Siren, WI Tornado on June 18, 2001

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Abstract

On a fateful night in June 2001, the town of Siren, WI was leveled by an F3 tornado. A total of 205 structures were destroyed, and many others damaged. Despite the fact that the town's only tornado warning siren was inoperable at the time of the storm, only three people were killed. This can be attributed to the hard work and determination of Siren's chief of police who went door to door alerting residents of the impending danger, as well as the 50 minute advanced warning for the twister. Sadly, countless dairy cows perished. The high precipitation supercell that produced the tornado was initiated by synoptic-scale forcing, and the chance for tornado formation was enhanced as the storm progressed into a region of increased low-level shear.

Introduction

On the night of June 18, 2001 the town of Siren, WI was leveled by a massive F3 tornado. The twister was responsible for 3 deaths and 17 injuries, as well as the destruction of 205 homes, farms and businesses. Their brand new hockey arena was also destroyed. The damage was so intense that it could be seen on satellite pictures taken the following day, shown in Fig. 1. In addition to human casualties, the storm took its toll on dairy cattle. One dead cow was discovered up a tree, while other cattle disappeared from pastures, only to surface days later from the depths of nearby lakes. Figure 2 is a conceptual model of an HP supercell that shows the complexity of this type of storm. The high precipitation aspect of this supercell caused poor visibility of the funnel due to it being rain-wrapped, and it could not be seen until it was almost in town. The ironic part of this story is that the town's only tornado warning siren was inoperable at the time of the storm.

This particular tornado was spawned by a high precipitation supercell thunderstorm, for which many conditions must be present in order for the storm to develop. Sufficient heat and moisture, along with vertical speed shear and the turning of winds with height are necessary ingredients required to make this type of storm. Once a supercell forms, other conditions must amalgamate for tornadogenesis to occur. There must be a persistent mesocyclone, enhanced lower-level helicity, and a low lifting condensation level (Lese et al., 2004). This paper will discuss both the synoptic and mesoscale processes that came together to form the Siren tornado.

Data

This case study was produced using ETA model data interpreted in GARP, LandSat satellite images from the University of Wisconsin-Madison, and local surface mesonet observations.

Synoptic Overview

At 6 PM on June 18, 2001 synoptic conditions over Minnesota and Wisconsin were shaping up for severe weather. At the surface, an occluding cyclone was present in NE Minnesota, while a secondary cyclone was located to its south, just to the west of Siren. A zonally oriented warm front extended eastward from this southern low to immediately south of the city. A north-south directed cold front was located to the south of this low pressure. This surface triple point was the focus for severe thunderstorm development.

At upper levels, the right entrance of a 500mb 40 m/s jet streak was approaching Siren, as shown in fig. 3. The upper level divergence associated with this feature induced upward vertical motion which aided in storm development. In addition, there was also lower level convergence according to mass continuity. The presence and effect of this convergent wind field will be discussed in greater detail in the following section.

Mesoscale Analysis

The Siren supercell formed in a region of synoptic-scale ascent and propagated into an area that was very favorable for tornadogenesis. The storm formed near the triple point of the low pressure system, under the upper level divergence caused by the 500mb jet streak. It then propagated to the east along the northern edge of the warm front into a region of strong moisture and temperature gradients. Fig. 4 displays a vertical cross section of potential temperature and equivalent potential temperature. As can be seen, cooler and drier air resides to the north of the storm (shown as the theta-e plume), and moist, warm air to its south. Fig. 5 shows a surface mesoscale analysis at 00Z highlighting the positions of fronts, areas of maximum moisture, and convergent winds. In the case of the Siren tornado the key ingredient for tornado formation was the presence of strong directional wind shear in the lower levels associated with the surface wind convergence just north of the surface warm front.

Because of the storm's relative location to the warm front, lower-level backing of surface wind was occurring. This not only created surface wind convergence which aided in upward vertical motion, but it also contributed greatly to local values of high helicity. Although there was no data available about helicity values near Siren, the presence of rapidly turning winds near the surface was indicative of high values of helicity. Values greater than 300 m^2/s^2 of storm relative helicity are favorable for mesocyclone and tornado formation.

