Summary of November 12-13 2010 Central U.S. Winter Storm
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Event Overview

The first significant snowfall of the 2010-2011 season affected portions of the plains and upper Mississippi valley from November 12th to 13th. The strong disturbance resulted in a narrow swath of precipitation from the Texas panhandle to Lake Superior (Fig.1).

Snow was first reported on November 12th in a portion of the Texas panhandle, with 4-5 inches near Amarillo. Precipitation fell mainly as rain across Oklahoma and Kansas with 2-3 inch rain totals over central Kansas (Fig. 1). The rain changed to snow before ending over northeastern Kansas and eastern Nebraska late on the 12th and into the 13th. Snow accumulations were light over northeast Kansas, but ranged up to about 4-5 inches near Omaha. The main batch of snow of generally 6-12 inches occurred in a narrow axis from western Iowa to eastern Minnesota and northwestern Wisconsin (Figures 2 and 3). Snowfall rates of 1-2 inches per hour along with lightning were observed across southern and eastern Minnesota during the morning of the 13th. The heaviest observed total was 14 inches in Palo Alto county in northwest Iowa. Farther north, snow amounts were only near a trace near the southern shore of Lake Superior, where surface temperatures remained above freezing. However, just a few miles inland from the lake, up to 11 inches was measured. The 8 inch snowfall at MSP was the largest pre-Thanksgiving, as well as November snowfall at Minneapolis since the "Halloween Blizzard" of October 31-November 2, 1991.

Although snow totals were not exceptional with this event, the heavy and wet snowfall still produced some damage and very hazardous road conditions. The heavy wet snow toppled hundreds of trees in the Amarillo area. More than 400 highway accidents were reported in Minnesota, injuring around 45 people. Two people were killed in a car crash in northern Wisconsin that was blamed on the storm. The heavy snow also downed trees and caused sporadic power outages in Minnesota and Wisconsin, where 60,000 power outages were reported.

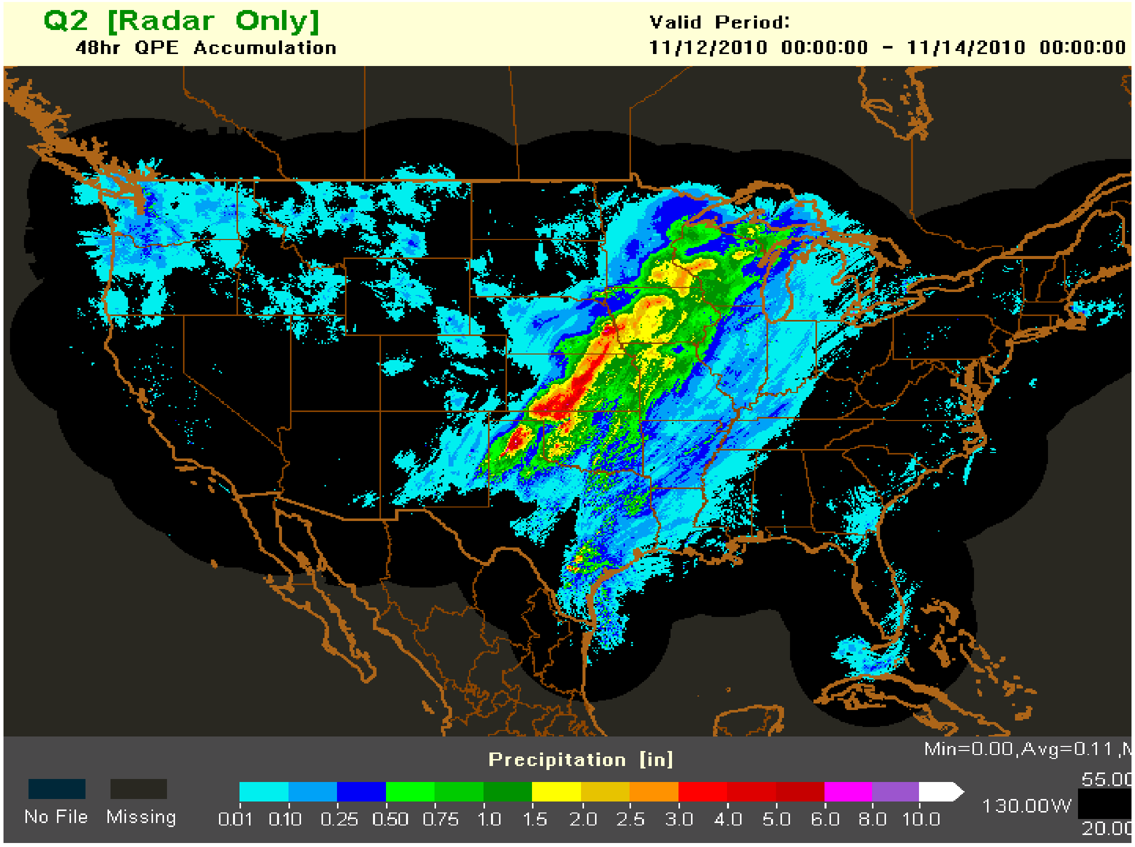

Fig. 1 Total precipitation from 00 UTC Nov 12 2010 to 00 UTC Nov 14 2010 (NSSL).

