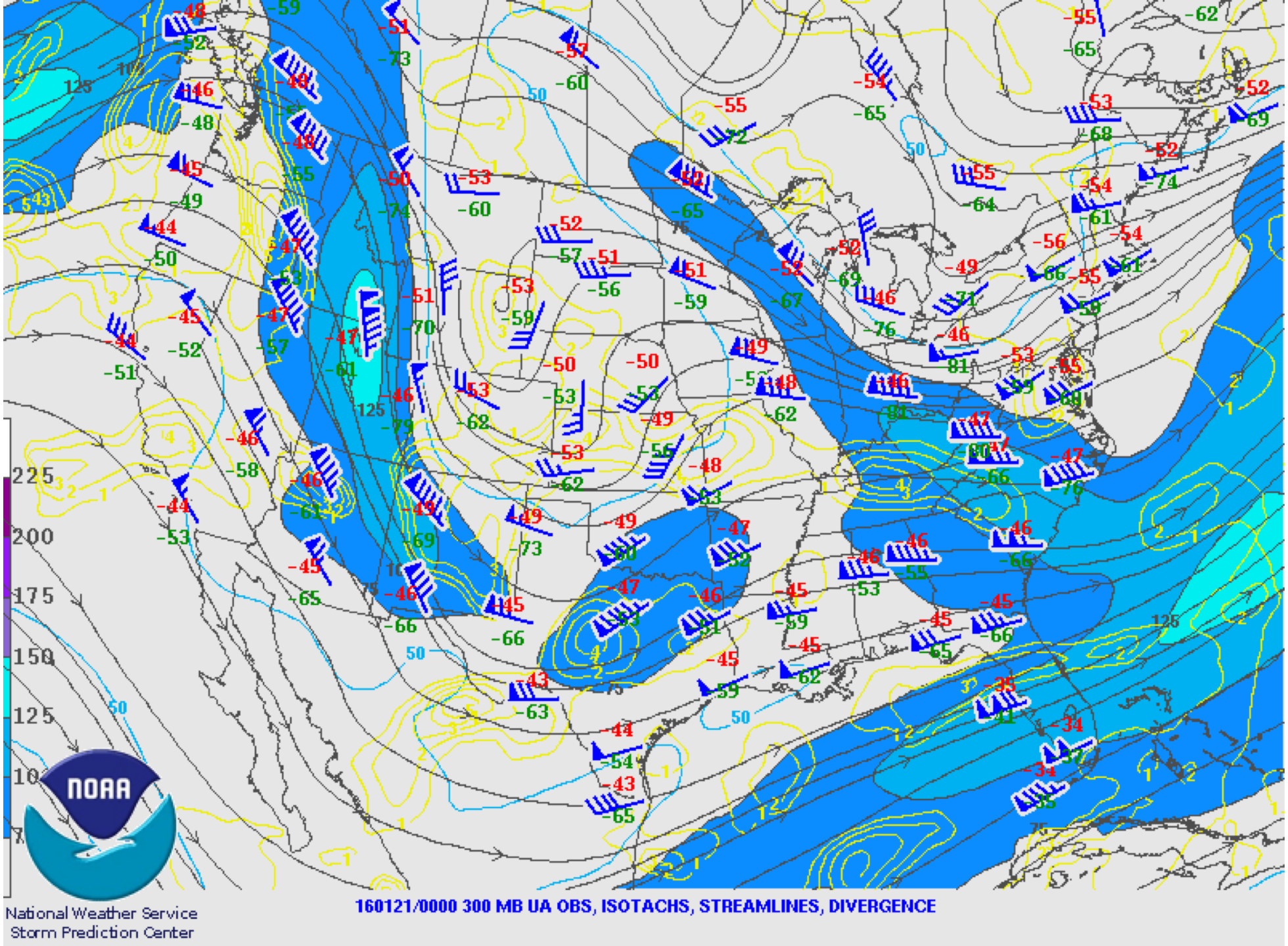
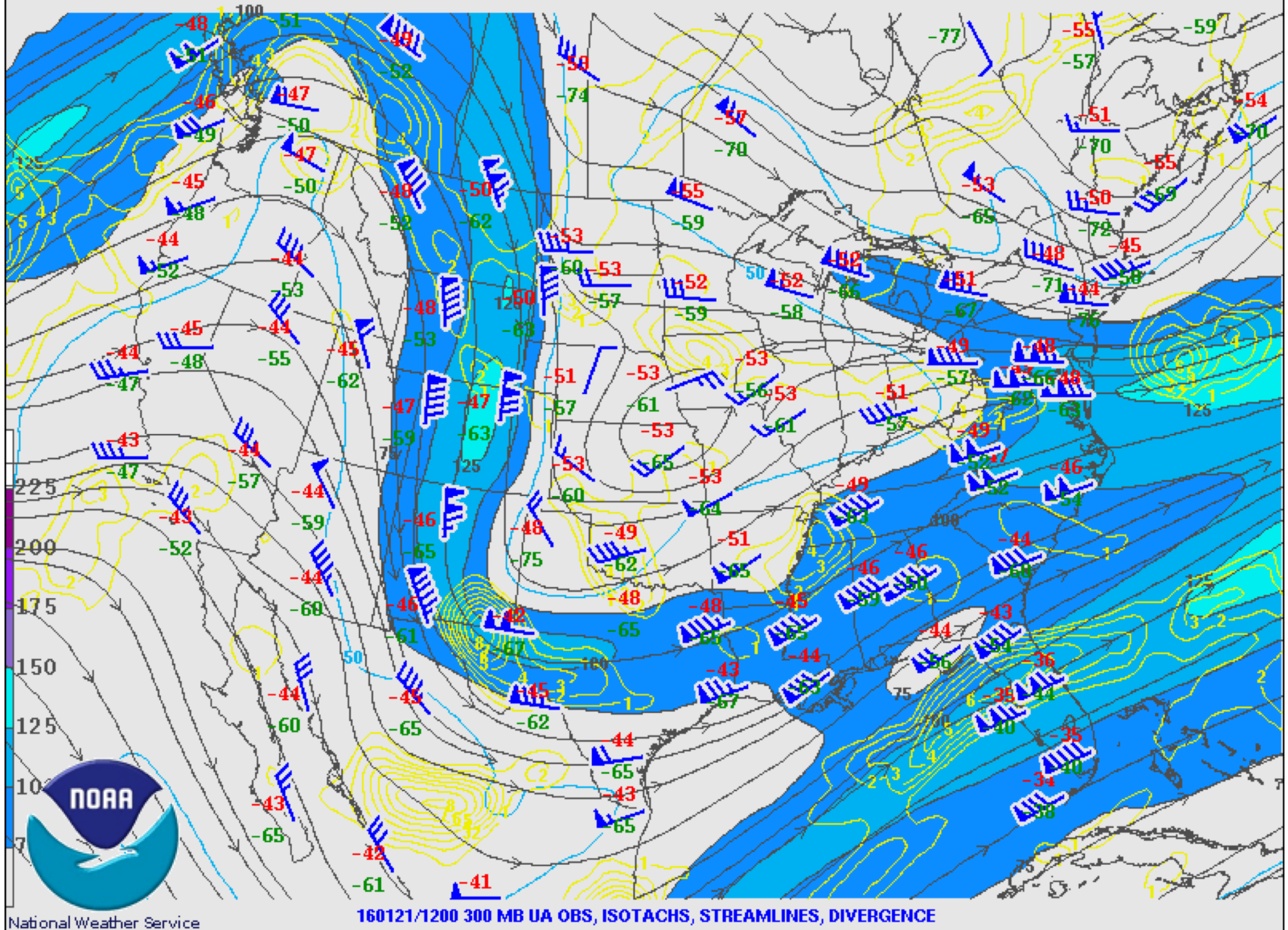
Mid-Atlantic Winter Storm (22-23 January 2016)

