# The November 15-16, 2018 Winter Storm

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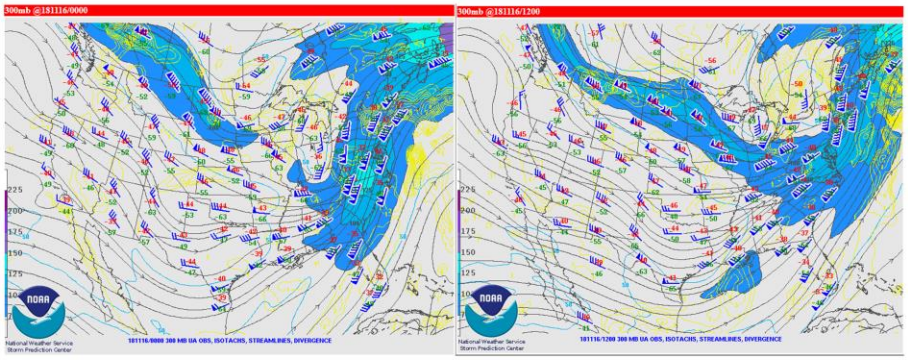
# Outline

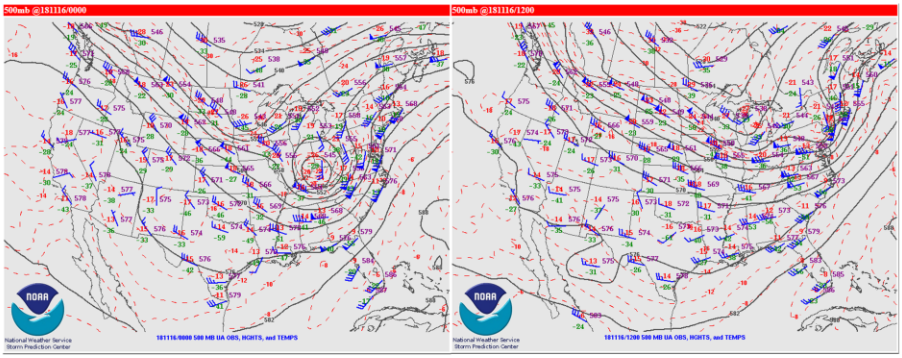
- Large-scale pattern
- Meso-scale pattern / forcing
- Model / WPC forecasts
- Radar and observations
- Summary and conclusion

# 300 mb analysis



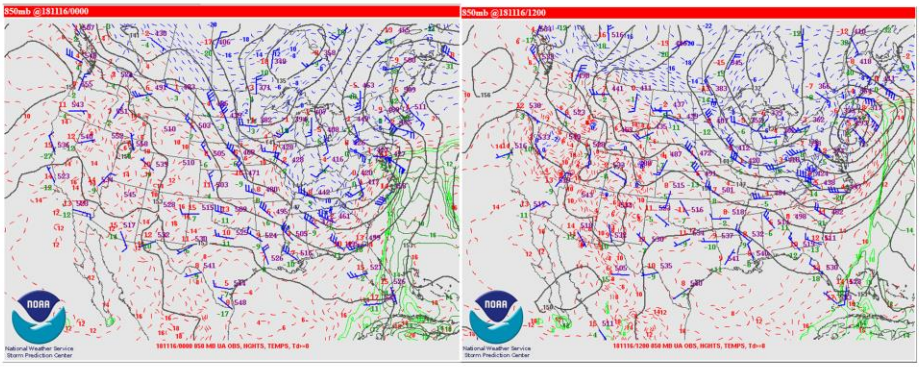

New York and New England were east of an approaching upper level trough early on the 16th, between two upper level jet streaks. One jet streak was advancing north up the mid-Atlantic coast while a second was moving east across the Canadian Maritimes. These features moved east as the trough progressed off the east coast at 12z on the 16th.

# 500 mb analysis



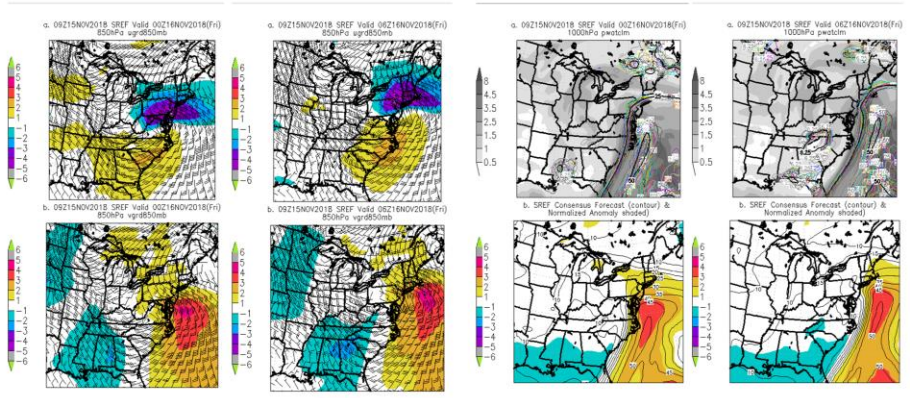

A mid-level closed low tracked east across the Ohio Valley on November 15th. The low opened up as it reached the northern mid-Atlantic region early on the 16th.