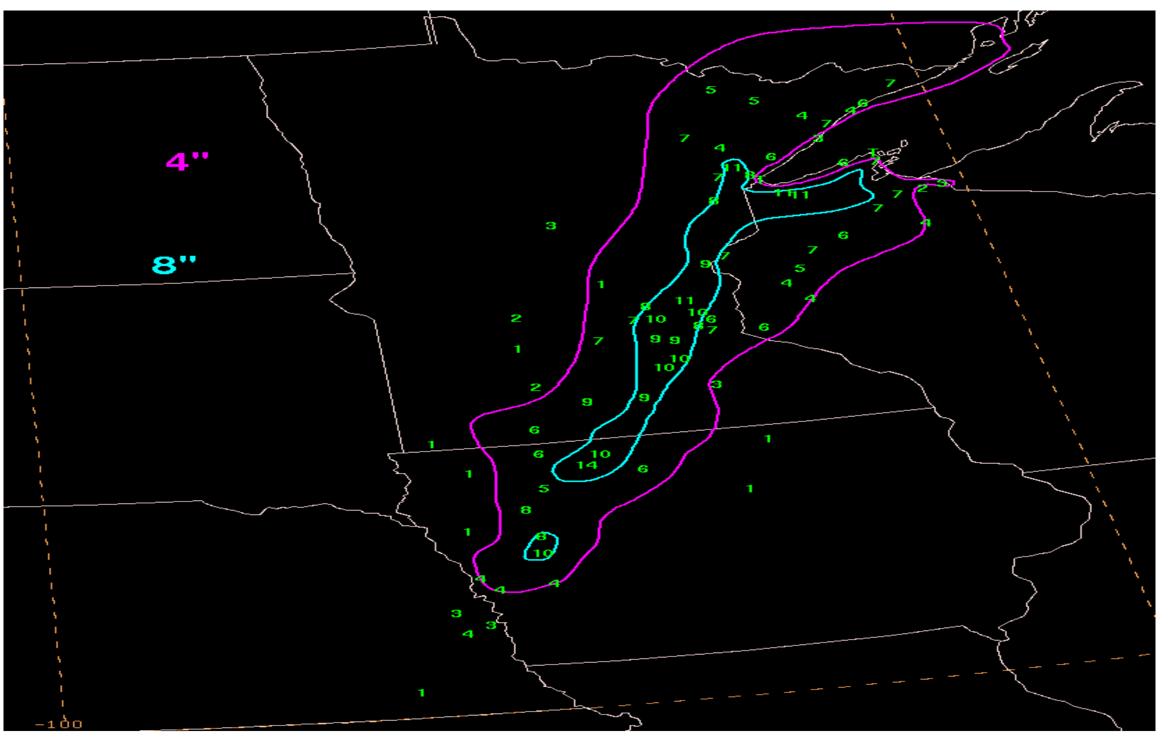

Fig. 2 Total Snowfall from November 12 to 14 2010.