FV3 initialized at 1200 UTC on 18 January 2016 and run out 168 hours

Results compared to operational GFS


225
200
175
150
125
100
NOAA
National Weather Service
Storm Prediction Center
160121/0000 300 MB UA OBS, ISOTACHS, STREAMLINES, DIVERGENCE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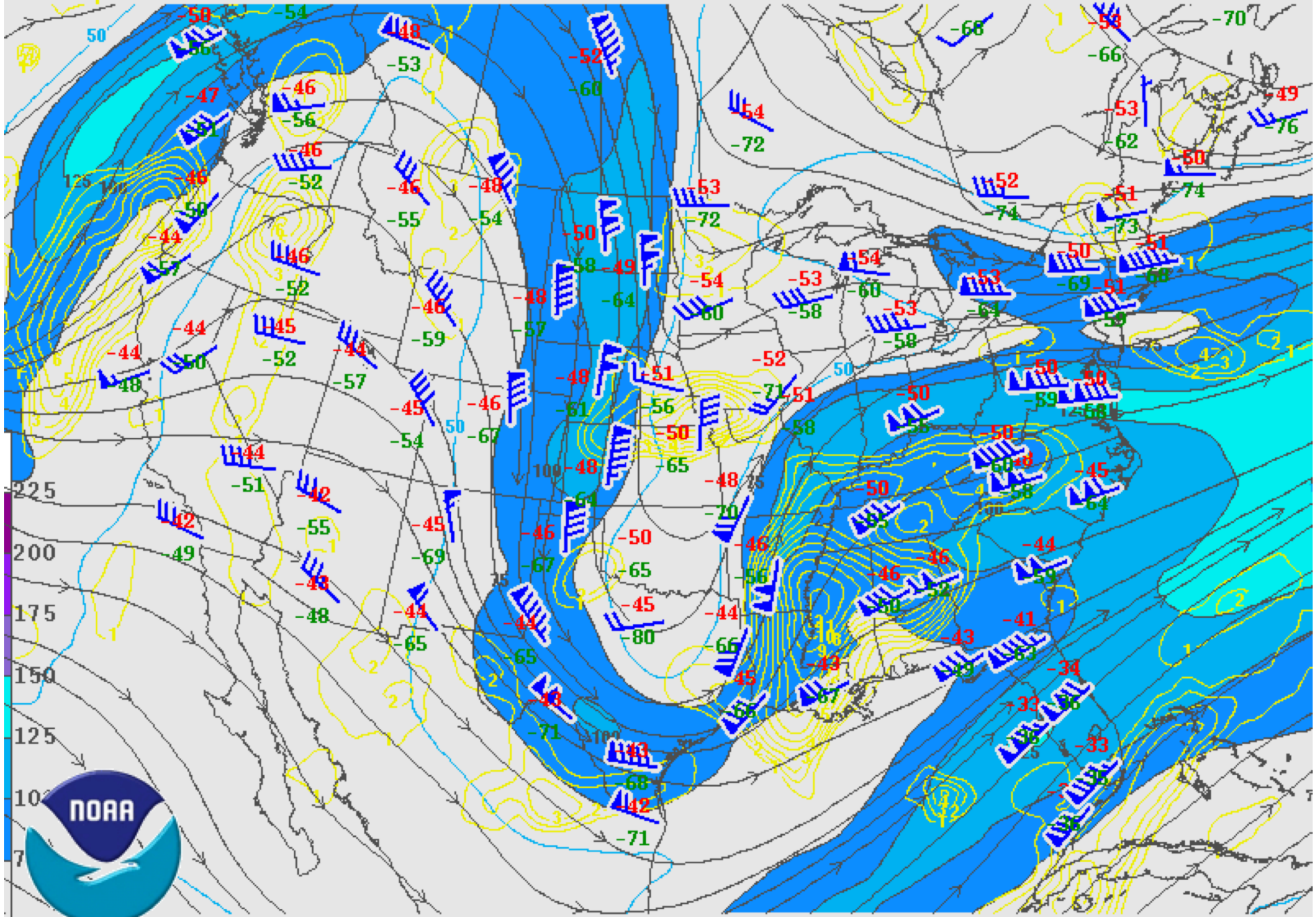
160121/1200 300 MB UA OBS, ISOTACHS, STREAMLINES, DIVERGENCE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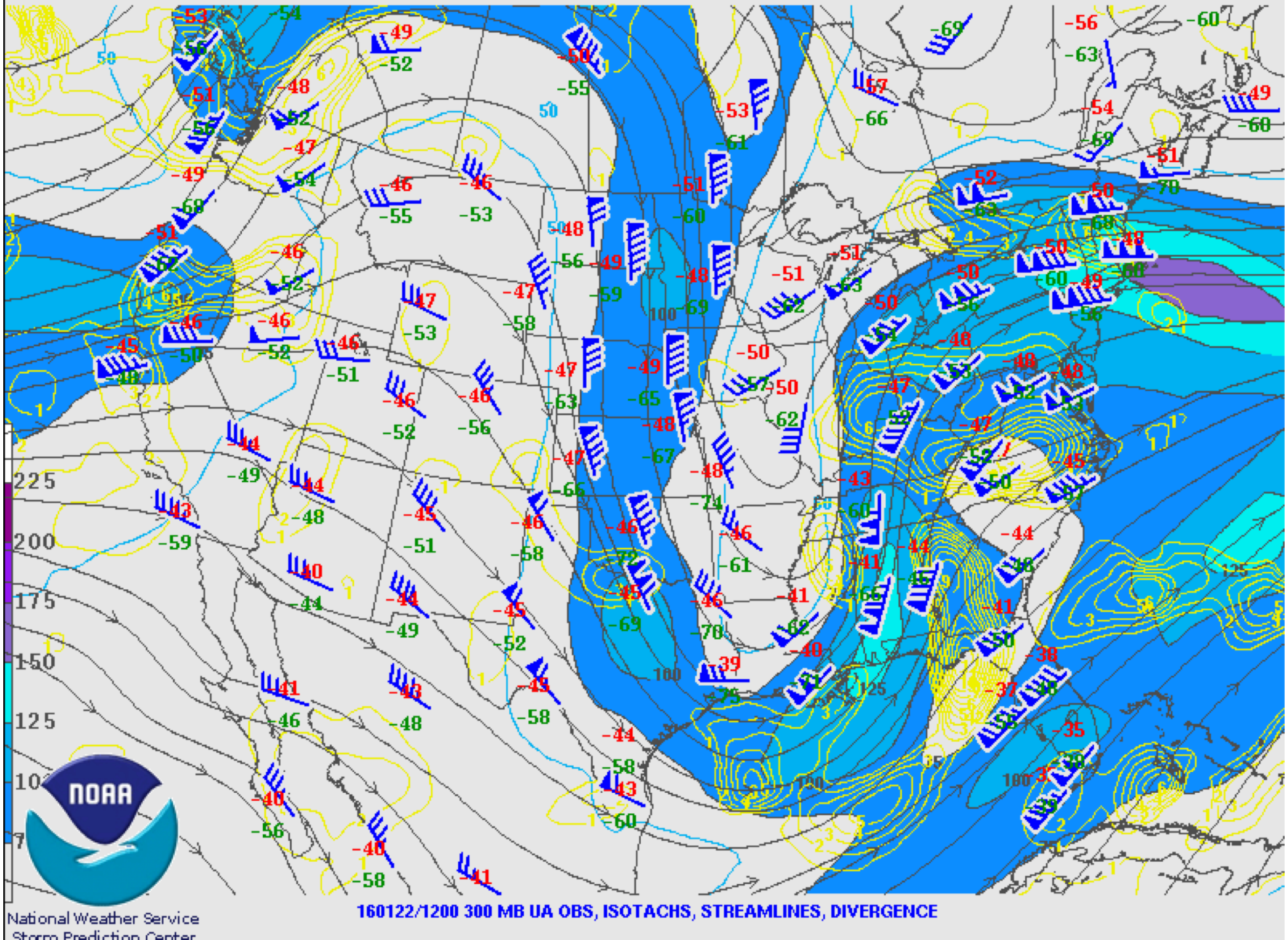
160122/0000 300 MB UA OBS, ISOTACHS, STREAMLINES, DIVERGENCE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Storm Prediction Center
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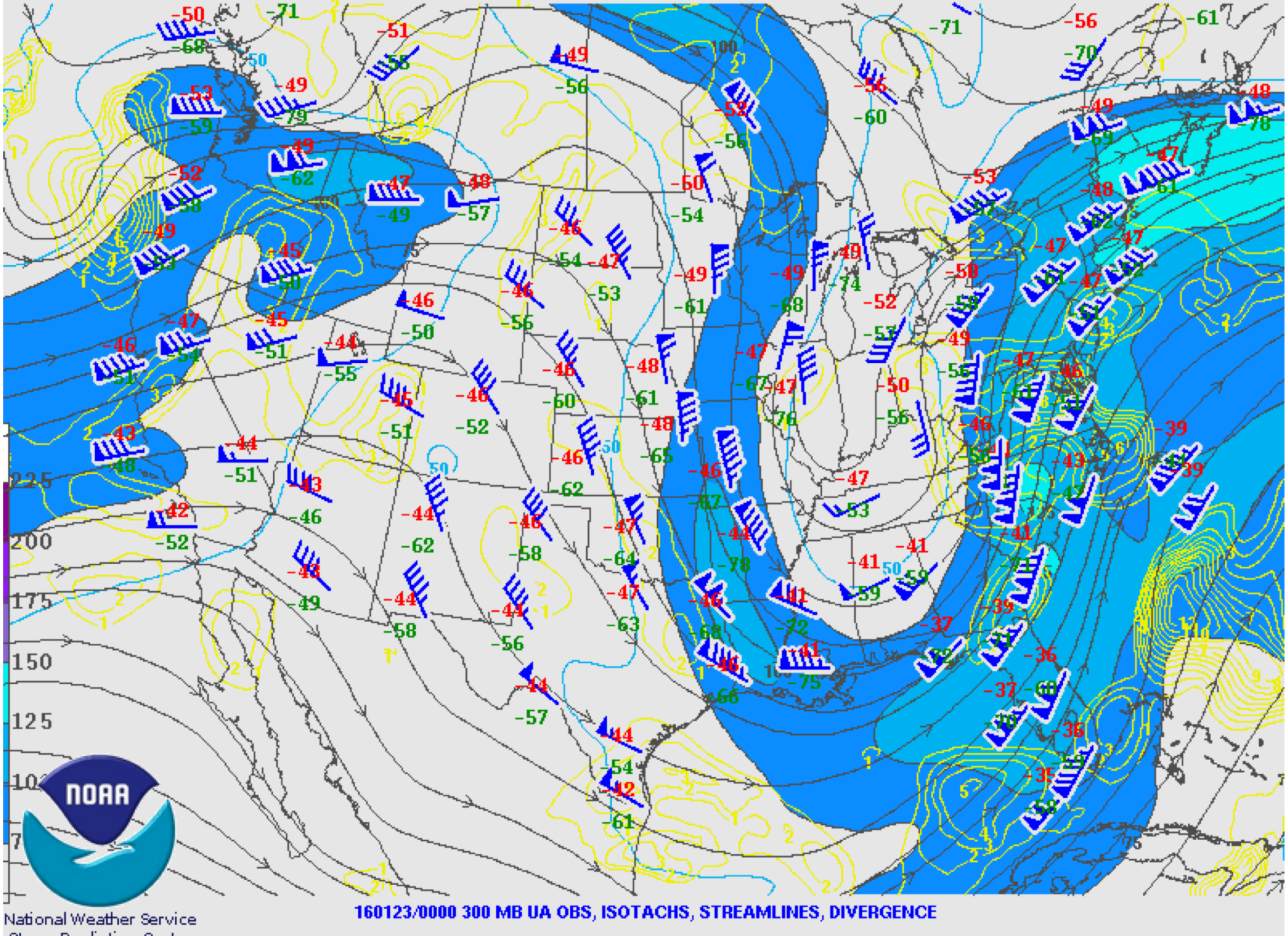
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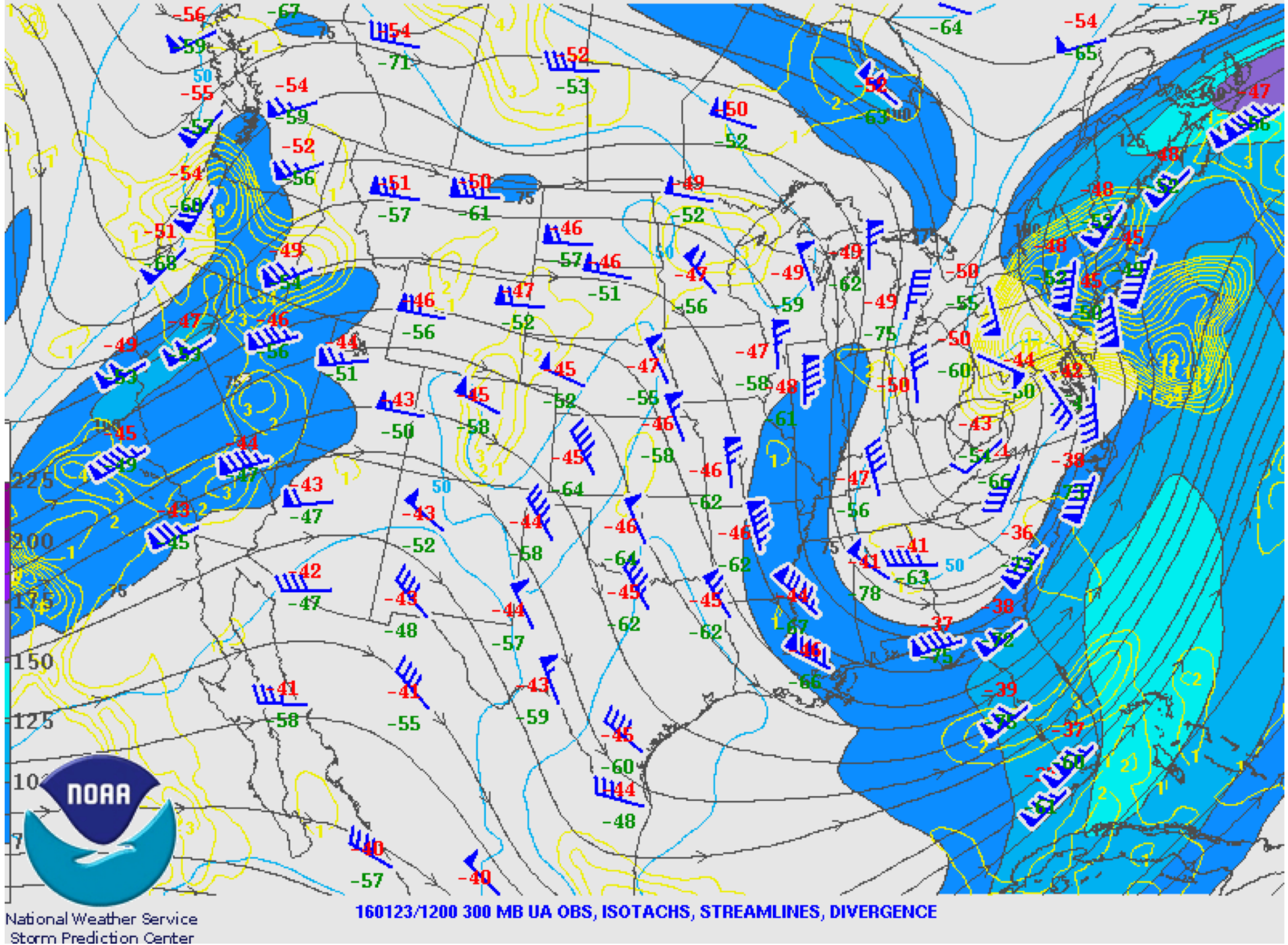
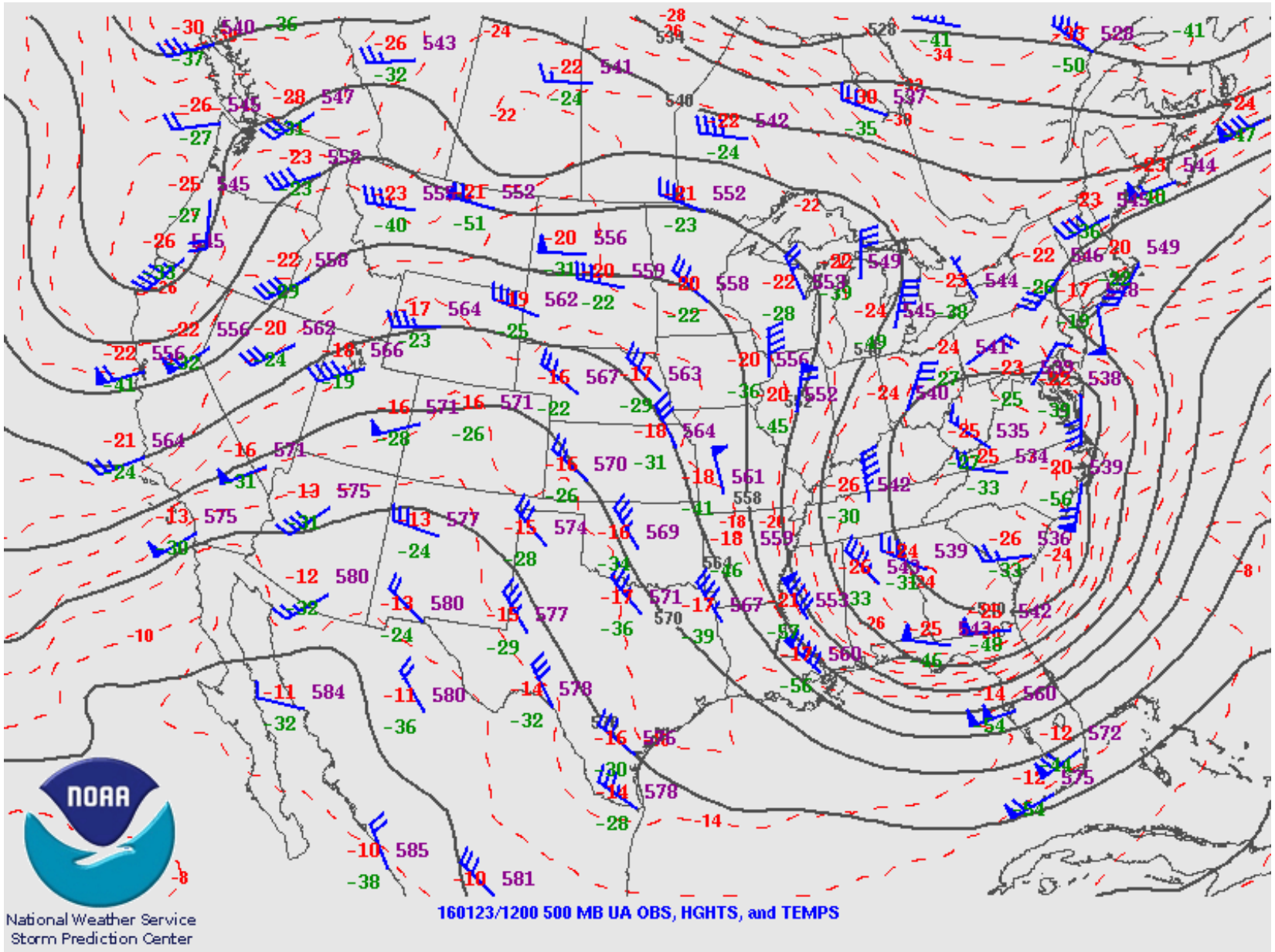
National Weather Service
160123/0000 300 MB UA OBS, ISOTACHS, STREAMLINES, DIVERGENCE

