Summary of February 1-3 2011 Central and Eastern U.S. Winter Storm
By Christopher Hedge

Overview:

One of the most significant events of the 2010-2011 winter season affected a widespread region from Texas to the Midwest and Northeast from February 1st to 3rd 2011. This system produced widespread heavy snow with blizzard conditions, along with significant freezing rain and sleet to other locations. Figure 1 shows the total snowfall accumulations that resulted from this event.

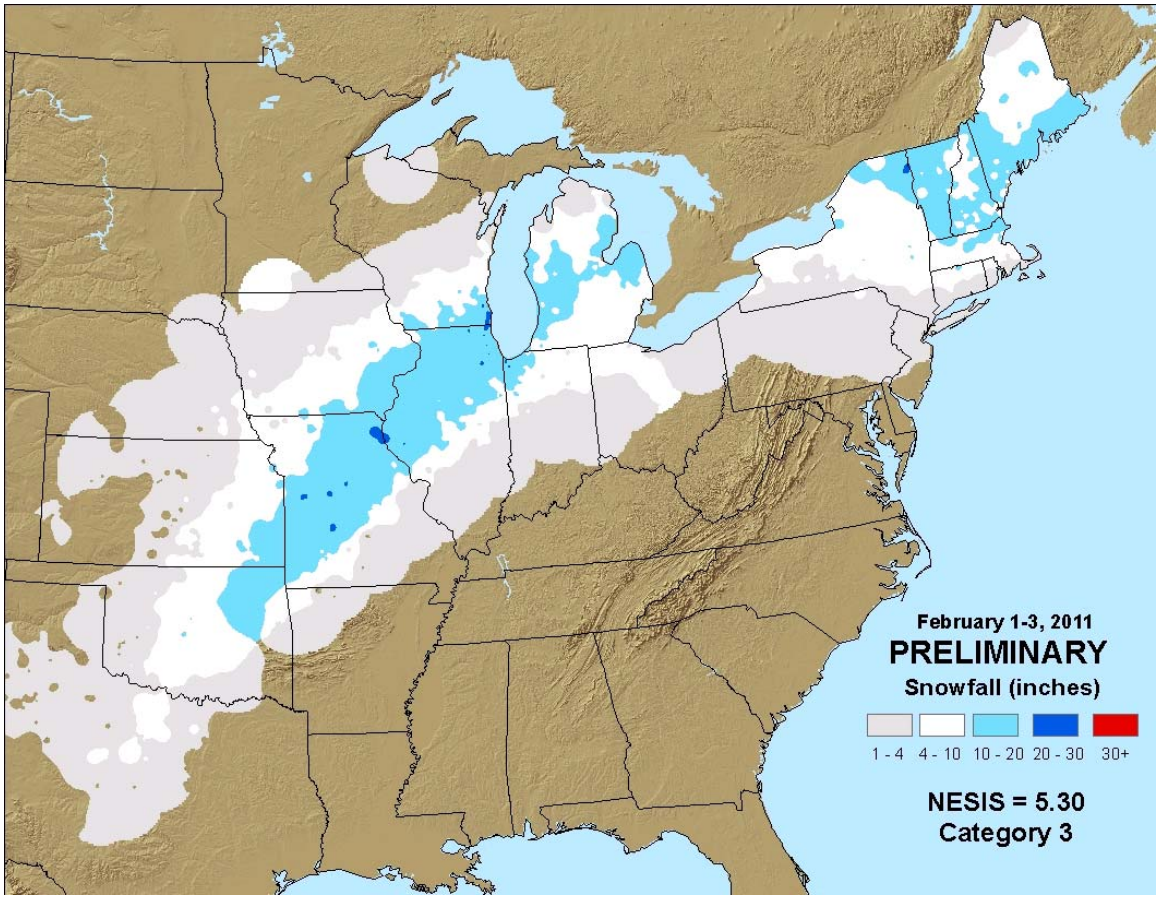

Fig. 1: snowfall accumulations across the central and northeast U.S. February 1-3 2011 (NCDC).

Snowfall amounts of 10 to 20 inches were common from northeast Oklahoma to lower Michigan. This storm produced 20.2 inches at Chicago (ORD), the third heaviest snowfall in the city since their records began in 1886, along with a peak wind of 61 mph. Heavy snow also affected the Northeast, with the highest totals across northern New York and central New England. This storm has been rated as a category 3 event (major) on the Northeast Snowfall Impact Scale (NESIS). Significant accumulations of freezing rain and sleet were also observed from portions of southeast Missouri to Pennsylvania

and southern New England. Convective rain, along with a few tornadoes, were reported across the Southeast and Tennessee Valley, though much of the significant precipitation with this event was freezing or frozen. Total estimated precipitation amounts are indicated in Fig. 2.