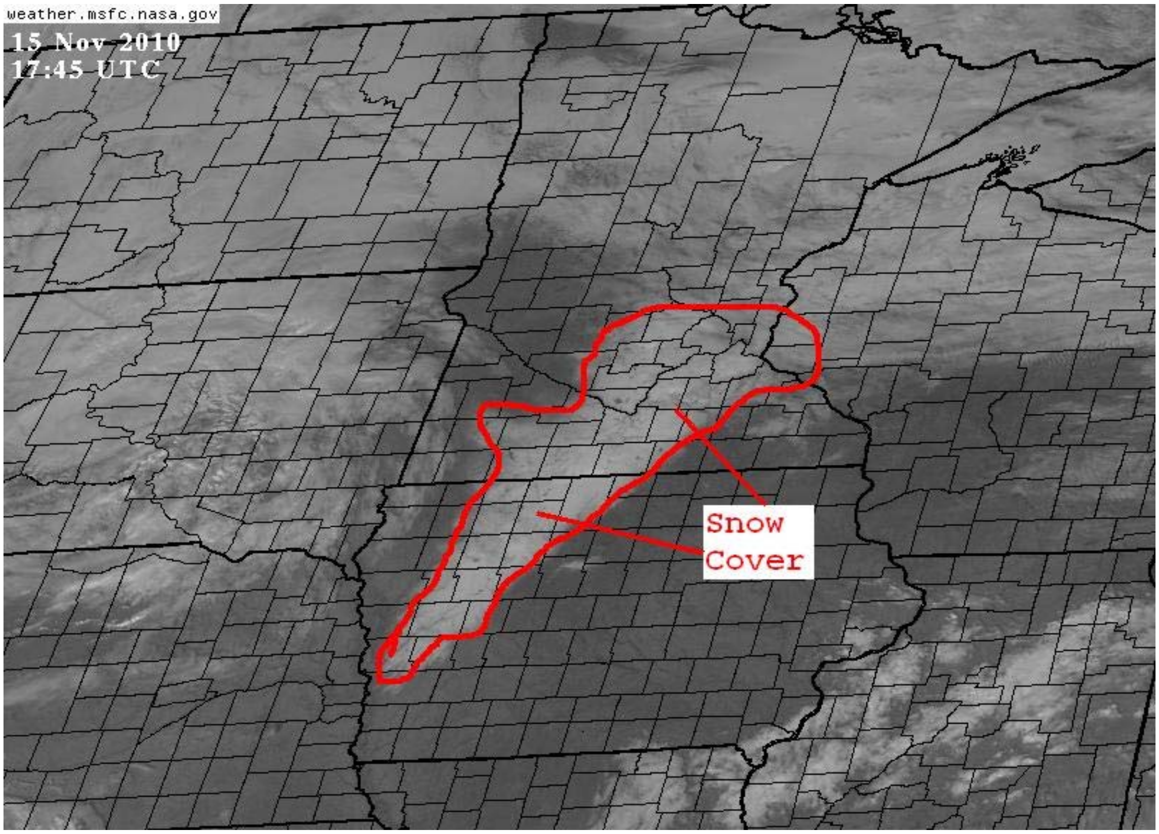

Fig. 3 Snow cover evident on visible satellite imagery from 1745 UTC Nov 15 2010. From NWS Minneapolis

Synoptic Overview

A sharp but progressive shortwave trough crossed New Mexico early on November 12th as a cold front slid southward across west Texas. Strong vertical motion over the Texas panhandle produced an area of heavy rain, which changed to snow before ending in a localized area near Amarillo.

The open 500 mb trough then crossed the southern plains with an area of heavy rain across Oklahoma and eastern Kansas. A 700 mb low formed over eastern Kansas by 00 UTC on the 13th before deepening and pulling northeast across Iowa. Rain changed to snow over northeast Kansas with little accumulation before ending. However, farther north, the precipitation shield within the developing comma head quickly changed to snow over western Iowa before crossing Minnesota and western Wisconsin. The circulation was the strongest at this point (early on the 13th), and produced heavy snow and some lightning along a narrow band to the northwest of the low level track. The surface system was never particularly intense, with surface pressures lowering to only around 1000mb as the center exited the Michigan upper peninsula. However, the upper level forcing for ascent from a combination of vorticity advection and warm air advection was intense in a narrow swath northwest of the surface cyclone track.

For example, Figs. 4-8 depict the system near the peak of the event around 12 UTC November 13. The water vapor imagery (Fig. 4) shows a well defined synoptic scale system. The deformation zone and associated comma head feature extends from western Iowa and eastern Nebraska into Minnesota. A dry slot appears from Missouri to eastern Iowa, while minimal convective activity is apparent along the trailing frontal boundary.

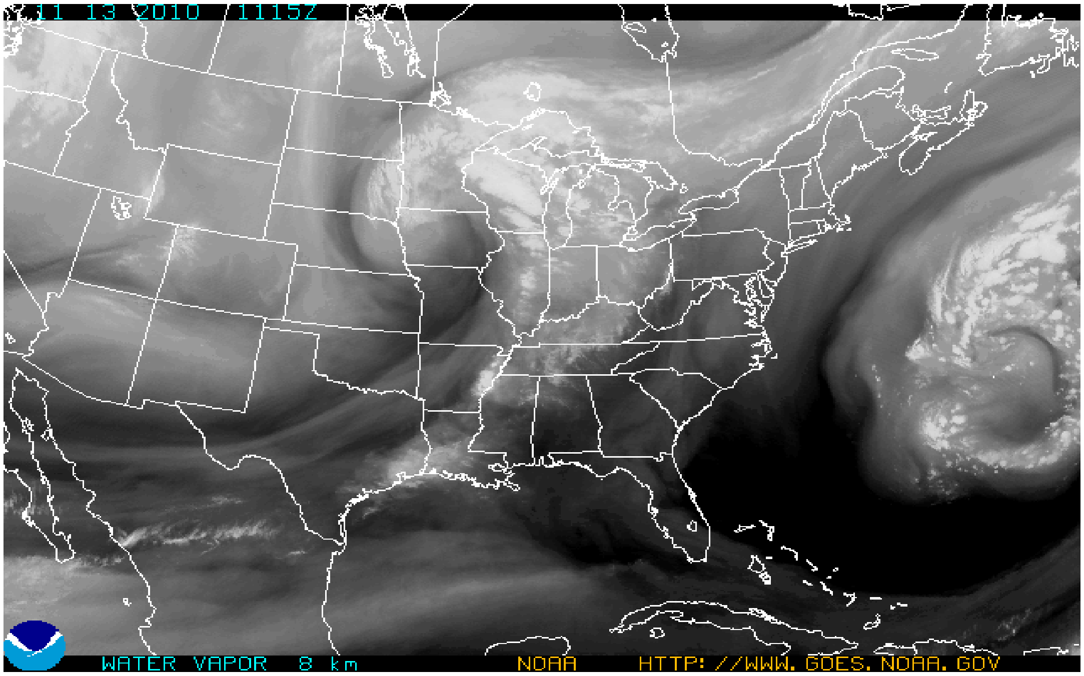

Fig. 4 Water vapor imagery 1115 UTC Nov 13 2010.

