December 3, 1978 Bossier City Tornado

Meteorological Discussion

The weather maps depicting the weather conditions present at midnight on December 3, 1978 will be discussed and shown in this section. These charts will display just a few of the fields meteorologists examine when forecasting your weather. The charts shown here will also display the *standard deviation* of each field with warm and cool colors. By examining the standard deviation, you can see how “rare” or “common” the height pattern, wind speeds, or temperatures were when compared to “normal” for early December.

Background:
A cold front moved through Northwest Louisiana on Monday, November 27. By Friday, December 1, a positively-tilted trough was present in the upper atmosphere from the High Plains to the Desert Southwest. This allowed Gulf moisture to return to the lower part of the atmosphere Friday night, in response to surface low pressure developing over the Texas Panhandle. Considering the placement of the upper atmospheric trough, the associated cold front moved very little from Thursday through Saturday. It remained stretched from the surface low into the Ohio River Valley.

Upper Atmosphere Charts

250mb
A deep, positively tilted trough axis stretches from western North Dakota to Baja California. However, the 250mb chart is useful in displaying the location and position of the jet stream. This chart shows a strong jet stream, with wind speeds of 120 to 130 knots, extending from southern New Mexico into the Ohio River Valley. Some diffluence is evident near the Interstate 30 corridor as the core of the jet starts to move northeast. Effectively, our region was moving into the right entrance region of the jet stream. This area of the jet is known for enhancing atmospheric lift and favoring the development of thunderstorms.

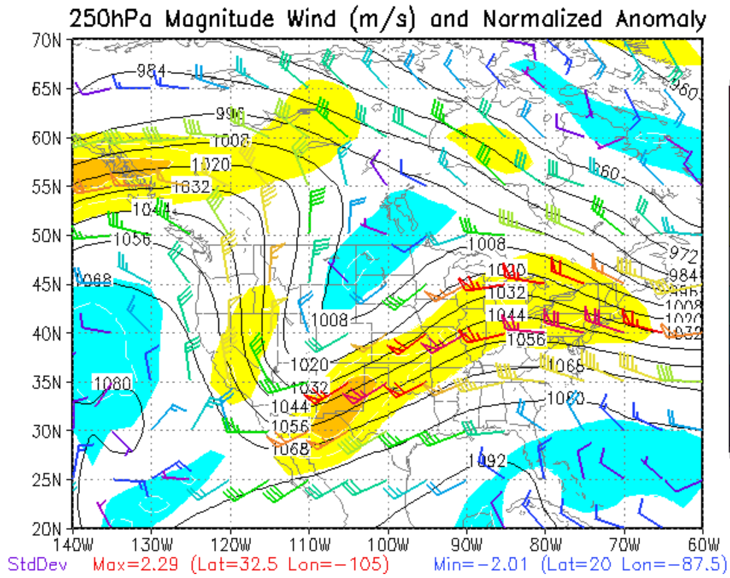

Figure 1. 250mb chart for midnight on December 3, 1978. Heights, wind barbs, and the standard deviation of wind speeds are shown.

500mb

The deep trough is again noted on the 500mb chart. Wind speeds are unusually strong at this level as well, with speeds near 90 knots and standard deviations of almost 3 across Central Oklahoma. These charts, though, are rather useful in depicting the location and movement of “shortwave troughs,” more commonly known as “upper-level disturbances.” One such disturbance is seen in the temperature field as a subtle trough from Central Kansas toward the Interstate 30 corridor. This disturbance passed through the region during the overnight hours, providing yet another source of atmospheric lift for thunderstorm development. Incidentally, standard deviations between 3 and 4 were noted near the base of the trough, providing another indication of the strength of this storm system.

