Midwest High Wind Event
October 25th – October 27th 2010
By: Mary Beth Gerhardt, HPC Surface Analyst

Overview:

A powerful cyclone over the Upper Midwest impacted much of the country on October 25th-27th, 2010. The storm caused a variety of weather phenomenon including tornadoes in the Ohio Valley, strong winds over the central U.S., and blizzard conditions in the Northern Plains (Fig. 1). However, this storm was mostly noted for the deep surface low that quickly developed across the state of Minnesota on Tuesday, October 26th. The deep surface cyclone broke records for the lowest pressure recorded in several cities across the Midwest, including Duluth, MN and International Falls, MN (Fig. 2). The 955.2 hPa (28.21 inches) pressure recorded in Bigfork, MN and the 961.3 hPa (28.39 inches) pressure recorded in Superior, WI set new lowest pressure state records in Minnesota and Wisconsin, respectively (Fig. 2). While the storm did not break any national records, it ranks among the lowest pressures recorded in the United States according to NCDC (National Climatic Data Center) (Fig. 3). The deep surface low over Minnesota resulted in a broad area of large pressure gradients and associated strong winds over much of the U.S. during the peak of the storm. Multiple locations across the Midwest reported synoptically driven wind gusts of 50 to 60 mph during the event, with a few locations reporting gusts in excess of 70 mph (Fig. 1b).

Precipitation totals were not as impressive as the pressure and wind fields; however, the storm did cause a broad area of 0.50 to 1 inch rainfall totals over the eastern half of the country U.S., with isolated areas in excess of 3 inches, near the surface low track across the Upper Midwest and along the trailing cold front in the Southeast U.S. (Fig. 4). As the surface low lifted northward into Canada, rain changed over to snow on the back side of the storm. Snowfall totals ranging between 2 and 4 inches covered northeastern Montana, much of North Dakota, and northern portions of eastern and central South Dakota (Fig. 5). A narrow band of 1 to 4 inch snowfall totals, with localized higher amounts, was observed in a line stretching from west central Minnesota to the northeastern tip of the state (Fig. 5). In addition to the record breaking pressure readings, strong winds, rain, and snow, this storm also spawned a severe weather outbreak. Tuesday, October 26th was the most active day during the event and resulted in 339 wind, 57 tornado, and 6 hail reports over the eastern half of the country (Fig. 6).

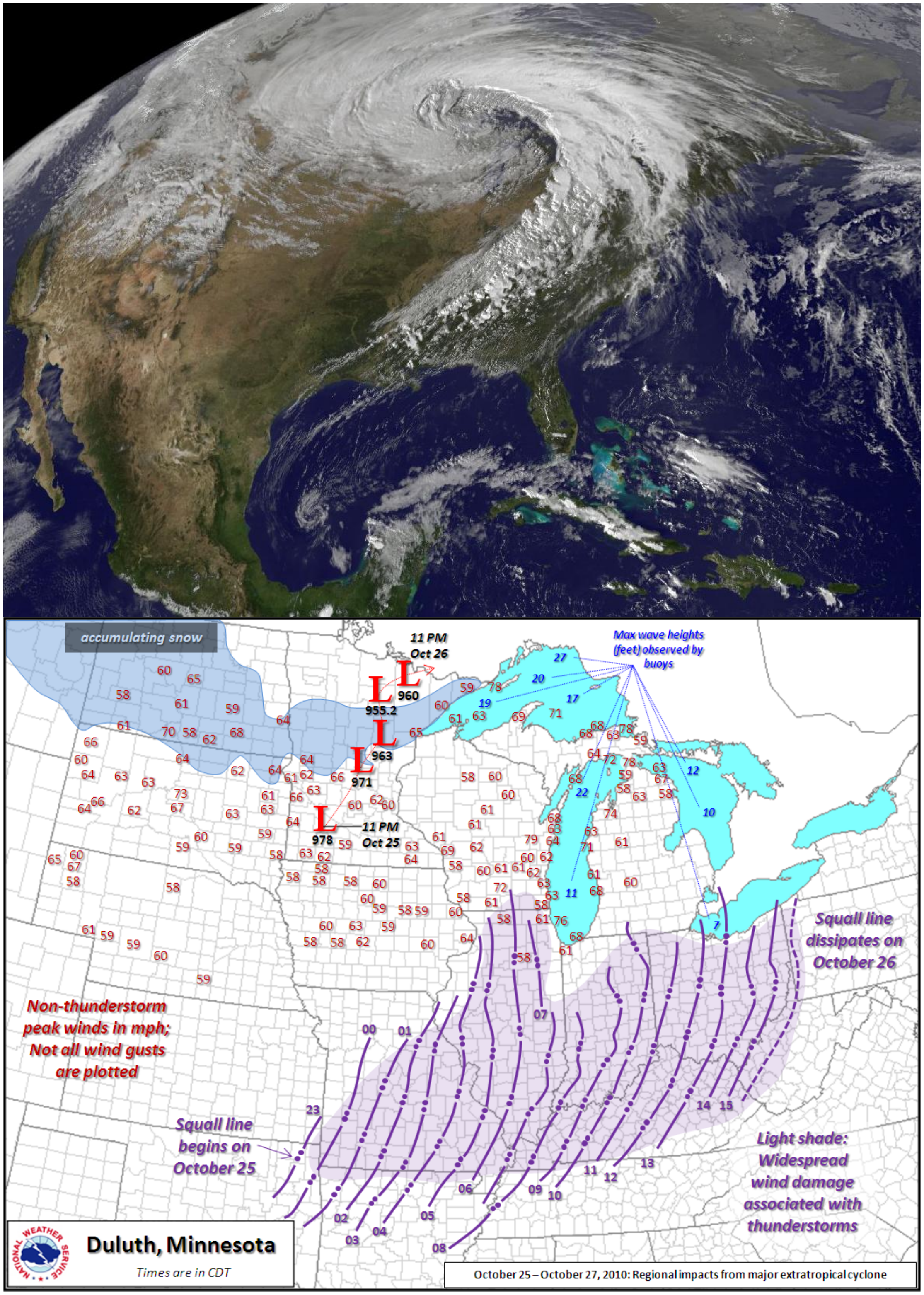


Figure 1: (a) True color satellite image of the storm at 2132 UTC on October 26. (b) Summary of weather hazards from the October 25-27th, 2010 event *(Image provided by the Duluth Weather Forecast Office).*