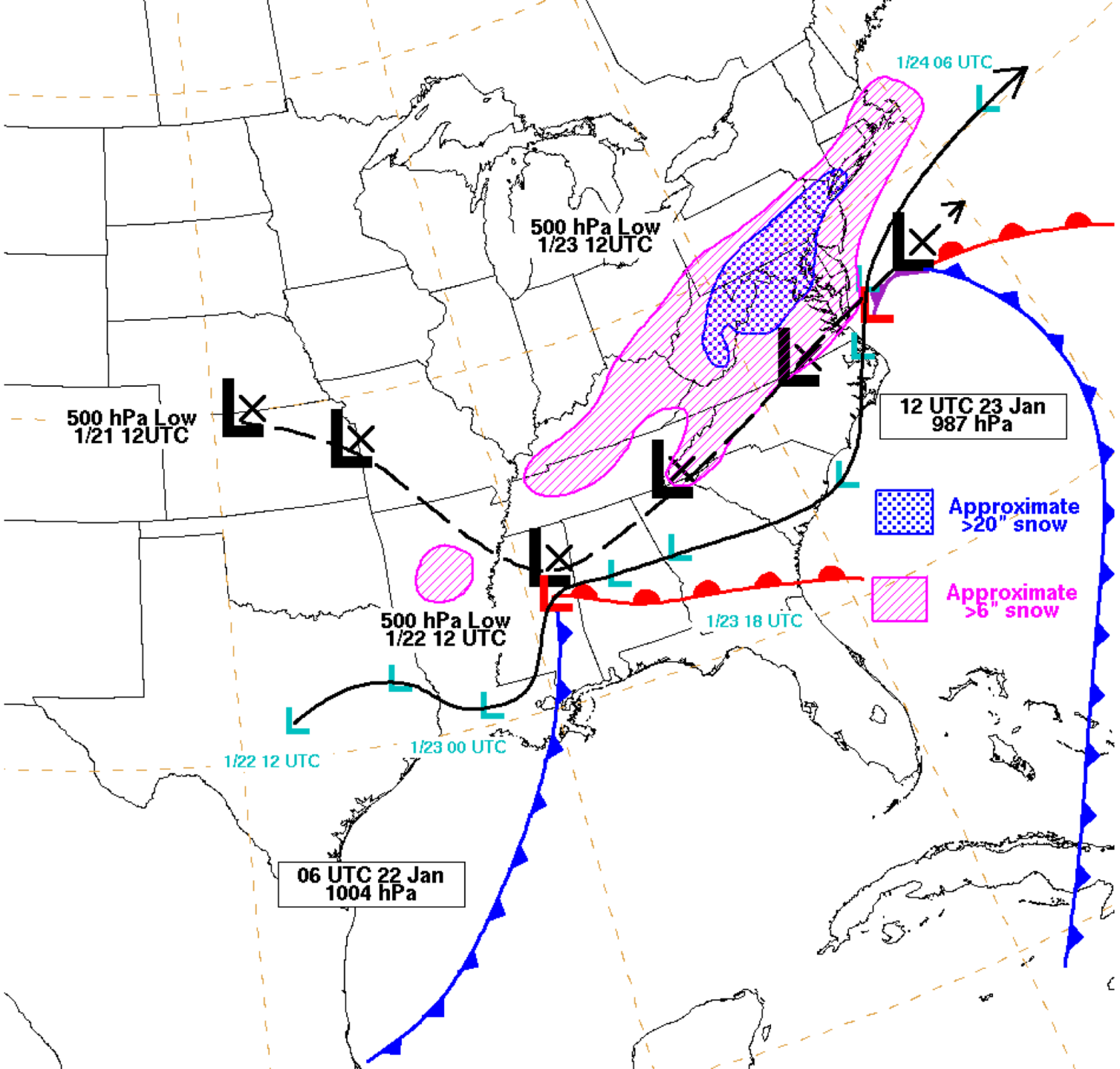

NOAA
National Weather Service
Storm Prediction Center
160123/1200 300 MB UA OBS, ISOTACHS, STREAMLINES, DIVERGENCE