# 850 mb analysis



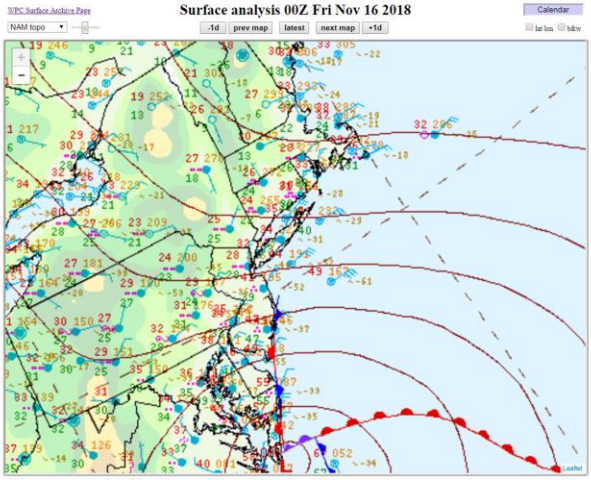

At 850 mb, low pressure deepened along the northern mid-Atlantic coast. At 00z on the 16th, a 50 to 60 kt southeasterly flow can be seen over the Delmarva region, overrunning a cold air mass in place across Pennsylvania and New Jersey. The low-level jet weakened a bit as it moved north along the coast, with 40 kt east-southeasterly flow observed near the New England coast at 12z on the 16th.

# 850 mb wind and precipitable water Anomalies



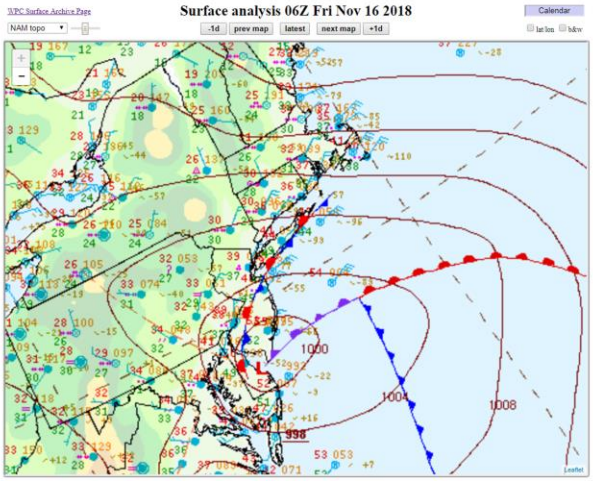

The easterly flow at 850 mb was 4-5 standard deviations above normal early on the 16th. Anomalously high precipitable water values moved up the east coast, staying just off shore east of New Jersey and southern New England.

# 00z surface analysis



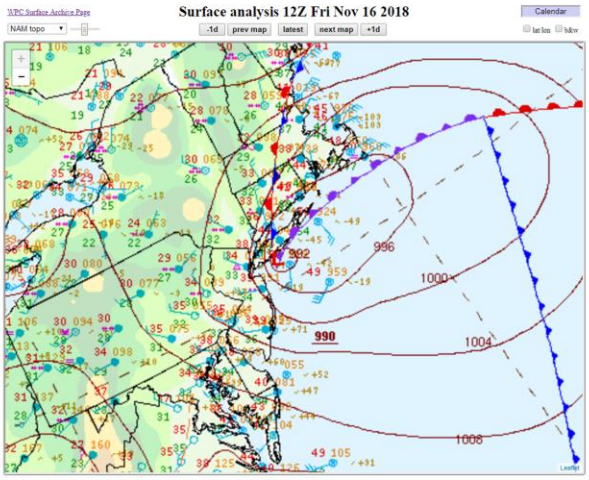

At the surface, low pressure was centered over the southern tip of Delmarva at 00z on the 16th. A band of heavy snow was moving north up the lower-Hudson Valley and Connecticut.

# 06z surface analysis



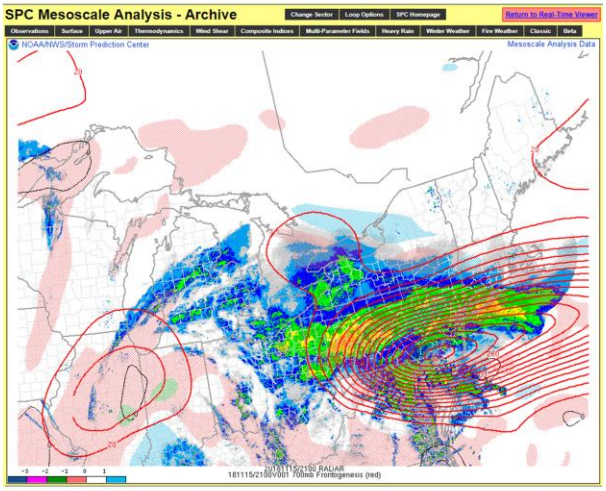

At 06z, the surface low was moving slowly north to near the Delaware coast. Snow had changed to sleet and freezing rain as far north as Albany.

# 12z surface analysis



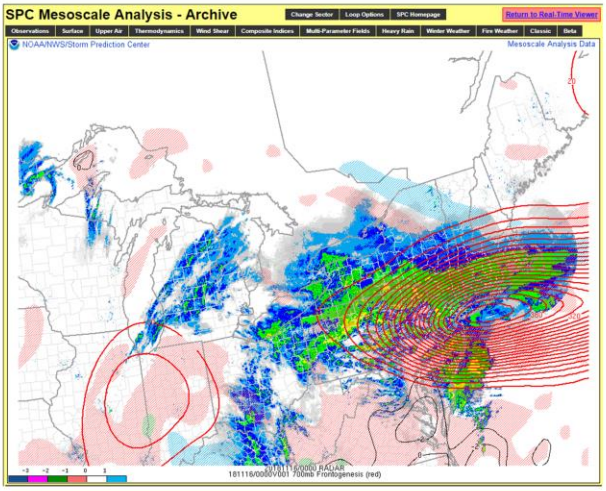

At 12z the surface low was located over southern Long Island. Mixed precipitation had changed back to moderate snow at Albany.