In order to gain a better understanding of atmospheric winds, it was important to look at a vertical sounding. While there was no skew-t for Siren, it was possible to compare their conditions with those taken at Minneapolis. Fig 6 displays the 00Z June 19, 2001 sounding for Minneapolis. A look at the recorded sounding shows that Minneapolis had a helicity of 173 m^2/s^2 with southwest surface winds and westerly winds aloft. At the same time, Siren had a southeast surface wind with a westerly wind aloft which indicated greater lower level directional wind shear than in the sounding. As a result, the helicity in

Siren, WI was greater than in Minneapolis and could have possibly approached the 300 m^2/s^2 value.

Conclusion

Massive amounts of damage and complete destruction occurred in the town of Siren, WI on the night of June 18, 2001. Three people died, with an additional 17 injured. An unknown number of cows were killed. The HP supercell that spawned the deadly Siren, WI tornado was initiated by synoptic-scale forcing, and enhanced by mesoscale processes. The right entrance region of an upper level jet streak, combined with frontal forcing near the surface was sufficient to initiate deep convection. As the storm progressed to the east, the addition of higher helicity and strong low-level backing winds north of the warm front created an environment favorable to rotation. Without this increased mesoscale wind shear, the storm would have likely remained a classic non-tornadic HP supercell and the town of Siren would still have their hockey arena.

Appendix

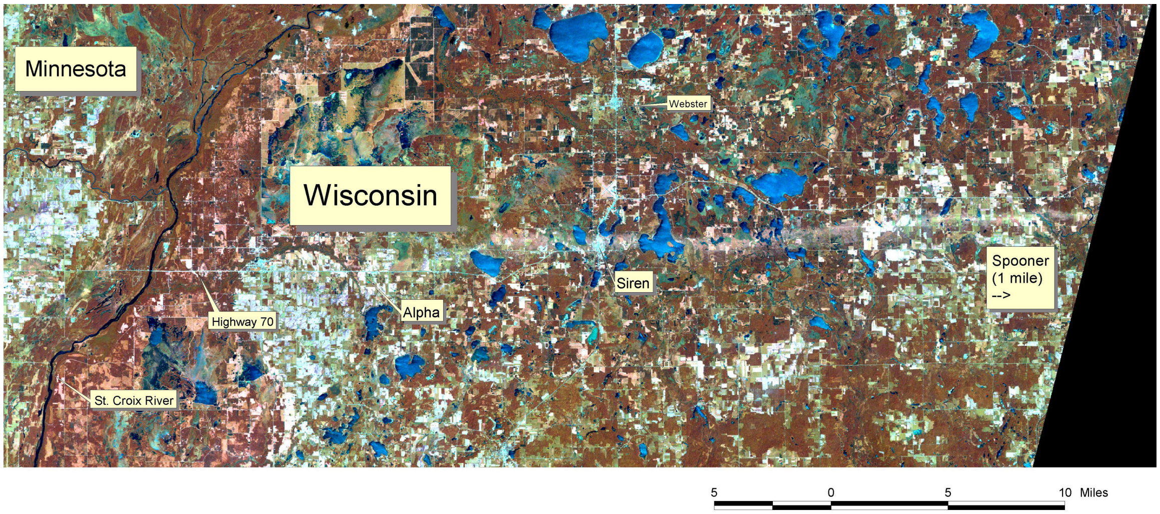

Fig. 1: A LandSat photo from UW-Madison of the tornado damage path, shown as the white line, on June 19, 2001.

