CENTRAL MONTANA SUPERCELL EVENT 08 JULY 2002

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Introduction

08 July 2002 was a significant severe weather day for Central Montana. The event occurred during the peak severe weather season for the area, which is climatologically from mid June through mid July.

There was extensive damage from tornados, strong wind gusts, and large hail associated with supercell thunderstorms. The environment that the storms formed in was conducive for classic supercell development. Severe thunderstorms were observed in five counties in Central Montana (Fig. 1). The most impressive damage was from a microburst wind gust at Neihart, where a one-quarter mile swath of trees were sheared off (Fig. 2). Confirmed tornados caused damage in parts of Fergus and Southern Blaine counties. Large hail up to 2.5 inches in diameter was reported in Judith Basin and Fergus counties. Several funnel clouds were also sighted in these areas.

Synoptic and Mesoscale Environment

At 1200Z (600am MDT) 08-Jul-2002, there was already a "loaded gun" sounding at Great Falls with a CAPE of around 1500 joules per kilogram (J/Kg) and a veering wind profile in the lowest 3 kilometers (km) (Fig. 3). At 1900Z (100pm MDT) a surface low pressure center was located near Billings with a surface trough extending north to near Lewistown and Havre (Fig. 4). There was also a stationary front located just west of Great Falls (Fig. 4). This surface trough was significant in that the low-level wind direction along and east of the boundary was east-southeast, thus increasing the magnitude of directional wind shear in the lower levels. Also, there were higher theta-E (~350 K) and dewpoints (lower to mid 60s) east of this boundary (Fig. 5). The boundary was also responsible for focusing low-level convergence, although this was not the main forcing mechanism for the severe weather outbreak.

Impressive large-scale forcing occurred from a vigorous short-wave trough that moved east-northeast through Central Montana between 200pm and 600pm (Fig. 6). Central Montana was also located in the left-front quadrant of a compact 80 knot (kt) 250mb jet streak, which further aided in significant dynamic forcing (Fig. 7).

Given the environment that day, supercell formation was likely. Since the Great Falls County Warning Area (TFX CWA) is fairly large, pinpointing the most favorable locations for supercell development was crucial. After investigating satellite imagery and observations, it was obvious that the potential for the greatest build-up of instability was over central and eastern portions of the TFX CWA where there was a distinct lack of cloud cover from morning through early afternoon (Fig. 8). Also, surface observations showed the highest dewpoints and theta-E values across eastern zones. The large-scale forcing anticipated during the mid to late afternoon hours coincided with the area of greatest instability present from about Great Falls eastward, so this is where the greatest threat for severe weather was assumed to be.

Since it was anticipated the best chance for severe weather was to generally be east of Great Falls, some severe storm parameters from these areas were investigated using LAPS point sounding data and MSAS analyses. Surface-based convective available potential energy (CAPE) values were generally in the 2500-4000 J/Kg range during the afternoon. These type of CAPE values signified an extremely unstable atmosphere, especially for Montana. There was also a decent amount of directional wind shear, with significant veering of winds in the lowest 150mb in vicinity of the aforementioned surface boundary. The 0-6 km bulk shear was about 50-60 kts, which is very favorable for supercell development. Lifting condensation levels (LCL) were approximately 775mb, which is low for Montana, where higher based storms are much more common. Dewpoints in the 60s, which is very moist by Montana standards, were widespread in this area as well. 0-3 km helicity values were around 225-400 m2 s-2. All these ingredients pointed toward a definite tornado threat. The potential for significant rotating updrafts with likely supercell formation were indicators that severe hail was also a threat.

Discussion

Thunderstorms developed during the mid-afternoon hours, with some cells becoming severe quickly. The severe storms that formed were mainly supercells. The first damaging storm developed in northern Meagher county, moved through the southeast tip of Cascade county, and eventually into Judith Basin county (Fig. 9). This storm was responsible for blowing down a one-quarter mile swath of trees in the Neihart vicinity around 2100Z. The storm had a pronounced inflow notch with high reflectivity (60-65 dBz), and was best seen at the 1.5 degree elevation slice. Viewing just the 0.5 degree slice (Fig. 10) in this case would have been detrimental since it was not sampling the most relevant portion of the storm, and showed much weaker reflectivity returns and circulation. Deep circulation can be seen from the 1.5 degree elevation slice of the SRM data (Fig. 11). The storm also produced large hail as it moved through Judith Basin county.