# 700 mb frontogenesis, EPV and radar – 21z



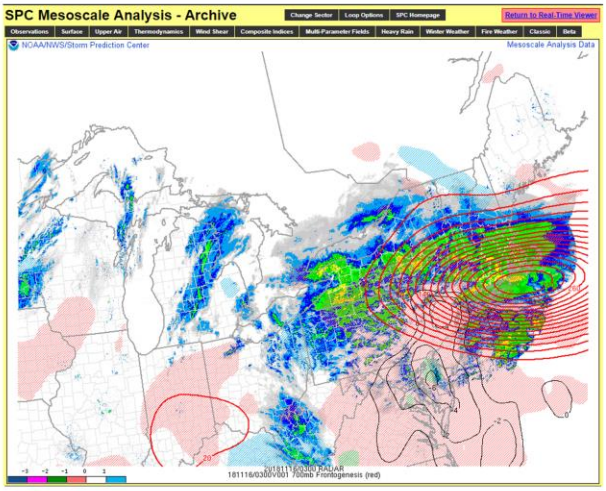

The data on this slide shows 700 mb frontogenesis (red contours) overlayed with equivalent potential vorticity (EPV from 650-500 mb, negative values shaded) and radar reflectivity at 21z. A band of moderate to heavy snow was moving north across Pennsylvania and southeast New York juxtaposed with the northern gradient of the frontogenesis. Some negative EPV, indicating low stability, was also in the area of this heavy snow band.

# 700 mb frontogenesis, EPV and radar – 00z



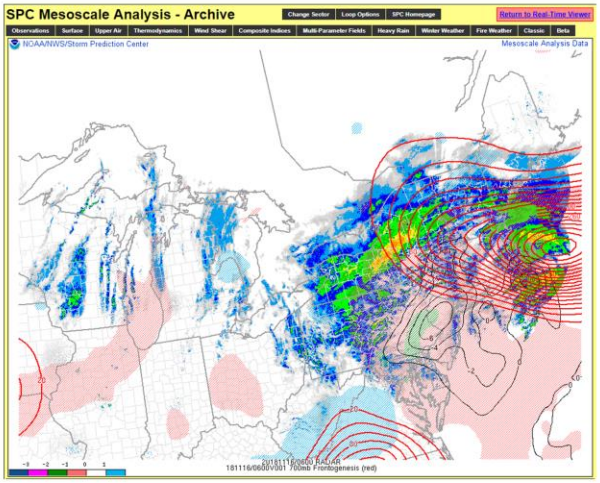

At 00z, the frontogenesis maxima was moving northeast near Long Island, while the heavy snow band was located over the mid-Hudson Valley.

# 700 mb frontogenesis, EPV and radar – 03z



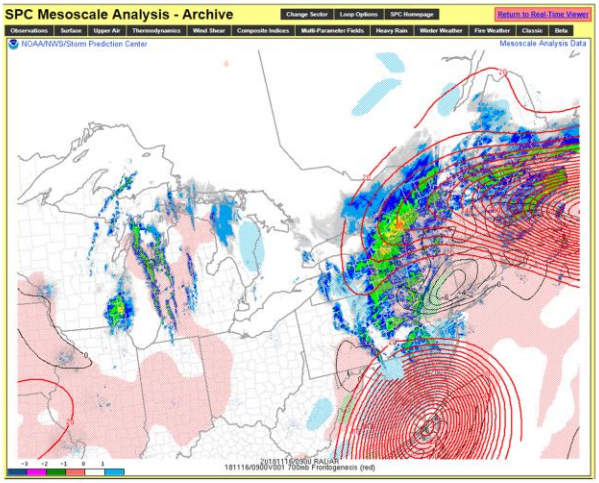

At 03z, the frontogenesis was tracking east-northeast, with heavy snow moving across portions of southern New England. The snow band over eastern New York was beginning to weaken and become slightly disorganized as the strongest frontogenesis was moving east of the region.

# 700 mb frontogenesis, EPV and radar – 06z



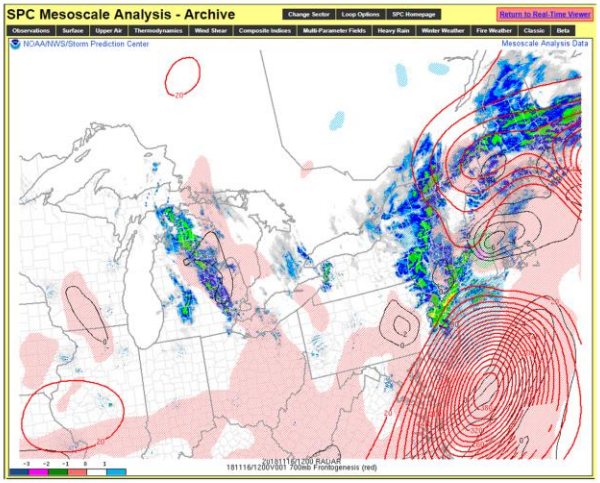

At 06z, the initial maxima of frontogenesis was moving east-northeast, to the south of Cape Cod. A band of heavier precipitation was re-forming northwest of the Capital District across central New York into the southern Adirondacks.