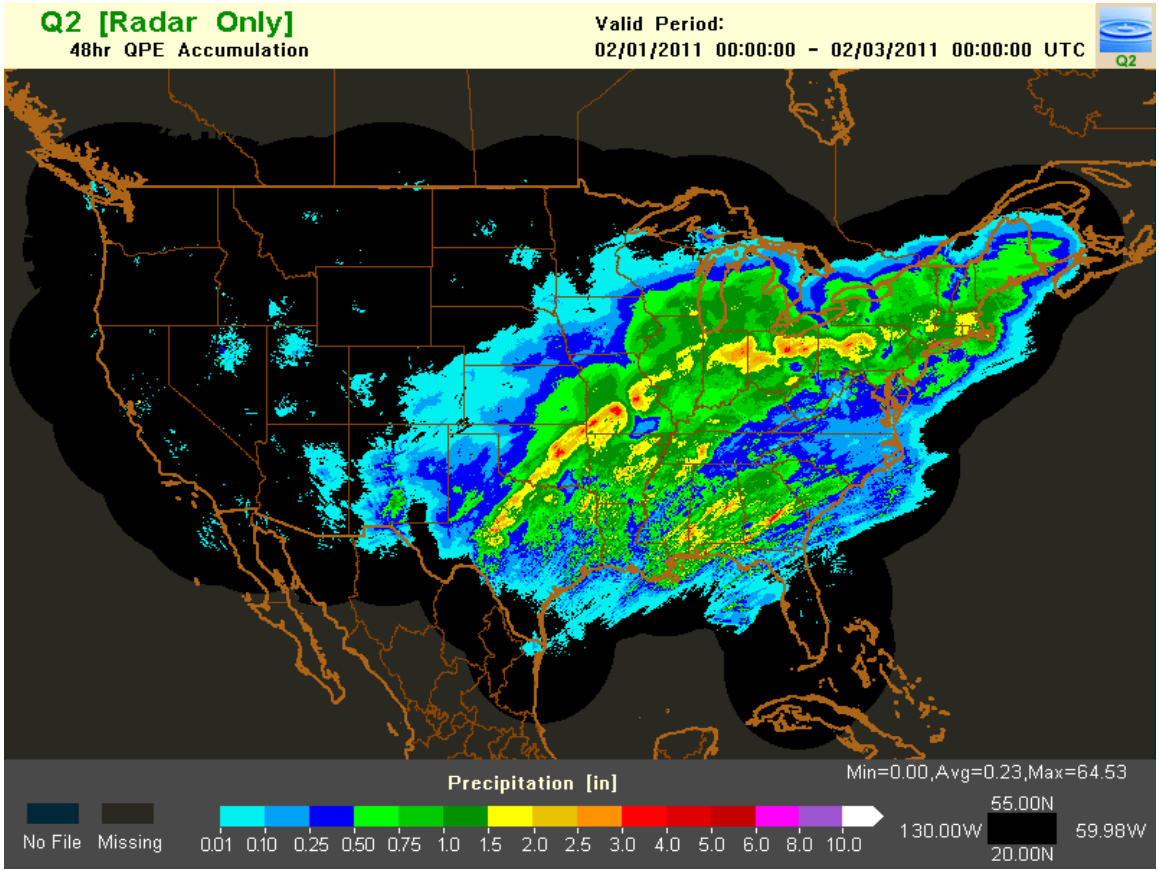

Fig. 2 Total precipitation from 00 UTC Feb 1 2011 to 00 UTC Feb 3 2011 (NSSL).

Synoptic Pattern:

The upper pattern during the days preceding this event featured a persistent arctic vortex over eastern Canada, with a sprawling and very cold surface ridge extending from the Plains to the Northeast. An upper ridge over the eastern Pacific amplified sharply, allowing a trough to carve into the Rockies. Figures 3-6 feature plots at 00 UTC on February 2 2011, around the peak of the event across the Mississippi Valley and Midwest. At 250mb, a 130 knot jet aligned along the Mexican border, before reaching northward across the Mississippi Valley (Fig. 3). A westerly 250mb jet also streamed from the Great Lakes to the Northeast, to the south of the eastern Canada vortex. This strong coupled jet pattern at 00 UTC Feb 2 placed Illinois within the left exit region of the southern jet streak, and the right entrance region of the northern portion of the upper jet (Fig. 3).

