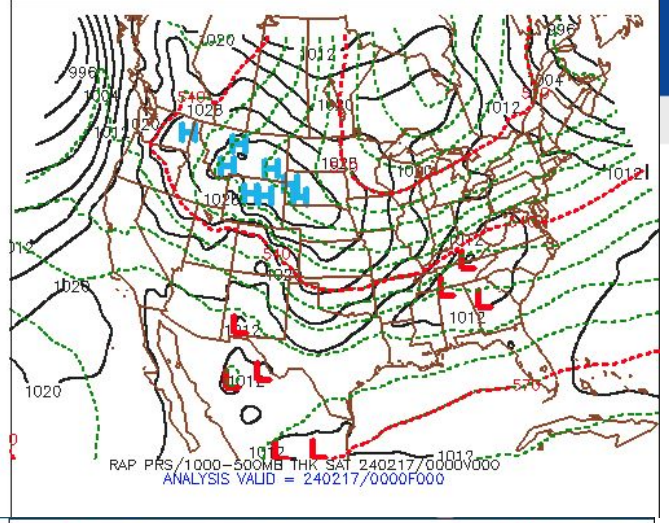
Overview

- We will review what happened including model performance

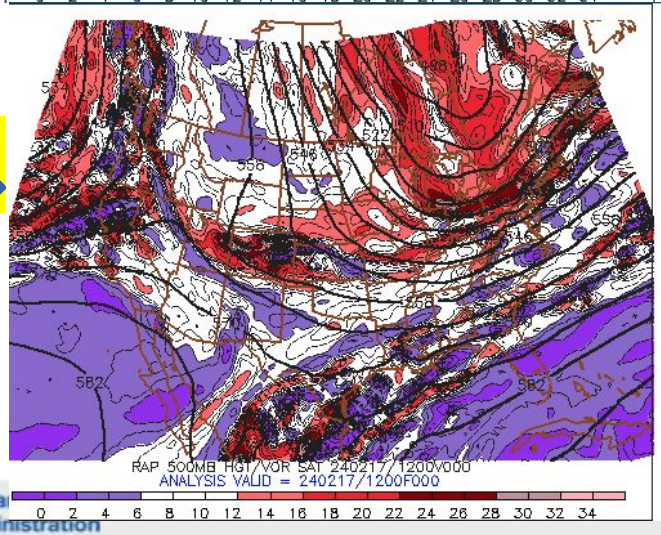
- ***Were there any clues in the guidance and/or analysis in the 12 -18 hours leading up to the event telling us what would ultimately happen? - If yes, we can learn from this and apply to future events!***