# 700 mb frontogenesis, EPV and radar – 09z



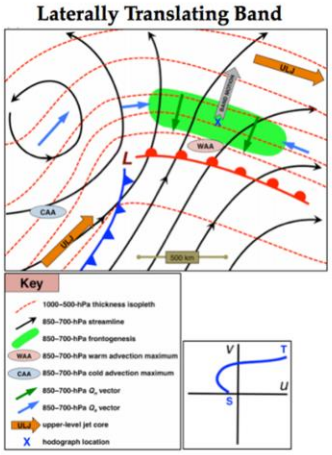

The snow band north and west of the Capital District became the primary band of moderate to heavy snow on the northwest edge of the cyclone by 09z. This band was located in an axis of 700 mb frontogenesis extending from east-northeast to west-southwest from New England to central New York.

# 700 mb frontogenesis, EPV and radar – 12z



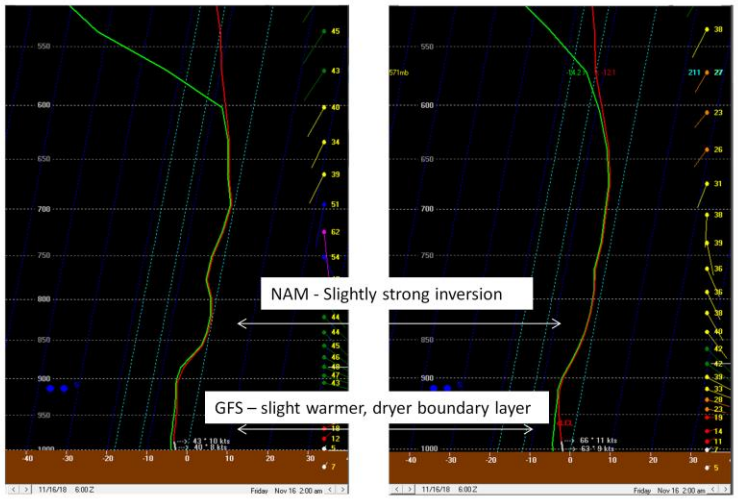

The frontogenesis and primary snow band weakened as they moved east across the eastern New York during the morning on the 16th.

# Schematic for expected band movement



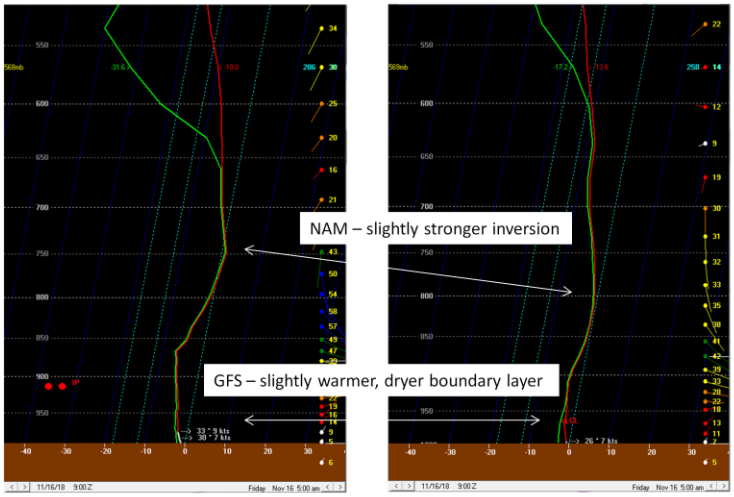

The forecast pattern late on the 15th and early on the 16th was similar to the pattern associated with laterally translating heavy snow bands identified in earlier CSTAR work at U-Albany. Strong warm advection north-northeast of low-level low pressure was associated with a band of frontogenesis translating from south to north. The band in this case was best organized over Pennsylvania northeast to the mid-Hudson Valley. The frontogenesis ultimately tracked east-northeast off the New England coast, and the snow band weakened as it moved north toward the Capital District, away from the best forcing.

# 18 hour forecast soundings



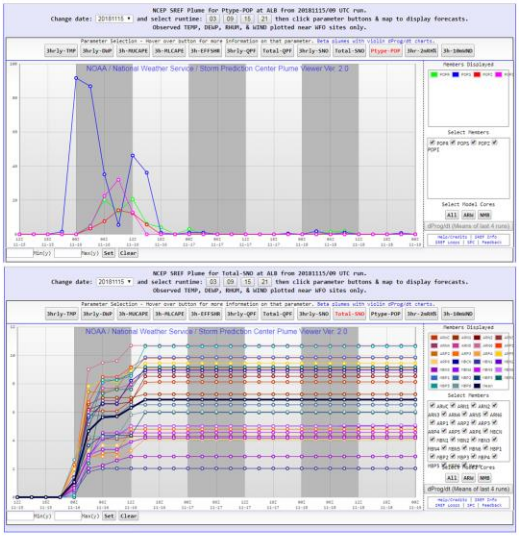

Model forecast soundings valid at 06z at Albany on the 16th from the 12z 15th runs of the NAM and GFS showed differences that have been noted previously when comparing the two models during winter storms. 06z on the 16th was the time when snow was transitioning to mixed precipitation at Albany. Both models showed moist soundings that were entirely below freezing, however the GFS was forecasting a slightly warmer, dryer boundary layer, while the NAM was forecasting a slightly stronger, warmer mid-level (850-800 mb) inversion.