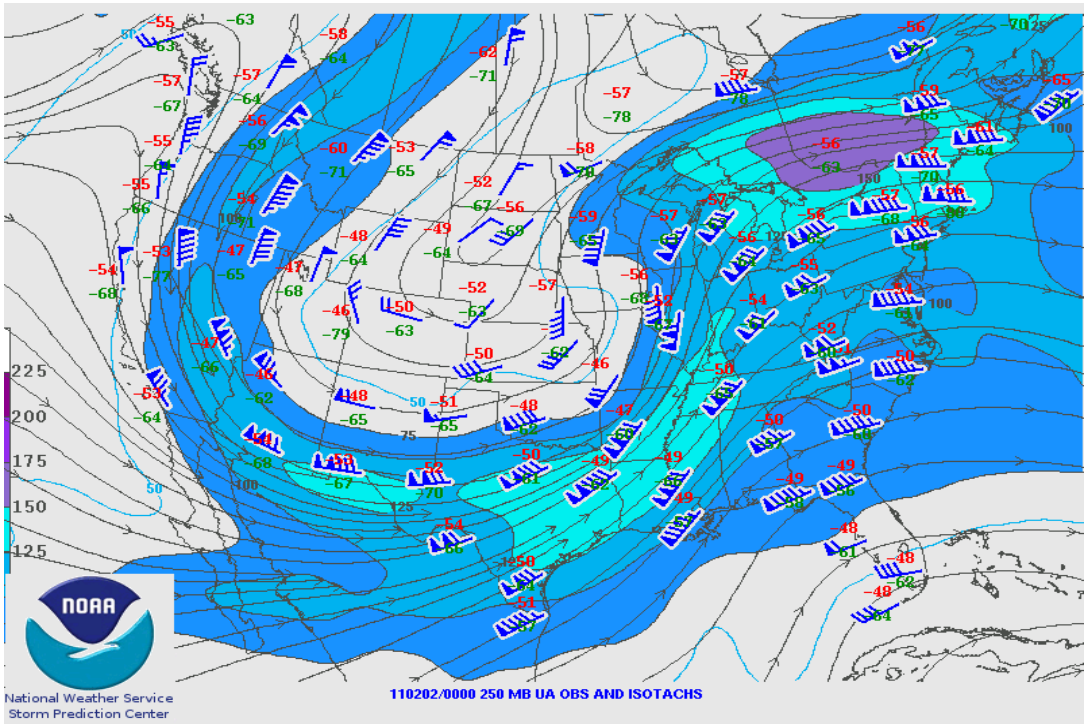

Fig. 3 250mb analysis 00 UTC Feb 02 2011 (SPC).

At 500mb, a broad and more complex trough is evident (Fig. 4). The 500mb low center over the high Plains remained nearly stationary. A secondary 500mb low, evident over Missouri in Fig. 4, detached from the main upper vortex and traveled across the Midwest and Northeast. This system developed a negative tilt, and was forced to track east-northeast, rather than into Canada, given the blocking vortex in place over eastern Canada.