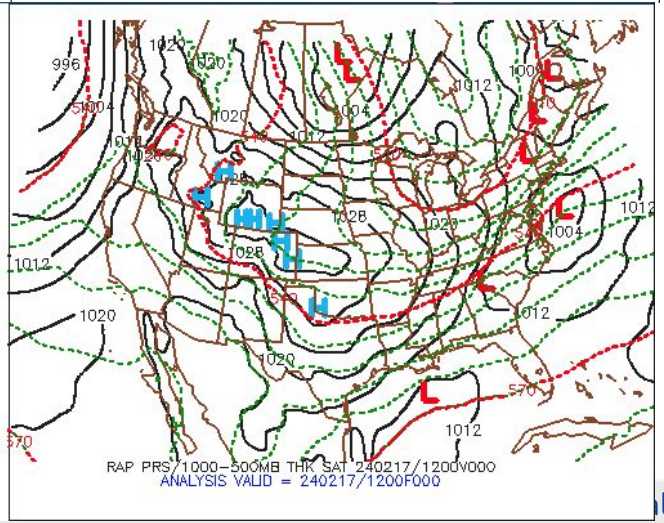
RAP 0hr valid 0z 2/17



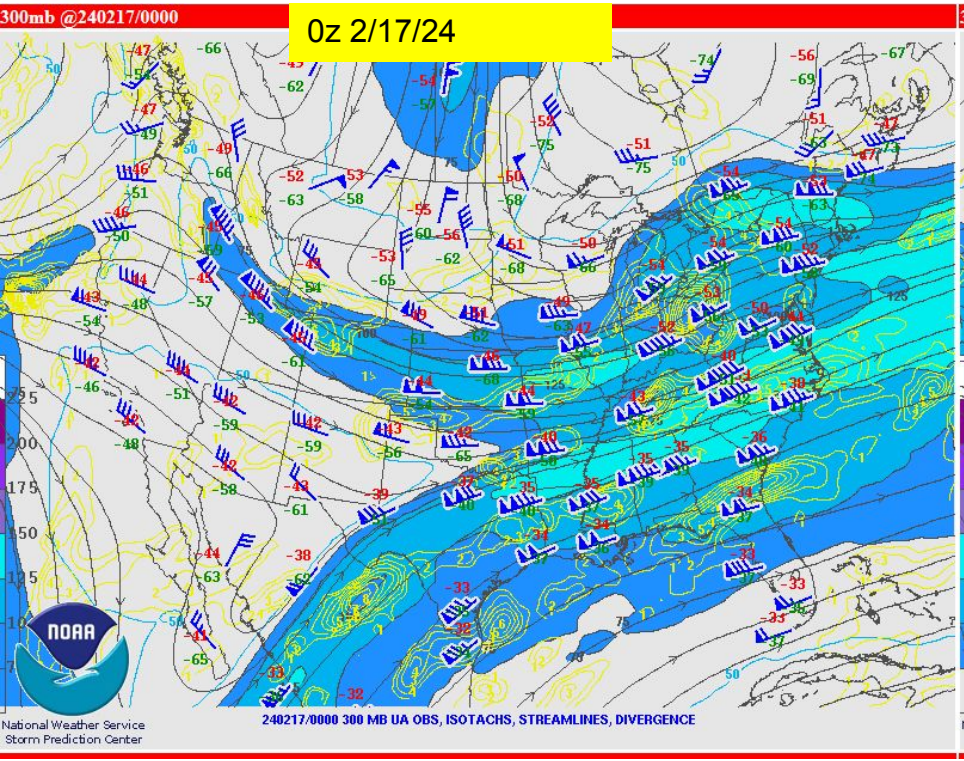


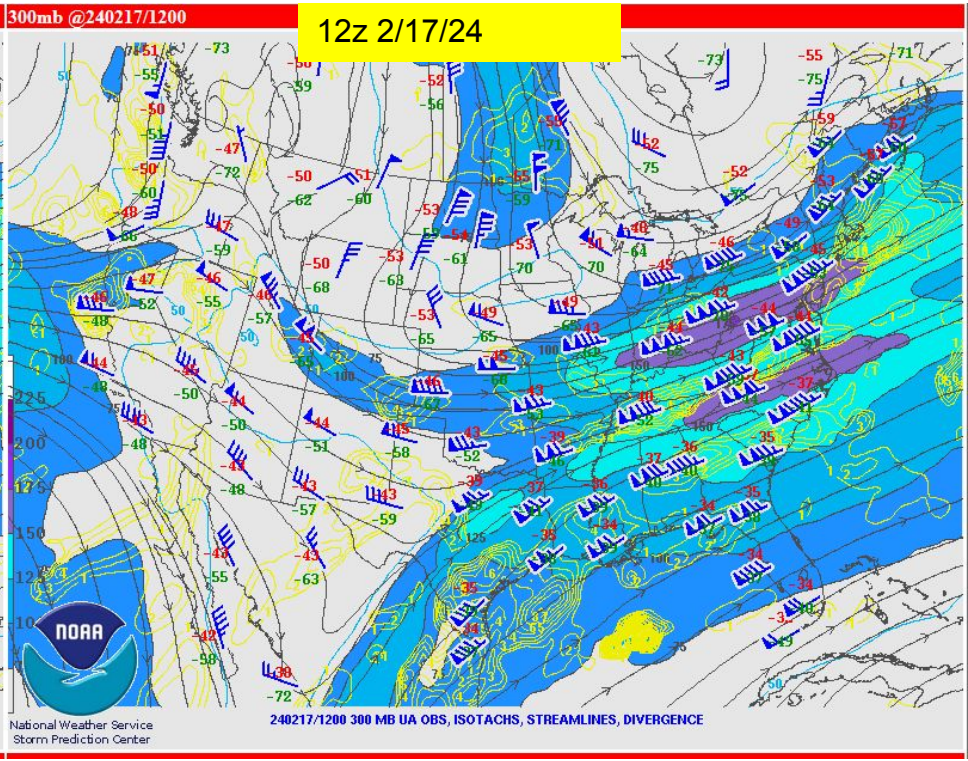
RAP 0hr valid 12z 2/17





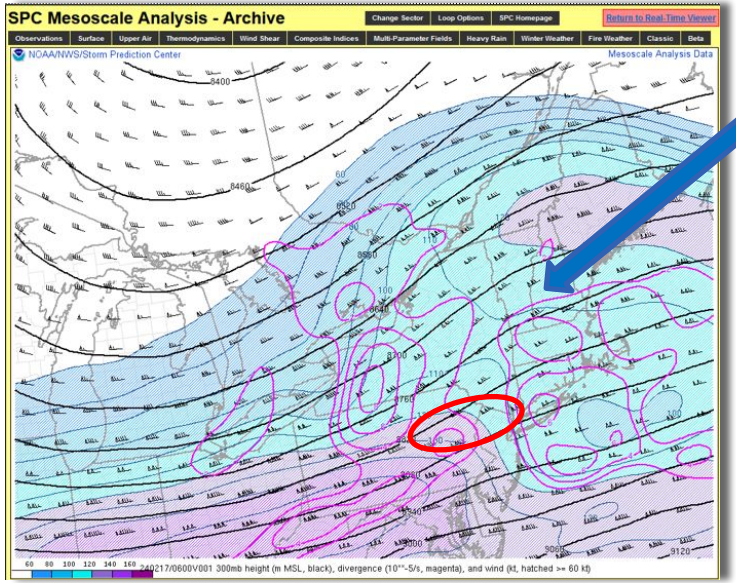
300 MB Analysis





Mesoscale Setup

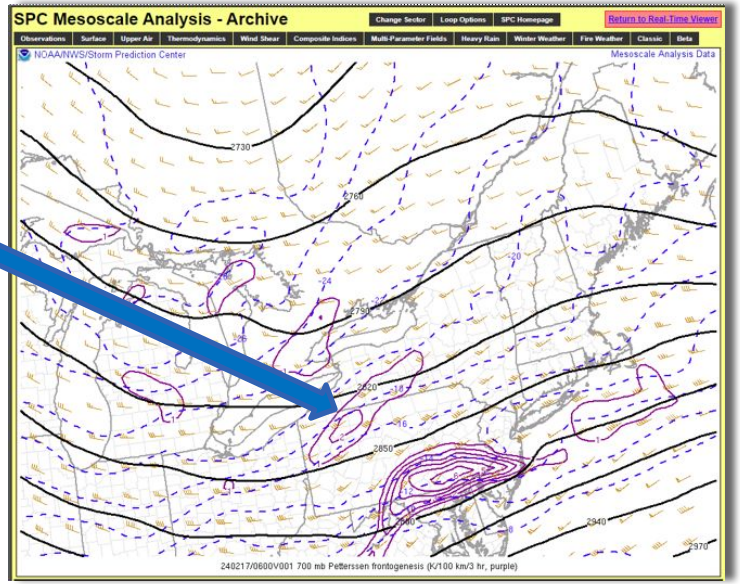
06z 300 mb heights, wind, divergence



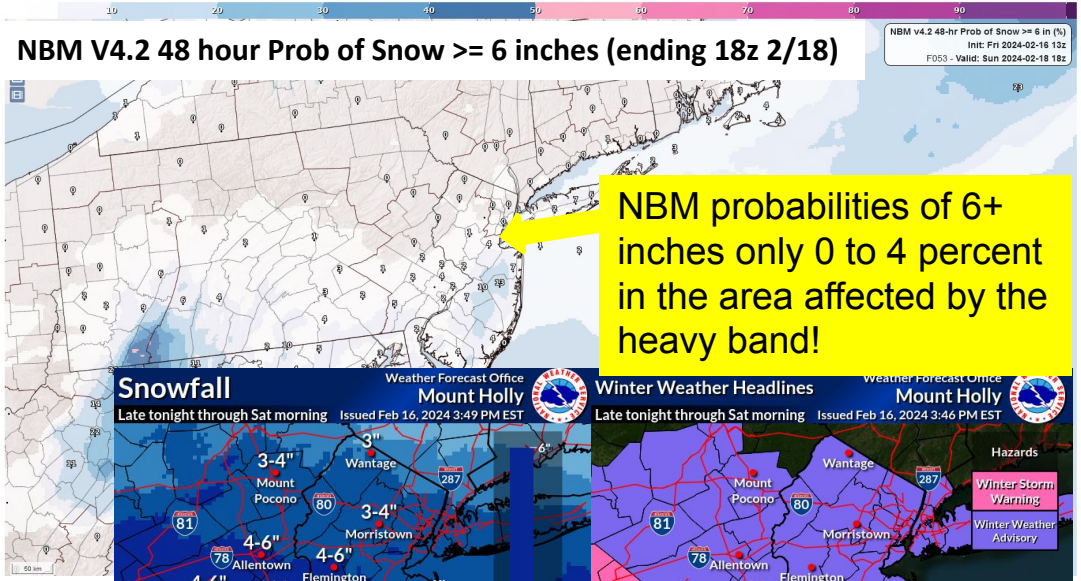
Band developed due to enhanced lift from dual jet streaks (left) & strong FGEN Forcing (right).

System driven by strengthening upper level jet rounding base of strong, progressive upper trough acquiring a neutral to slightly negative tilt as it moved east.