# 24 hour forecasting soundings



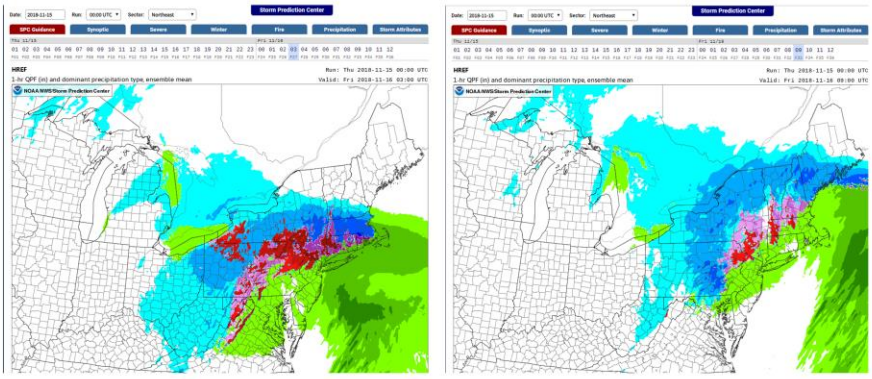

The same differences can be seen in forecast soundings valid at 09z. The GFS continued to forecast a slightly warmer, dryer boundary layer, while the NAM forecast a slightly warmer mid-level warm layer. In this case, the NAM warm layer was slightly above freezing, while the GFS remained slightly below freezing. Given that precipitation changed to sleet and freezing rain for awhile at Albany, it is likely that the NAM forecast was superior in this case.

# 09z 11/15 SREF forecasts at Albany



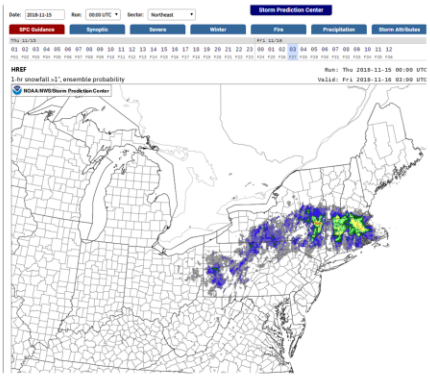

09z 15th runs of the SREF valid at Albany indicated a period of snow during the evening on the 15th, followed by a period when sleet and freezing rain would be more likely than snow between 06z and 12z, then a period toward the end of the event when snow became most again (top). Snowfall forecasts for Albany were highly variable, with most members in the ensemble forecasting between about 4 to 9 inches.

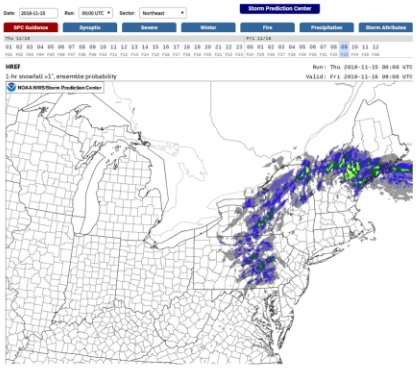
# 00z HREF valid 03z, 09z




Mean precipitation type from the high resolution ensemble (HREF) forecast indicated that precipitation at Albany would start as snow around before 00z on the 16th, then become spottier and change to sleet and freezing rain by 09z.

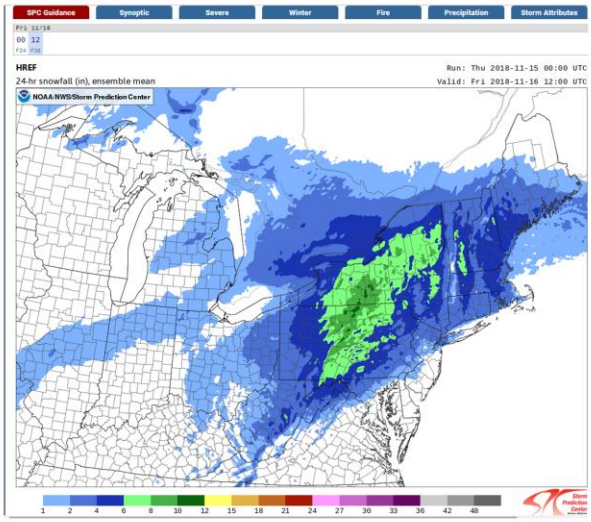
# 00z HREF prob snowfall > 1 valid 03z, 09z



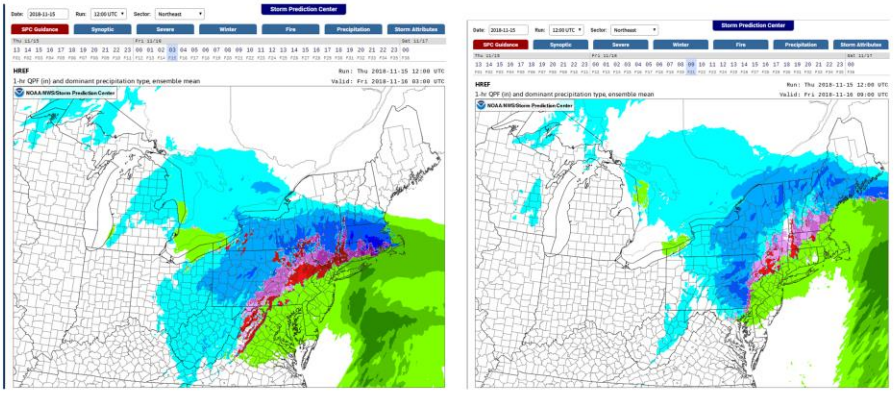

Some probability of greater than 1 inch per hour snowfall was indicated over the mid-Hudson Valley into the Capital District during the evening on the 15th, with the probabilities decreasing and shifting northward overnight.

