Northeast U.S. Winter Storm – 9-11 December, 2014
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Meteorological Overview: A multi-day winter storm affected much of the interior northeastern U.S. and into the Lower Great Lakes region. Initially, the event consisted of freezing rain from central/northern New Jersey into western Connecticut. Gradually the focus shifted farther inland where a widespread 6 to 12 inches of snow fell while heavier amounts concentrated across higher elevations along with locations downwind of Lake Ontario (Figure 1).

A complex evolution unfolded as the initial upper trough which moved from the Ohio valley toward the North Carolina Outer Banks on 9-10 December transitioned to a slow-moving, more dominant upper-level low across the northeastern states the following couple of days (Figure 2). The more inland track of the system led to a strong push of maritime air into the region which moved the rain/snow line well inland. Initially the primary threat was an icing event as a cold dome of high pressure strengthened over Nova Scotia (1043 hPa on 9 December 06 UTC). This built a strong cold-air damming event extending along the spine of the central/northern Appalachians while modest 850-700 hPa warm advection overran this layer. The 'warm nose' was particularly pronounced in the 9 December 00 UTC sounding out of OKX (Upton, New York). This sounding showed above 0° C air extending between 840-750 hPa while an isothermal/saturated sub-freezing layer persisted beneath. An uptick in the vertical velocities along an enhanced axis of 850-700 hPa frontogenesis helped spread higher ice accumulations from northeastern Pennsylvania/northern New Jersey northeastward into western Connecticut (0.13-0.25"). This appeared to be collocated within a broad area of bright banding noted on the radar mosaic.

The system would gradually gather strength as the secondary upper low began to intensify across the Upper Mid-Atlantic around 10 December 00 UTC. Its slow progression would carry it from eastern Pennsylvania to central Vermont (~275 statute miles) during the following 48 hours spanning 10-12 December. During this evolution, a rather potent 850 hPa wave lifted northward along the New England coast while being accompanied by easterly winds in excess to 60-70 knots. The climate forecast system (CFS) reanalysis suggested this flow was 4-5 standardized anomalies above normal. This enhanced low-level warm advection overran a coastal baroclinic zone (Figure 3) which aided in a broad region of isentropic lift. While heavy rains were more commonplace over the lower elevations of New England, strong northerly flow on the western edge of the 850 hPa circulation allowed sufficient cold air to sink southward from far eastern Canada. This resulted in light to moderate snowfall from upstate New York into most interior locations of Vermont, New Hampshire, and Maine. By 10 December 06 UTC, the maximum in low-level frontogenetic lift moved up into southern Quebec which shut down precipitation across northern New England. Meanwhile, snowfall continued within the comma-head with the axis of precipitation pivoting from Vermont back toward much of upstate New York. This activity tended to congregate on the western side of the 500 hPa circulation where the coldest air aloft locally steepened vertical lapse rates. Eventually these precipitation cores south of Lake Ontario would weaken by the afternoon of 10 December giving way to another surge of moisture toward coastal New England.

Surface analysis showed a synoptic warm front moving toward Maine with precipitable water values reaching one inch along the coastline. The cyclonic flow around New England was able to draw this enhanced Atlantic moisture back toward inland locations. Radar imagery by 10 December 18 UTC showed the precipitation blossoming across the northeastern U.S. which coincided with the increase in strength of the 850/700-hPa waves. Thereafter, a persistent axis of rainfall affected northern Maine along the anomalous moisture channel while a separate batch of wintry precipitation fell within the subfreezing air across the interior Northeast. Again, the bands of moderate to heavy snow would pivot

back toward central New York as the circulation center drifted northward toward southern New Hampshire. These axes of intense snowfall would have access to an impressive batch of low/mid-level moisture with 700-500 hPa relative humidity values spiking to above 80% from 10 December 18 UTC through 12 December 00 UTC. In addition, lake enhancements came into play as the intensity of the snowfall bands increased to the south of Lake Ontario. This is where Jamesville, New York (just southeast of Syracuse) reported over 27 inches of snow. Toward the end of the event, the core of stronger vertical velocities shifted southward into the Mid-Atlantic while activity more showery in nature was commonplace in its wake underneath the center of the upper low.

Impacts: Freezing rain on the morning of 9 December led to downing of power lines across areas of New Jersey where up to a quarter inch of ice fell. Farther to the north, icy conditions caused numerous car accidents across Massachusetts. Meanwhile, the heavy, wet snow wreaked havoc on the northeastern U.S. as hundreds of flights were delayed with widespread power outages over the region.