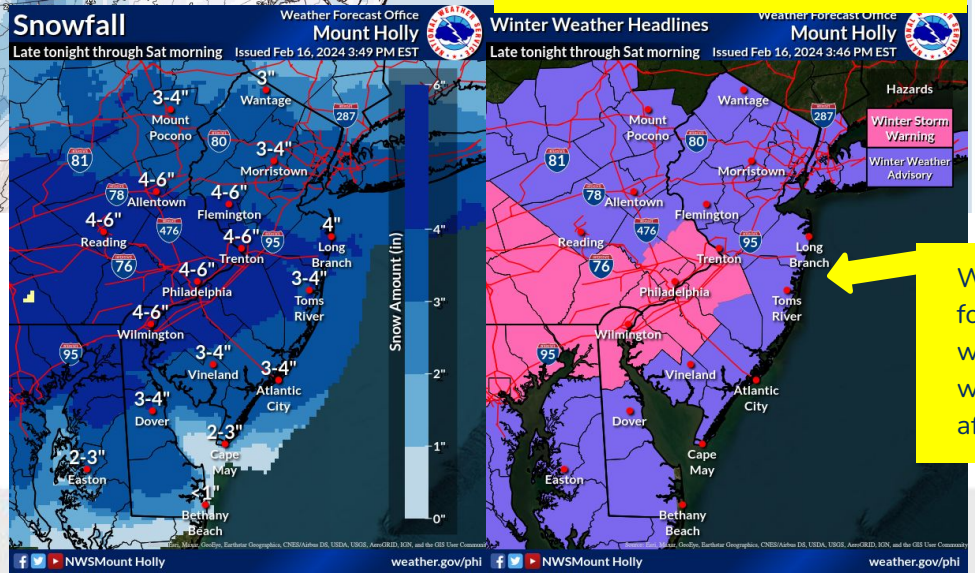
06z 700 mb heights, temperature, Fgen



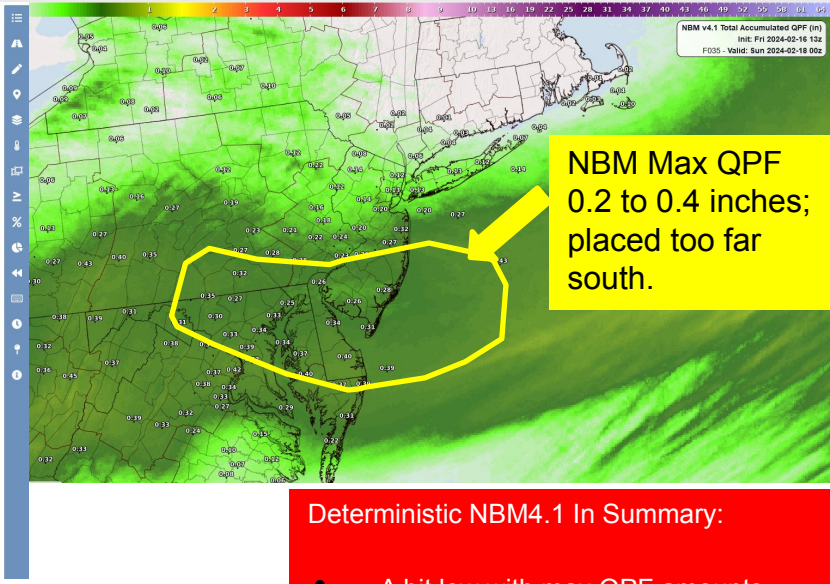
An Imperfect Forecast….



NBM probabilities of 6+ inches only 0 to 4 percent in the area affected by the heavy band!



WFO PHI snowfall forecast and winter weather headlines with Friday, 2/16 mid afternoon update.



NBM Max QPF 0.2 to 0.4 inches; placed too far south.

Deterministic NBM4.1 In Summary:

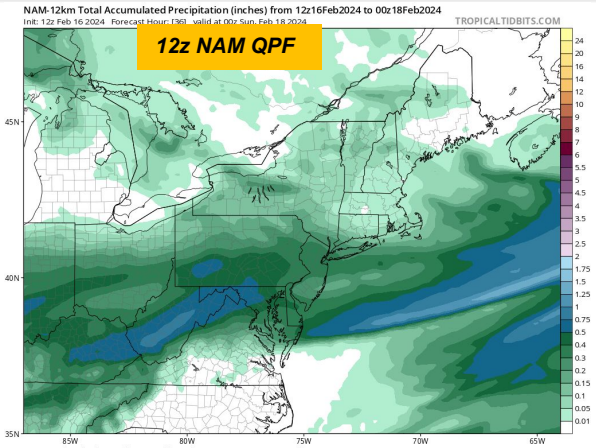
- A bit low with max QPF amounts.
- Too low with snow ratios under band.
- Axis of heaviest QPF displaced too far south.

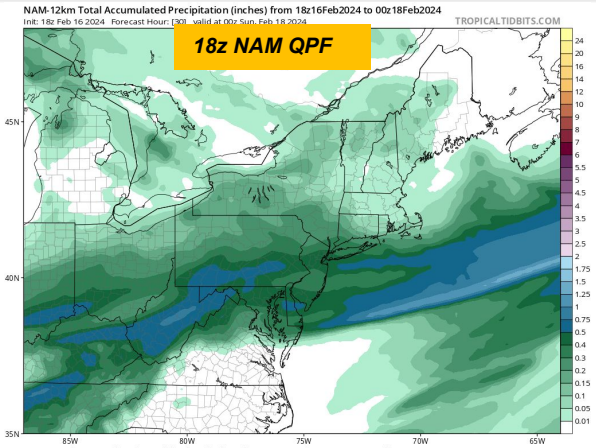
National Weather Service
Philadelphia/Mount Holly

- So….were there clues???.....

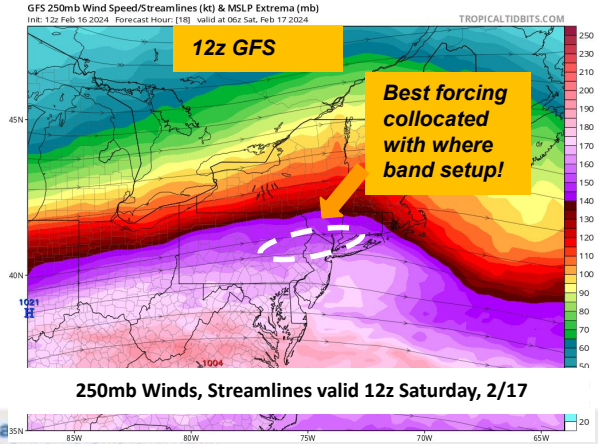
Clues In the Model Guidance…

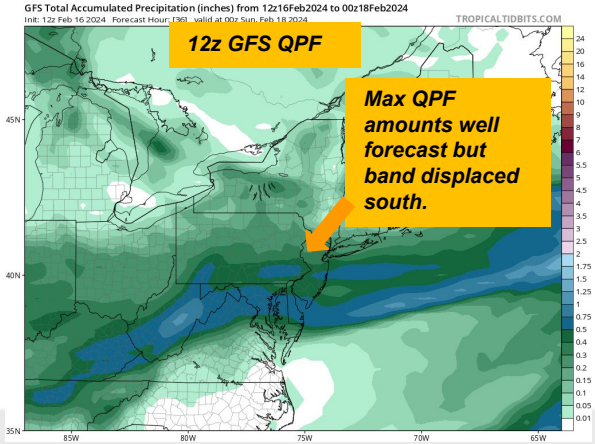
Clue #1: NAM is a northern outlier and also trending north.





Clue #2: GFS places strongest forcing north of its max QPF (this affects NBM!).