PUBLIC INFORMATION STATEMENT
NATIONAL WEATHER SERVICE DULUTH MN
1227 PM CDT WED OCT 27 2010

...LOW PRESSURE RECORDS BROKEN ON OCTOBER 26 2010...

THIS IS A PRELIMINARY STATEMENT ON THESE PRESSURE RECORDS. HERE IS WHAT WE KNOW SO FAR ABOUT THE LOW PRESSURE RECORDS SET ON OCTOBER 26TH:

A FEW OF THE RECORDS HAVE BEEN RECALCULATED TO ADJUST FOR TRUE MEAN SEA LEVEL PRESSURE. SOME OF THE PREVIOUS VALUES WERE CALCULATED USING A STANDARD ATMOSPHERE ASSUMPTION /THE ALTIMETER SETTING AT THE STATION/. THE VALUES IN MILLIBARS ARE THE ONES THAT WILL BE MORE EXACT.

AN UNUSUALLY INTENSE LOW AFFECTED THE STATE OF MINNESOTA. AT 513 PM CDT...**THE AUTOMATED WEATHER OBSERVING SYSTEM AT BIGFORK MINNESOTA RECORDED A 955.2 MILLIBAR /28.21 INCHES/ PRESSURE. THIS BREAKS THE ALL TIME MINNESOTA STATE RECORD FOR THE LOWEST OBSERVED PRESSURE.**

THE PREVIOUS RECORD WAS 962.7 MB SET ON NOVEMBER 10 1998 AT ALBERT LEA AND AUSTIN IN SOUTHERN MINNESOTA. THE RECORD WAS INITIALLY BROKEN SHORTLY AFTER 10 AM AS THE LOW PASSED BY AITKIN MINNESOTA. HOWEVER...THE LOW CONTINUED TO INTENSIFY INTO THE AFTERNOON OVER NORTH CENTRAL MINNESOTA WHERE THE RECORD PRESSURE READING WAS ULTIMATELY ESTABLISHED AT BIGFORK.

.**DULUTH**...THE LOW PRESSURE RECORD AT DULUTH WAS SET AT 1115 AM WITH A PRESSURE OF 960.2 MILLIBARS /28.35 INCHES/. THE PREVIOUS RECORD WAS 964.3 MILLIBARS WHICH OCCURRED ON NOVEMBER 10 1998.

.**INTERNATIONAL FALLS**...THE LOW PRESSURE RECORD AT INTERNATIONAL FALLS WAS SET AT 345 PM WITH A PRESSURE OF 956.0 MILLIBARS /28.23 INCHES/. THE PREVIOUS RECORD WAS 971.9 MILLIBARS ON OCTOBER 10 1949.

.**WISCONSIN**...THE LOW PRESSURE RECORD FOR THE STATE OF WISCONSIN WAS SET IN SUPERIOR AT 1115 AM WITH A PRESSURE OF 961.3 MILLIBARS /28.39 INCHES/. THE PREVIOUS RECORD WAS 963.4 MILLIBARS WHICH OCCURRED AT GREEN BAY ON APRIL 3 1982.

Figure 2: Public information statement from the Duluth Weather Forecast Office.

Selected List of U.S. Pressure Readings

The following list diplays selected minimum central pressure readings from storm systems that were referenced in the context of the Big Fork, Minnesota pressure observation of October 26, 2010. It is not intended to be a comprehensive list of all intense storm systems. The pressure value observed at Matecumbe Bay, Florida in 1935 is recognized as the lowest sea-level pressure observed in the United States by the National Climate Extremes Committee.

Sea Level Pressure (millibars) (inches of mercury * 33.8637)	Date	Location	Notes
892.3	September 2, 1935	Matecumbe Key, Florida	Florida Keys Labor Day Hurricane measured onboad a docked ship at Craig, Florida. For more details see: Monthly Weather Review publication for October 1935
908.9	August 17, 1969	Bay St. Louis, Mississippi	Hurricane Camille
922.1	August 24, 1992	Homestead, Florida	Hurricane Andrew
926.8	September 14, 1919	Dry Tortugas	Atlantic Gulf Hurricane of 1919. Measurement made onboard a moored ship. Official landfall south of Corpus Cristi.
927.0	October 25, 1977	Dutch Harbor, Alaska	Not verified
928.9	September 16, 1928	Palm Beach, Floida	San Felipe-Okeechobee Hurricane 1928
929.6	September 16, 1928	West Palm Beach, Florida	Not verified
929.9	September 1960	Florida	Hurricane Donna
946.2	September 21, 1938	Long Island, New York	New England Hurricane 1938
951.6	March 3, 1914	Bridgehampton, New York	Not verified
955.0	January 13, 1913	Canton, New York	Lowest non-tropical system whose pressure can be confirmed
955.0	March 7, 1932	Block Island, Rhode Island	Lowest non-tropical system whose pressure can be confirmed
955.2	October 26, 2010	Big Fork, Minnesota	NWS Event Page
956.0	January 26, 1978	Mount Clemmons, Michigan	Weather Log
956.0	October 26, 2010	International Falls, Minnesota	NWS Event Page
957.3	January 26, 1978	Port Huron, Michigan	Weather Log
958.5	January 26, 1978	Cleveland, Ohio	Verified through NCDC WBAN 14820

Figure 3: List of the lowest pressures recorded in the United States in comparison to the October 26th, 2010 event, which is highlighted in yellow (*Image provided by NCDC)*.