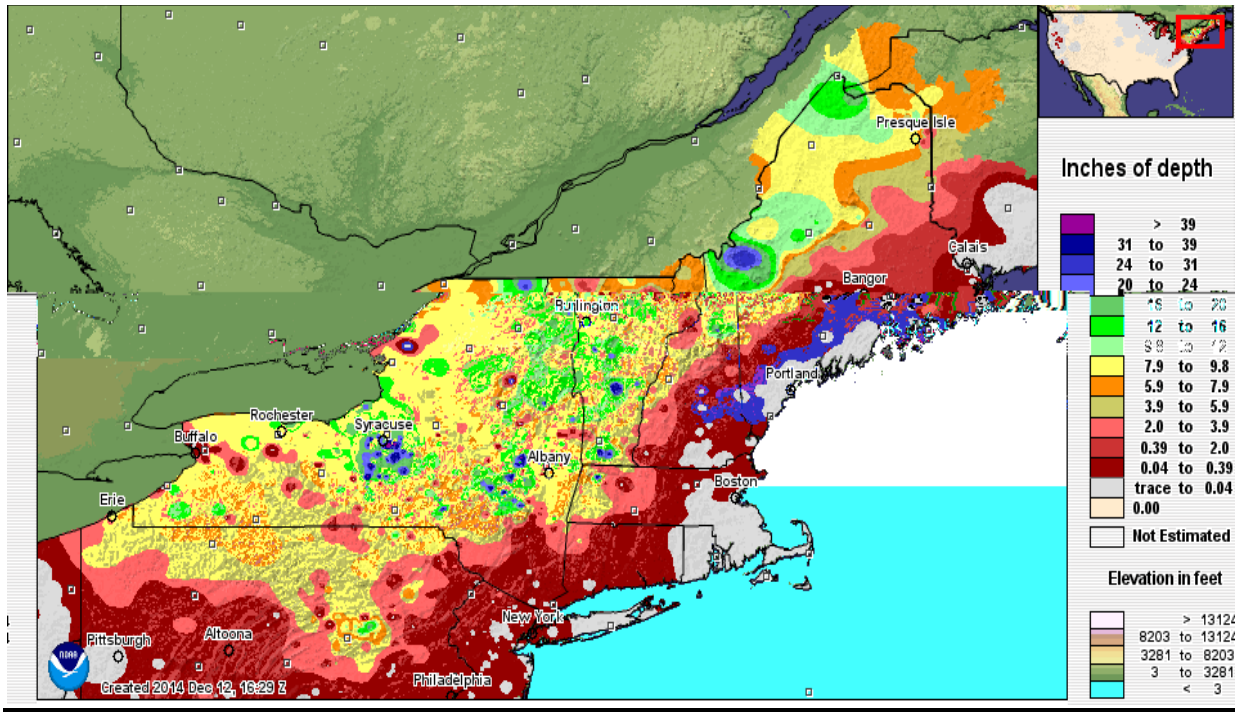

Figure 1: Total snowfall (inches) during the 9-11 December snowstorm (image from National Operational Hydrologic Remote Sensing Center)