The surface map (Fig. 5) depicts a 1005mb occluded surface low over central Iowa, with a cold front extending southward into the western Gulf of Mexico. Easterly to northeasterly winds are indicated across the upper Mississippi valley where the heaviest precipitation is occurring. A warm front extends east across northern Illinois and Indiana.

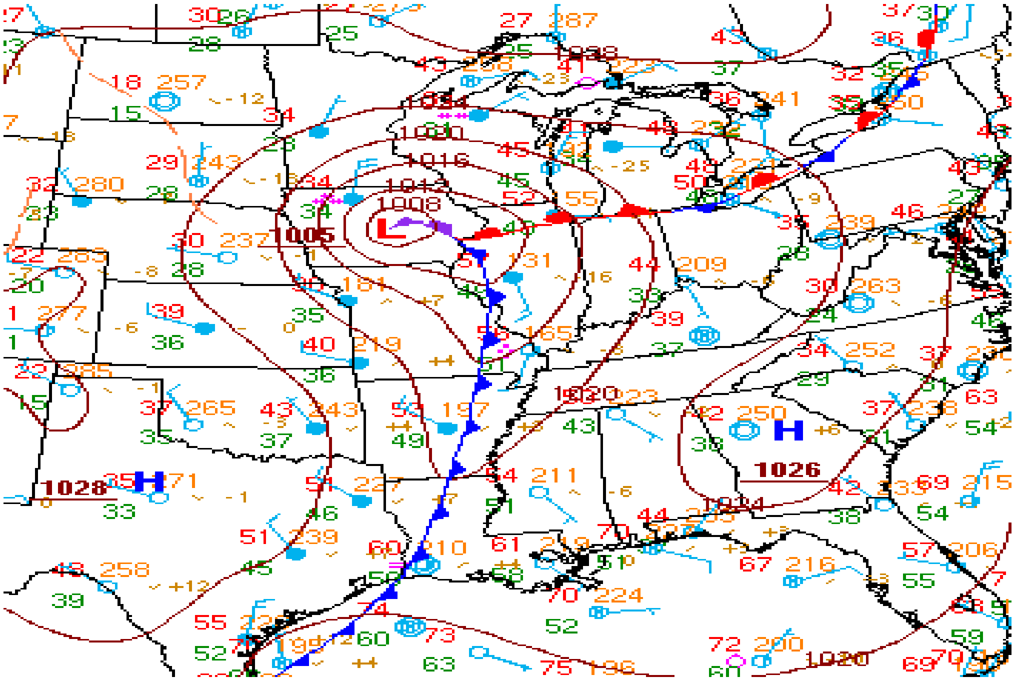

Fig. 5 NCEP Surface Analysis 12 UTC Nov 13 2010.

The 850mb analysis (Fig. 6) shows a closed center over Iowa, similar to the location of the surface low. The 0° C isotherm extends across central Iowa northeastward to central Wisconsin. A thermal ridge axis associated with the occlusion is evident in eastern Iowa. Intense warm air advection is implied across northeast Iowa, eastern Minnesota, and Wisconsin associated with 40kt winds and the tight thermal gradient.

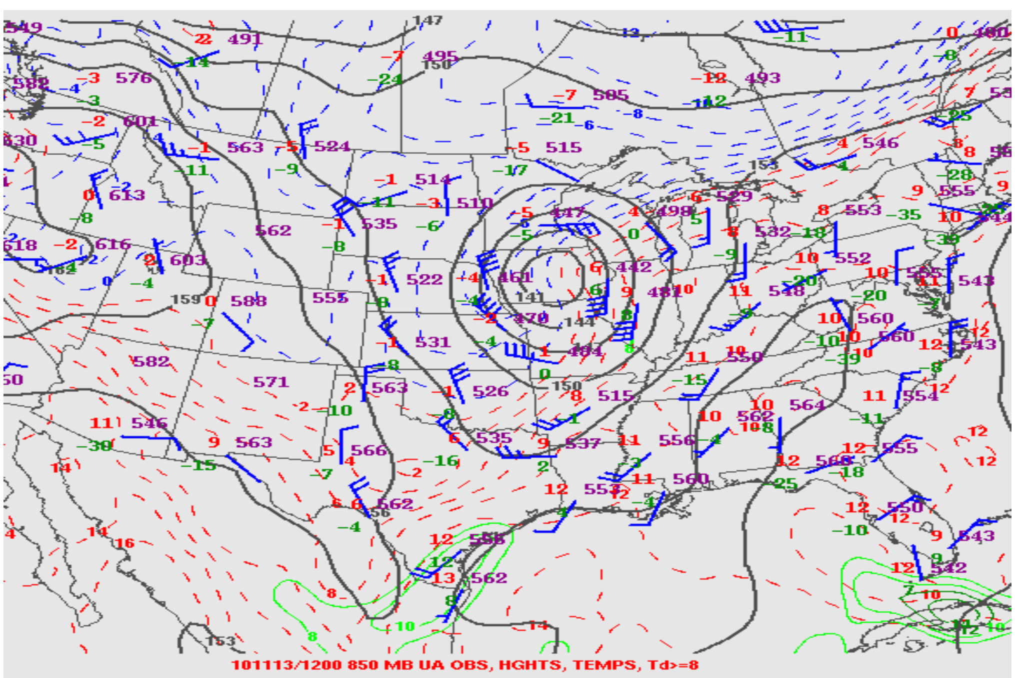

Fig. 6 850mb Analysis 12 UTC Nov 13 2010 (SPC).