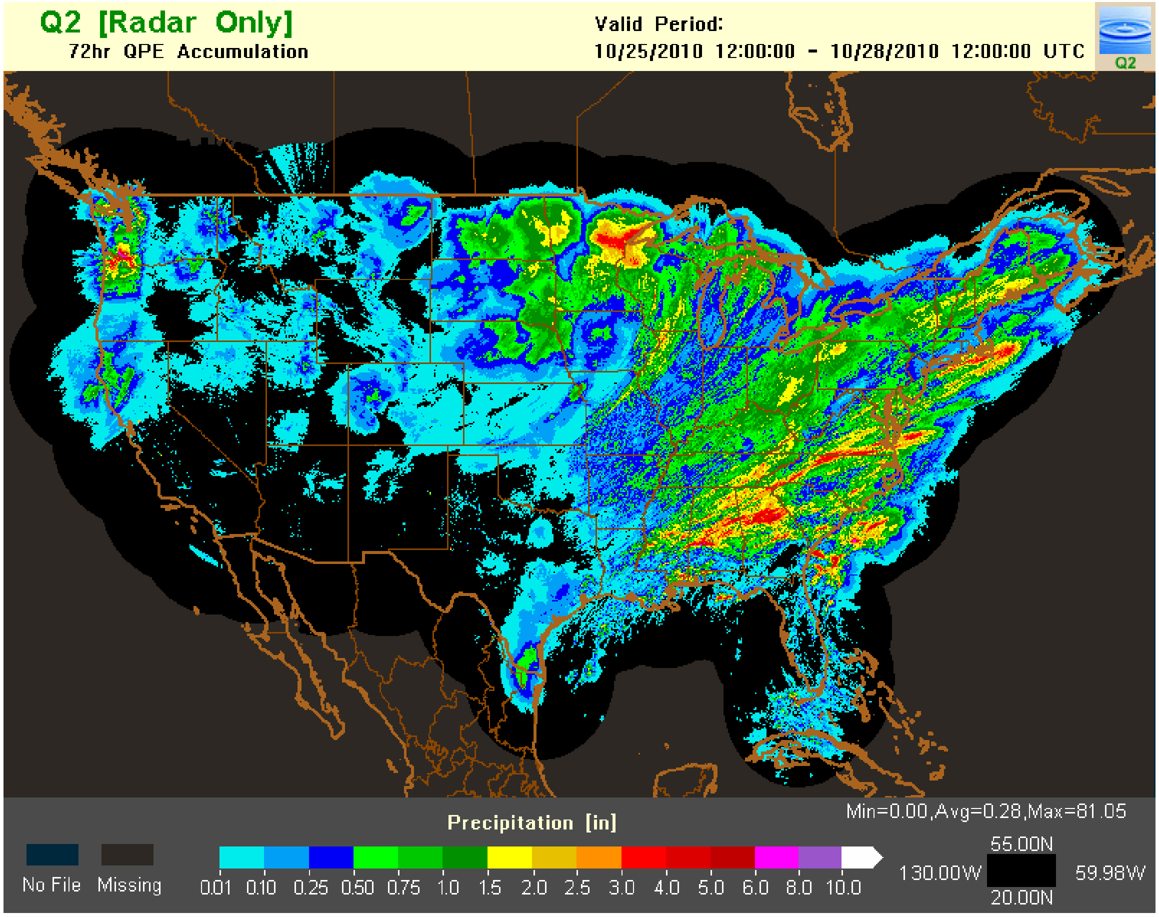


Figure 4: 72 hour radar estimated precipitation (in inches) valid from 12 UTC October 25th, 2010 through 12 UTC October 28th, 2010 *(Image provided by NMQ)*.

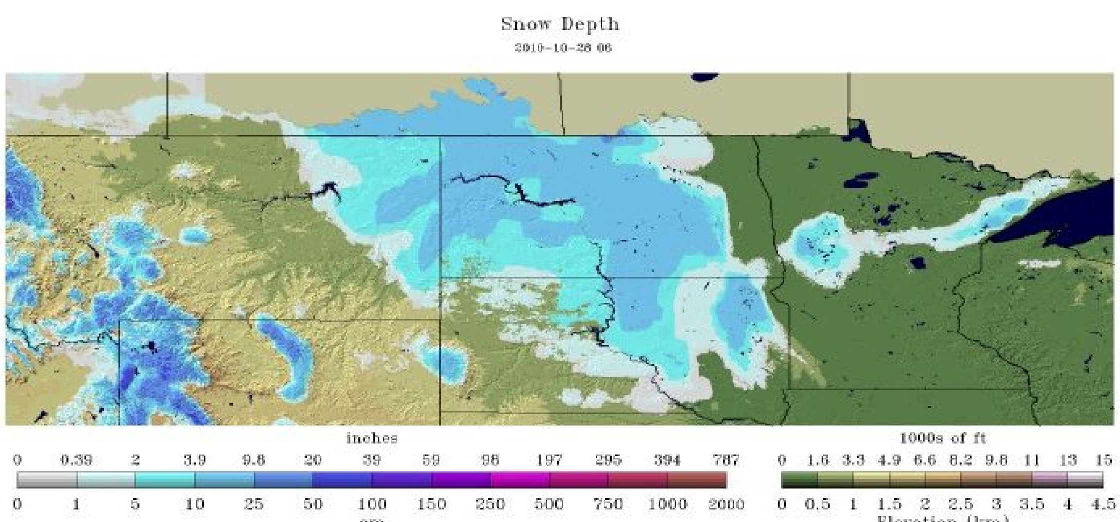


Figure 5: Estimated snow depth on October 28th, 2010 *(Image provided by NOHRSC)*.