500-hPa Upper Air Chart Valid at 12Z January 23rd, 2016

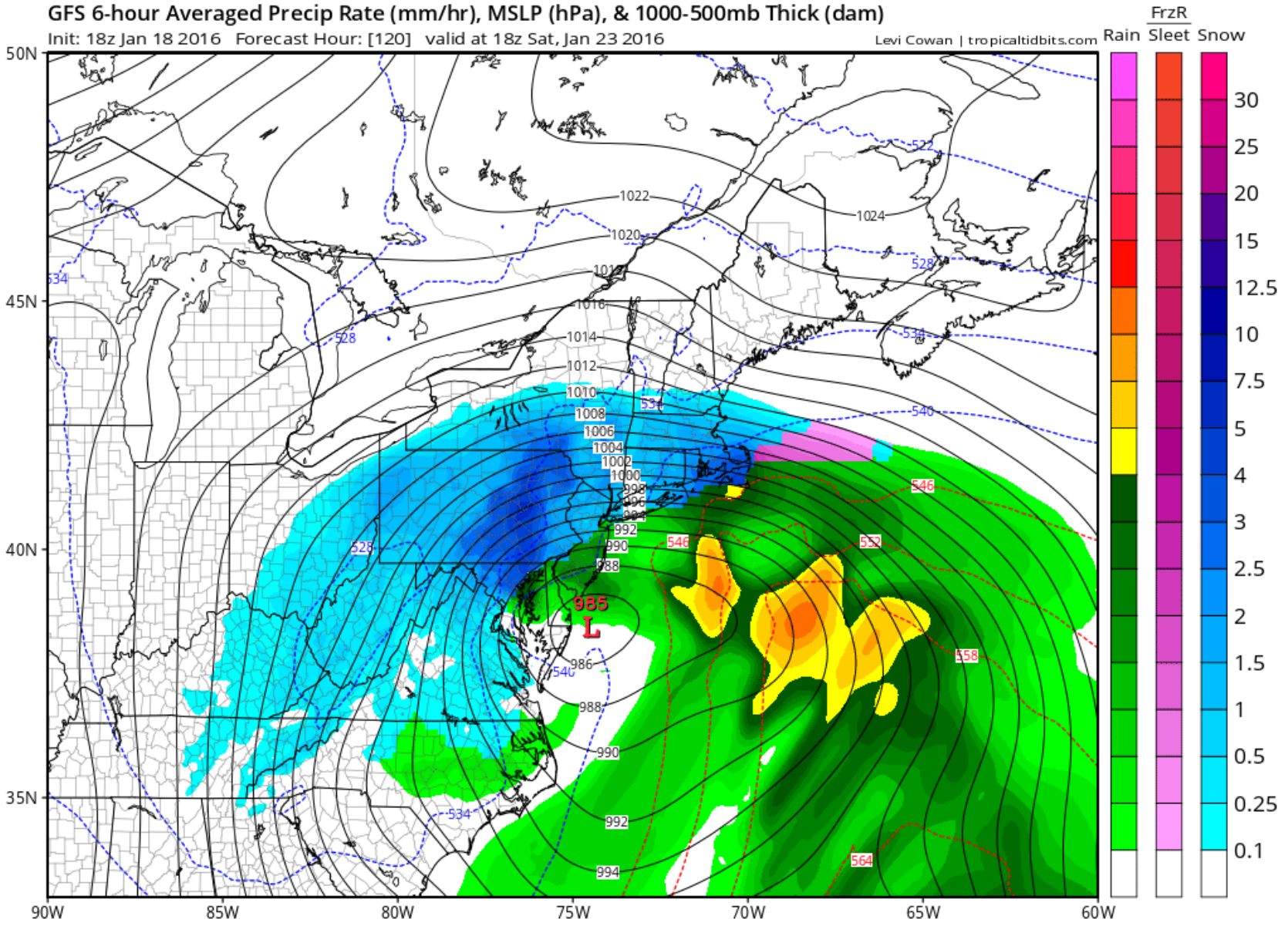


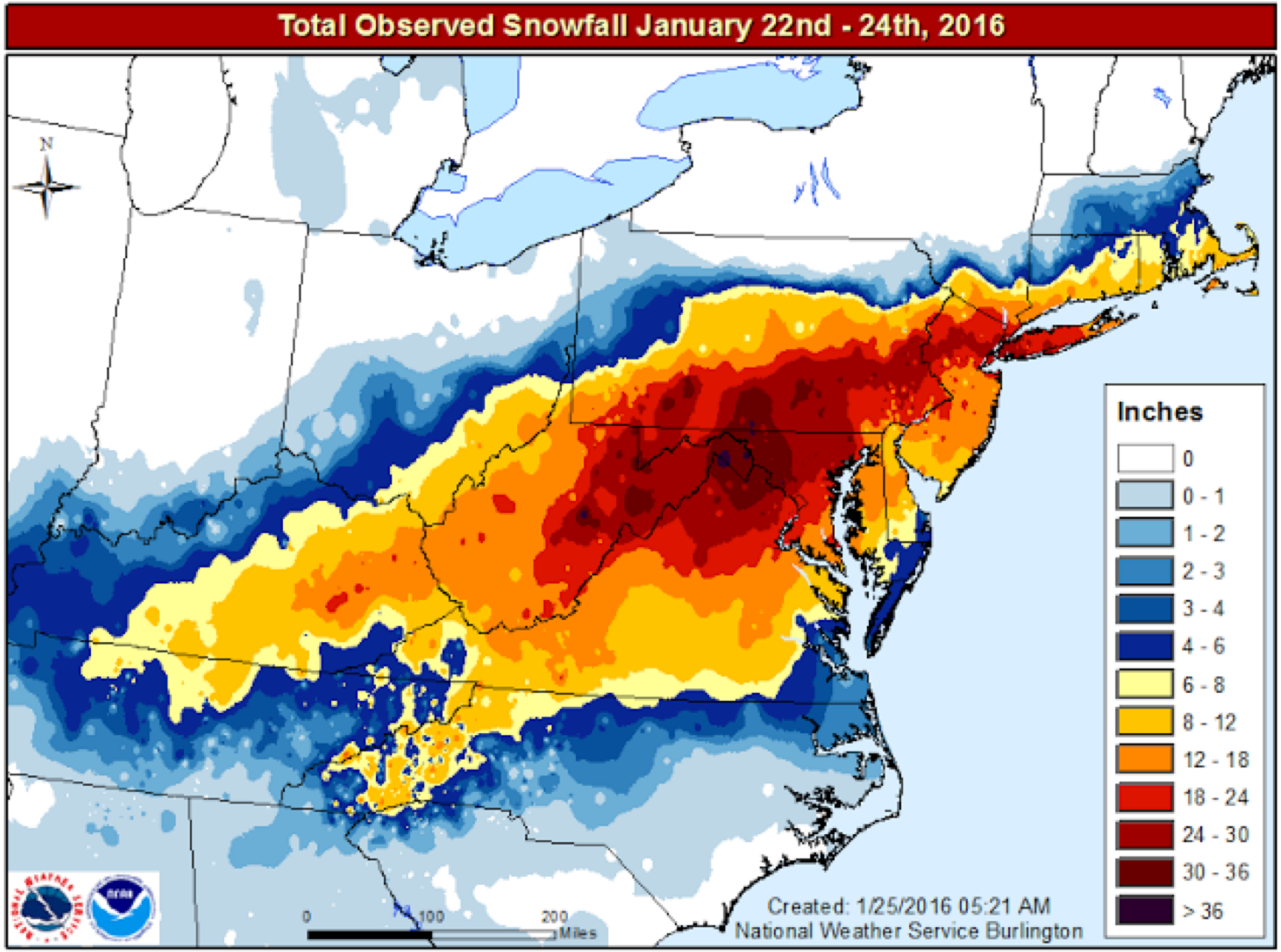
Path of storm

- Upper level low in black
- Surface low in teal
- Pink is > 6” snow
- Purple is > 20” snow



GFS 6-hour Precip Rate (120-h forecast), valid at 18Z 1/23/2016




Total Observed Snowfall January 22nd - 24th, 2016
N
Inches
0
0 - 1
1 - 2
2 - 3
3 - 4
4 - 6
6 - 8
8 - 12
12 - 18
18 - 24
24 - 30
30 - 36
> 36
0
100
200
Miles
Created: 1/25/2016 05:21 AM
National Weather Service Burlington

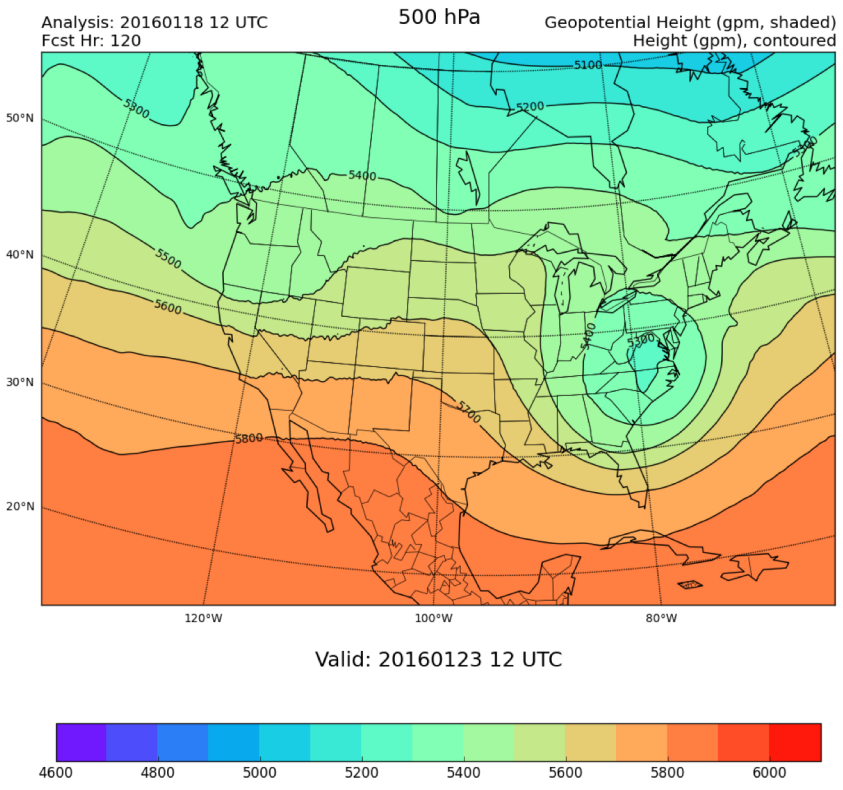
Forecast Comparison Between FV3 and GFS

- Forecasts were initialized from 12Z on 20160118 and run out 168 hours
- FV3 forecasts were interpolated to a latitude/longitude grid and then converted to quarter-degree resolution to match that of the GFS
- The MET verification package was used to calculate standard measures of average RMSE and bias as a function of lead time and for vertical profiles, as well as frequency bias and Gilbert Skill Score for defined thresholds
- Observations from METAR and RAOB stations were used for verification, in addition to CCPA data for precipitation accumulations
- Verification was conducted separately for FV3 and GFS, with differences also calculated between models for each metric
- Spatial plots were created using Python scripts to qualitatively analyze specific variables

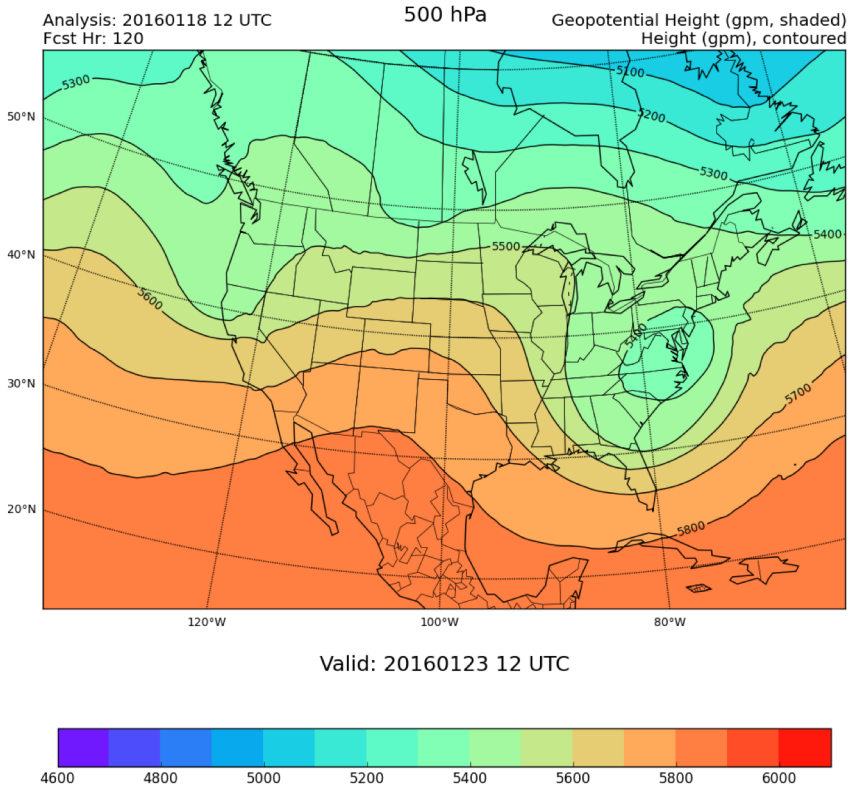
Geopotential Height at 500 hPa for the 120-Hour Forecast Valid at 1200 UTC on 23/1/2016

- Both models accurately capture the location of the upper-level low over Virginia/North Carolina
- The GFS identifies a slightly stronger upper-level low with heights less then 5380 m, while the FV3 does not have heights quite as low
- The GFS is closer to the actual geopotential height of 5340 m measured in northern North Carolina (from slide eight)