A negatively tilted upper trough is apparent at 500mb (Fig. 7) and 250mb (Fig. 8). A 500mb low is evident near the South Dakota/Minnesota border, but is not strong enough to have a closed contour. Differential cyclonic vorticity advection was present in IA, MN, and WI, supporting ascent. The broad upper trough extended well to the west and northwest, with an additional weak upper center analyzed over eastern Montana. The upper jet crossed the central plains to Illinois, with winds approaching 100kt at 250mb (Fig. 8). Portions of Iowa, Minnesota, and Wisconsin were found in the favorable left-exit region of this jet (Fig. 7).

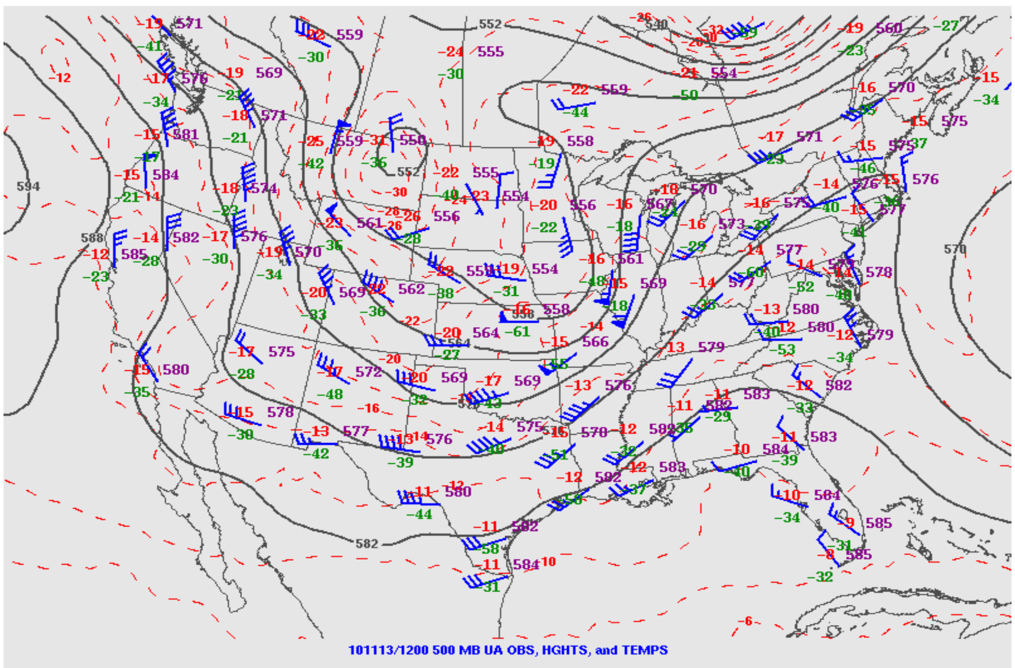

Fig. 7 500mb analysis 12 UTC Nov 13 2010 (SPC).