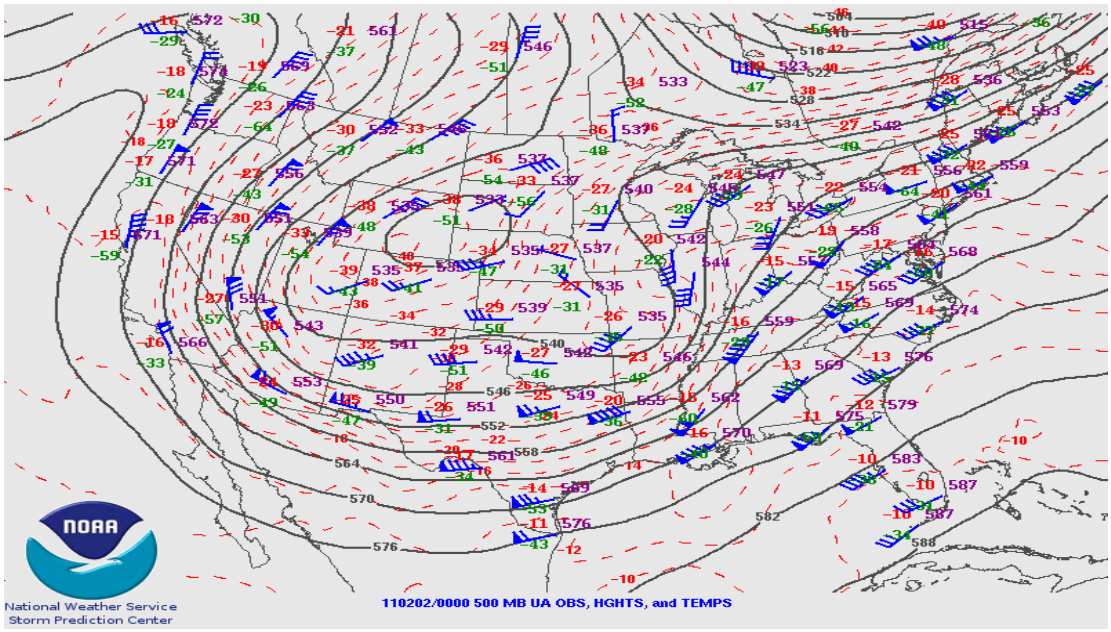

Fig. 4 500mb analysis 00 UTC Feb 02 2011 (SPC).

During February 1st, a low level circulation formed over northeast Texas along a strong thermal boundary before intensifying and reaching to the mid Mississippi Valley by 00 UTC on February 2 (Fig. 5). Heavy snow set up to the north and west of the deep low, which was centered near southern Illinois at that time.

With a strong arctic surface ridge to the north of the system, a very tight surface pressure gradient set up over the Plains and Midwest as the low level circulation intensified (Fig. 5), resulting in widespread blizzard conditions. Heavy sleet and freezing rain was most prevalent across Indiana. Surface temperatures were able to warm above freezing to the east of the circulation as far north as the Ohio Valley.

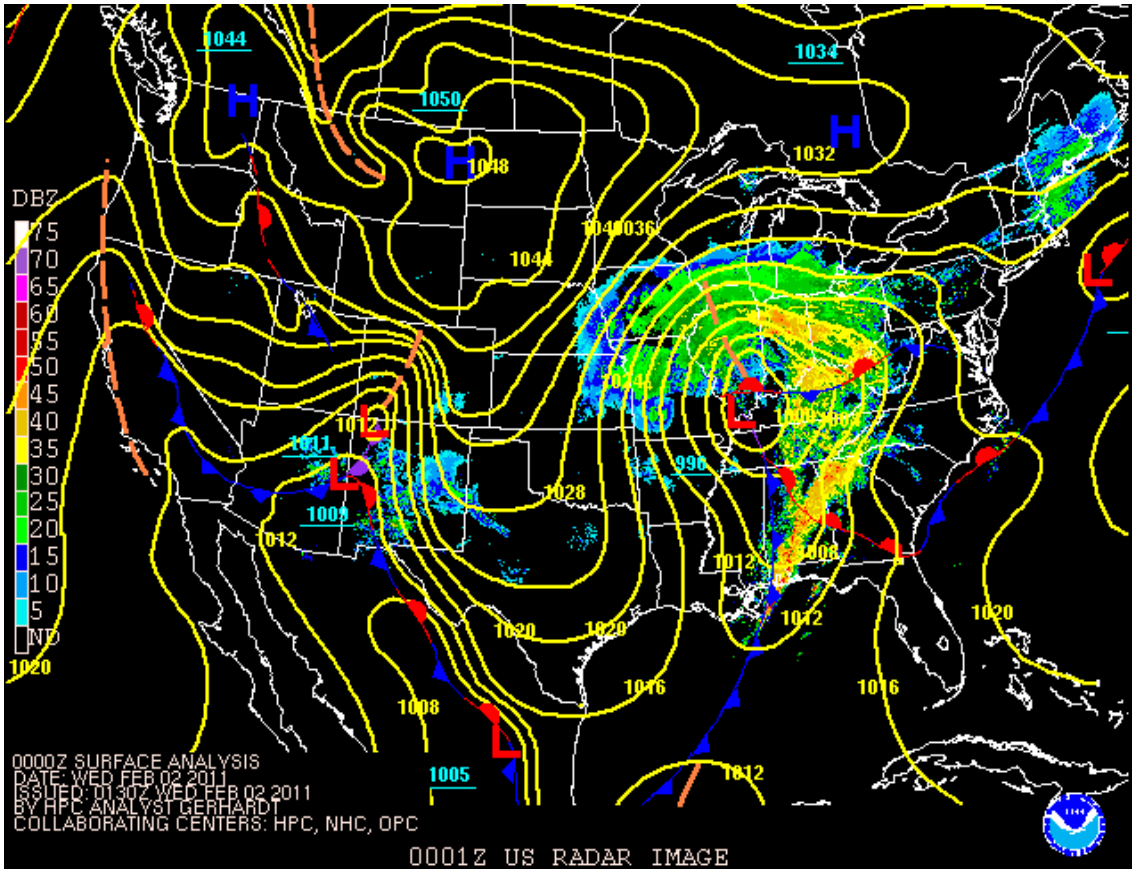

Fig. 5 surface analysis and radar composite at 00 UTC Feb 2 2011 (HPC).