GFS



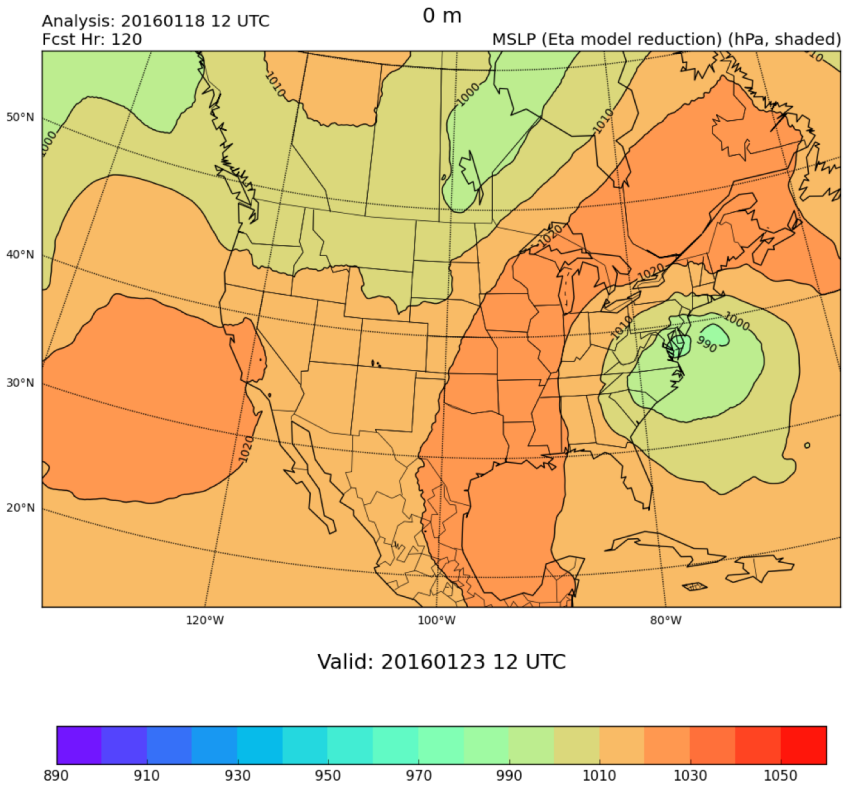
FV3



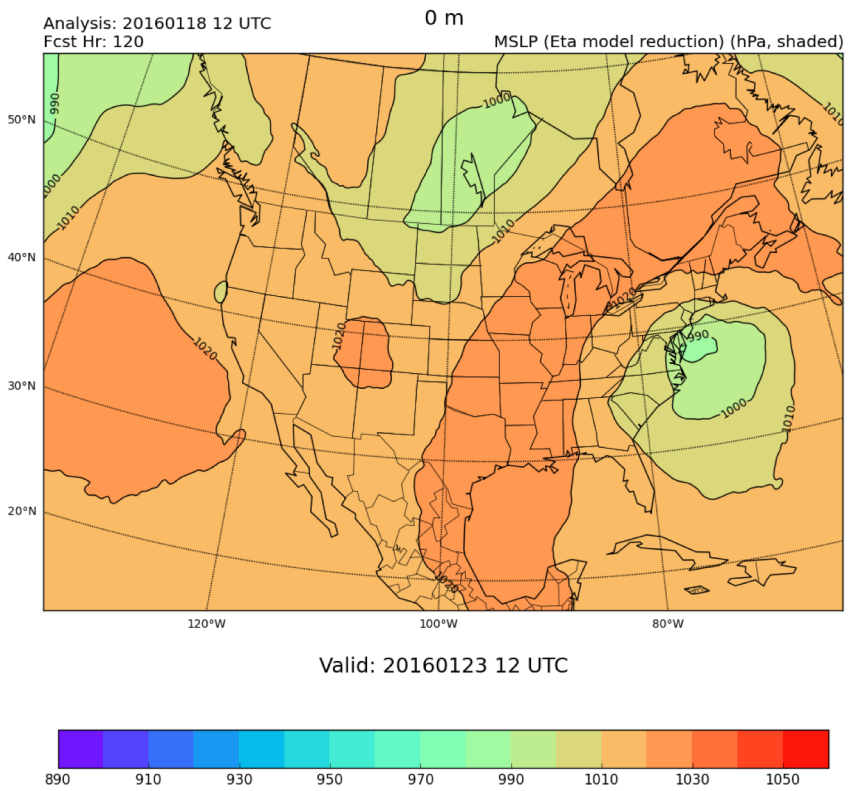
Mean Sea Level Pressure Forecast for the 120-Hour Forecast Valid at 1200 UTC on 23/1/2016

- Both models accurately capture the location of the surface low off of the Delmarva peninsula
- FV3 identifies a single region of < 990 hPa surface pressure, while the GFS has two separate regions of < 990 hPa surface pressure
- Both models are very close to the actual surface pressure of 987 hPa (from slide nine)

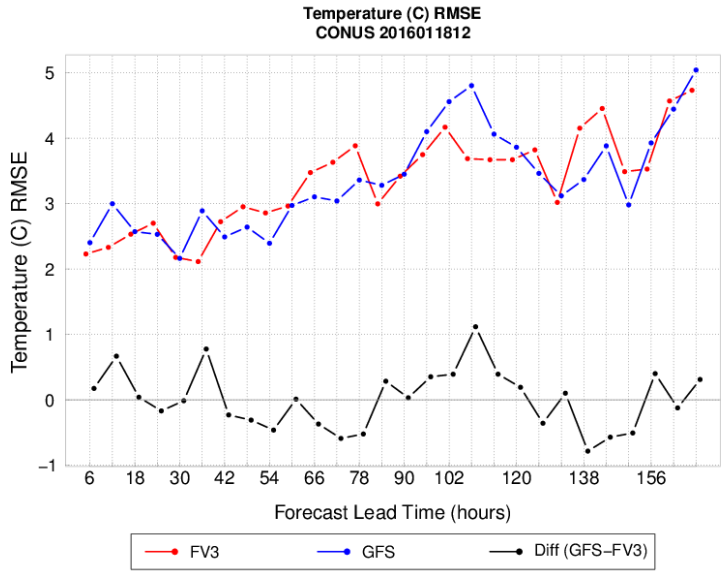
GFS

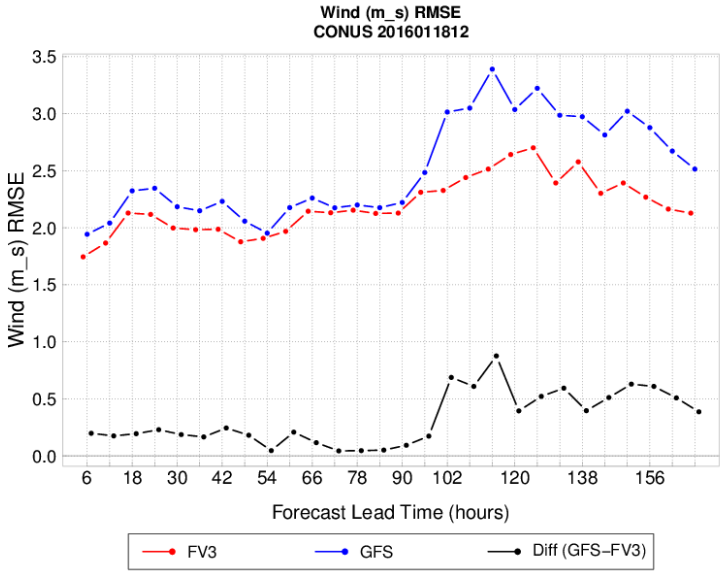


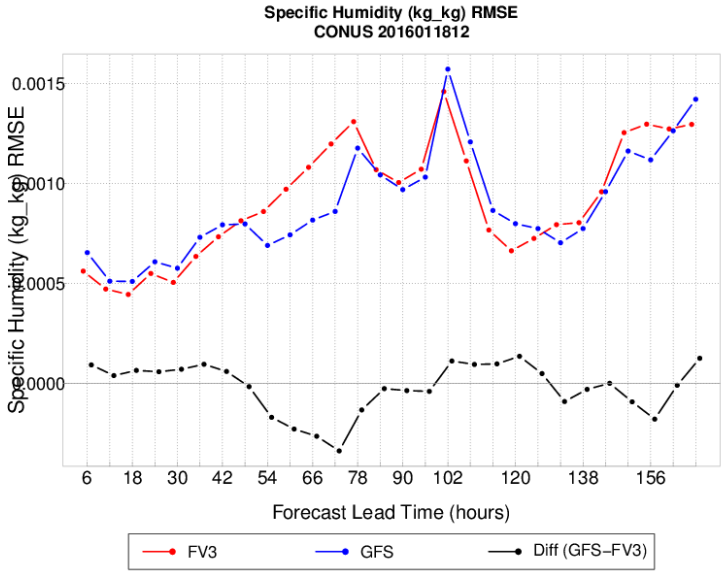
FV3

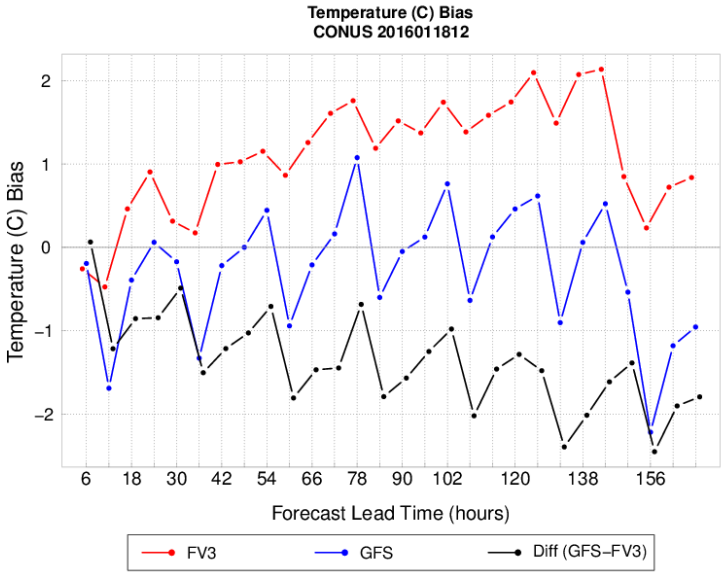


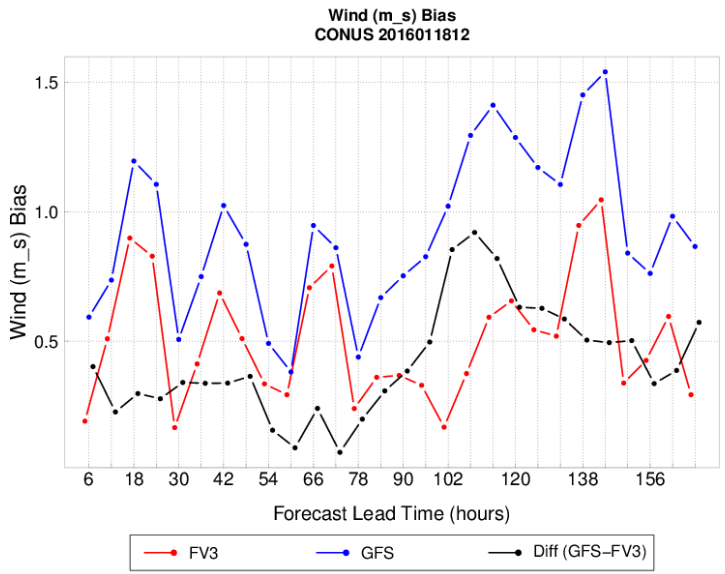
CONUS Surface Variable Average RMSE and Bias