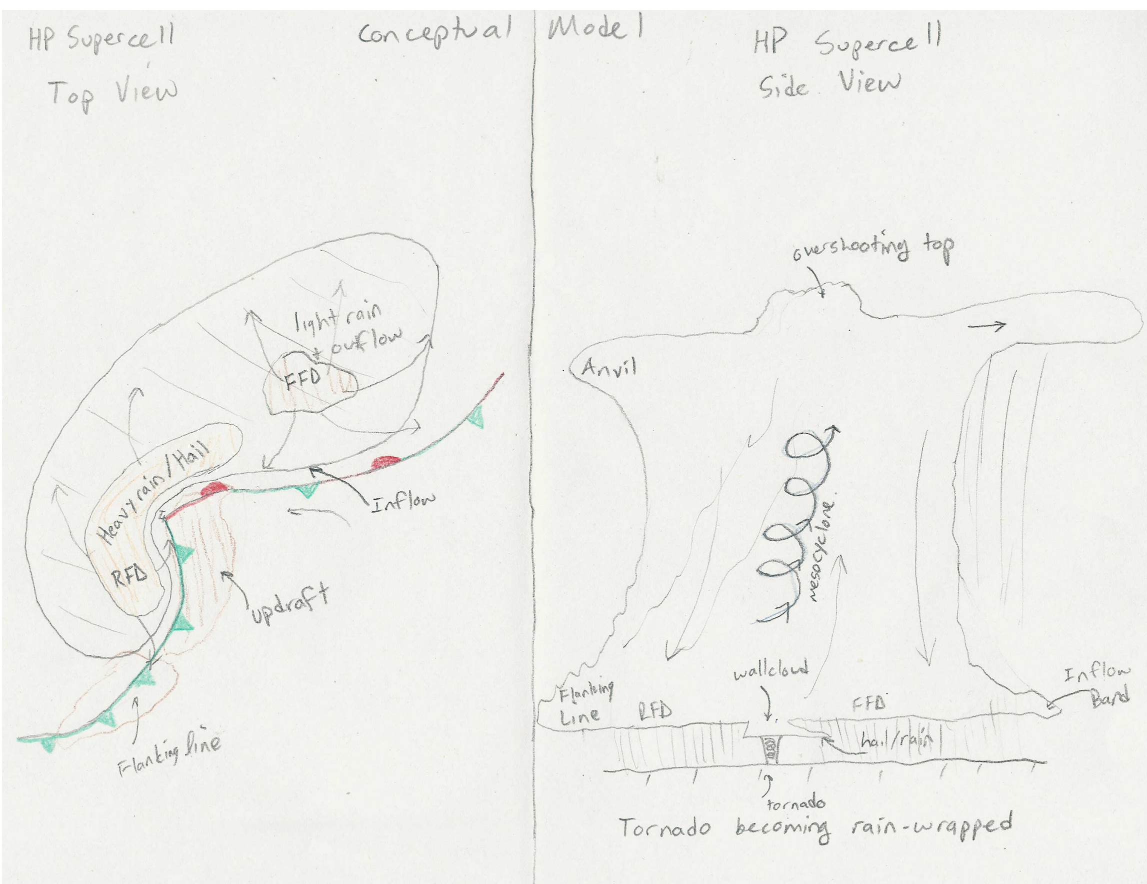

Fig. 2: Top and side views of an HP supercell

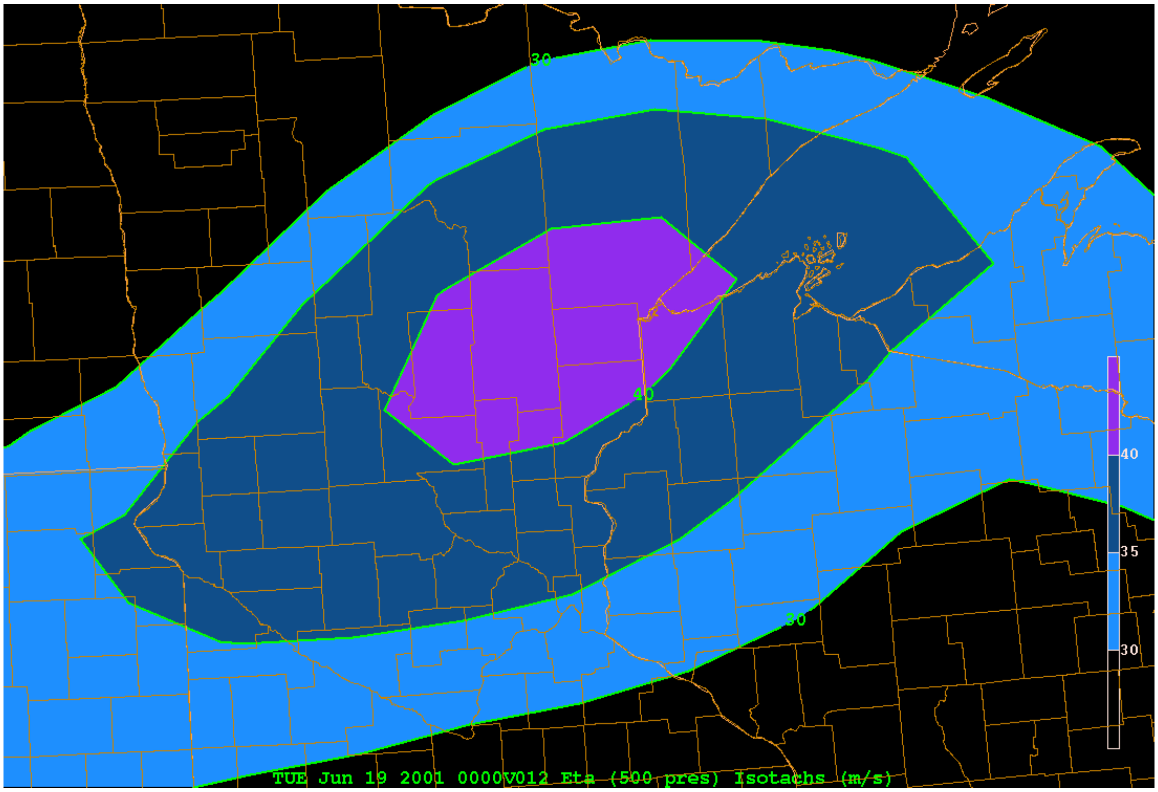

Fig. 3: 500mb jet streak at 00Z June 18, 2001.