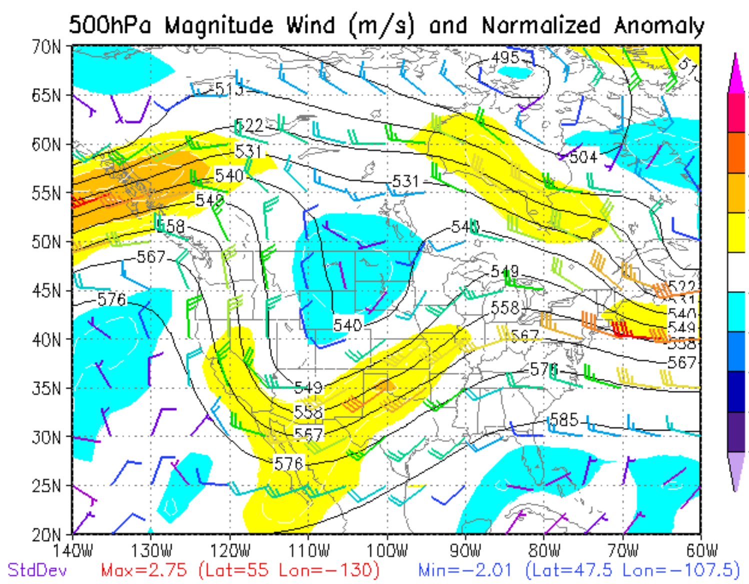

Figure 2. 500mb chart for midnight on December 3, 1978. Heights, wind barbs, and the standard deviation of wind speeds are shown.

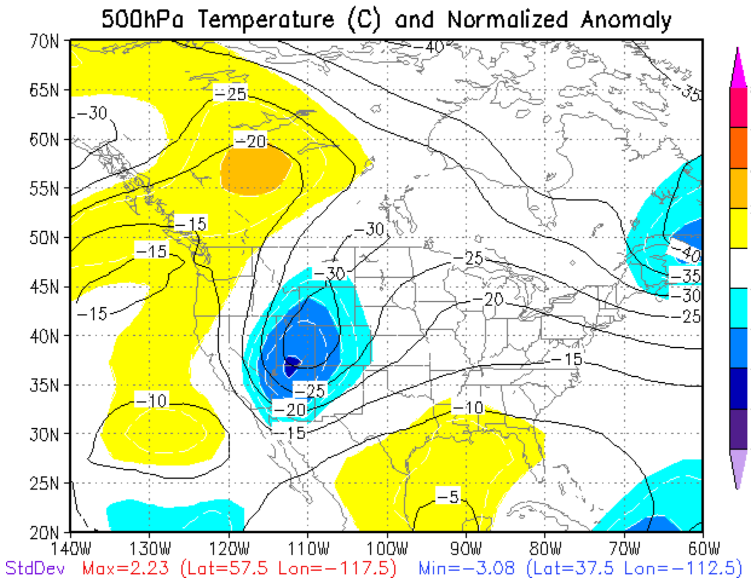

Figure 3. 500mb chart for midnight on December 3, 1978. Isotherms and the standard deviation of temperatures are shown.

850mb

Evidence of a warm and moist airmass, brought into the region by a strong (50 knot) low-level jet, is presented in the 850mb charts. Temperatures at this level (approximately 5000 feet) averaged between 15° and 20° Celsius, or 59° and 68° Fahrenheit, which are up to 2 standard deviations above normal. Warm temperatures at this height, especially in early December, are not usually a good sign. Why? With warmer temperatures, you have a greater possibility of being “capped.” The cap, known by meteorologists as an inversion, allows instability to increase in the lower part of the atmosphere. The instability is then realized when a lifting mechanism, such as a front or “upper-level disturbance” combines with a developing thunderstorm to “break the cap.” This can result in seemingly explosive thunderstorm development in a short period of time.

Another indication of the amount of moisture present in the lower part of the atmosphere is shown in the precipitable water chart. Values at midnight were in excess of 3.5 centimeters, or 1.4 inches, over much of the Four State Region. In fact, drier air did not start filtering into the region until after noon on December 3.

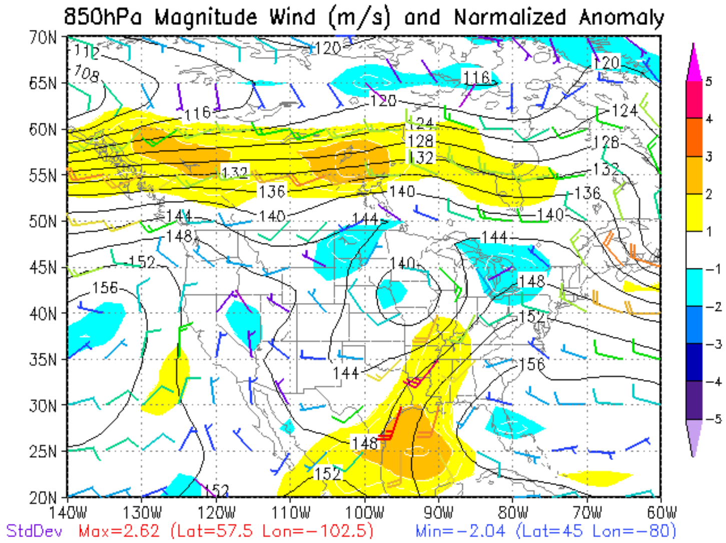

Figure 3. 850mb chart for midnight on December 3, 1978. Heights, wind barbs, and the standard deviation of wind speeds are shown.