The low level system then tracked east-northeast to Lake Erie by 12 UTC on Feb 2 (Fig. 6a) before weakening across New York state (Fig. 6b). A surface low formed near the triple point location over the Mid Atlantic region, before lifting northeastward off the coast, reaching close to Nova Scotia by 00 UTC on Feb 3 (Fig. 6b). The track of this secondary low, along with the 1030mb arctic surface ridge in place to the north of the system, kept sufficient cold air across the interior Northeast for widespread snow and ice.

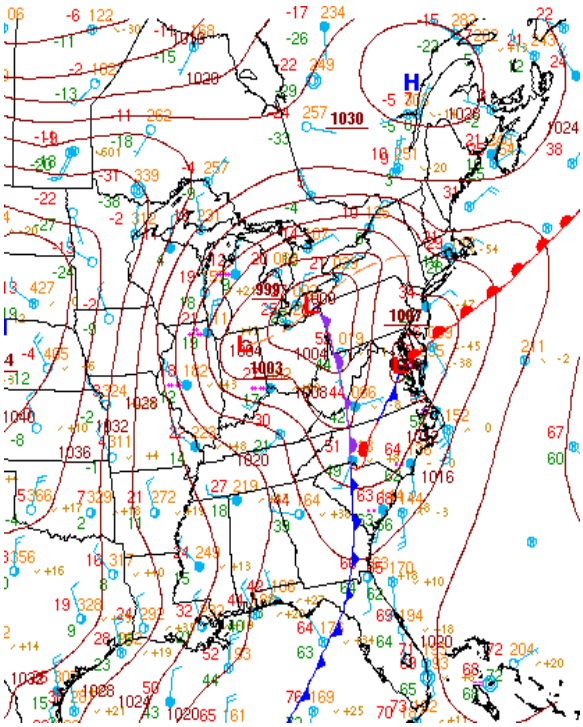

Fig 6a 12 UTC Feb 2 2011
HPC Surface Analysis

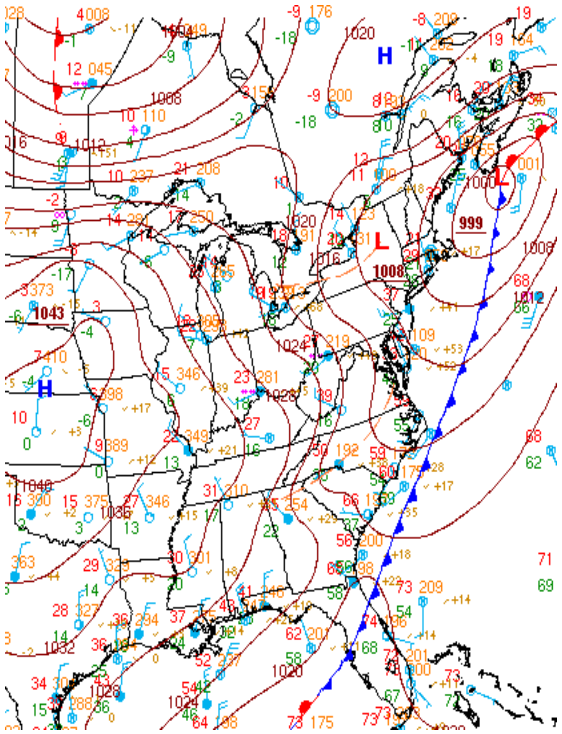

Fig. 6b 00 UTC Feb 3 2011

Mesoscale Pattern:

A number of mesoscale factors contributed to the excessive snowfall across the Midwest and Northeast. A 65 knot 850 mb southerly low level jet brought plenty of Gulf moisture northward to overrun the thermal boundary and reach into the developing circulation (Figs 7a,7b). Intense warm advection is implied from northern Illinois to southern Michigan at 00 UTC on Feb 2nd given the tight thermal and pressure gradients (Fig. 7a). The strong northeasterly flow into northern Illinois and southern Wisconsin evident in Figure 7a also allowed for the development of lake enhanced snow bands. The blocking upper pattern over eastern North America sent the track of the system to the east-northeast, keeping the region from Missouri to Michigan within the comma head and deformation zone and associated band of heaviest precipitation.