# 00z HREF mean snowfall



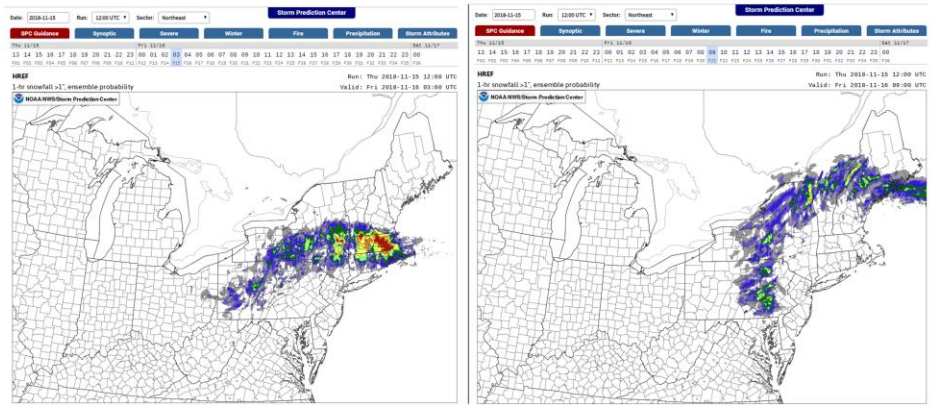

Mean 24-hour forecast snowfall for the period ending at 12z on the 16th indicated heaviest snowfall north and west of Capital District. Much of eastern New York from Albany southward was forecast to receive from 2 to 6 inches of snow, while areas to the north and west of Albany were forecast to receive from 6 to 10 inches.

# 12z HREF p-type valid 03z, 09z



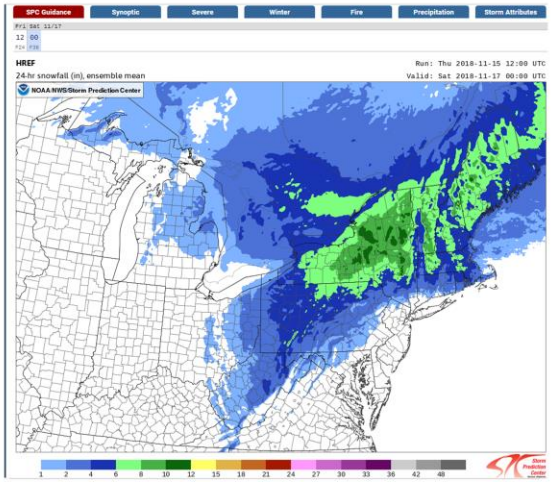

The 12z run of the HREF also showed mainly snow from the mid-Hudson Valley northward at 03z, transitioning to a mix of sleet and freezing rain from Albany southward by 09z. Note that despite the fact that these are mean graphics composed of several models, topographically forced details are still apparent. For example, at 03z (left) note the axis of mixed precipitation extending northward along the west slopes of the Berkshires and Taconics in a down-sloping zone, while precipitation remains snow farther to the west.

# 12z HREF prob snowfall > 1 inches valid 03z, 09z



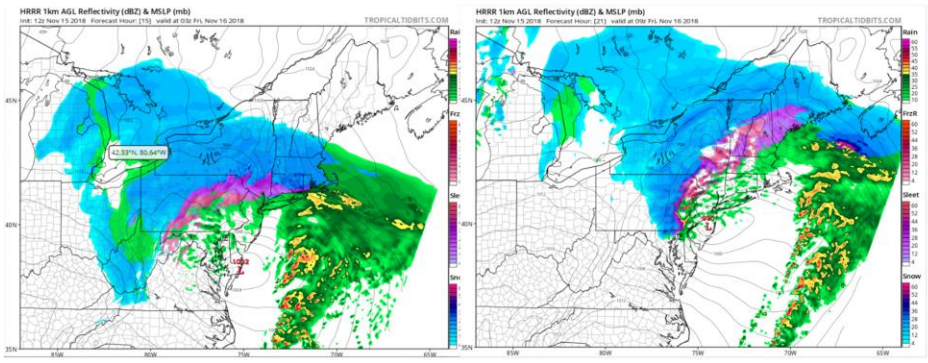

Scattered areas of high probability for greater than 1 inch per hour snowfall can be seen from the mid-Hudson Valley toward the Capital District by 03z. By 09z, the highest probabilities have shifted north, and are considerably lower.

# 12z HREF mean snowfall



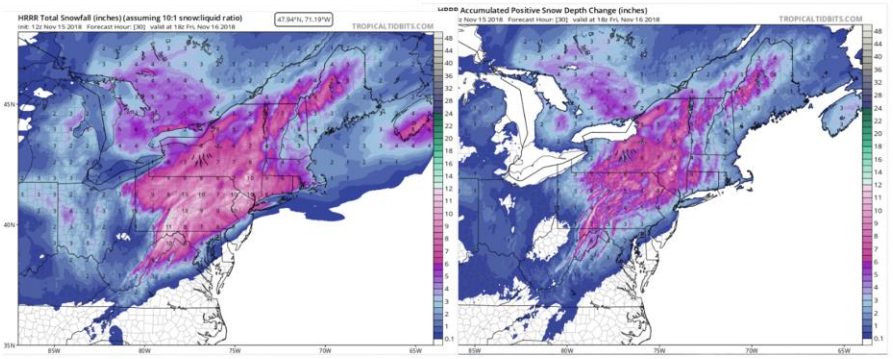

The mean snowfall from the 12z HREF appeared to increase a bit compared to the 00z run. Much of our area was forecast to receive anywhere from 6 to 12 inches of snow.