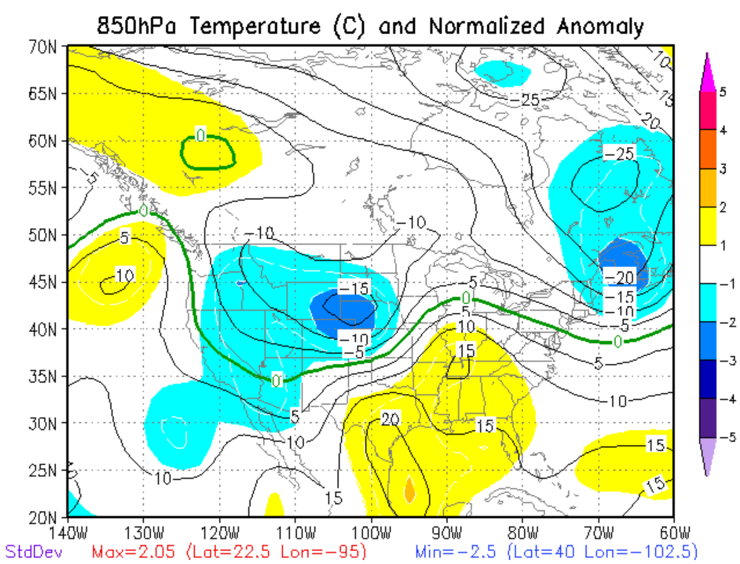

Figure 3. 850mb chart for midnight on December 3, 1978. Isotherms and the standard deviation of temperature are shown.

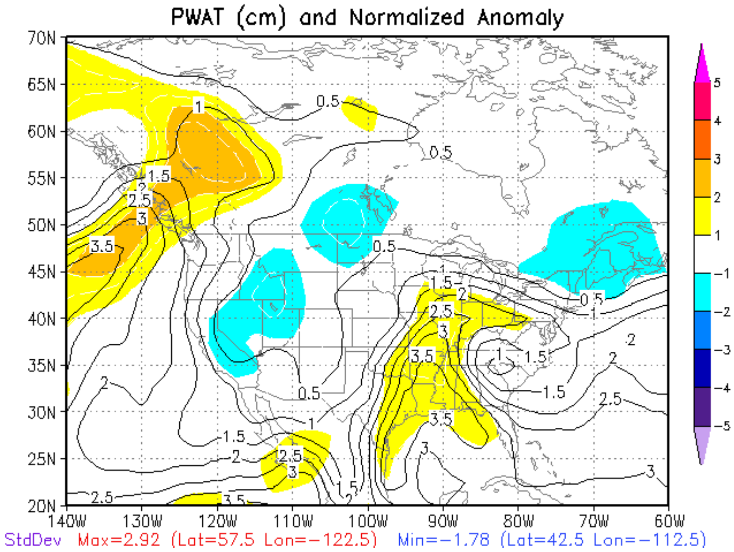

Figure 4. Precipitable water chart for midnight on December 3, 1978. Contours of precipitable water and their standard deviation are shown.

Surface Map

A rough overview of the midnight surface map is presented here. The front stretched across North Texas, then northeastward across Southeast Oklahoma, and into Central Missouri. It is a rather strong front for early December, with surface pressure values between 1 and 2 standard deviations lower than what would normally be anticipated. The front extended along the Interstate 30 corridor by 6 am on December 3, and finally moved of the Shreveport/Bossier City area by noon.

A closer look at surface observations (not shown) indicates the presence of an area of low pressure over Northeast Texas. The presence of this surface low likely increased the amount of low-level wind shear available for thunderstorms. If the amount of low-level wind shear is high enough, tornadoes may be possible.