Clues In the Model Guidance…

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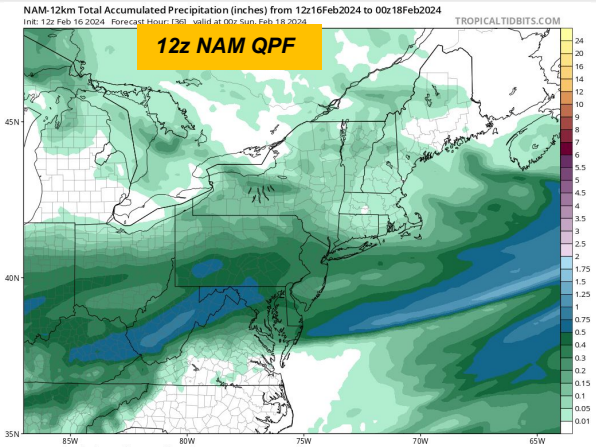

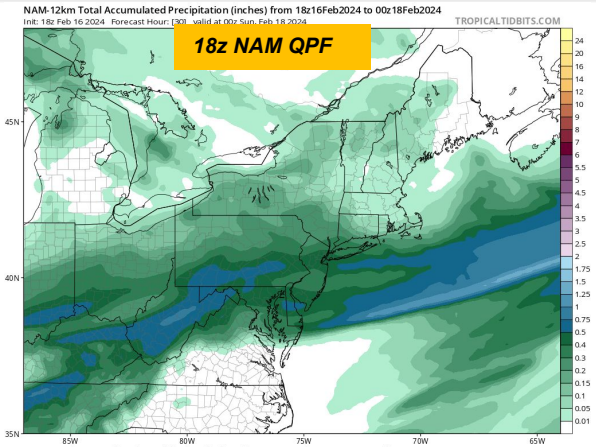

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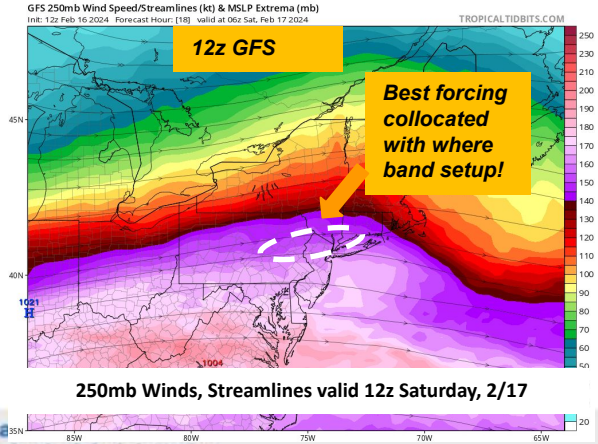
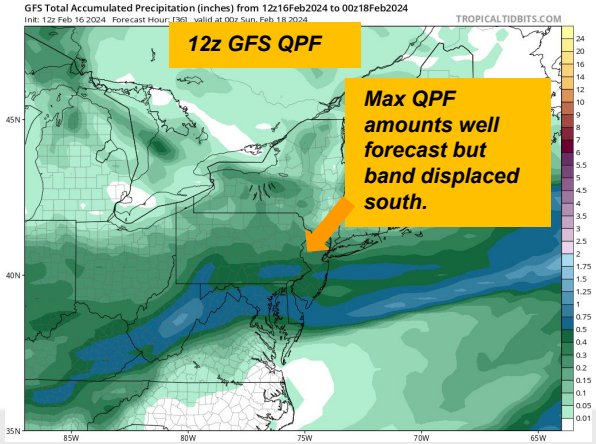
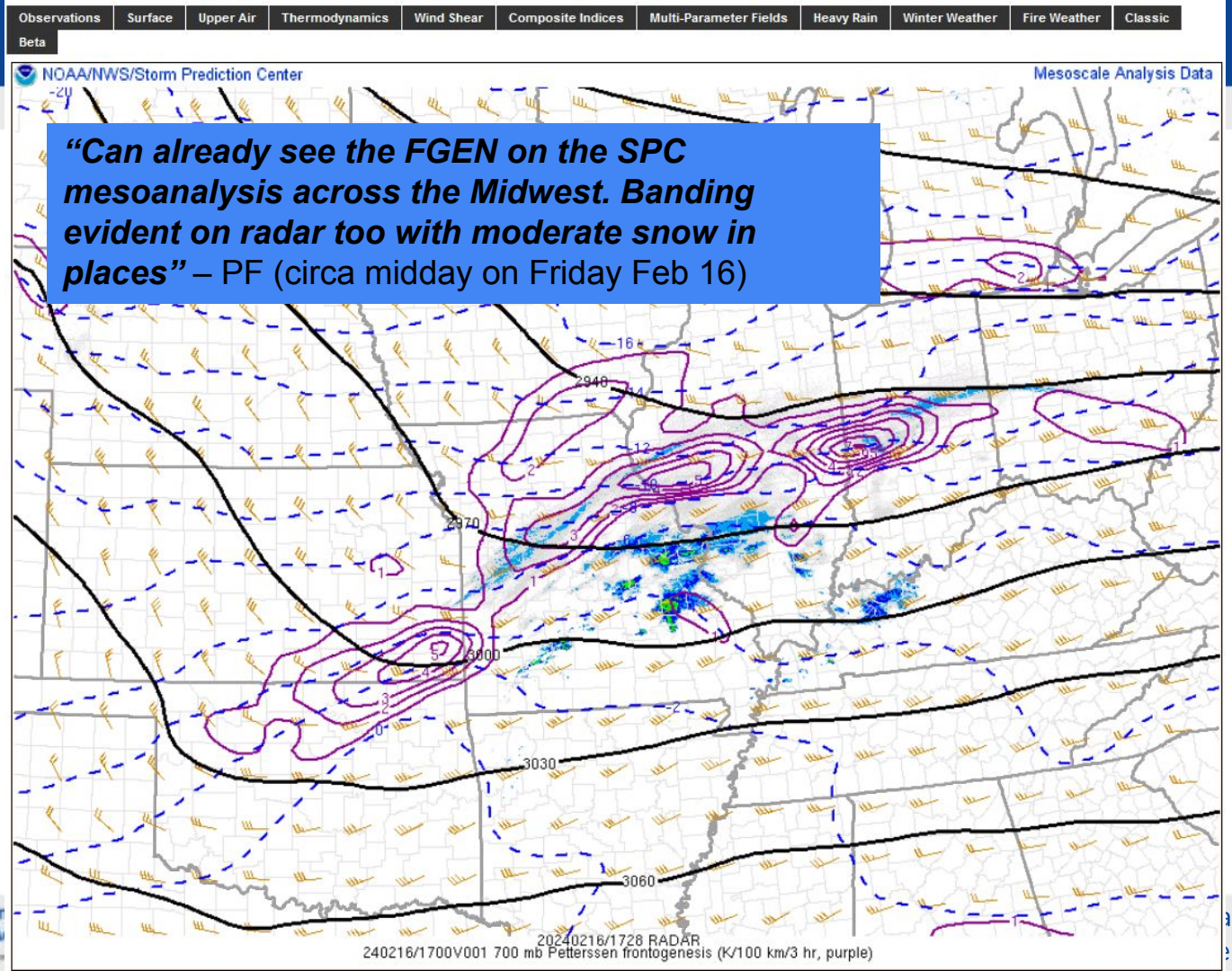
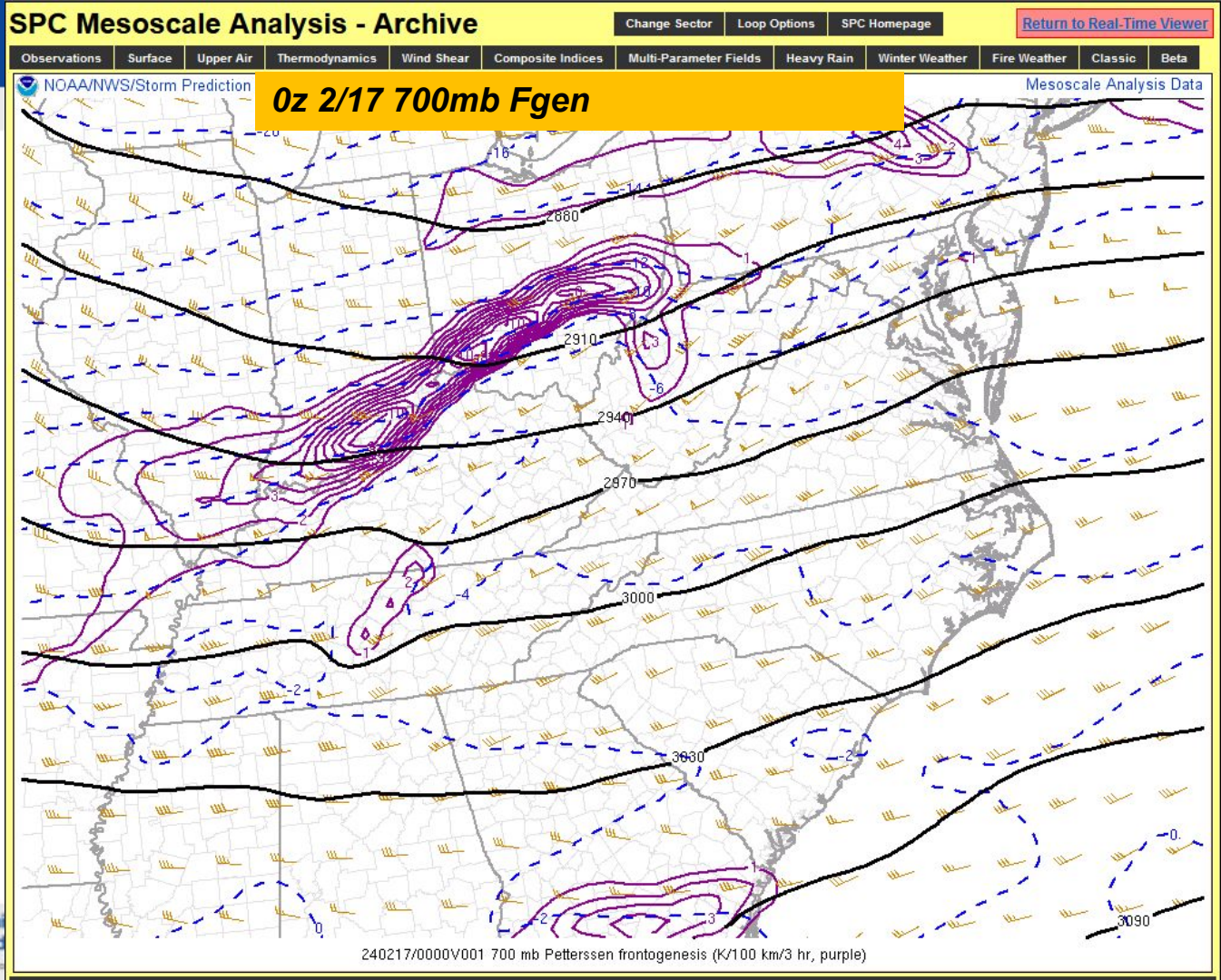