Several non-supercell storms that developed across Chouteau, Liberty, and Hill counties around 2150Z were impressive in terms of high reflectivity values (55-60 dBZ), but were not severe (Fig. 12). The environment was atypical for Central Montana in that the convection was very deep with high (60-65 thousand foot) tops. Therefore it took higher than usual (> 60 Kg/m2) vertically integrated liquid (VIL) values to produce severe hail. Higher VILs were found in supercell storms to the south and east (Fig. 13). Base velocity values were also unimpressive in the storms across Chouteau, Liberty, and Hill counties, making wind damage unlikely. There were no severe weather reports in these areas. These storms were likely just heavy rain and small hail producers.

More supercell storms formed and/or moved into Judith Basin, Fergus, and southern Blaine counties between 300pm and 500pm (2100-2300Z). Cyclonic rotation from SRM data can be seen in the lower elevation slices for these storms (Fig. 14). Also, classic hook echoes can be seen in the reflectivity data (Fig. 15a and Fig. 15b). As a result, several tornado warnings were issued for these areas. Low level radar data is difficult to view in Fergus and Blaine counties due to beam blockage from various island mountain ranges, and is a reoccurring obstacle for forecasters at Great Falls. Gate-to-gate shear is difficult to detect in many areas. Viewing storms using the Glasgow and Billings radars can be of some assistance for storms in eastern Fergus and Blaine counties, but many areas are still in relative blind spots.

Overall, this was a significant and memorable severe weather event for Central Montana. This was a good case for all of the forecasters to go through since it was a high-end severe weather event, especially in terms of tornado development. Each forecaster was able to gain valuable experience assessing the environment and issuing warnings in displaced real-time using the WES.