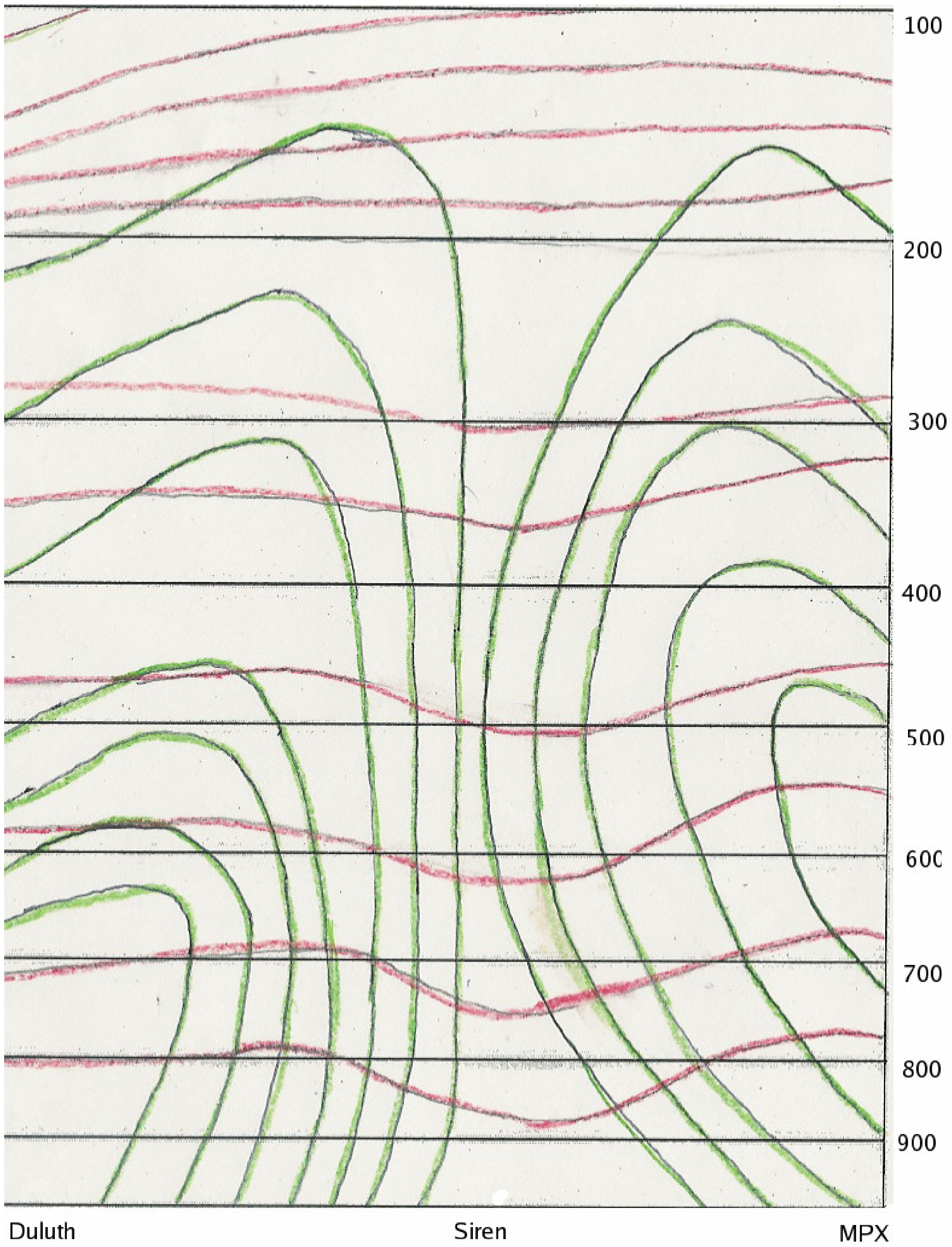

Fig 4: Lines of constant potential temperature in red and equivalent potential temperature in green. Note the drier, cooler air to the north of the