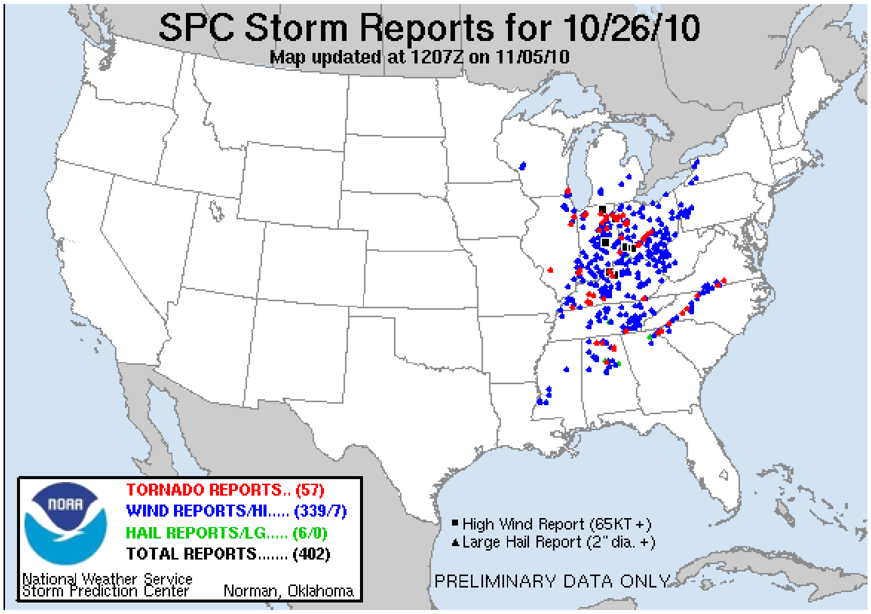
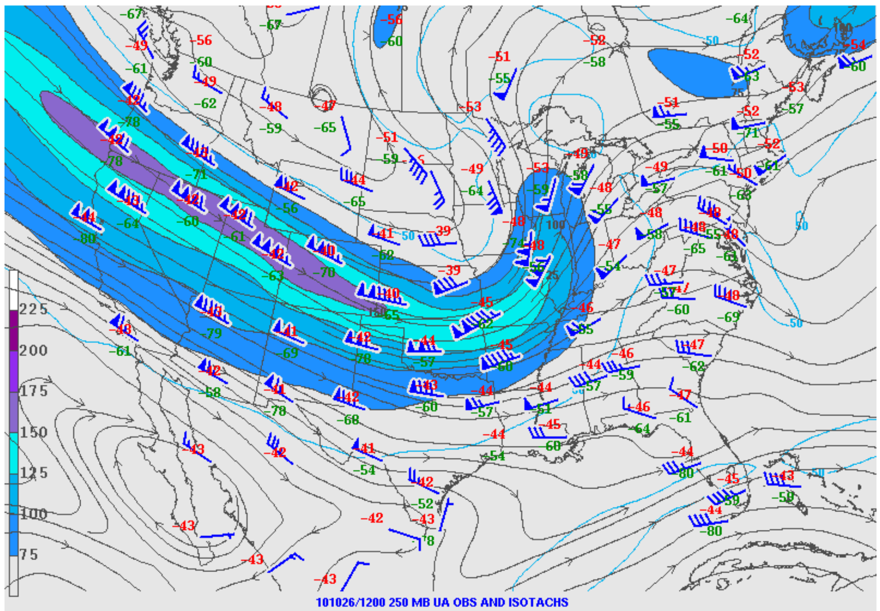


Figure 6: Reports of tornados (red), high winds (blue), and large hail (green) from October 26th, 2010 *(Image provided by SPC)*

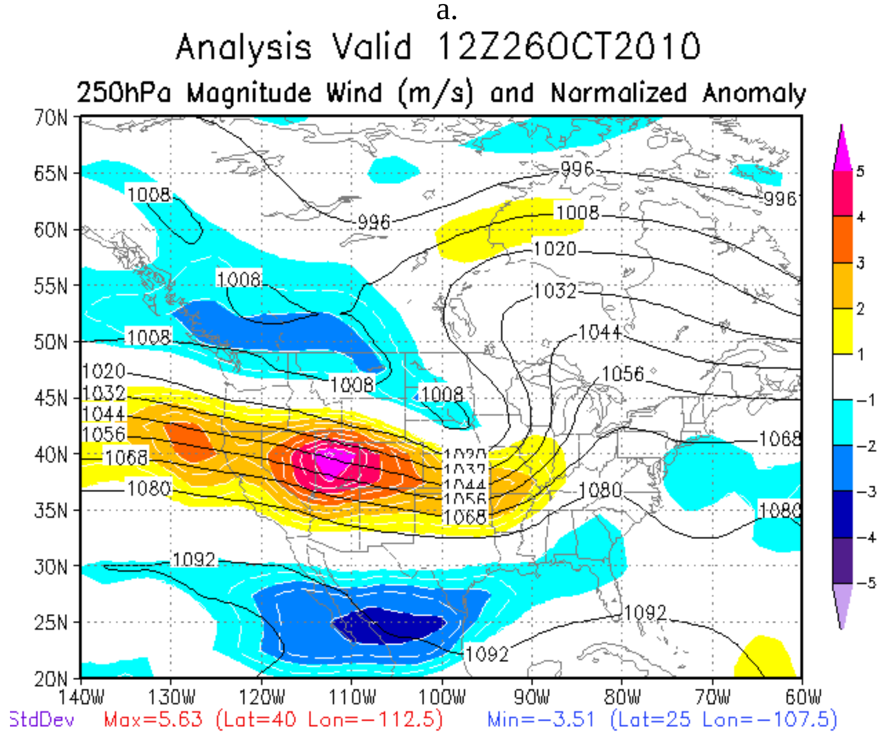
<u>Synoptic Pattern</u>:

This October storm had several key ingredients for a significant synoptic event. An anomalously strong upper-level jet was in place with an area of maximum winds in excess of 150 knots (175 mph), or 4 to 5 standard deviations above normal (Fig. 7). The jet moved in from the Pacific Northwest, streaked across the Great Basin, and curved into the Middle Mississippi Valley and Upper Great Lakes, creating an area of upper level divergence in the jet's left exit region over the Upper Midwest. At 500 hPa, a trough dug southeastward over the Rockies and Plains and then swung northeastward into the Upper Midwest (Fig. 8). By 12 UTC on October 26th, the trough was negatively tilted and the area of greatest vorticity advection was over northern Minnesota and eastern Wisconsin (Fig. 8). A southerly jet was also in place at 850 hPa, and it gained strength as the event progressed (Fig. 9). Low-level southerly winds ranged from 60 to 70 knots (70 to 80 mph) over the western Ohio Valley by 12 UTC on the 26th (Fig. 9 c), and were associated with an area of strong warm air advection across northern Wisconsin and northeastern Minnesota. As the system continued deepening, a 65 kt westerly 850 mb jet developed on it's south side (Fig. 9d), contributing to strong wind gusts over the Upper Midwest.

The strong upper-level divergence combined with cyclonic vorticity advection and low-level warm air advection allowed for a surface low to rapidly strengthen as it crossed the Upper Midwest on Tuesday, October 26th. On Monday evening, 00 UTC on October 26th, a 980 hPa surface low was located over eastern Nebraska, and a cold front extended southward from the low across the Central Plains and back into the southwestern U.S. (Fig. 10 a). The surface low progressed northeastward Monday night and deepened to 966 hPa over central Minnesota by Tuesday morning, 12 UTC on October 26th (Fig. 10 b). By Tuesday evening, around 00 UTC on the 27th, the surface front had bowed out over the eastern Ohio and Tennessee River Valleys, and the low moved slightly northward into north central Minnesota, reaching its minimum central pressure of 955.2 hPa (Fig. 10 c). The deep surface low left an impressively broad area of large pressure gradients across the north-central U.S. and south-central Canada that lasted into Wednesday morning, 12 UTC October 28th (Fig. 10 d).

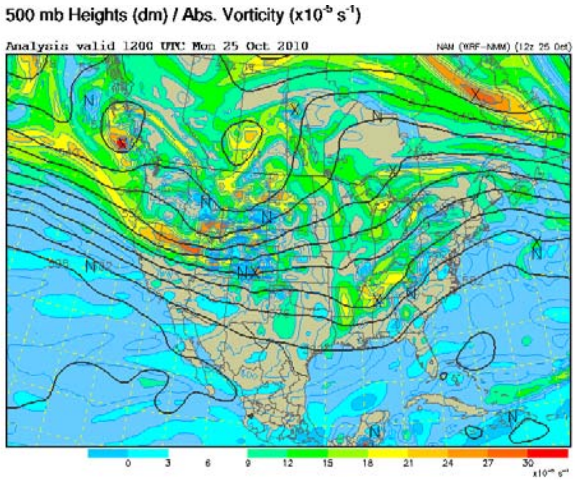


a.

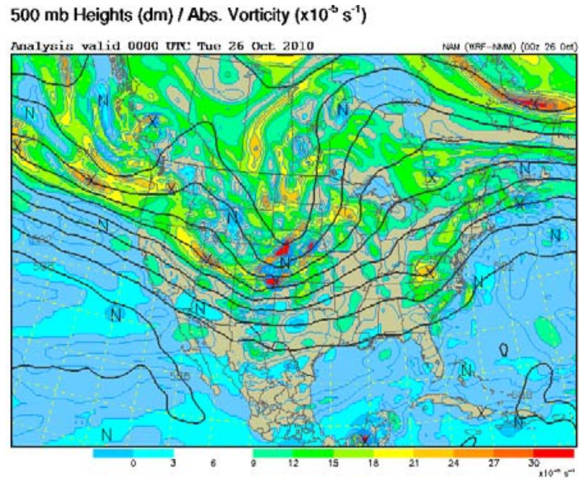


b.