.

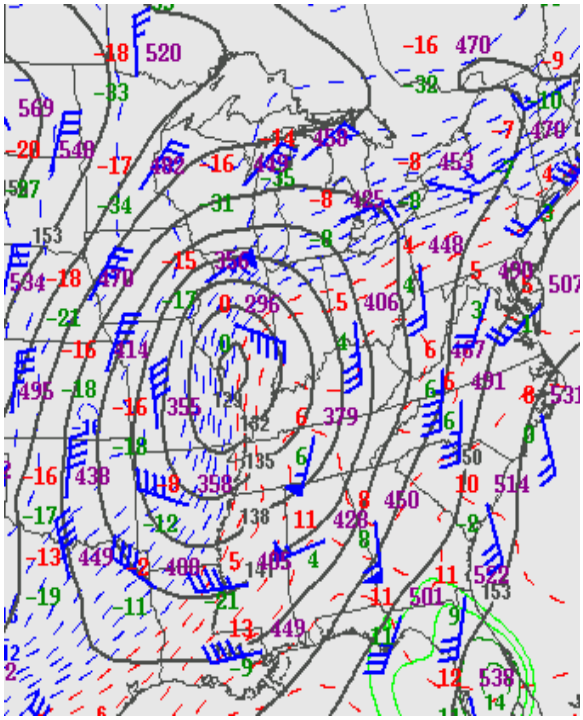

Fig. 7a 00 UTC Feb 02 2011 (SPC).
850mb analysis (SPC)

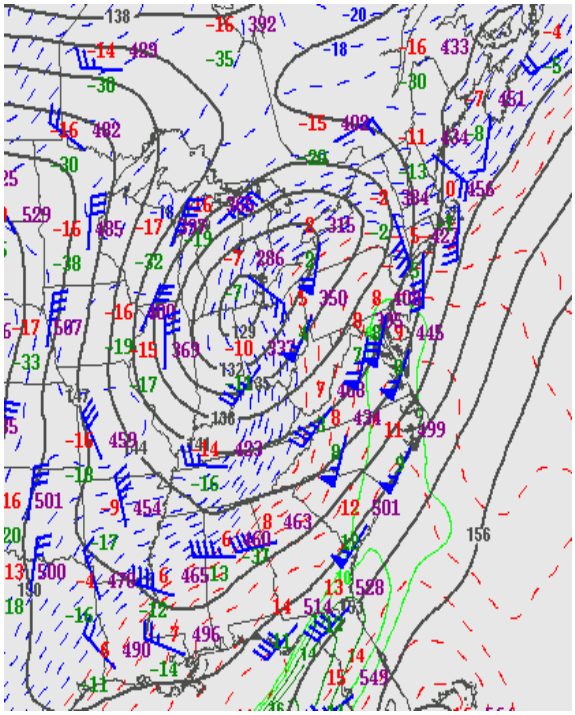

Fig 7b 12 UTC Feb 02 2011

Embedded convection produced intense snow rates over northern Illinois due to strong mid level frontogenesis and instability. The frontogenesis is shown in Figures 8a and 8b as it extended from the Midwest to the Northeast from 00 UTC to 12 UTC, in the same regions where the strong warm advection was noted. The heaviest precipitation was found in the vicinity of this frontogenesis maximum.

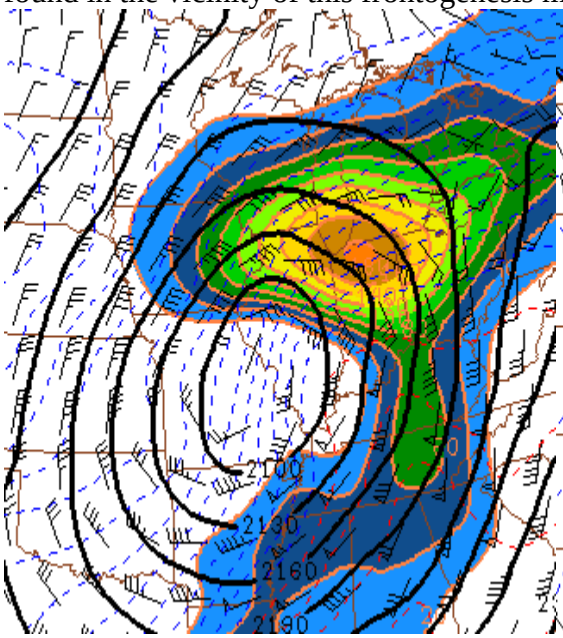

Fig. 8a 00 UTC Feb 2 2011
850-700mb frontogenesis (SPC)