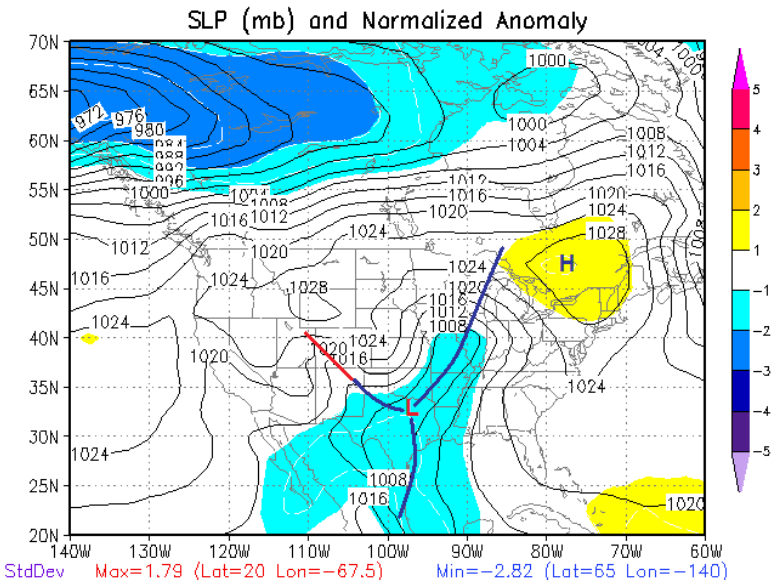

Figure 5. Surface weather map for midnight on December 3, 1978. Isobars and the standard deviation of pressure are shown.

Sounding Analysis

These data are derived from weather balloons, which are launched twice daily from meteorological offices around the world. Of the two thick lines on the image, the line on the right is the temperature. The line on the left is the dewpoint. In the late 1970s, weather balloons were not launched at the National Weather Service in Shreveport. Instead, they were launched an office in Longview, Texas.

The 6 am sounding from December 2 shows a very moist airmass in place over the lowest 5000 feet. Near the top of this layer, around 850mb, a subsidence inversion (or “cap”) is present, with a large amount of dry air in place above the cap. The presence of the cap all but prohibits large-scale convective development while allowing instability to increase. Depth of the low-level moist layer increased through December 2, and was noticeably deeper by 6 pm. By 6 pm, the atmosphere across the Four State Region was very unstable for early December. The lifted index was -6.2°, with a CAPE (or Convective Available Potential Energy) of 2179 J kg^{-1}.

An examination of the 6 am and 6 pm soundings shows the height of the cap increased from 850mb at 6 am to almost 750mb at 6 pm. This was probably due to mechanical lifting of the air parcel in advance of the approaching shortwave trough. Wind speeds and low-level wind shear also increased throughout the day on December 2, as seen on both the soundings and associated hodographs. An estimate of the surface to 6 kilometer wind shear at 6 pm on December 2 shows an approximate magnitude of 40 knots. Studies have shown values such as these are sufficient to obtain the thunderstorm rotation which could lead to tornado development.

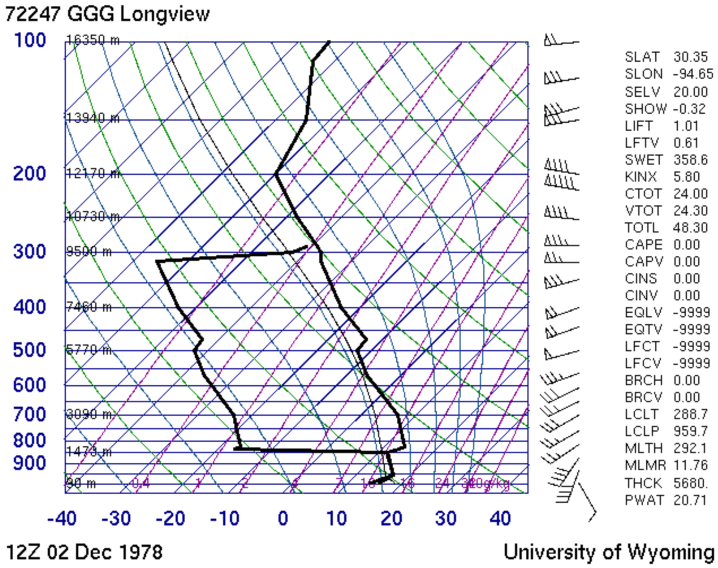

Figure 6. Upper atmospheric sounding taken at Longview, TX at 6 am on December 2, 1978.