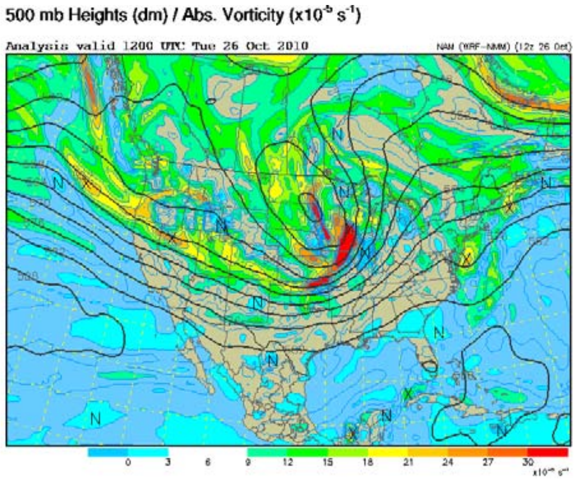
Figure 7: (a) 250 hPa observations and isotachs (knots) from 12 UTC on October 26th, 2010 *(Image provided by SPC).* (b) 250 hPa heights (dm) and normalized total wind anomaly *(Image provided by NCEP/NCAR Reanalysis Mapper).*



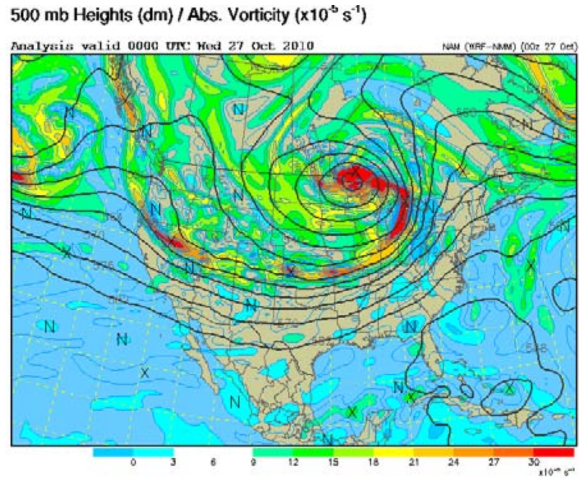
a.



b.

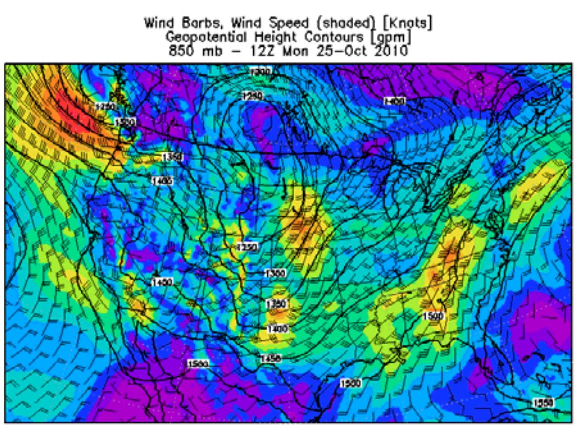


c.

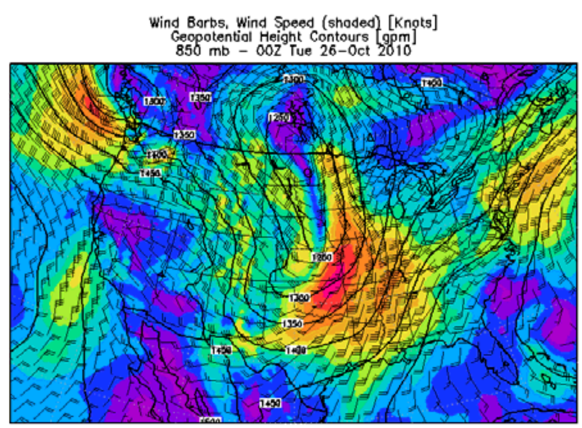


d.

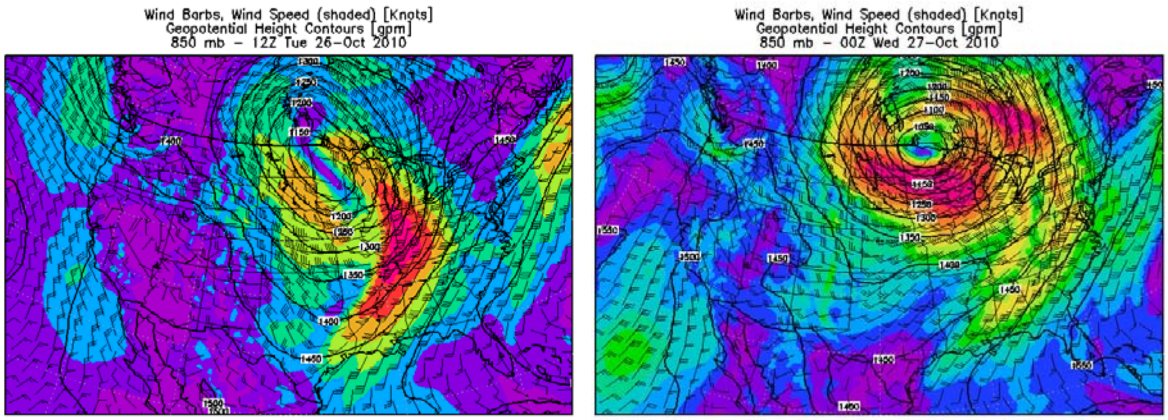
Figure 8: 500 hPa heights (dm) and absolute vorticity from (a) 12 UTC on the 25th, (b) 00 UTC on the 26th, (c) 12 UTC on the 26th, and (d) 00 UTC on the 27th of October 2010 *(Image provided by UCAR).*



a.