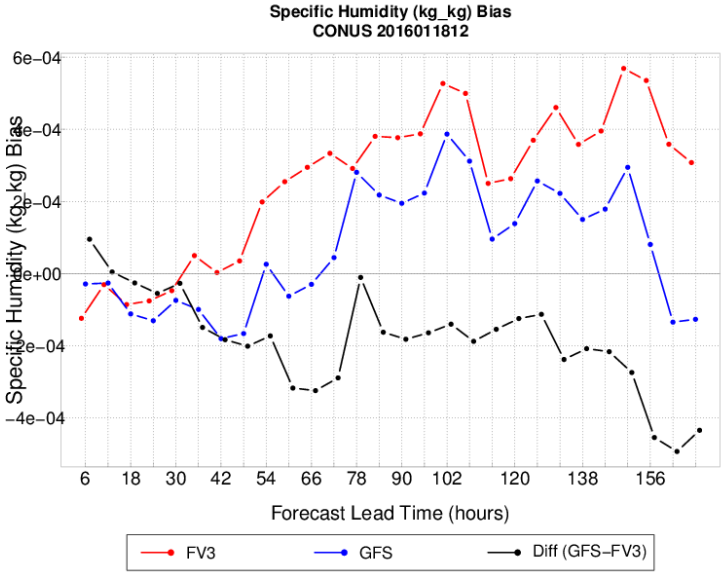








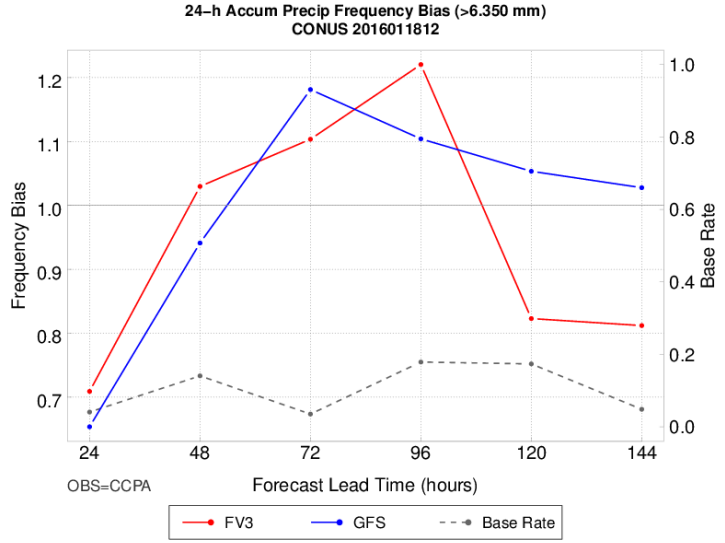


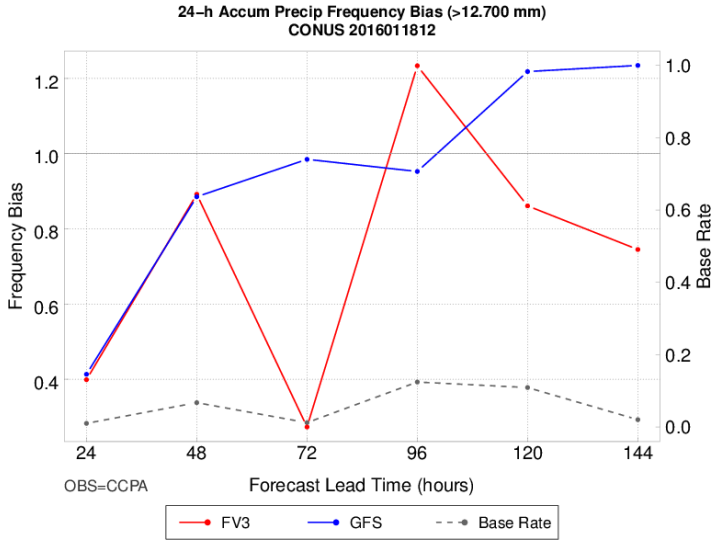


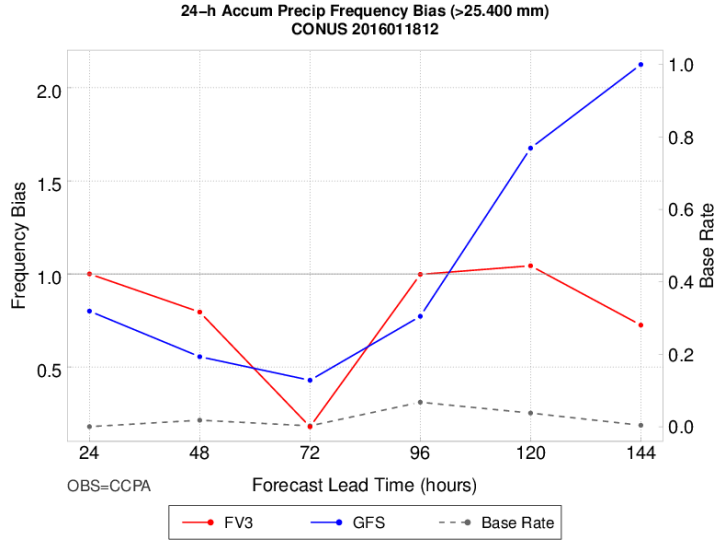
Conclusions for CONUS Surface Variable Average RMSE and Bias

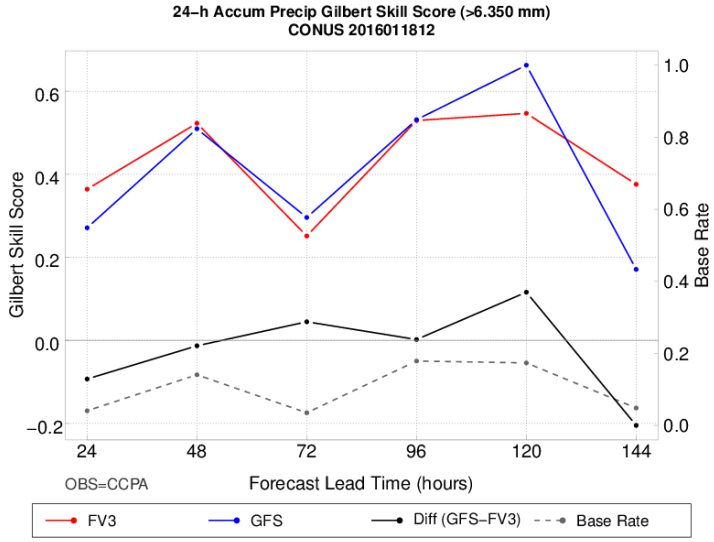
- GFS and FV3 forecasts of surface temperature, wind speed, and specific humidity show very similar RMSE with lead time, generally increasing with time; one exception is that the FV3 tends to have lower wind speed RMSE, especially for forecasts beyond 100 hours
- Both models experience diurnal cycle bias error, particularly with temperature and wind speed
- The GFS exhibits lower bias for surface temperatures and specific humidity forecasts, while the FV3 shows lower bias for wind speed values

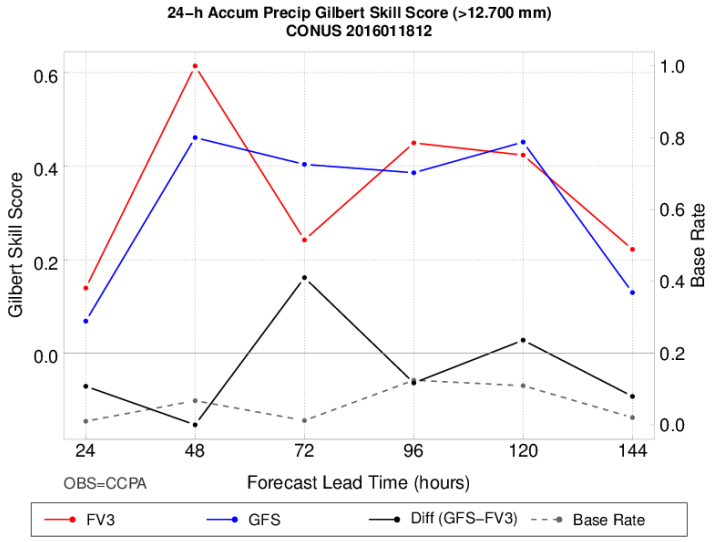
CONUS 24-hr Precipitation Accumulation Frequency Bias and GSS as a Function of Lead Time for Thresholds of > 6.35, > 12.7, and > 25.4 mm