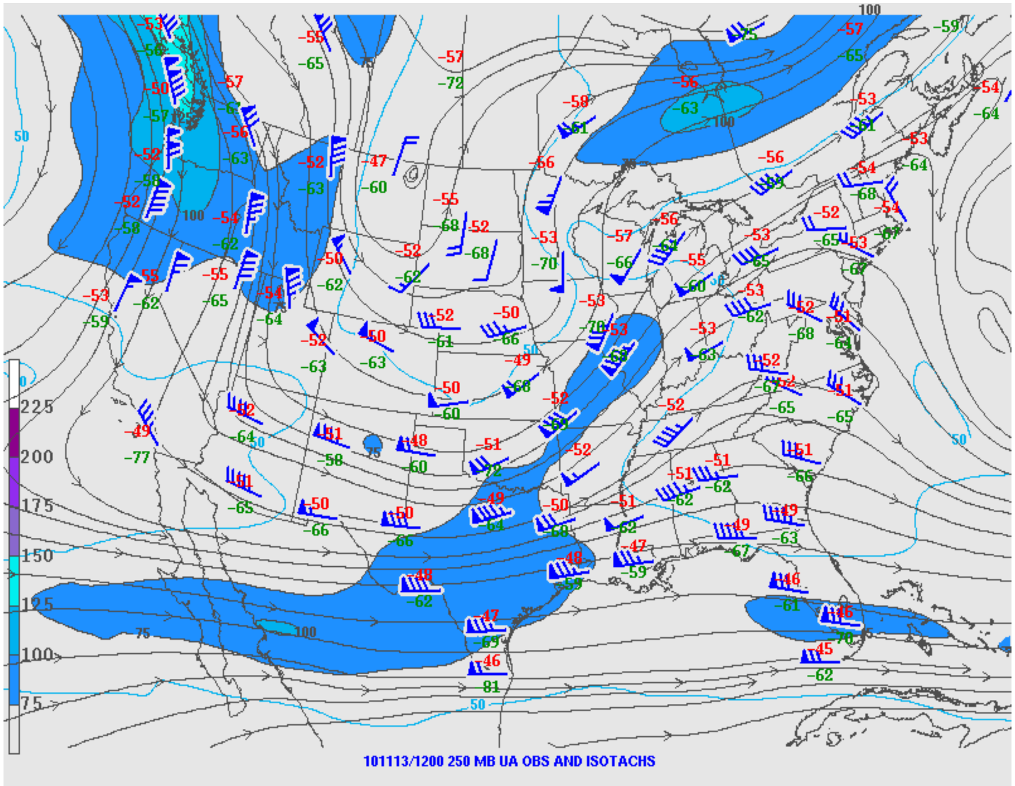

Fig. 8 250mb analysis 12 UTC Nov 13 2010 (SPC).

Mesoscale Pattern

The radar composite follows the evolution of this system from a broad area of precipitation and embedded convection across the southern plains on November 12th, to an organized synoptic circulation and developing comma head from eastern Kansas to the upper Mississippi valley on November 13th. Figure 9 shows the radar presentation as the storm was deepening around 00 UTC 13 November and around the peak of the event at 10 UTC 13 November over the upper Mississippi valley. Note that the heavy snow fell on the northwest edge of the precipitation shield. Cyclonically curved bands were evident on the radar (Fig. 9).

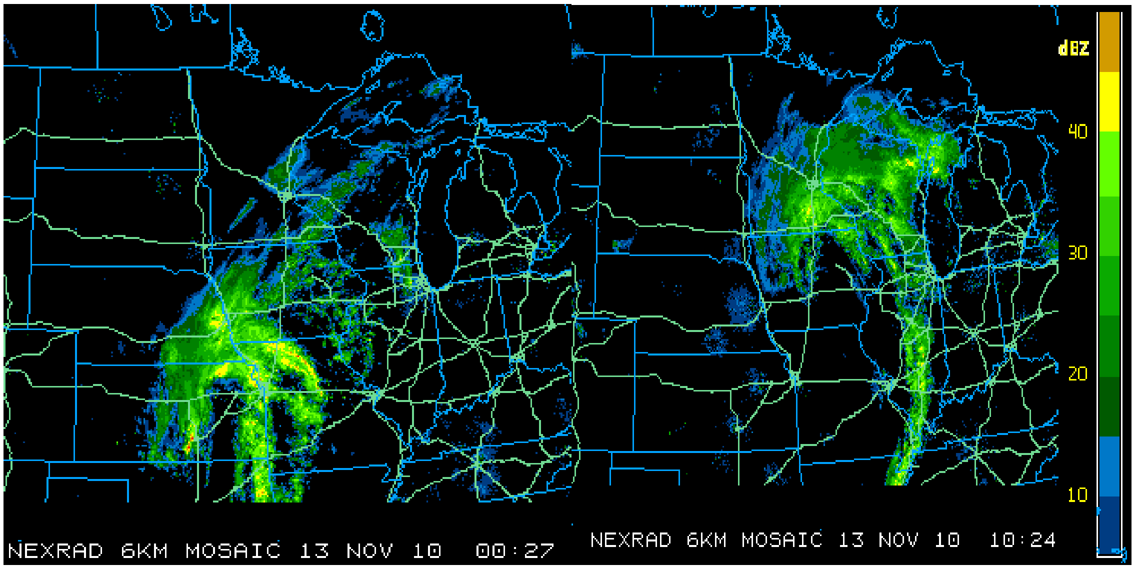

Fig. 9 Composite Radar at 0027 and 1024 UTC November 13 2010.

Surface temperatures were well above freezing prior to the arrival of this system. Once precipitation began, surface temperatures fell to right around freezing due to a combination of evaporative cooling initially, and cooling by melting (Kain et al. 2000). Figure 10 shows the sounding near Omaha, NE at 00 UTC on the 13th, which exhibits an isothermal 0° C layer from 850-750 mb. Such a layer is evidence of cooling by melting (Kain et al. 2000). The precipitation changed to snow in Omaha shortly after this sounding was taken. Veering winds from 850 – 600 mb suggest warm advection in this layer at this time.

The GFS boundary layer temperatures were generally analyzed between 0C and +2C within the region of heavy snow. The GFS analysis of the 850mb zero line (not shown) provided a good indicator for the rain/snow line. With a lack of low level cold air in place, freezing rain was not reported during this event.