# 12z HRRR valid 03z, 09z



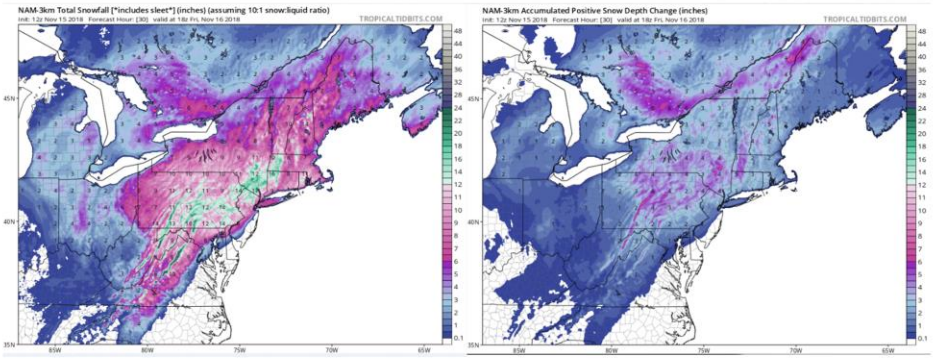

The 12z run of the HRRR was typical of the high resolution, short-range guidance for this event, showing an initial period of moderate snow, followed by spottier mixed precipitation later in the night.

# 12z HRRR snowfall vs snow depth change



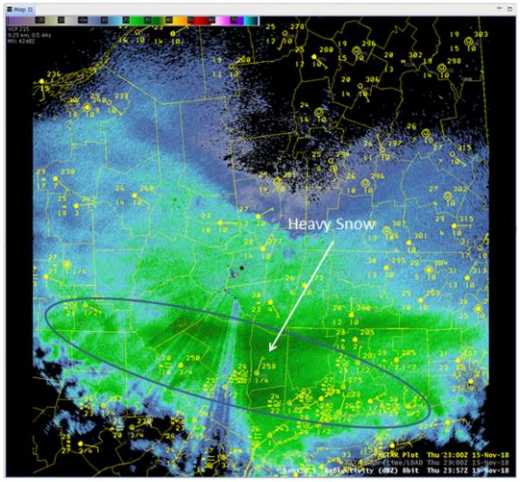

Snowfall (assuming a 10 to 1 ratio, even for sleet) and the change in snow depth from the HRRR both indicated widespread snowfall amounts of 6 to 10 inches, with the snowfall graphic on the left showing slightly larger values, as would be expected.

# 12z NAM Nest snowfall vs snow depth change



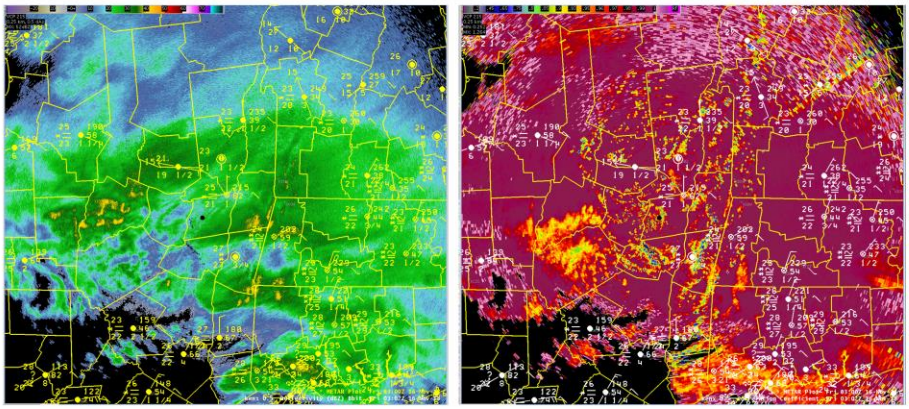

Snowfall using the 10 to 1 snow to liquid assumption from the NAM nest indicated a widespread 6 to 10 inch storm, with some 12 inch amounts in the Catskills and mid-Hudson Valley. The snow depth change graphic from the NAM nest was considerably lower, indicating that most areas would receive between 2 and 6 inches.

# Radar reflectivity – 00z November 16



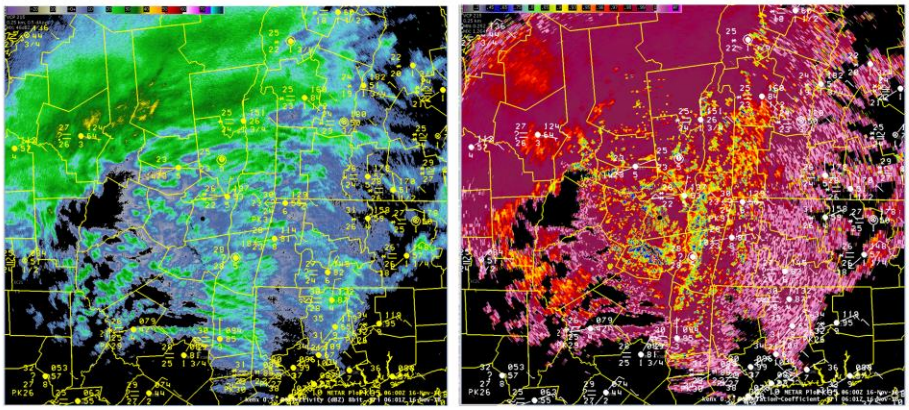

Radar reflectivity at 00z on the 16th showed a band of heavy snow moving north up the lower and mid-Hudson Valley. Reports indicated that some areas had 2 to 4 inches of snow per hour rates within this band.