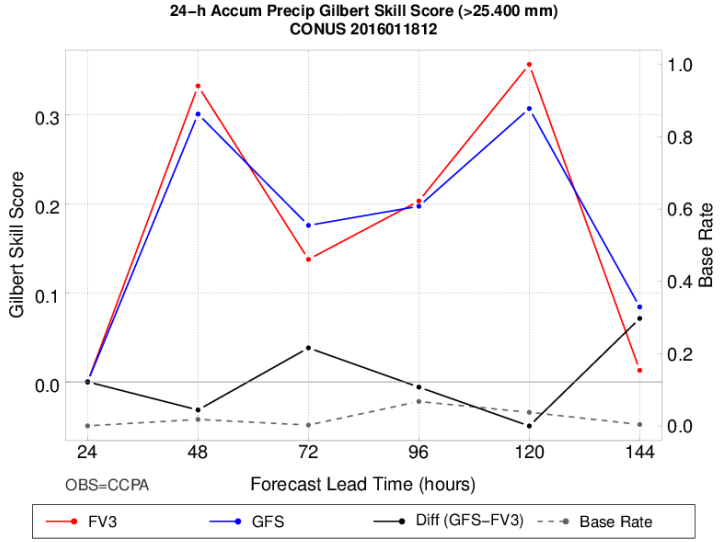








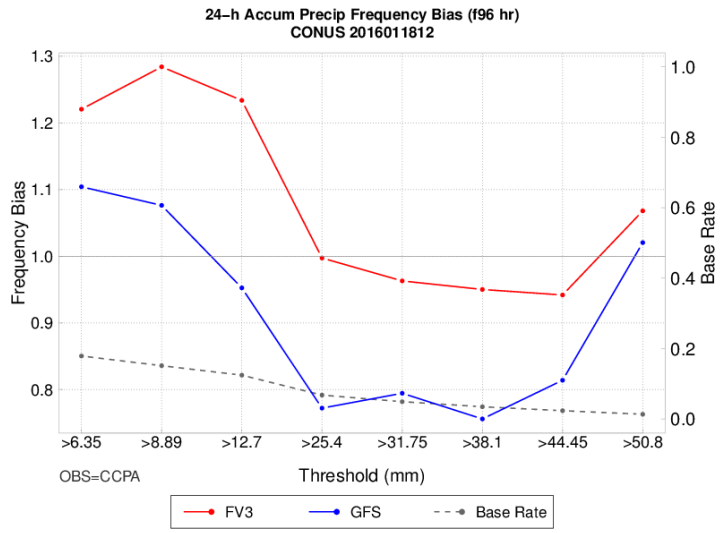


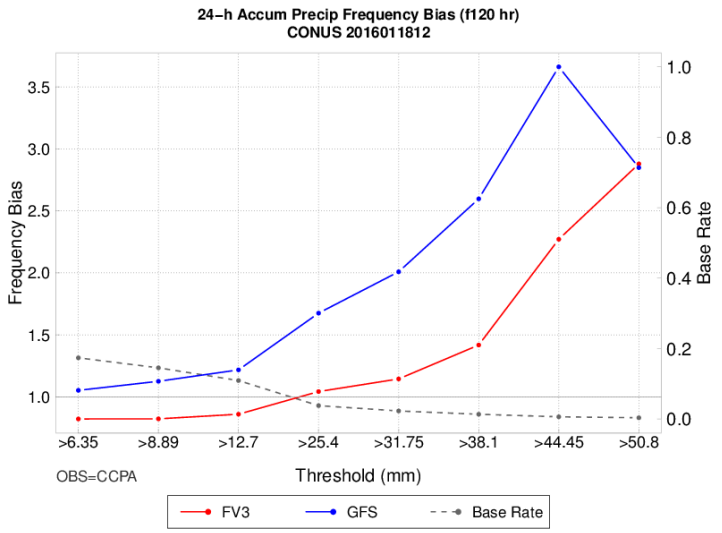


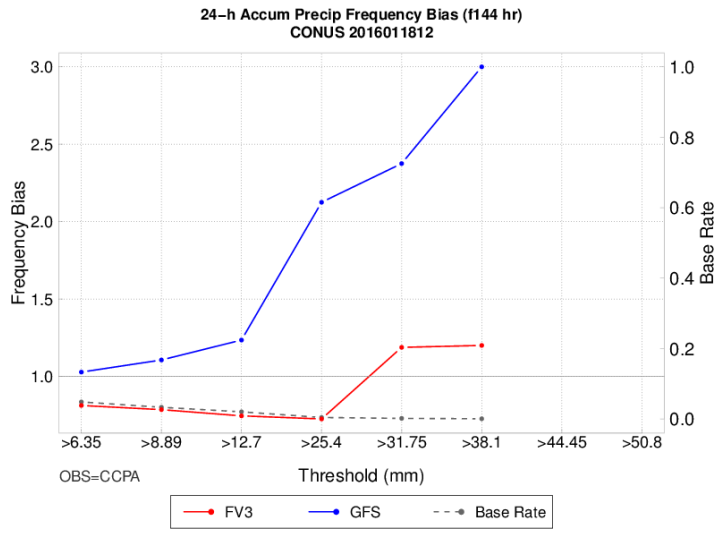
Conclusions for CONUS 24-hr Precipitation Accumulation Frequency Bias and GSS as a Function of Lead Time for Thresholds of > 6.35, > 12.7, and > 25.4 mm

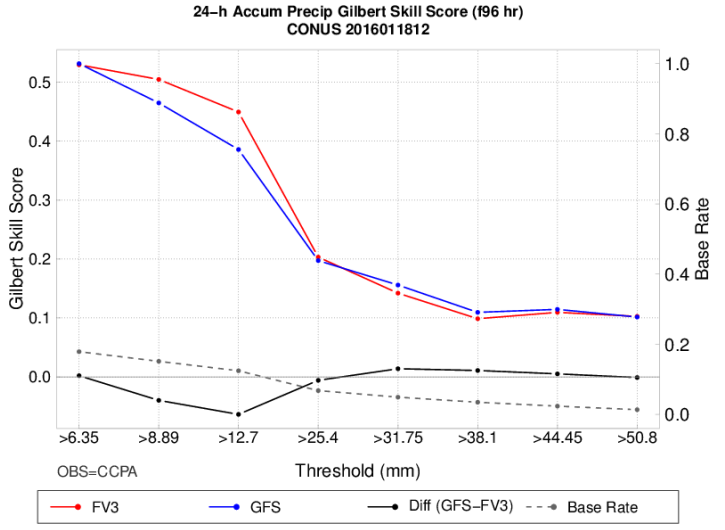
- GFS and FV3 forecasts of surface temperature, wind speed, and specific humidity show very similar RMSE with lead time, generally increasing with time; one exception is that the FV3 tends to have lower wind speed RMSE, especially for forecasts beyond 100 hours
- Both models experience diurnal cycle bias error, particularly with temperature and wind speed
- The GFS exhibits lower bias for surface temperatures and specific humidity forecasts, while the FV3 shows lower bias for wind speed values

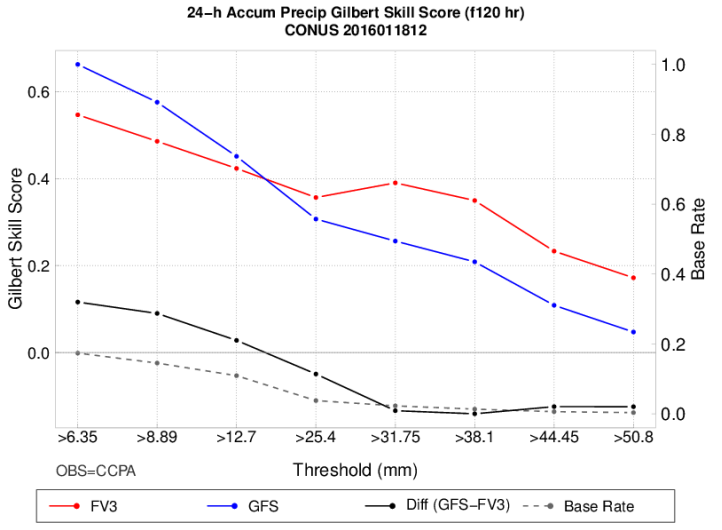
CONUS Precipitation Accumulation Frequency Bias and GSS as a Function of Threshold for 96-, 120-, and 144-hr Forecasts

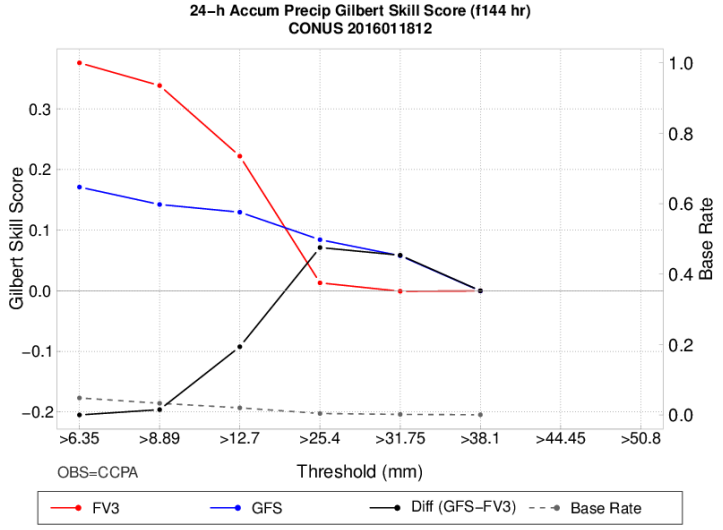








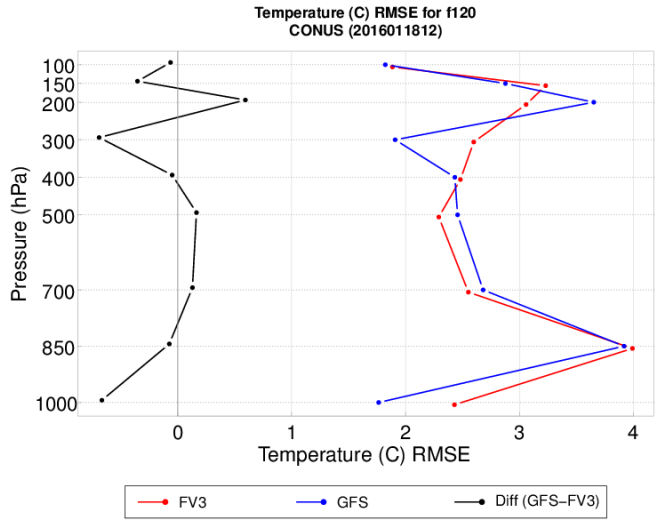


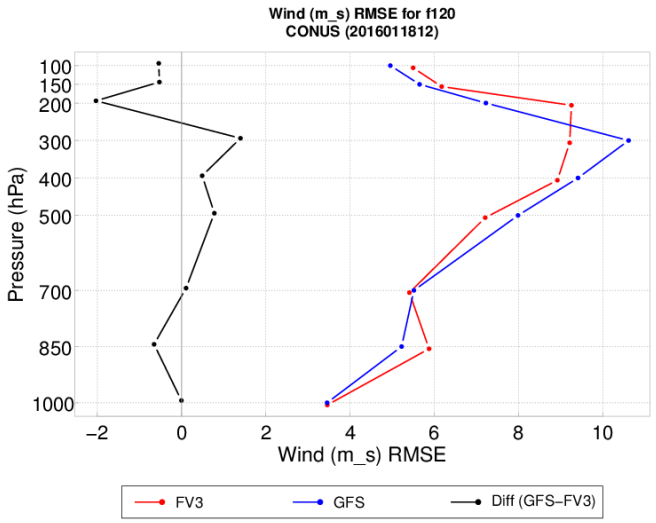


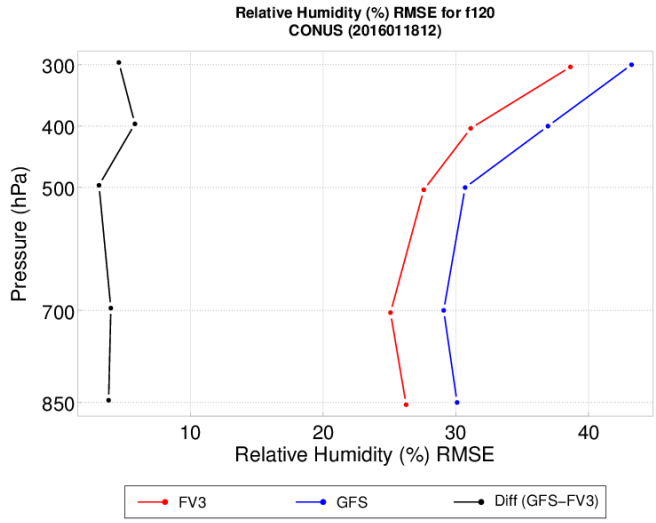
Conclusions for CONUS Precipitation Accumulation Frequency Bias and GSS as a Function of Threshold for 96-, 120-, and 144-hr Forecasts

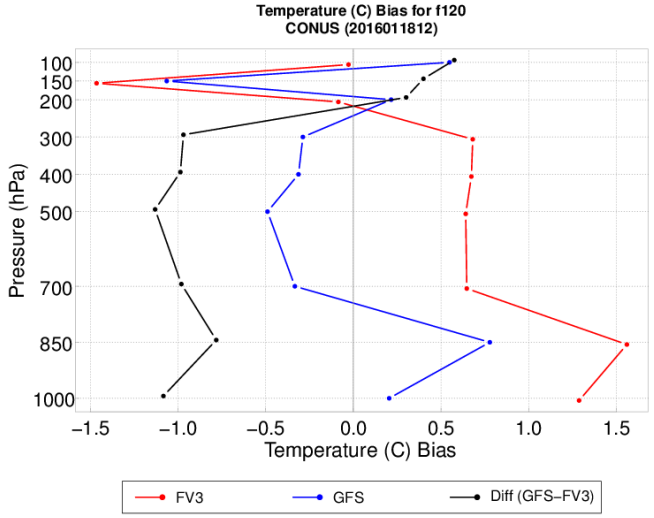
- For the latter forecasts (120 and 144 hours), the FV3 has lower frequency bias for nearly all thresholds, except for lighter precipitation thresholds (< 12.7 mm)
- Frequency bias for the 96-hr forecast shows that GFS is better with lighter thresholds, while FV3 is better with heavier thresholds (> 25.4 mm)
- GSS is very similar for both models at 96 hours, while there is no clear signal for the later forecasts on which model handles those thresholds better