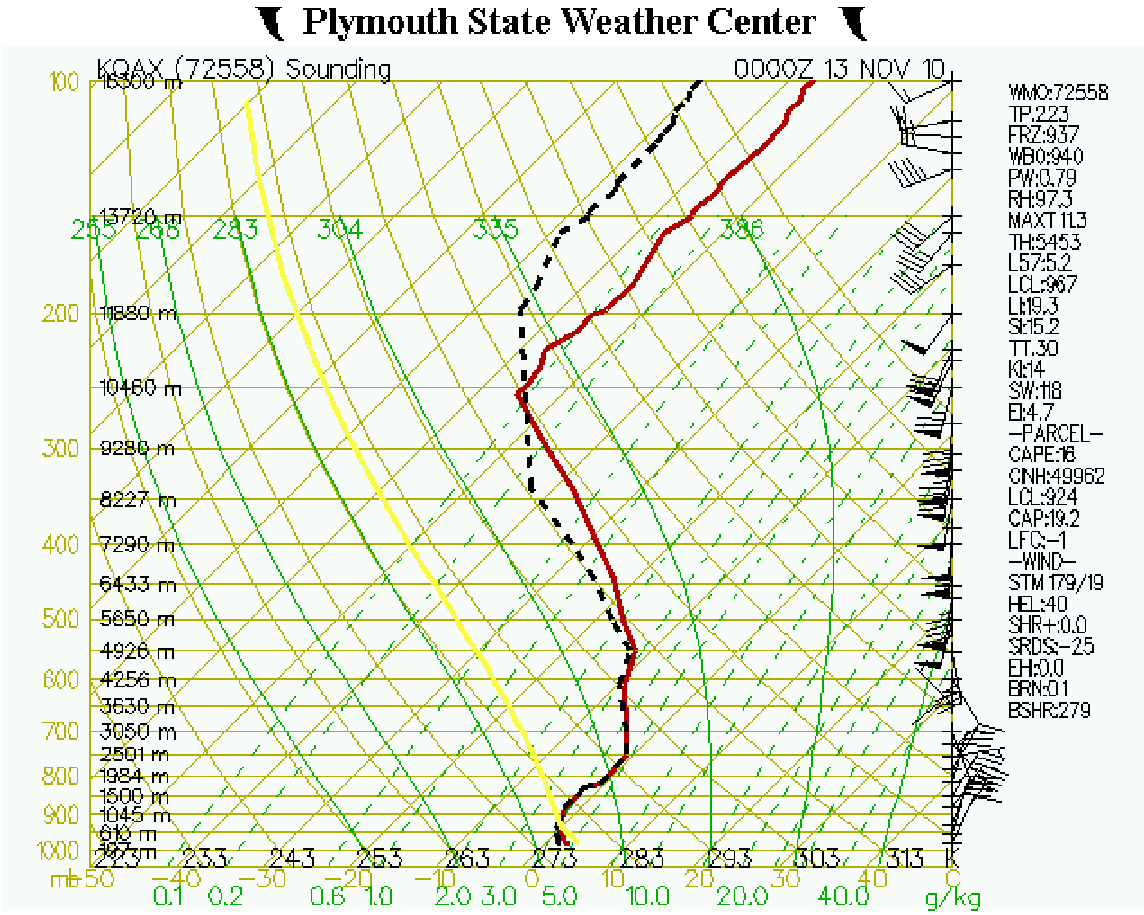

Fig. 10 Sounding near Omaha, NE at 00Z UTC November 13 2010.

Figure 11 depicts the frontogenesis in the 850-700mb layer crossing Iowa to the north of the low level circulation center at 06 UTC on the 13th. The region of frontogenesis coincided with an 850mb trough and associated wind shift from southerly to northeasterly winds across the boundary. The heaviest precipitation was found in the vicinity of this frontogenesis maximum around this time (Fig. 9). The frontogenesis maximum was found on the northern side of the maximum warm 850mb advection.