storm (theta-e plume) and warmer, moister air to the south in the warm sector of the cyclone.

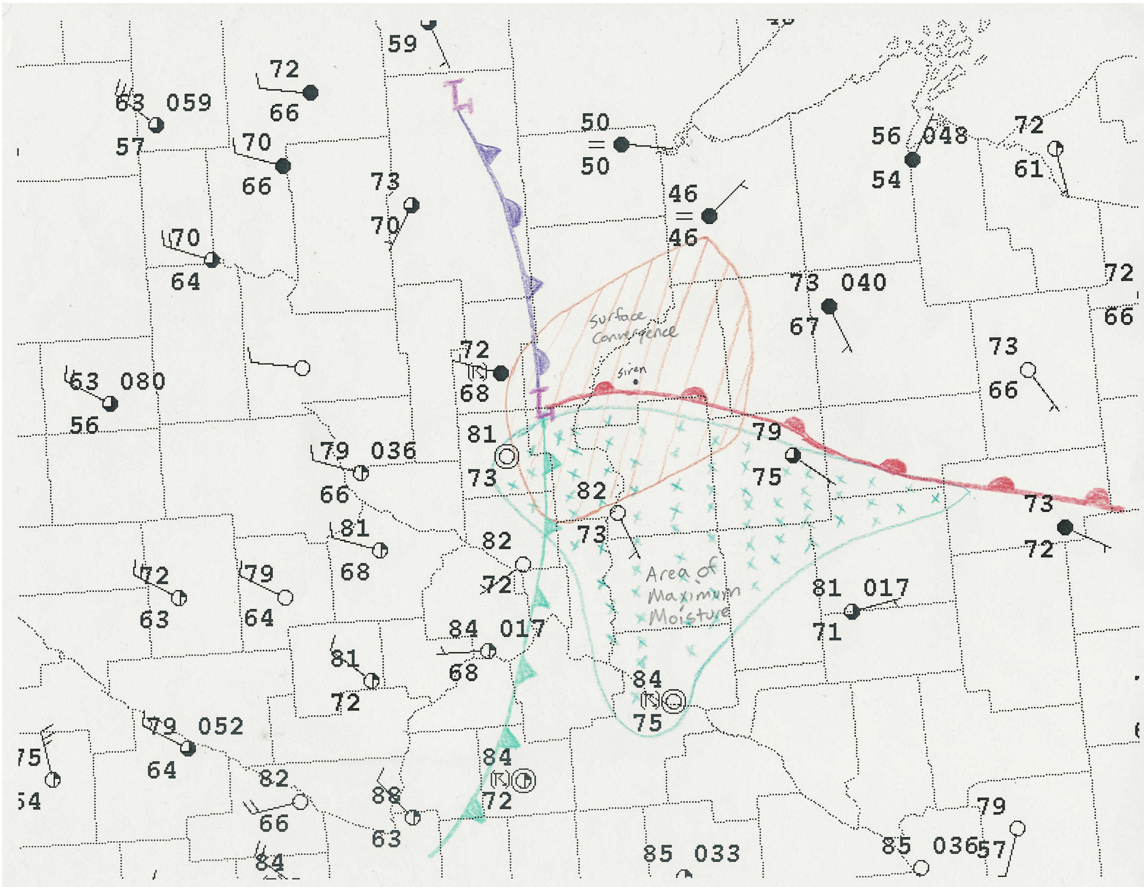

Fig. 5: Mesoscale surface analysis at 00Z June 18, 2001.