# Radar reflectivity and cc – 03z November 16



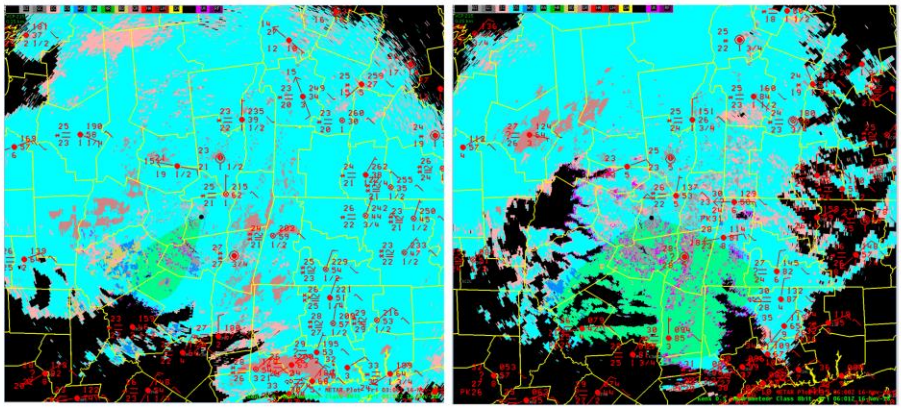
At 03z, the snow area was breaking up into multiple bands. The correlation coefficient product was starting to look “noisy”, indicating a little mixing of the precipitation was being detected, even though surface observations still indicated snow across the entire area.

# Radar reflectivity and cc - 06z November 16



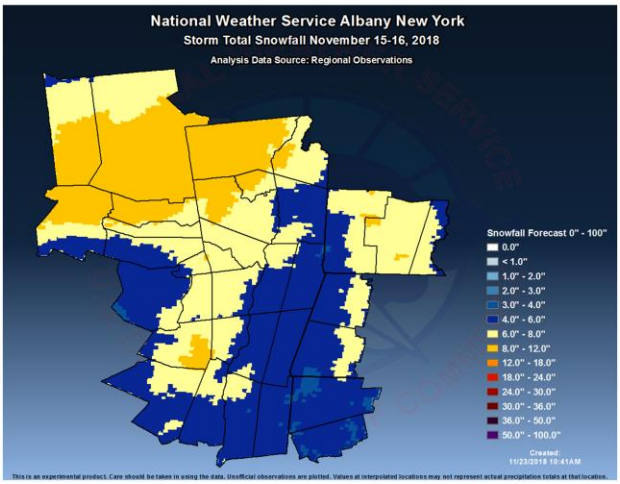
At 06z, the main snow area was re-organizing north of the Capital District, from the western Mohawk Valley across the southern Adirondacks. The correlation coefficient produce was very noisy of the area from the Capital District southward, indicating mixed precipitation. Observations also indicated a mix of precipitation from the Capital District southward.

# Hydrometeor classification – 03z and 06z November 16



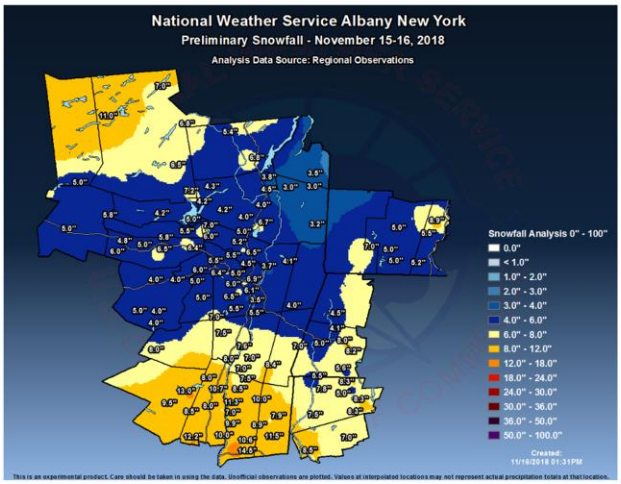
The hydrometeor classification scheme indicated rain south of Albany, but mainly snow from Albany northward through 06z. Based on surface observations, which indicated a mix of precipitation at Albany at 06z, it appears that that the algorithm did not identify the rain quite far enough to the north through 06z.

# Forecast snowfall




Forecast snowfall for this event indicated amounts of 4 to 6 inches within the Hudson Valley, with 6 to 12 inches over higher elevations and in the Mohawk Valley.

# Observed snowfall




Observed snowfall indicated that the heaviest snow actually fell in the mid-Hudson Valley south of Albany, where the initial heavy snow band produced totals of 10 to 12 inches. Snowfall diminished northward to totals averaging around 4 to 6 inches. Another maxima occurred over the southern Adirondacks where the snow band ultimately re-formed, producing a band of 6 to 12 inches.

# Summary and conclusions

- A winter storm occurred over eastern New York and western New England as low pressure moved up the east coast.
- The heaviest snow fell over the mid-Hudson Valley in an initial shot of warm air advection and strong frontogenesis.
- The heaviest snow did not continue northward into the Capital District; instead the strongest frontogenesis shifted east, and the heaviest snow shifted east across southern New England.
- High resolution models generally did not provide strong clues that the heaviest snow would be over the southern part of the area.
- High resolution models did do a good job showing location and timing of a transition zone from snow to sleet and freezing rain.