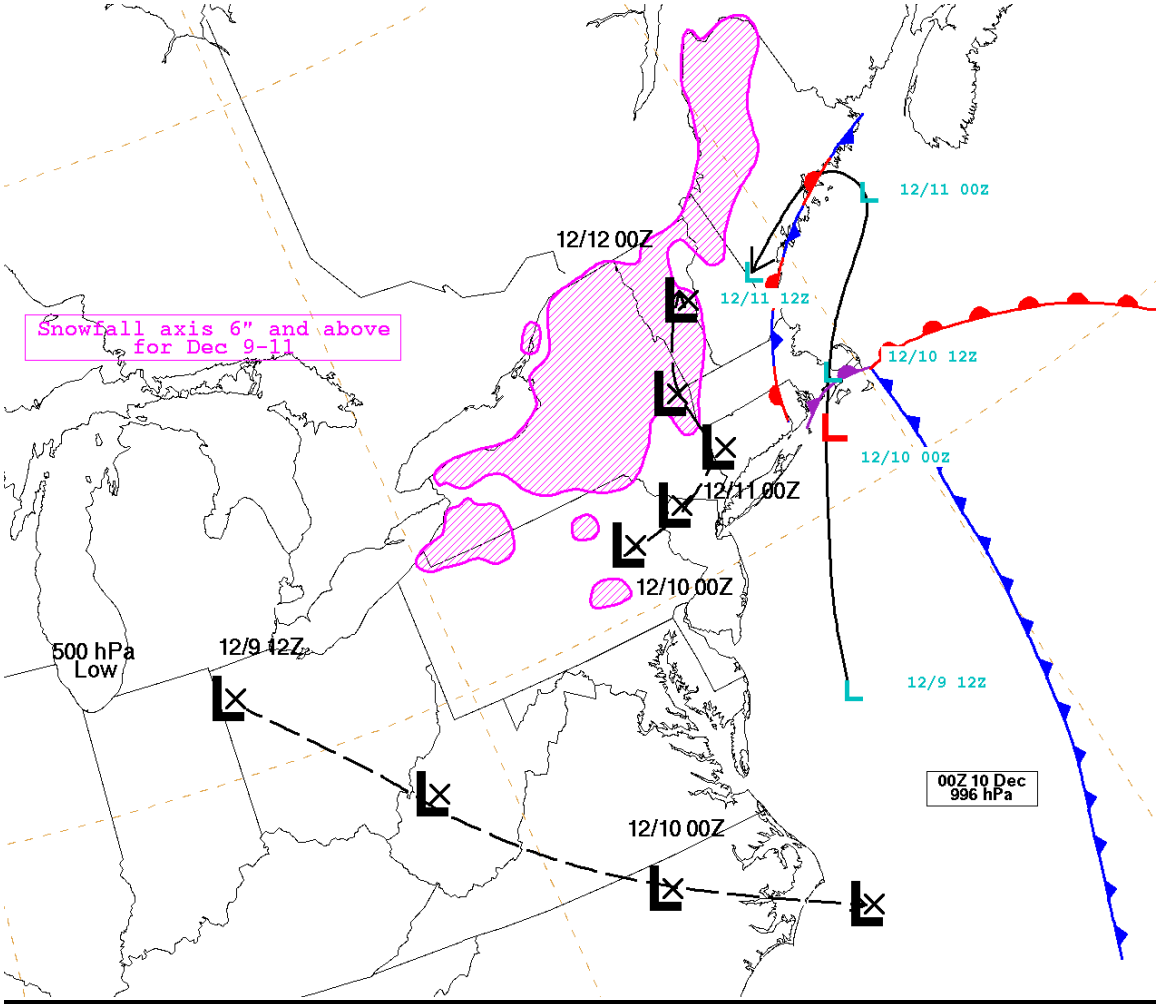

Figure 2: 500-hPa low tracks (black), surface low track (light blue), frontal analysis at 00 UTC on 10 December, snowfall axis 6" and above (pink)

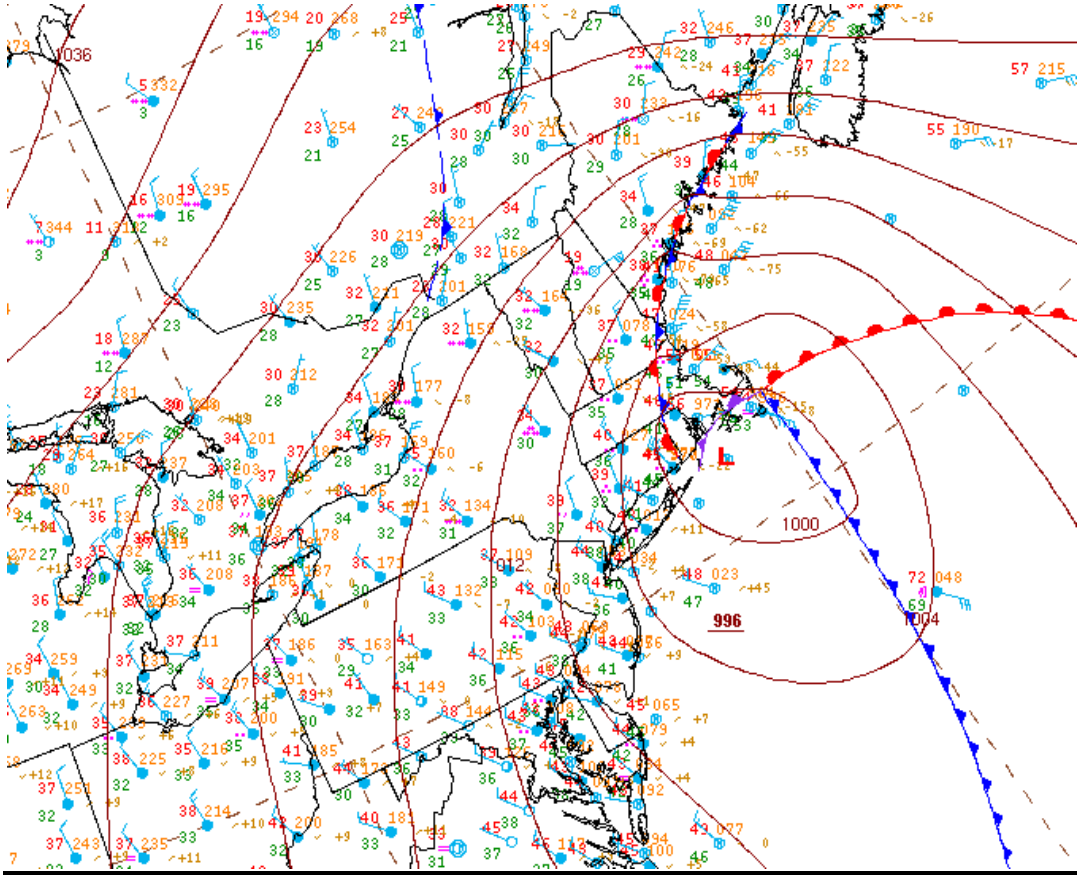

Figure 3: Surface analysis 10 December (0000 UTC) (image from the Weather Prediction Center)