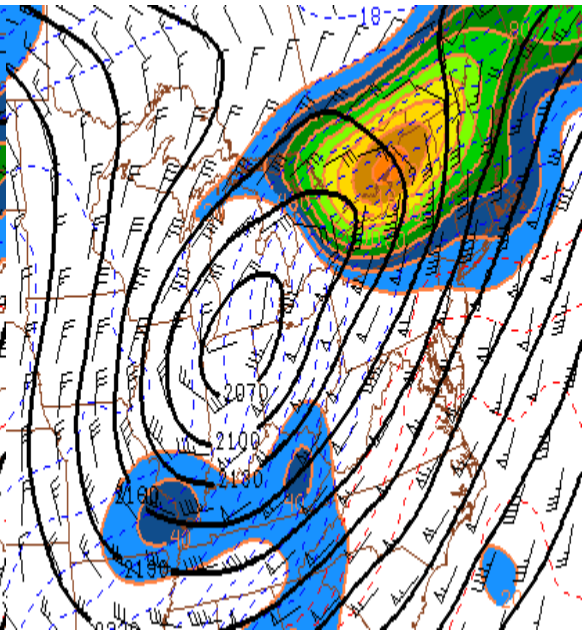

Fig. 8b 12 UTC Feb 2 2011

The track of the low level circulation to Lake Erie by 12 UTC Feb 02 allowed a surge of warm air advection across the Mid Atlantic area and Northeast (Fig. 7b). Accordingly, a batch of significant sleet and freezing rain extended from Indiana to Pennsylvania and interior southern New England, with primarily rain along the Mid Atlantic coast and south coast of New England (Figs 9a,9b).

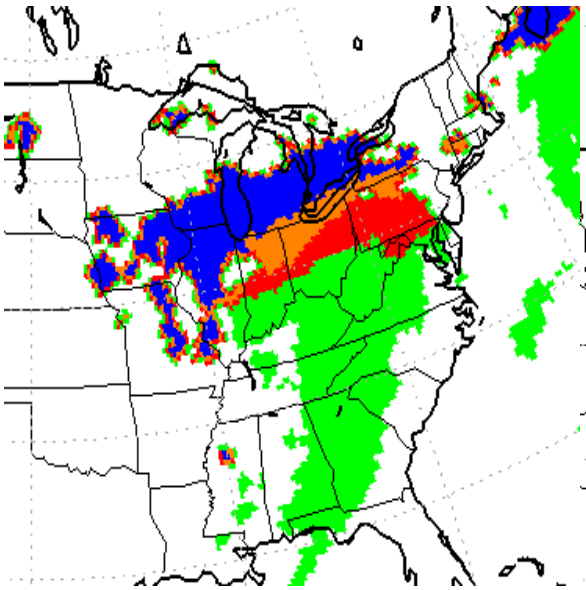

Fig. 9a 00 UTC Feb 02 2011

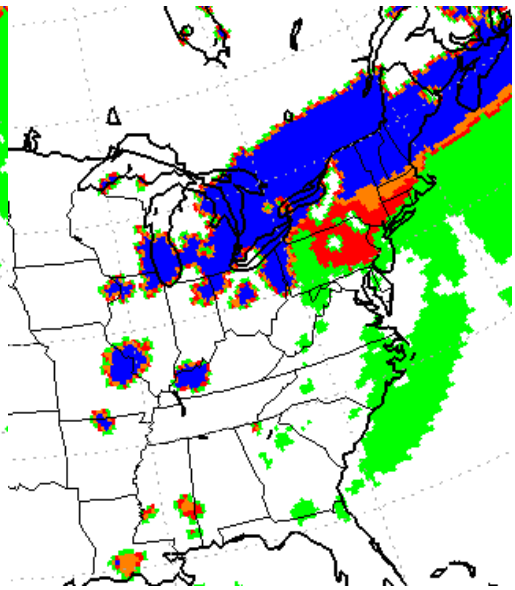

Fig. 9b 12 UTC Feb 02 2011

Precipitation type (NARR) snow (blue), sleet (orange), freezing rain (red), rain (green)

The sounding at Albany, NY at 12 UTC Feb 2 shows the warming aloft, with temperatures approaching 0C between 850mb and 750mb (Fig. 10). Snow accumulations at Albany were limited to 5.4 inches on Feb 02 due to a changeover to freezing rain and sleet. Areas just north and northeast of Albany remained all snow through the event, with 10 to 20 inch totals common across central New England.