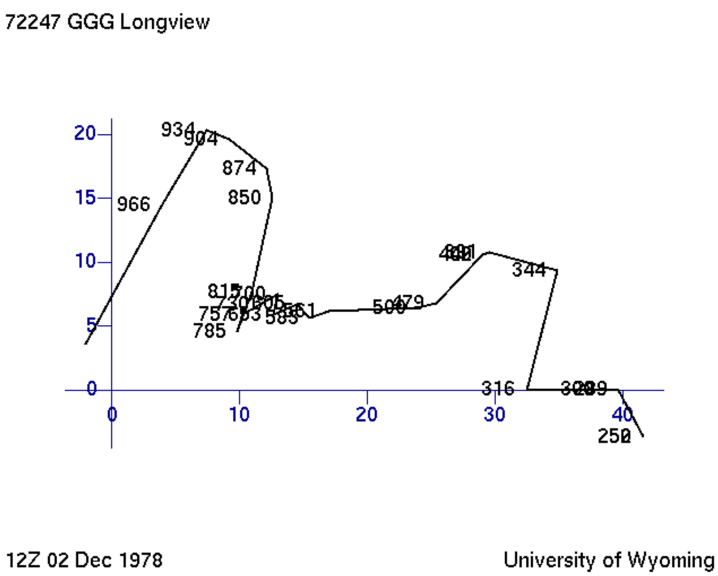

Figure 7. Hodograph from the upper atmospheric sounding taken at Longview, TX at 6 am on December 2, 1978.

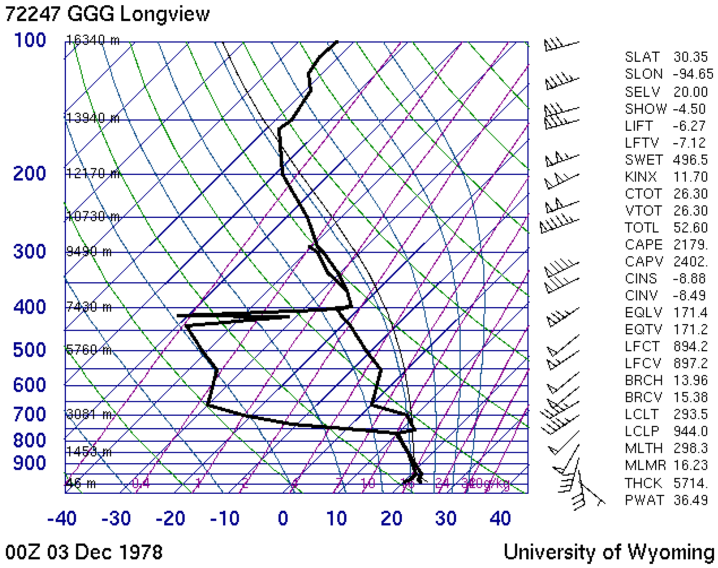

Figure 8. Upper atmospheric sounding taken at Longview, TX at 6 pm on December 2, 1978.

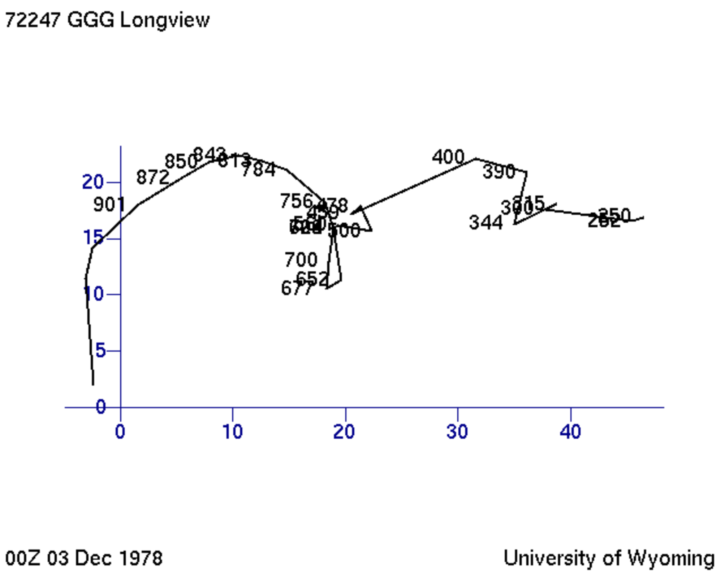

Figure 9. Hodograph from the upper atmospheric sounding taken at Longview, TX at 6 pm on December 2, 1978.