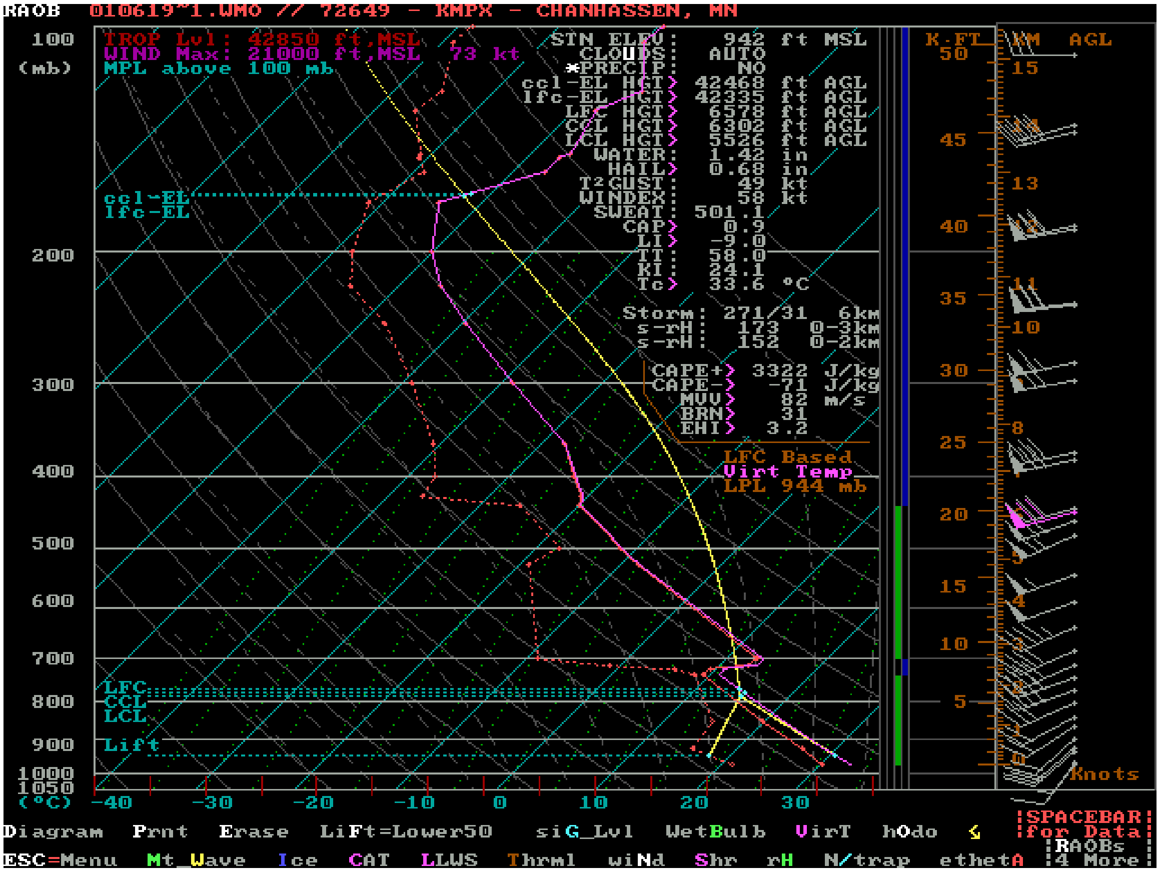

Fig. 6: Skew-T sounding for Minneapolis at 00Z June 18, 2001

References and Acknowledgements:

Lese, A. D., Wesley D. Browning, and Doug T. Cramer. A multi-platform approach to forecasting supercell tornado potential. NOAA/National Weather Service, Springfield, MO. 2004.

Special thanks to my table buddy Beth Konop for putting up with me all semester.