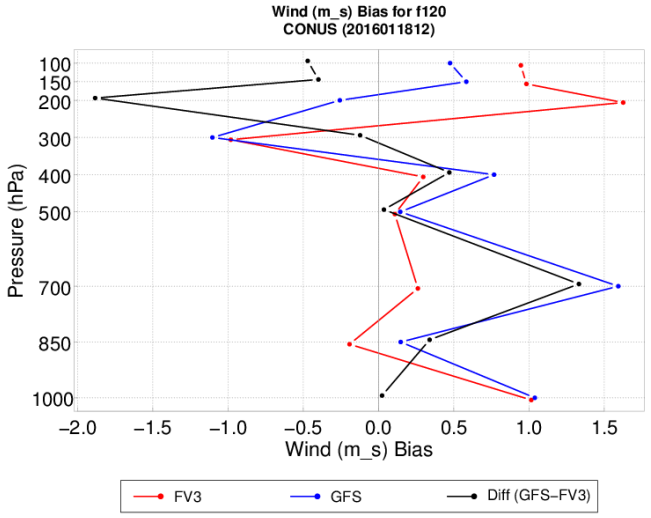
CONUS Upper-Air Variable Average RMSE and Bias for the 120-Hour Forecast Valid at 1200 UTC on 23/1/2016

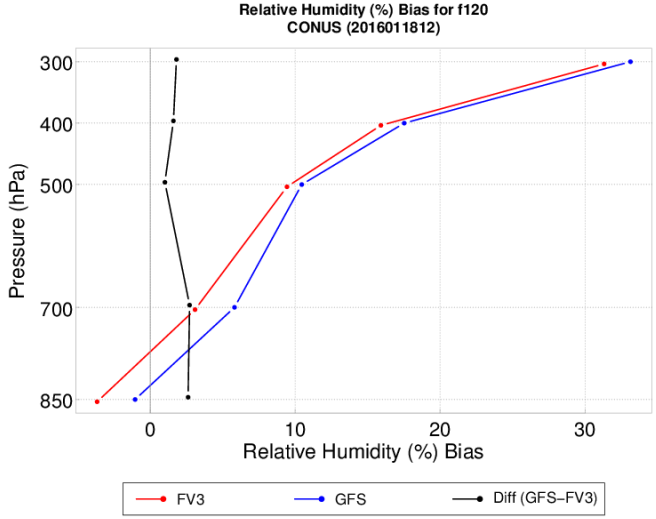








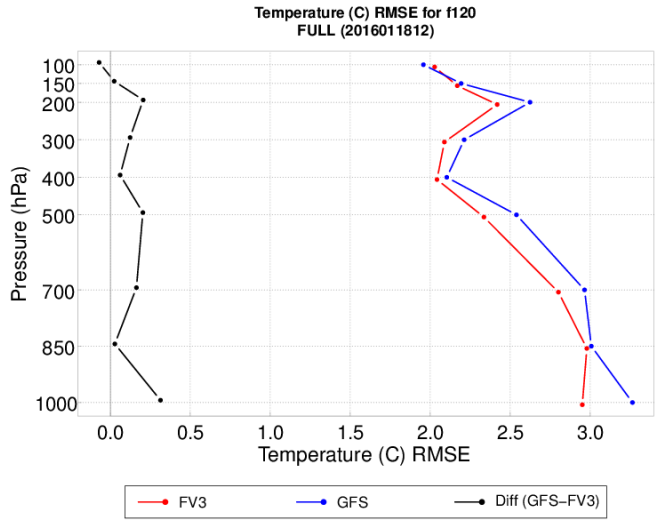


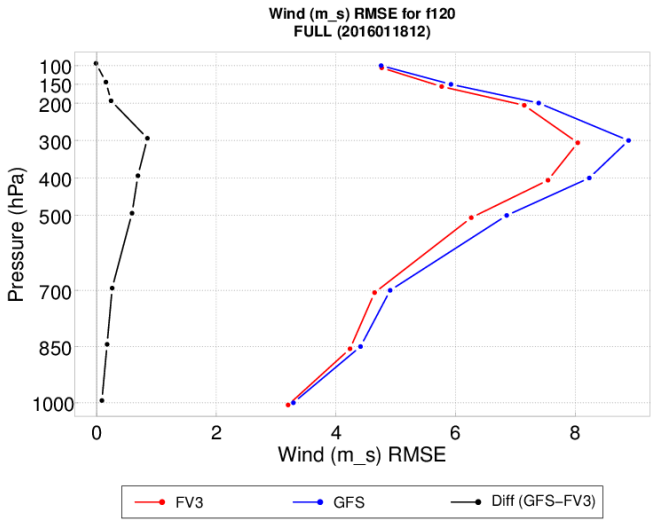


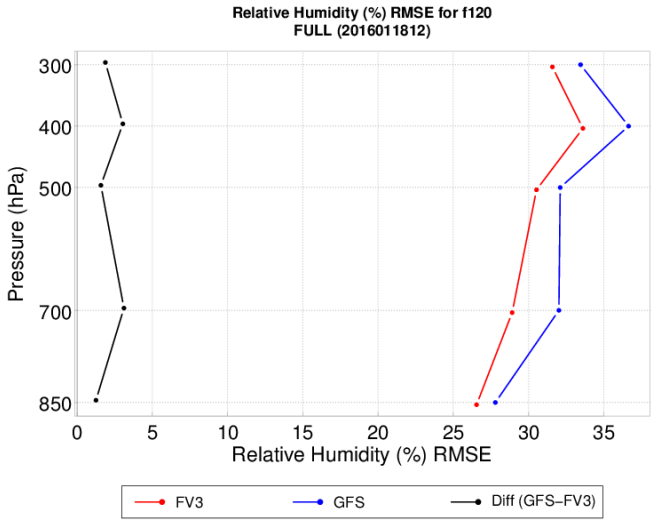
Conclusions for CONUS Upper-Air Variable Average RMSE and Bias for the 120-Hour Forecast Valid at 1200 UTC on 23/1/2016

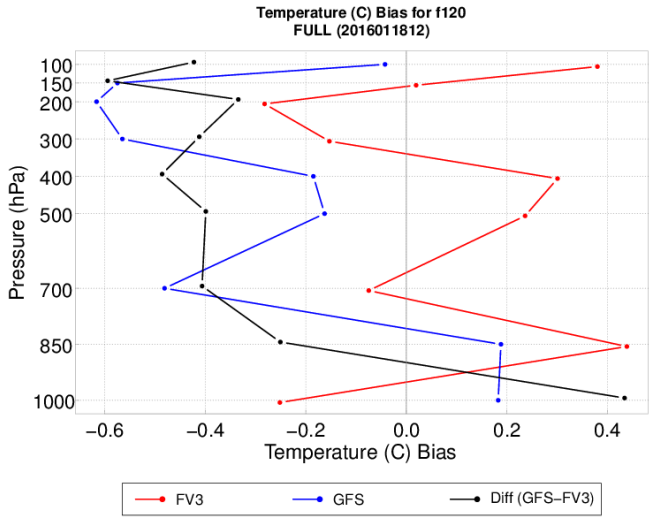
- RMSE for temperature and relative humidity is similar between models, with no indication that either models is superior to the other; However, the FV3 has smaller relative humidity RMSE with height than the GFS
- The GFS tends to have lower bias for most of the troposphere with respect to temperature RMSE, while the opposite is true for wind speed RMSE
- Aside from near the surface, the FV3 has lower bias than the GFS for relative humidity bias

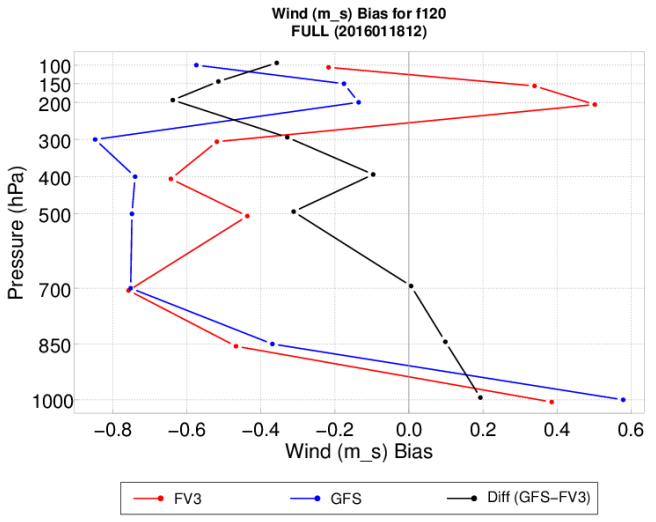
Global Upper-Air Variable Average RMSE and Bias for the 120-Hour Forecast Valid at 1200 UTC on 23/1/2016

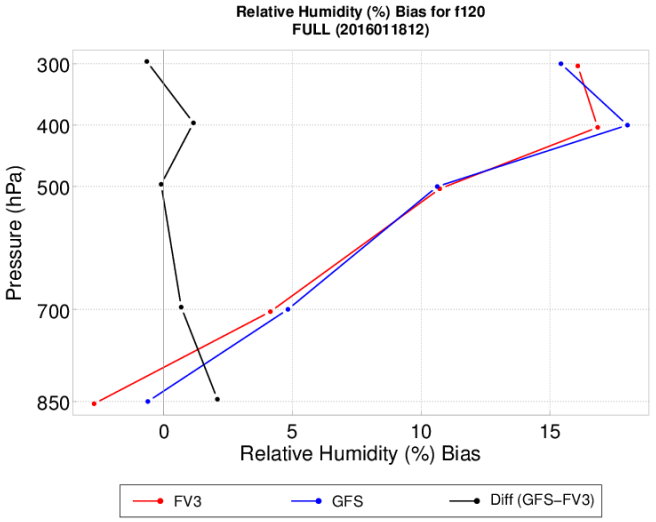












Conclusions for Global Upper-Air Variable Average RMSE and Bias for the 120-Hour Forecast Valid at 1200 UTC on 23/1/2016

- As opposed to the CONUS verification of upper-air variables, the global average RMSE for all three variables is lower with the FV3 than the GFS for all heights
- Temperature and wind speed bias are consistently lower for the FV3 than the GFS for the middle troposphere, while, on average, neither model has lower bias for the near surface and upper troposphere
- Bias for relative humidity is nearly identical between the FV3 and GFS for all levels, except at the surface, where the GFS has a lower bias

Overall Conclusions

- For the majority of lead times and thresholds, there is no clear indication that CONUS precipitation scores (GSS and frequency bias) or RMSE and bias are consistently better for either the FV3 or the GFS
- However, global, averaged vertical profiles of temperature, wind speed, and relative humidity for the FV3 have consistently lower RMSE than the GFS
- Therefore, the current comparison has shown that for this case study, the FV3 is able to compete with the GFS in terms of both CONUS and global verification of temperature, wind speed, and relative/specific humidity, as well as CONUS precipitation accumulation verification