Figure 1

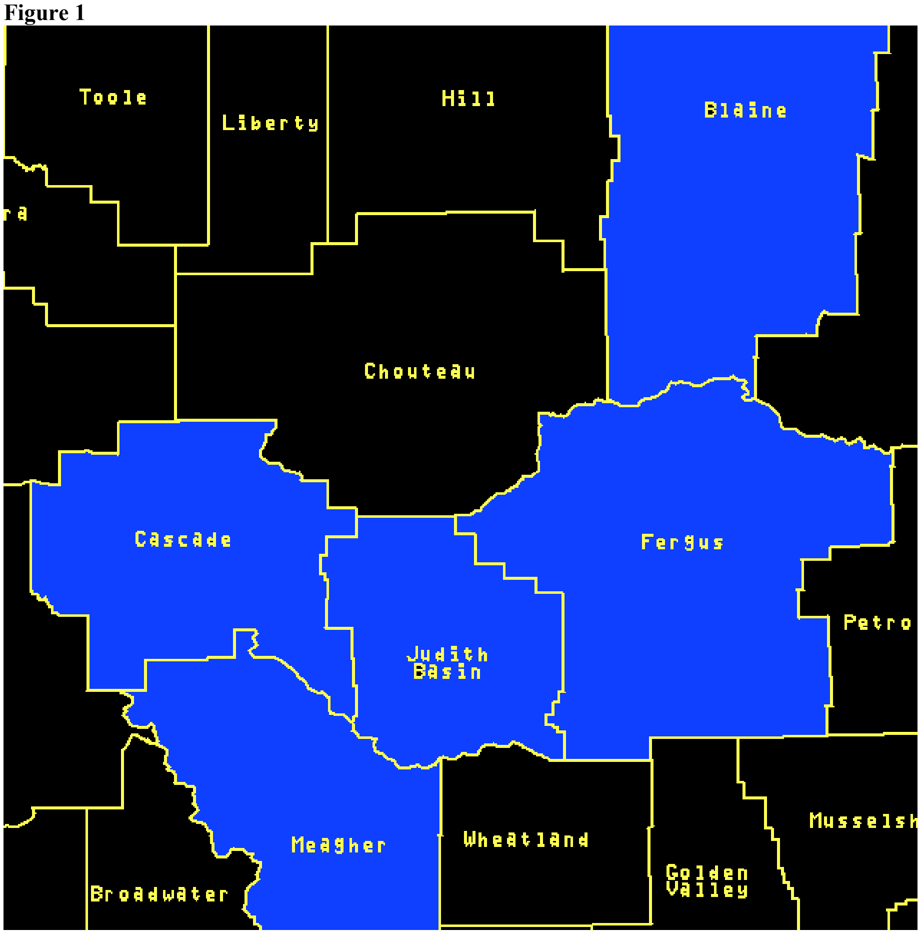


Figure 2

Figure 3

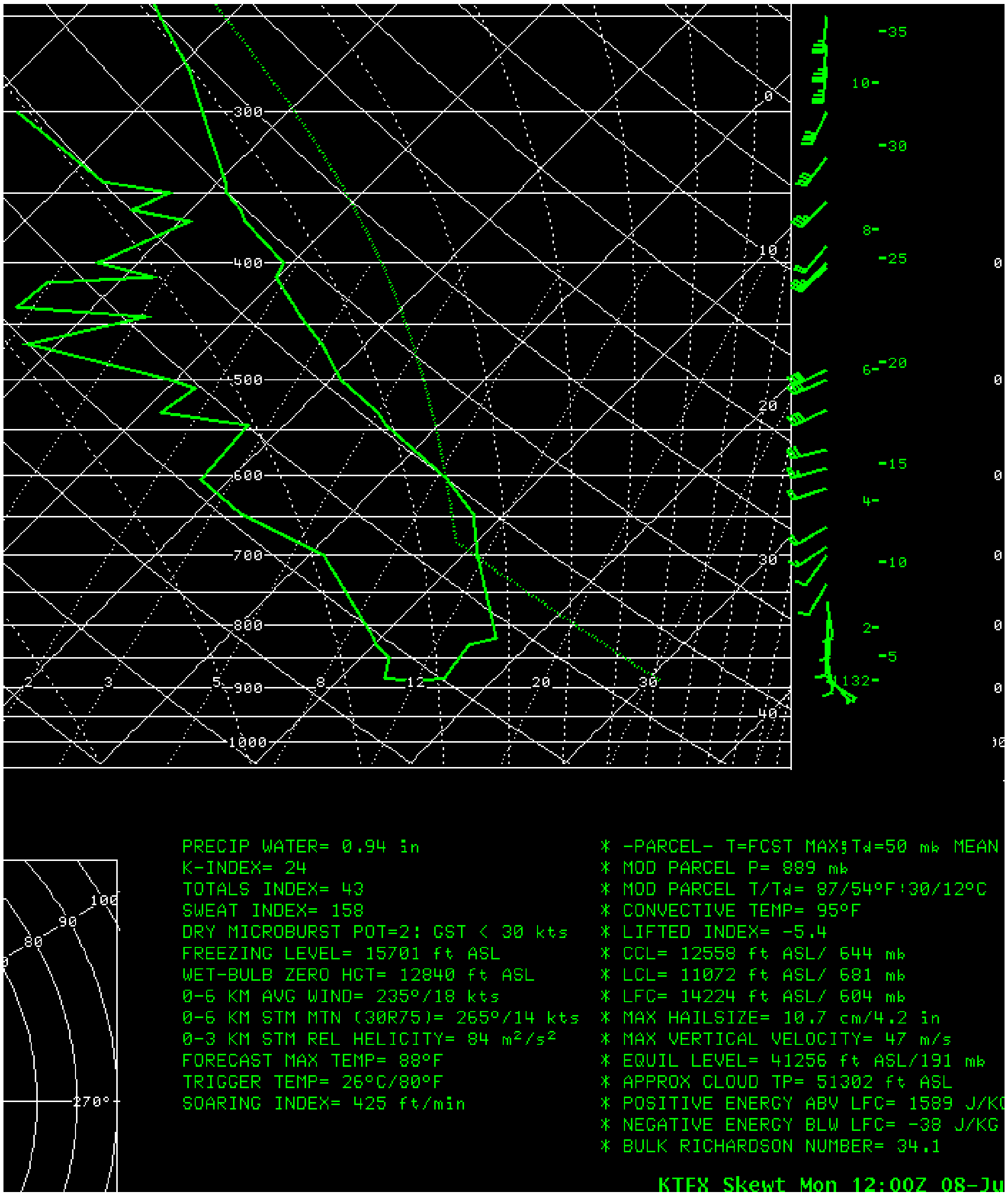

PRECIP WATER= 0.94 in
K-INDEX= 24
TOTALS INDEX= 43
SWEAT INDEX= 158
DRY MICROBURST POT=2: GST < 30 kts
FREEZING LEVEL= 15701 ft ASL
WET-BULB ZERO HGT= 12840 ft ASL
0-6 KM AVG WIND= 235°/18 kts
0-6 KM STM MTN (30R75)= 265°/14 kts
0-3 KM STM REL HELICITY= 84 m^2/s^2
FORECAST MAX TEMP= 88°F
TRIGGER TEMP= 26°C/80°F
SOARING INDEX= 425 ft/min
* -PARCEL- T=FCST MAX;Td=50 mb MEAN
* MOD PARCEL P= 889 mb
* MOD PARCEL T/Td= 87/54°F:30/12°C
* CONVECTIVE TEMP= 95°F
* LIFTED INDEX= -5.4
* CCL= 12558 ft ASL/ 644 mb
* LCL= 11072 ft ASL/ 681 mb
* LFC= 14224 ft ASL/ 604 mb
* MAX HAILSIZE= 10.7 cm/4.2 in
* MAX VERTICAL VELOCITY= 47 m/s
* EQUIL LEVEL= 41256 ft ASL/191 mb
* APPROX CLOUD TP= 51302 ft ASL
* POSITIVE ENERGY ABV LFC= 1589 J/KG
* NEGATIVE ENERGY BLW LFC= -38 J/KG
* BULK RICHARDSON NUMBER= 34.1
KTFX Skewt Mon 12:00Z 08-Ju