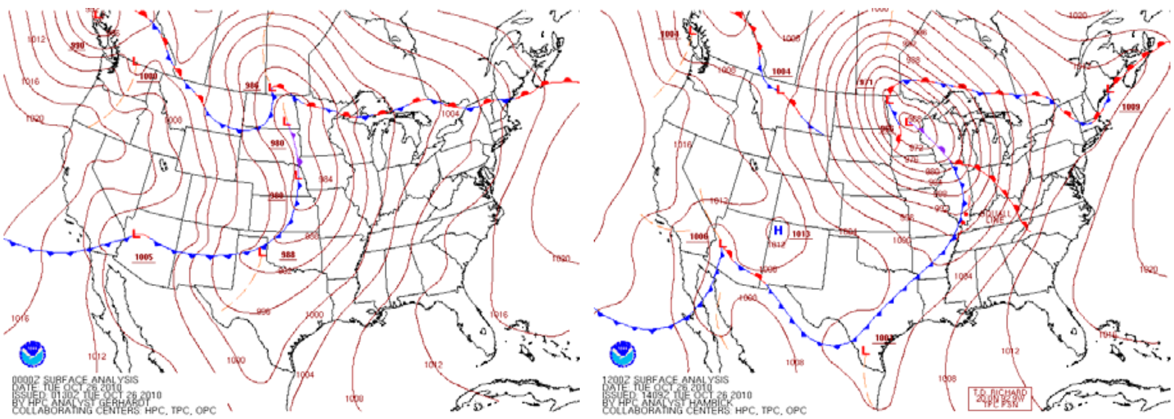


b.

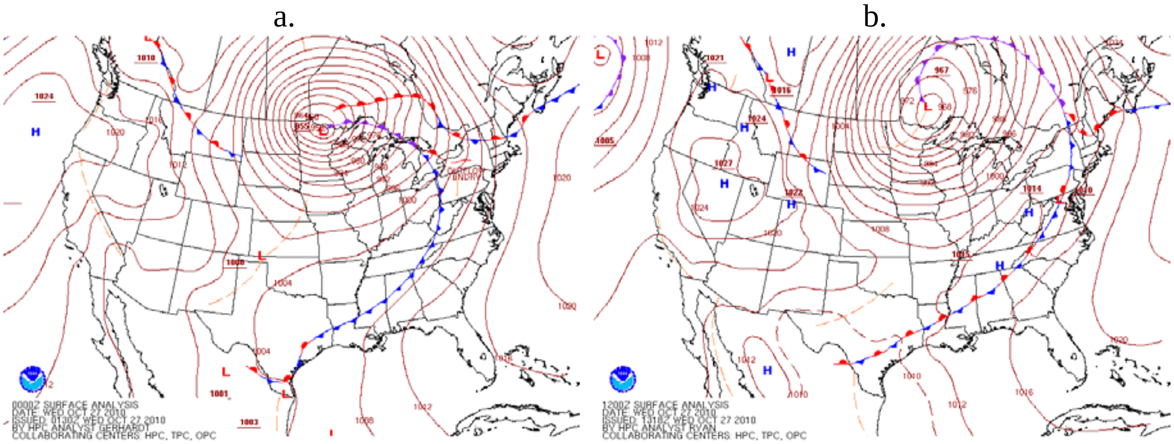


c. d.

Figure 9: 850 hPa heights and wind barbs (knots) from (a) 12 UTC on the 25th, (b) 00 UTC on the 26th, (c) 12 UTC on the 26th, and (d) 00 UTC on the 27th of October 2010 *(Image provided by NCDC).*



a. b.

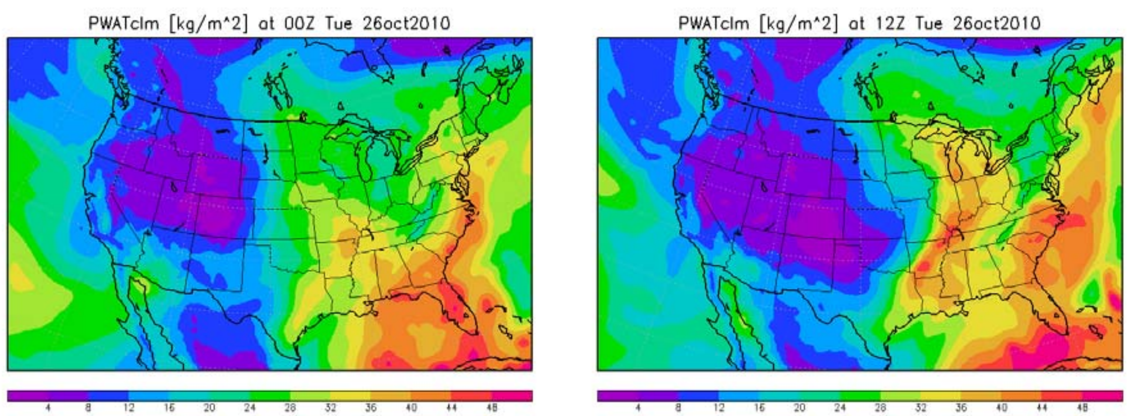


c. d.