Based on these clues, would it be reasonable to increase snow amounts farther north and consider expanding Winter Storm Warning north?



"Can already see the FGEN on the SPC mesoanalysis across the Midwest. Banding evident on radar too with moderate snow in places" – PF (circa midday on Friday Feb 16)


SPC Mesoscale Analysis - Archive
Change Sector
Loop Options
SPC Homepage
Return to Real-Time Viewer
Observations
Surface
Upper Air
Thermodynamics
Wind Shear
Composite Indices
Multi-Parameter Fields
Heavy Rain
Winter Weather
Fire Weather
Classic
Beta
NOAA/NWS/Storm Prediction
0z 2/17 700mb Fgen
Mesoscale Analysis Data
2880
2910
2940
2970
3000
3030
3060
3090
240217/0000V001 700 mb Petterssen frontogenesis (K/100 km/3 hr, purple)

Enter a start time and end time for Local Storm Reports

Start Date: 02 / 16 / 2024 Start Hour: 12:00 -1 Day +1 Day

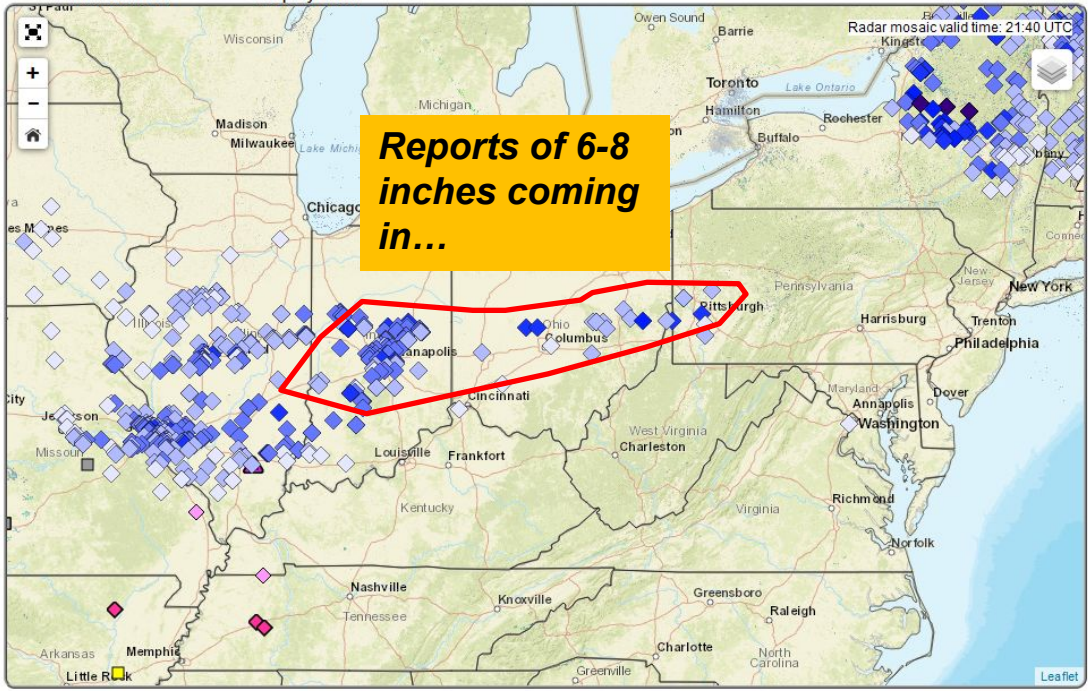
End Date: 02 / 17 / 2024 End Hour: 00:00 -1 Day +1 Day

Create a bounding lat/lon box for a more specific search

Southern Latitude: Northern Latitude: Eastern Longitude: Western Longitude:

Get Data

Auto Refresh Display Text



Radar Control -5 Minutes Play Pause + 5 Minutes

Radar Opacity 0.5

+ Icon Legend

Icon Legend

Rain	●	Flood	> 0	1"	2"	3"	4"	5"	6"	8"			
Snow	◆	Blizzard	> 0	2"	4"	6"	8"	12"	18"	24"	30"	36"	48"	60"