Figure 4

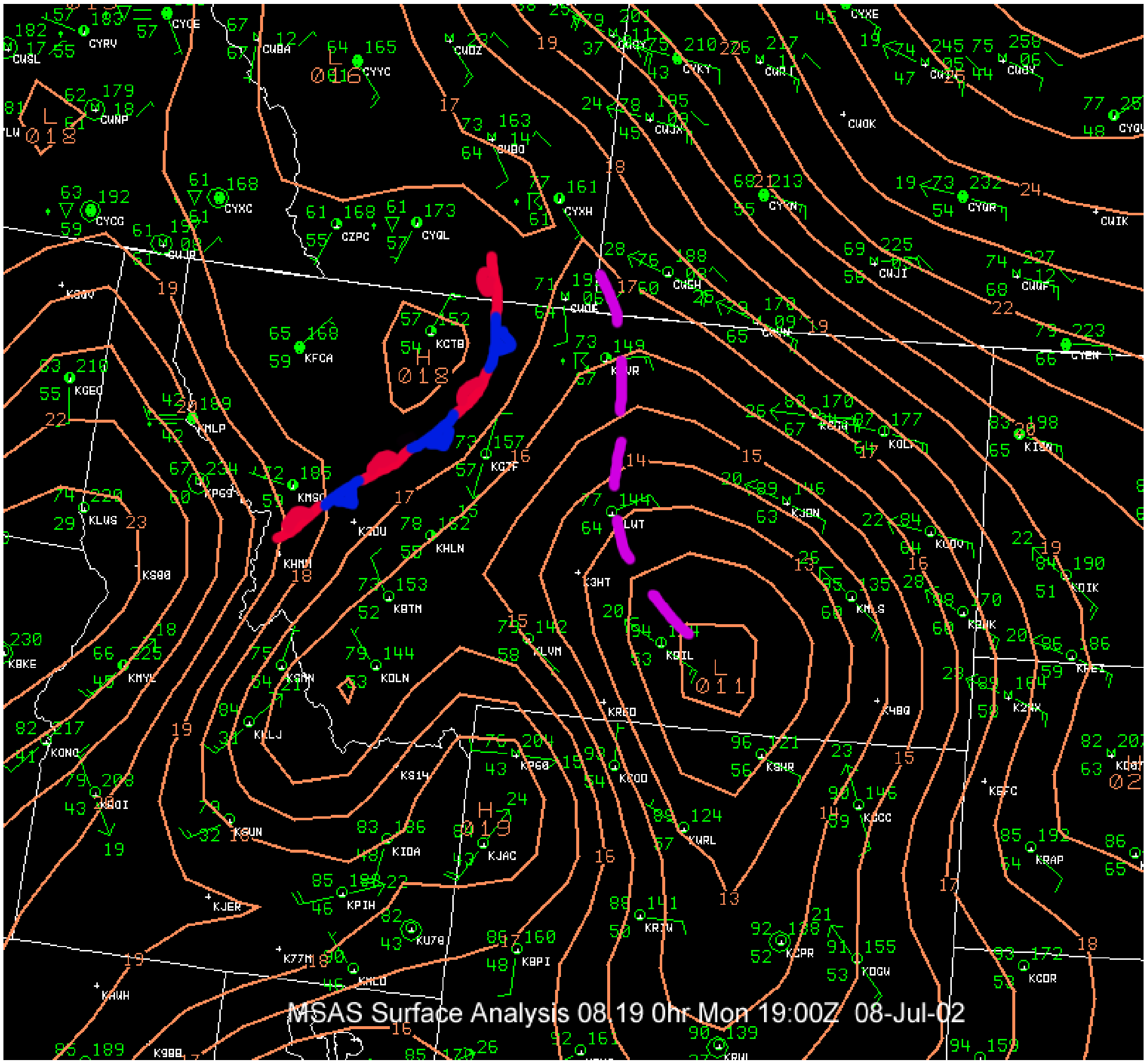


Figure 5

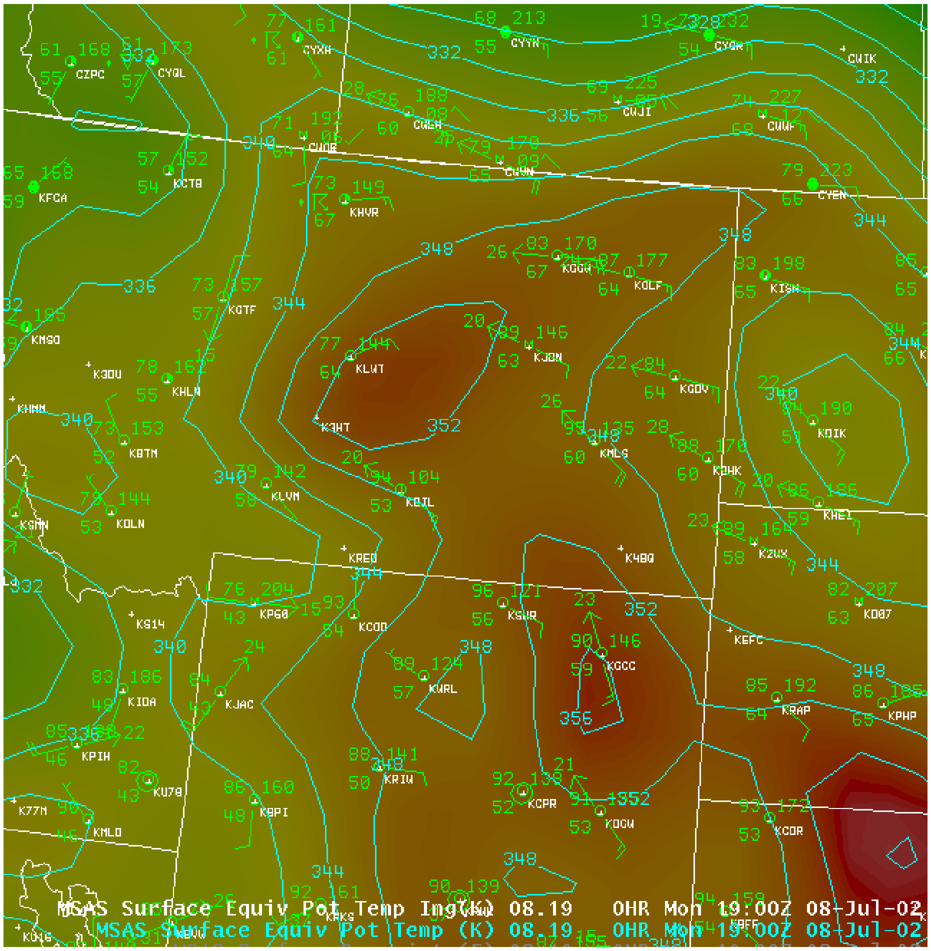

MSAS Surface Equiv Pot Temp Img(K) 08.19 OHR Mon 19:00Z 08-Jul-02
MSAS Surface Equiv Pot Temp (K) 08.19 OHR Mon 19:00Z 08-Jul-02