Figure 10: Analyzed surface pressures (isobars every 4 mb) and fronts at (a) 00 UTC on the 26th, (b) 12 UTC on the 26th, (c) 00 UTC on the 27th, (d) and 12 UTC on the 27th, from October 2010 *(Images provided by HPC).*

Severe Weather Development:

The October 25th-27th, 2010 event resulted in multiple reports of wind, hail, and tornados across the eastern half of the country. Conditions did not initially support any severe weather, but as the storm system strengthened and the surface cold front pushed eastward, the environment became more favorable for thunderstorm development. The increase in low-level southerly flow on Monday night and Tuesday morning (Fig. 9b and c) brought moisture and warmer air northward into the Middle Mississippi, Tennessee, and Ohio River Valleys. Instability increased across the region as precipitable water values over Illinois and southeastern Missouri went from around 36 kg/m^2 (1.4 inches) at 00 UTC on October 26th to nearly 48 kg/ m^2 (1.9 inches) by 12 UTC (Fig. 11). The strong southerly jet at 850 hPa also led to a large amount of vertical wind shear ahead of the cold front. Wind shear values between the surface and 6 km were in excess of 80 knots (90 mph) across the Middle Mississippi and western Ohio Valley by 12 UTC on October 26th (Fig. 12). The increase in moisture and instability, combined with large scale lift provided by the synoptic pattern, allowed for a line of thunderstorms to develop along the cold front by 06 UTC on October 26th (Fig. 13 a). The large amount of vertical wind shear allowed for the line of thunderstorms to become severe and stay organized as they progressed eastward for over 12 hours (Fig. 13).



a. b.

Figure 11: Precipitable water in a column (kg/m^2) from 00 UTC (a) and 12 UTC (b) on October 26th, 2010 *(Image provided by NCDC).*

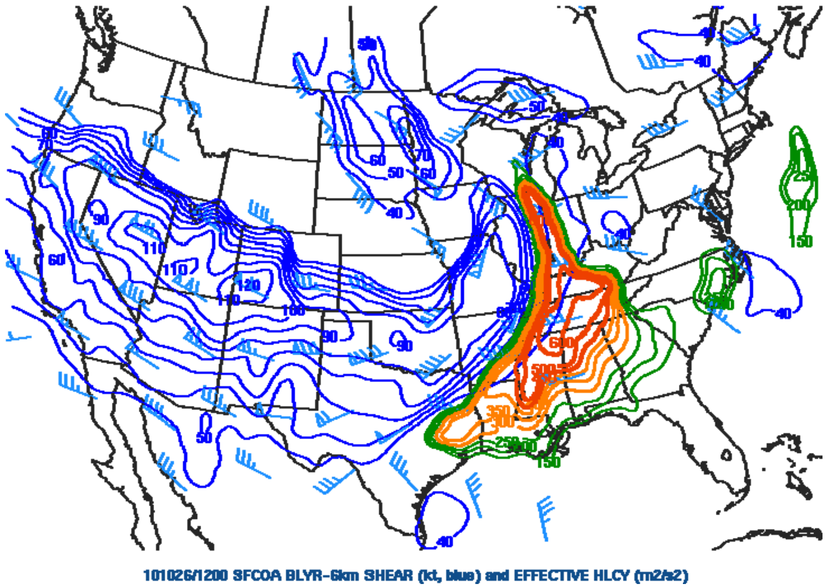
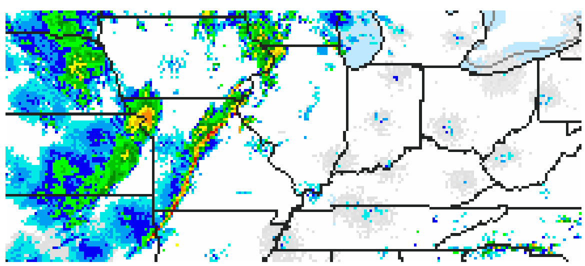
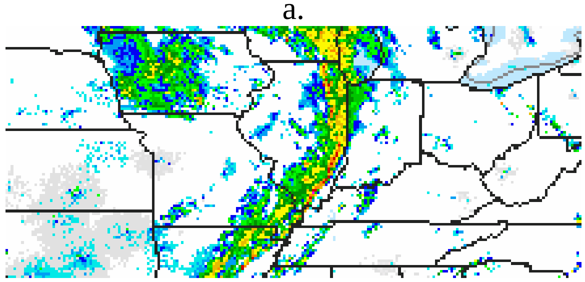


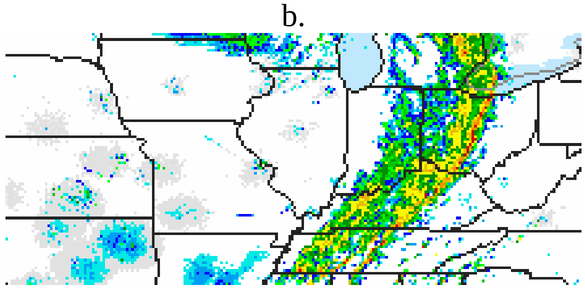
Figure 12: Surface to 6 km shear (kt,blue) and effective storm-relative helicity (m^2/s^2) from 12 UTC on October 26th, 2010 *(Image provided by SPC)*.



a.



b.



c.

Figure 13: Radar over the Midwest from 06 UTC (a), 12 UTC (b), and 18 UTC (c) on October 26th, 2010.

<u>Conclusion</u>:

The October 25-27th event caused a variety of weather hazards across much of the central United States. Rain, accumulating snow, severe thunderstorms, and high winds covered a large portion of the Midwest, but the attention was mostly focused on the storm system's impressively deep surface low center. The storm made the record books in both Minnesota and Wisconsin, where the lowest pressures in the states' histories were recorded. The left exit region of an anomalously strong upper-level jet, 500 hPa cyclonic vorticity advection, and warm air advection, created the ideal synoptic setup for rapid cyclogenesis over the Upper Midwest Tuesday afternoon and evening. The strong southerly flow at 850hPa also helped fuel a line of severe and long lived thunderstorms along the surface cold front by increasing low-level moisture, instability, and especially vertical wind shear. The size and strength of the storm as well as the range of impacts it had across the Midwest will make this an event to remember for years to come.