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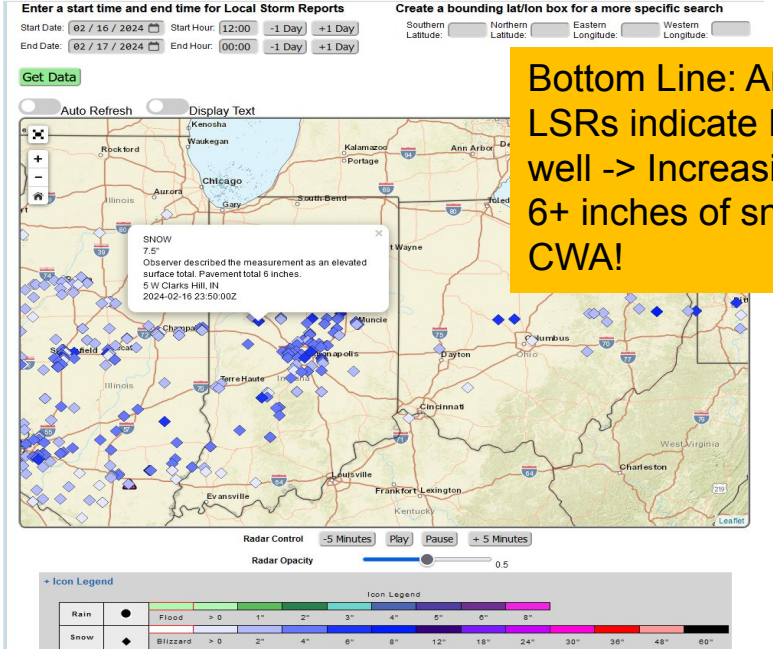
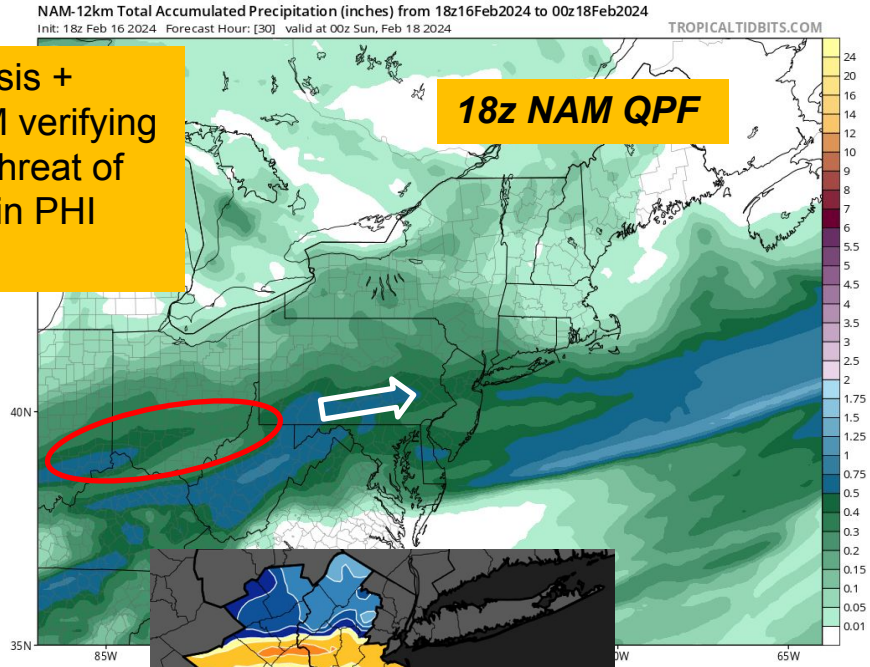
U.S. Department of Commerce

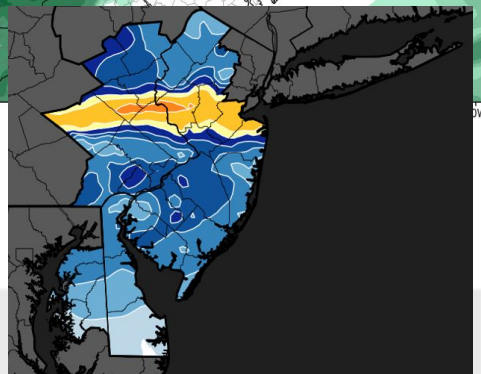
National Weather Service
Philadelphia/Mount Holly

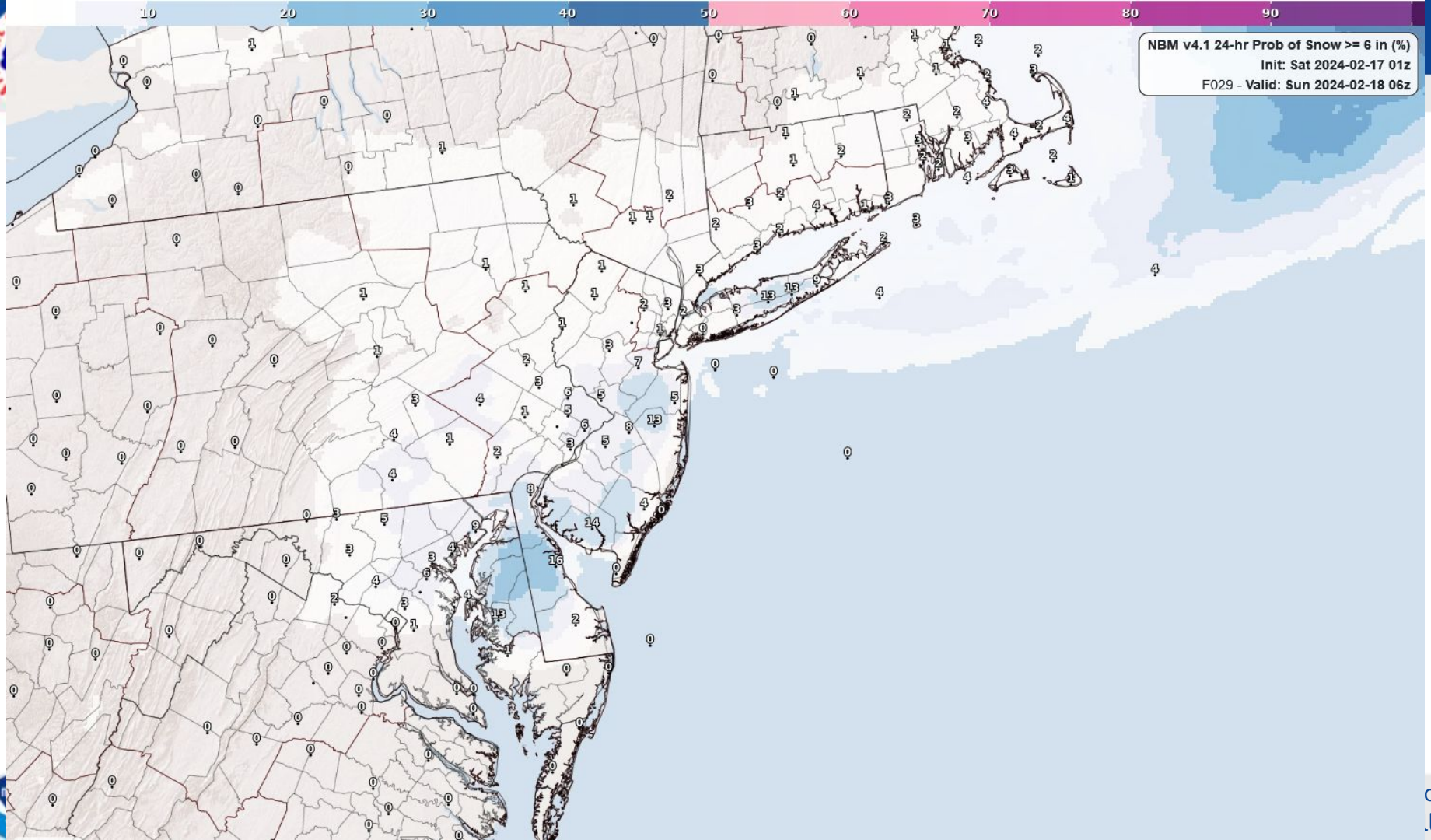
Putting It All Together!