Figure 6

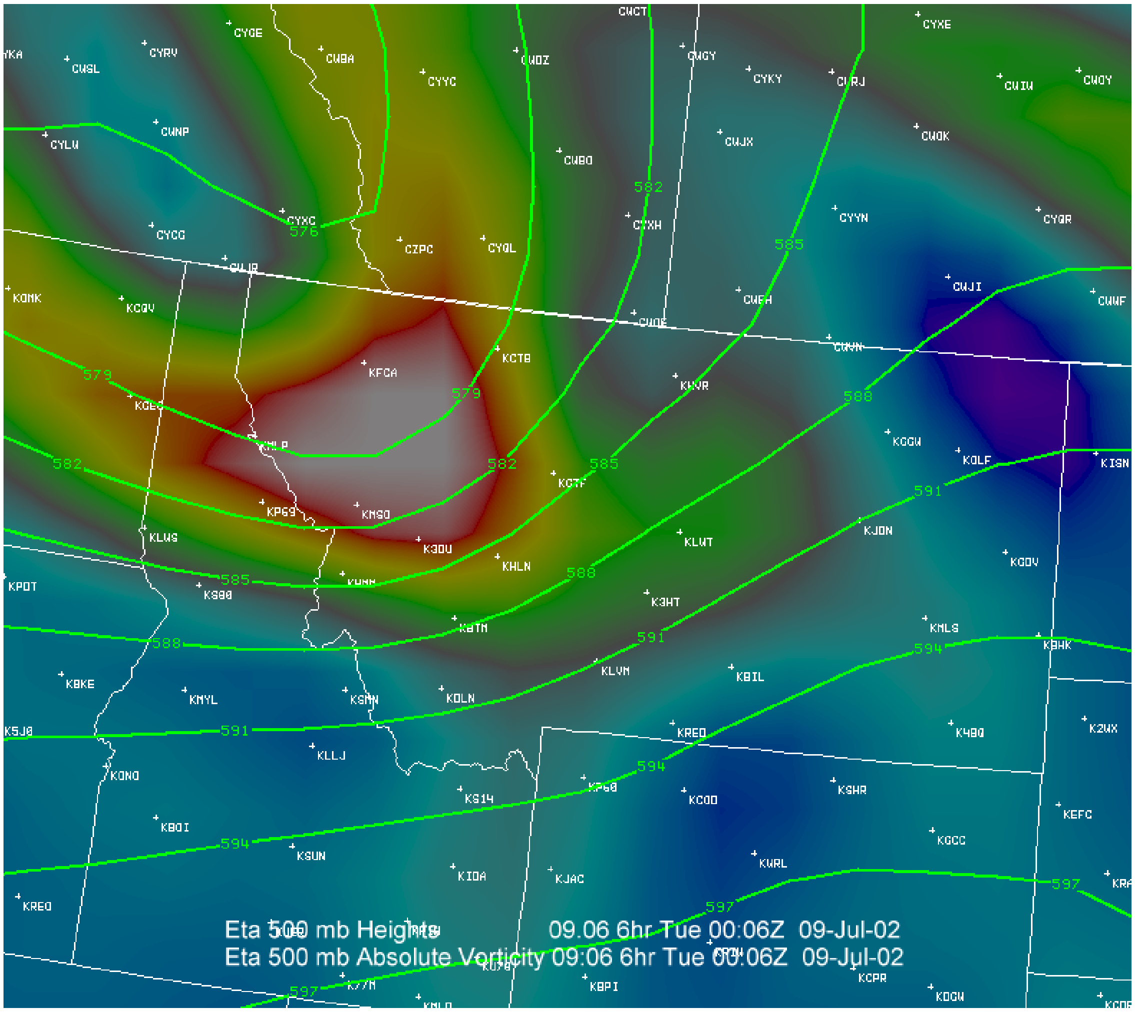

Eta 500 mb Heights 09.06 6hr Tue 00:06Z 09-Jul-02
Eta 500 mb Absolute Vorticity 09:06 6hr Tue 00:06Z 09-Jul-02