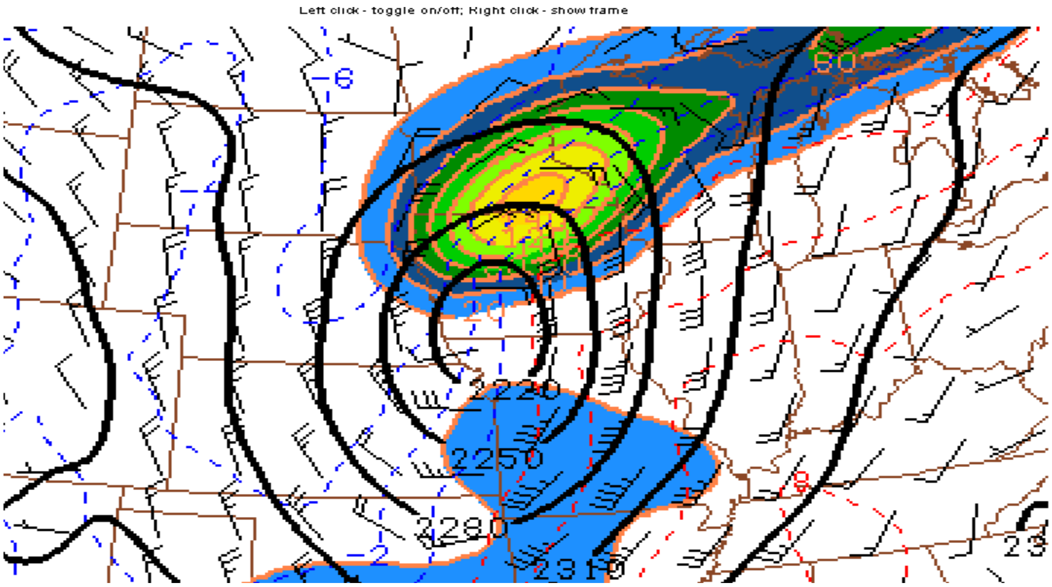

Fig. 11 RUC analysis of 850-700mb Frontogenesis 06 UTC November 13 2010.

The upper air sounding at 12 UTC on the 13th during the peak of the event at Chanhassen, MN is shown in Fig. 12. The sounding shows deep saturation up to 400mb, a -1 C warm nose near 800mb, and a near freezing surface temperature. The wind profile veers from the surface to 600mb, indicative of the warm advection in this layer. The snow-liquid ratio at MSP was 8:1 during the event, producing the heavy and wet snowfall.

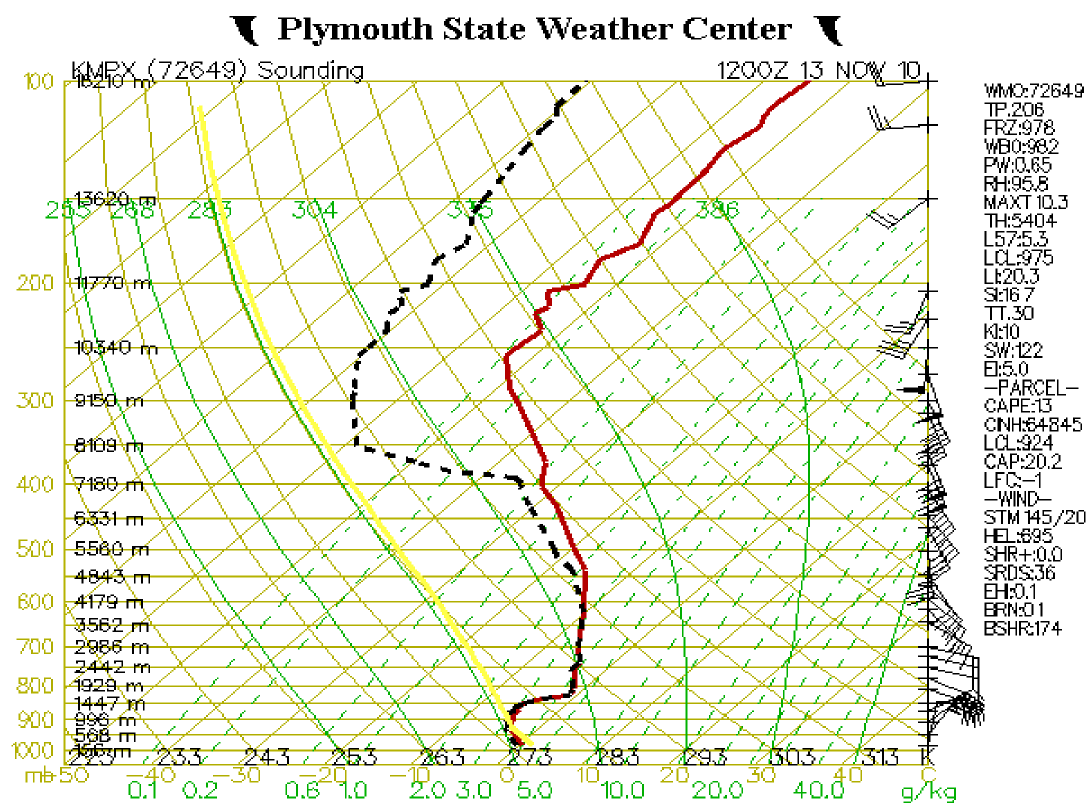

Fig. 12 Sounding at Chanhassen, MN at 12Z UTC November 13 2010.

Conclusion

A fast moving shortwave trough lifting through the plains sparked a heavy early season snowfall event in areas of the plains and upper Mississippi valley, as well as the Texas panhandle.

A unique aspect of this event included the axis of heavy snow, which was limited to a very narrow band over northwest Iowa and eastern Minnesota. This band occurred on the northwest edge of the larger comma-head precipitation shield. The marginal critical temperatures played an important role in the rain/snow line and snow totals. While the surface circulation was not especially strong, ideal upper-level dynamics were in place in a narrow swath. The impact was substantial in the areas that were affected by the heavy, wet snow.

REFERENCES

Kain, J. S., S. M. Goss, M. E. Baldwin, 2000: The melting effect as a factor in precipitation-type forecasting. *Wea. Forecasting*, **15**, 700–714.