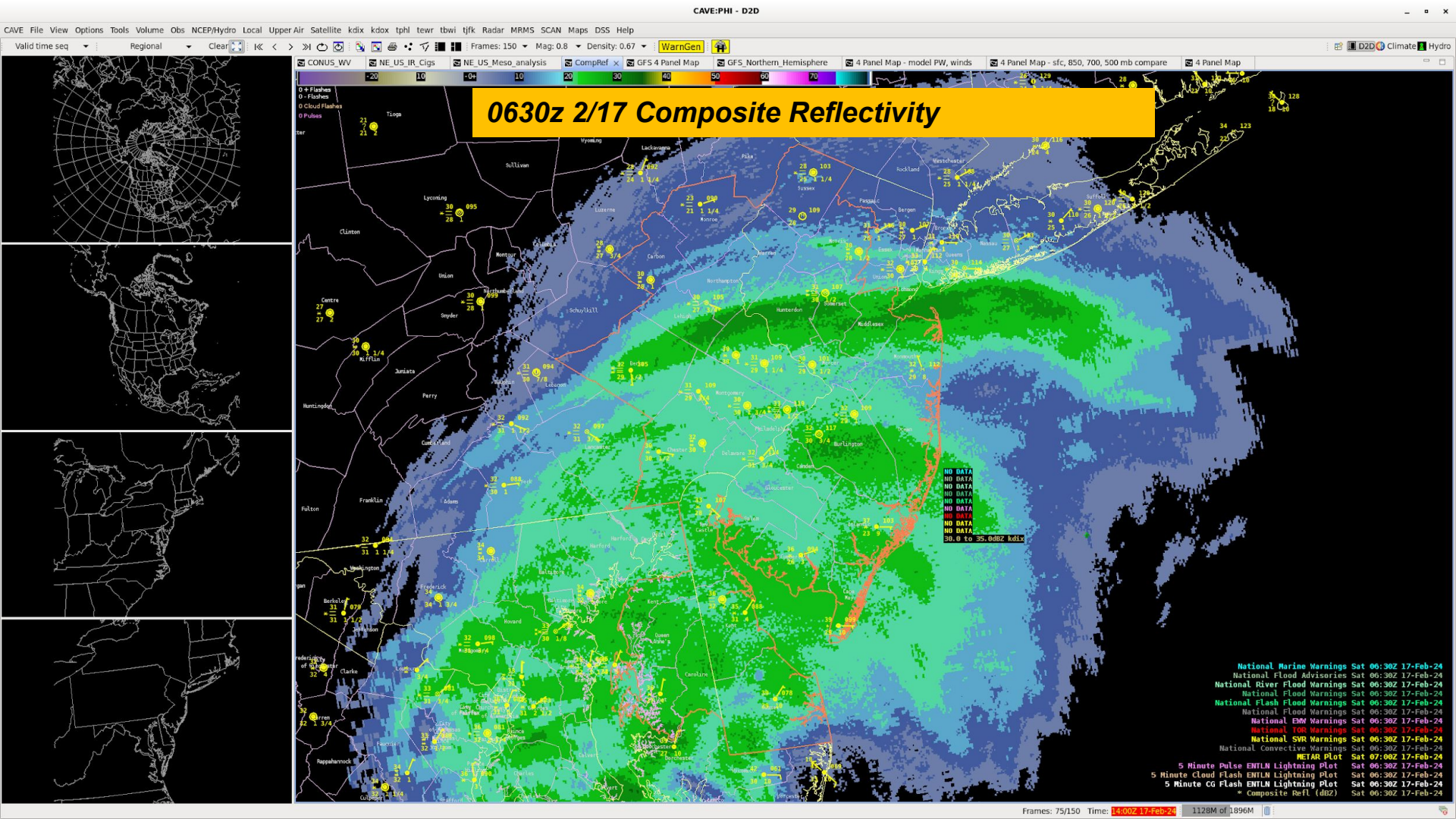


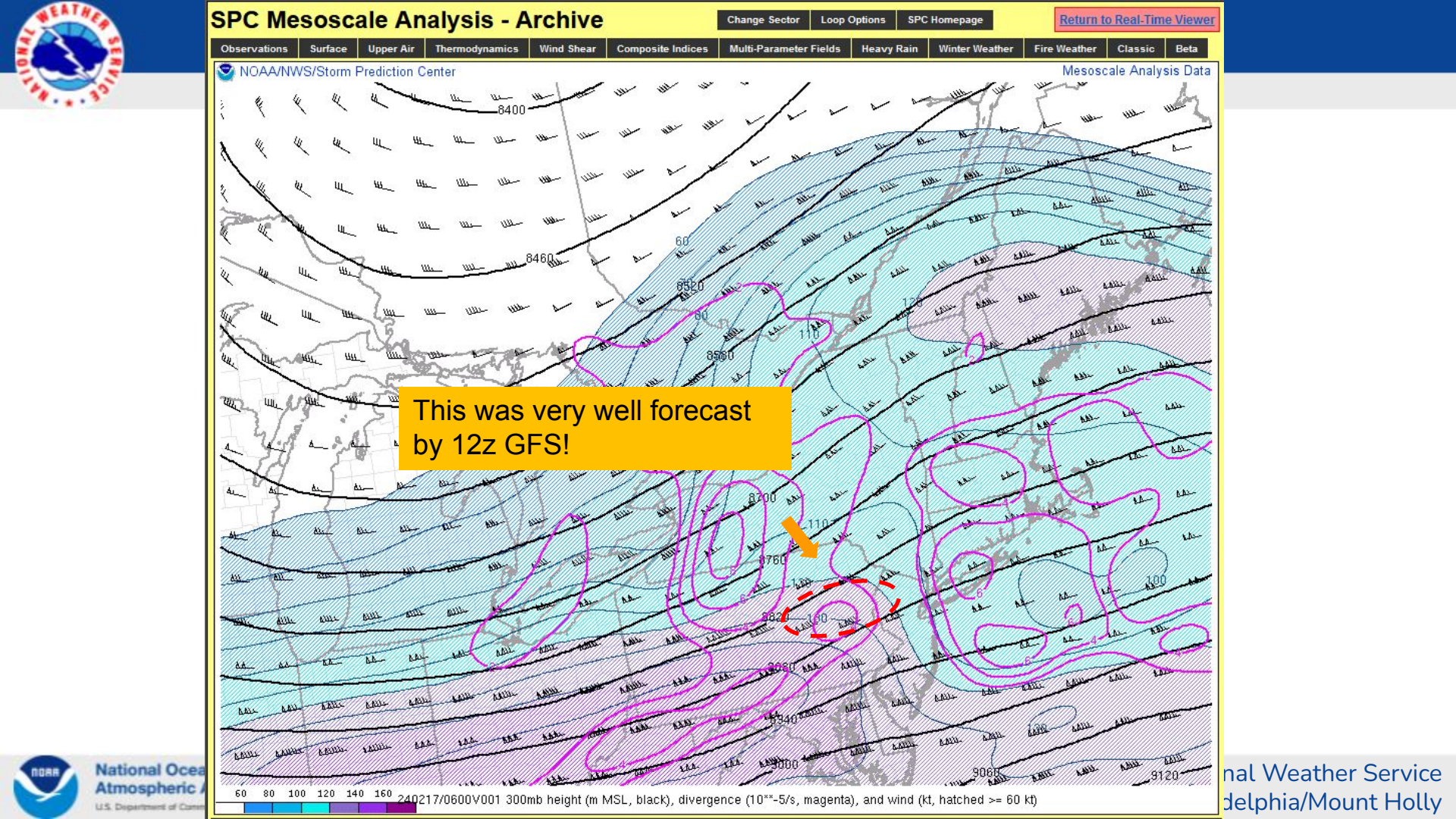
Bottom Line: Analysis + LSRs indicate NAM verifying well -> Increasing threat of 6+ inches of snow in PHI CWA!