Figure 7

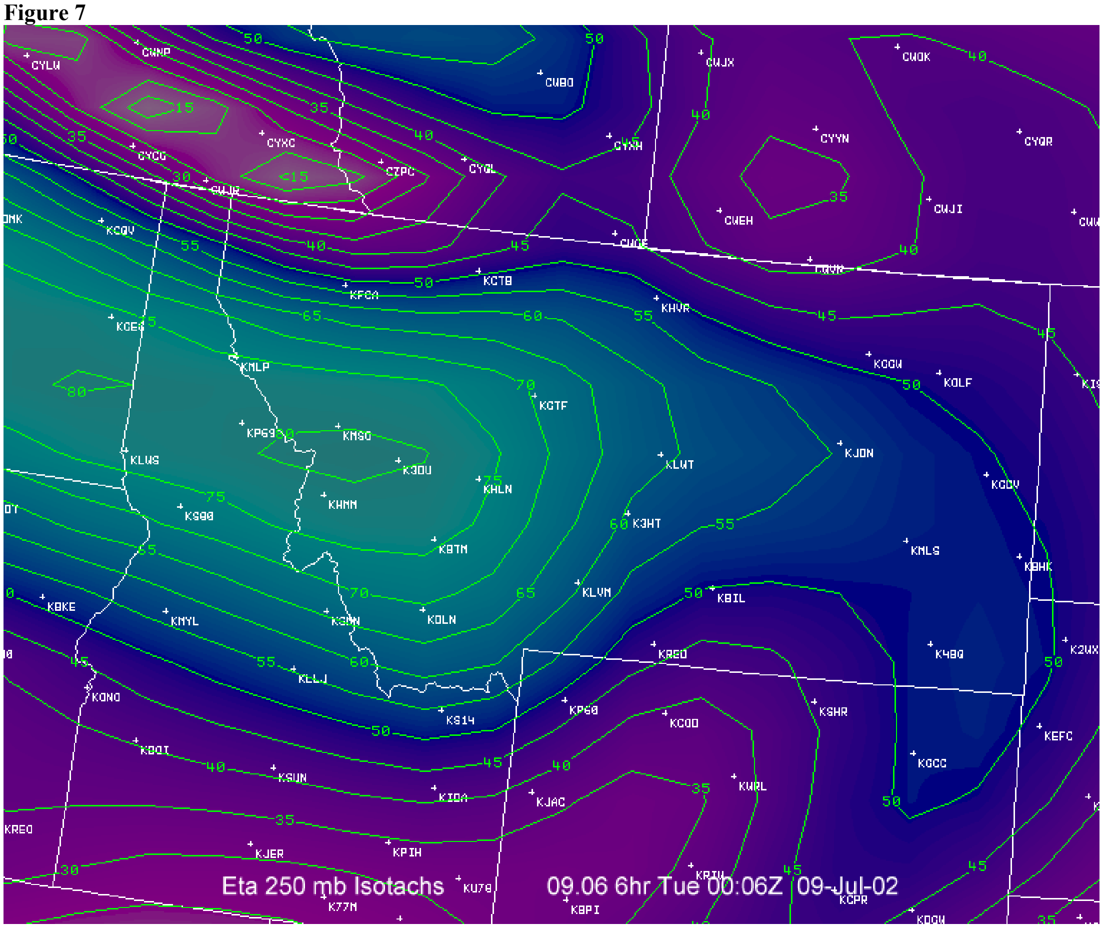

Eta 250 mb Isotachs 09.06 6hr