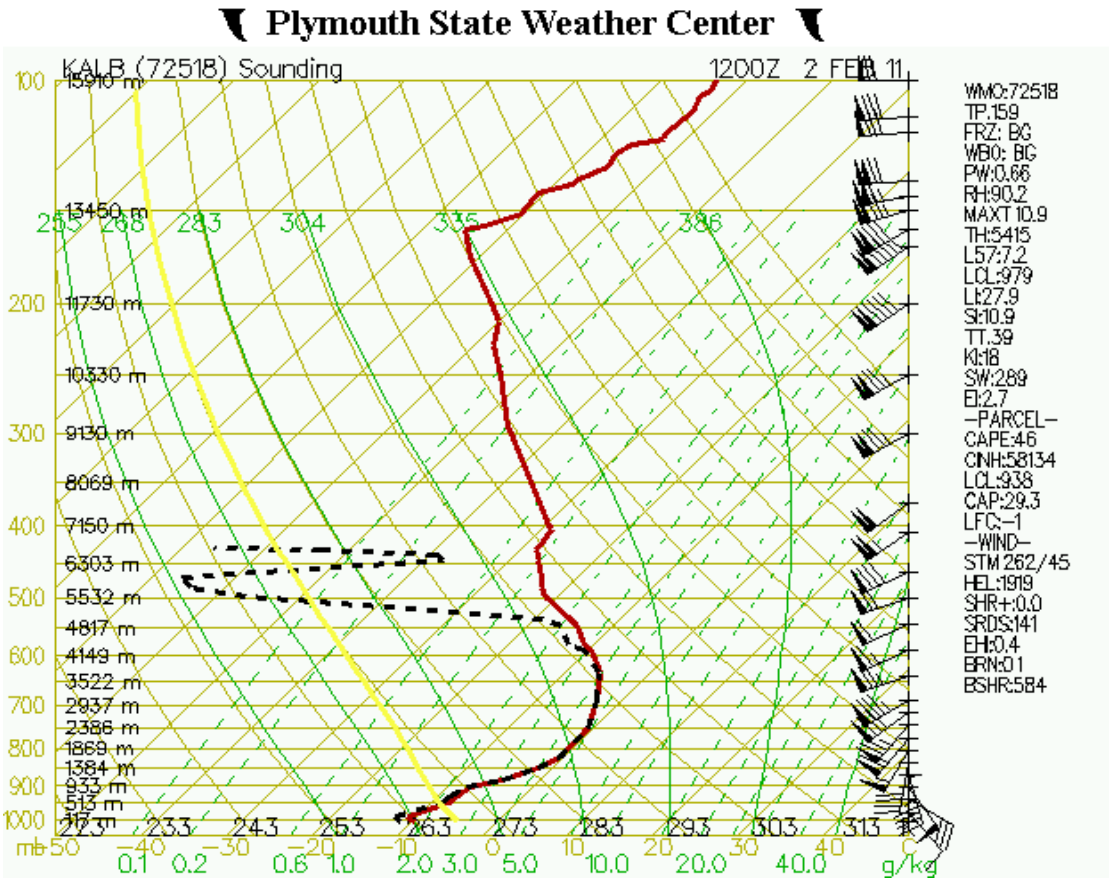

Fig. 10: Sounding at KALB 12 UTC Feb 2 2011 (Plymouth State)

Conclusion

A moist and energetic circulation sparked a significant winter storm event across an extensive portion of the United States. The impact of this storm was substantial on transportation and commerce, especially through the Midwest. Heavy snow with blizzard conditions affected areas from Oklahoma to Michigan, including the cities of Chicago, Detroit, Kansas City, and Tulsa. Significant sleet and icing was also noted in other areas. The snow and ice fell on top of an unusually deep snow cover in parts of southern New England, resulting in numerous roof collapses.

A unique aspect of this event included the widespread axis of heavy snow with high winds and low visibilities across the Midwest. The tight pressure gradient between the deepening circulation and Canadian air mass, along with a steady inflow of gulf moisture contributed to the blizzard conditions. The persistent blocking pattern also played an important role in the storm track and the resulting snow and ice coverage and totals.