10
20
30
40
50
60
70
80
90
NBM v4.1 24-hr Prob of Snow >= 6 in (%)
Init: Sat 2024-02-17 01z
F029 - Valid: Sun 2024-02-18 06z


CAVE:PHI - D2D
CAVE File View Options Tools Volume Obs NCEP/Hydro Local Upper Air Satellite kdix kdox tphl tewr tbwi tjfk Radar MRMS SCAN Maps DSS Help
Valid time seq
Regional
Clear
Frames: 150
Mag: 0.8
Density: 0.67
WarnGen
D2D Climate Hydro
CONUS_WV
NE_US_IR_Cigs
NE_US_Meso_analysis
CompRef
GFS 4 Panel Map
GFS_Northern_Hemisphere
4 Panel Map - model PW, winds
4 Panel Map - sfc, 850, 700, 500 mb compare
4 Panel Map
0 + Flashes
0 - Flashes
0 Cloud Flashes
0 Pulses
0630z 2/17 Composite Reflectivity
NO DATA
30.0 to 35.0dBZ kdix
National Marine Warnings Sat 06:30Z 17-Feb-24
National Flood Advisories Sat 06:30Z 17-Feb-24
National River Flood Warnings Sat 06:30Z 17-Feb-24
National Flood Warnings Sat 06:30Z 17-Feb-24
National Flash Flood Warnings Sat 06:30Z 17-Feb-24
National Flood Warnings Sat 06:30Z 17-Feb-24
National EWW Warnings Sat 06:30Z 17-Feb-24
National TOR Warnings Sat 06:30Z 17-Feb-24
National SVR Warnings Sat 06:30Z 17-Feb-24
National Convective Warnings Sat 06:30Z 17-Feb-24
METAR Plot Sat 07:00Z 17-Feb-24
5 Minute Pulse ENTLN Lightning Plot Sat 06:30Z 17-Feb-24
5 Minute Cloud Flash ENTLN Lightning Plot Sat 06:30Z 17-Feb-24
5 Minute CG Flash ENTLN Lightning Plot Sat 06:30Z 17-Feb-24
* Composite Refl (dBZ) Sat 06:30Z 17-Feb-24
Frames: 75/150 Time: 14:00Z 17-Feb-24 1128M of 1896M


SPC Mesoscale Analysis - Archive
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Composite Indices
Multi-Parameter Fields
Heavy Rain
Winter Weather
Fire Weather
Classic
Beta
NOAA/NWS/Storm Prediction Center
Mesoscale Analysis Data
This was very well forecast by 12z GFS!
60 80 100 120 140 160
240217/0600V001 300mb height (m MSL, black), divergence (10**-5/s, magenta), and wind (kt, hatched >= 60 kt)

SPC Mesoscale Analysis - Archive

Change Sector | Loop Options | SPC Homepage | Return to Real-Time Viewer

Observations | Surface | Upper Air | Thermodynamics | Wind Shear | Composite Indices | Multi-Parameter Fields | Heavy Rain | Winter Weather | Fire Weather | Classic | Beta

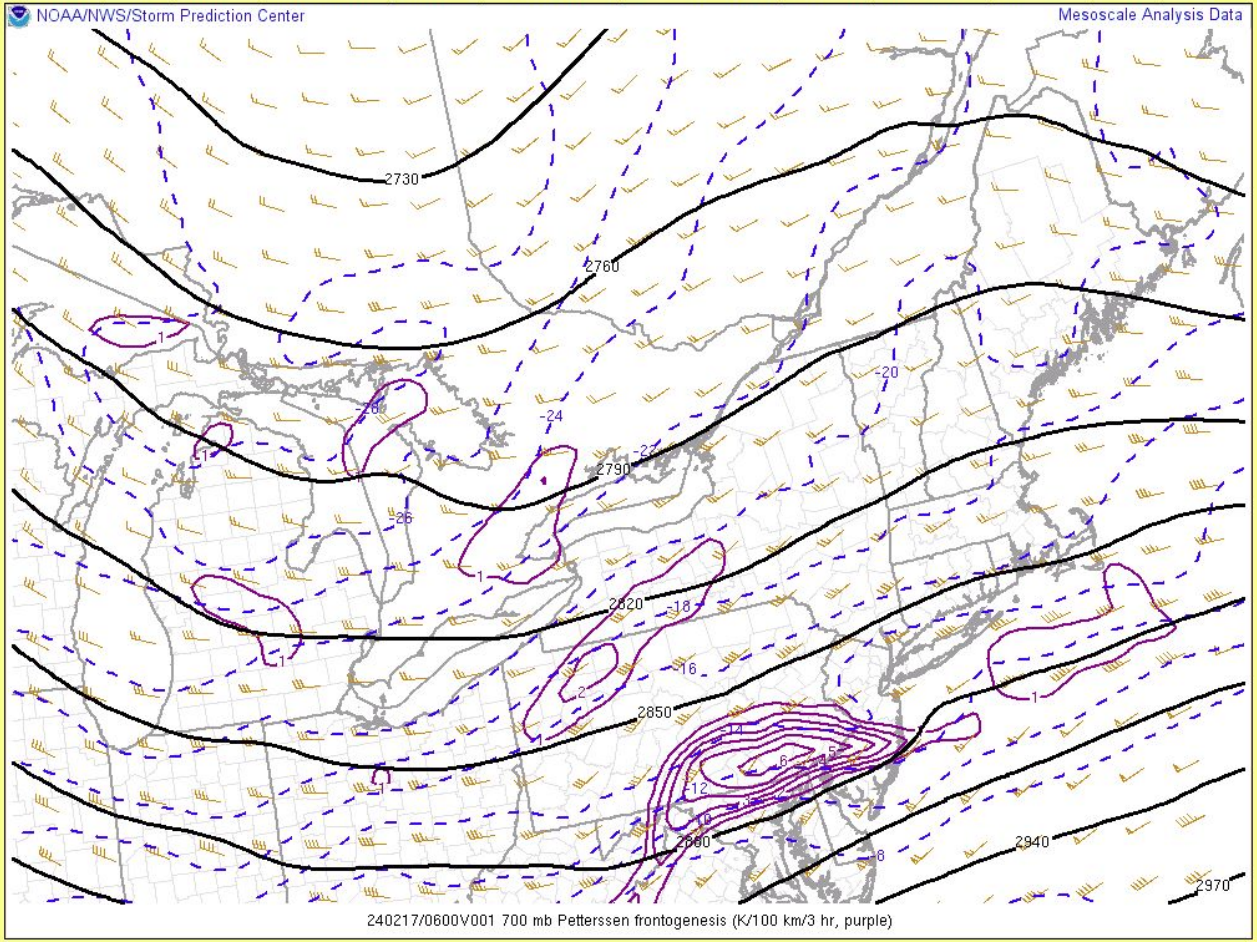

Image overlays: ☑ County Boundaries | ☐ County Warning Areas | ☐ Hiways & Cities | ☐ NWS Watches & Warnings

Image underlays: ○ None | ◉ Radar | ○ Terrain | ○ Population | ○ Sfc Obs

In Summary

- A meteorologist can diagnose likely model errors in QPF placement based on how it compares to it's forcing fields

- This (above) can serve as evidence we may need to "move the needle" on the NBM probabilities of hazardous weather; Note: still not "picking a winner" here!

- Careful mesoanalysis and monitoring of observations (SA) can provide further evidence as the event draws closer!