Tue 00:06Z 09-Jul-02

Figure 8

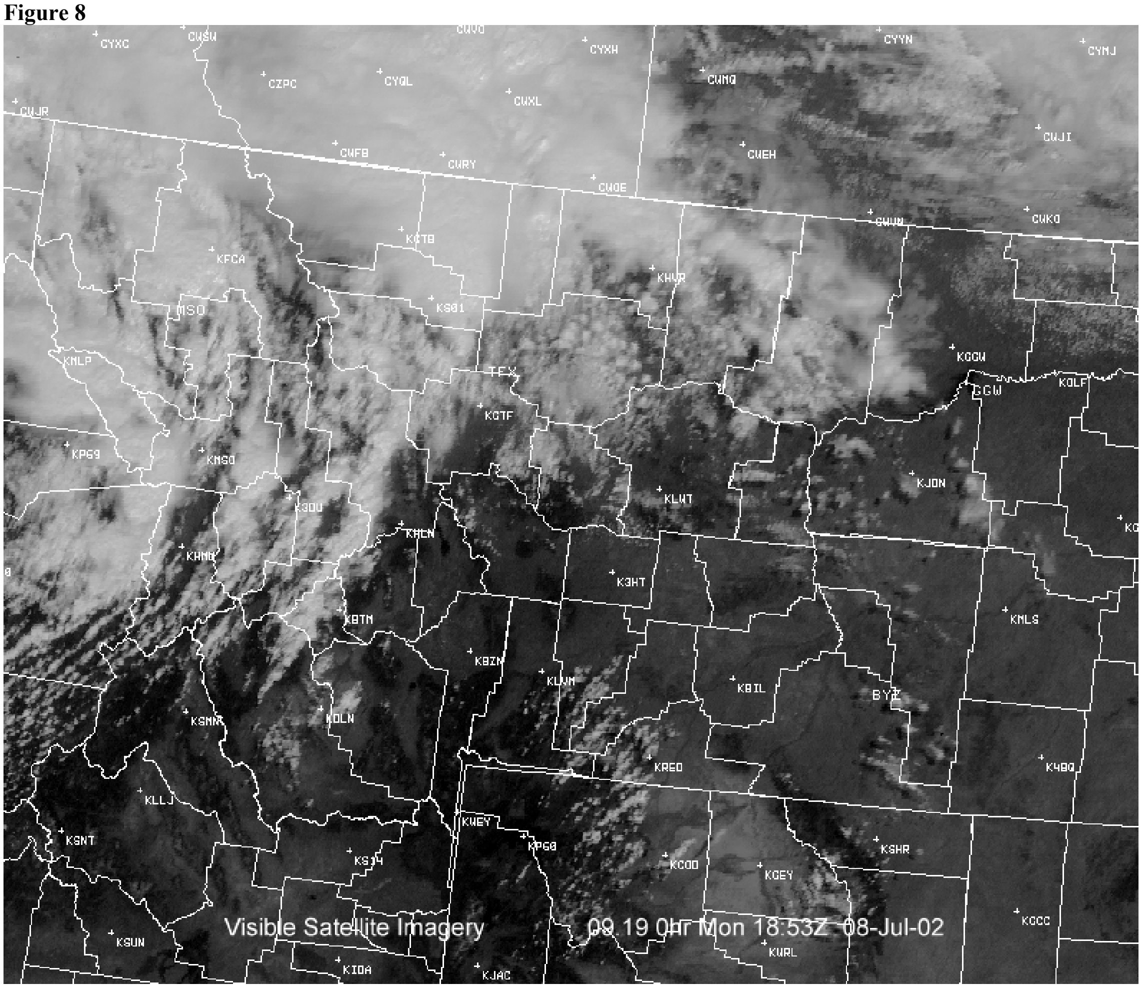


Figure 9

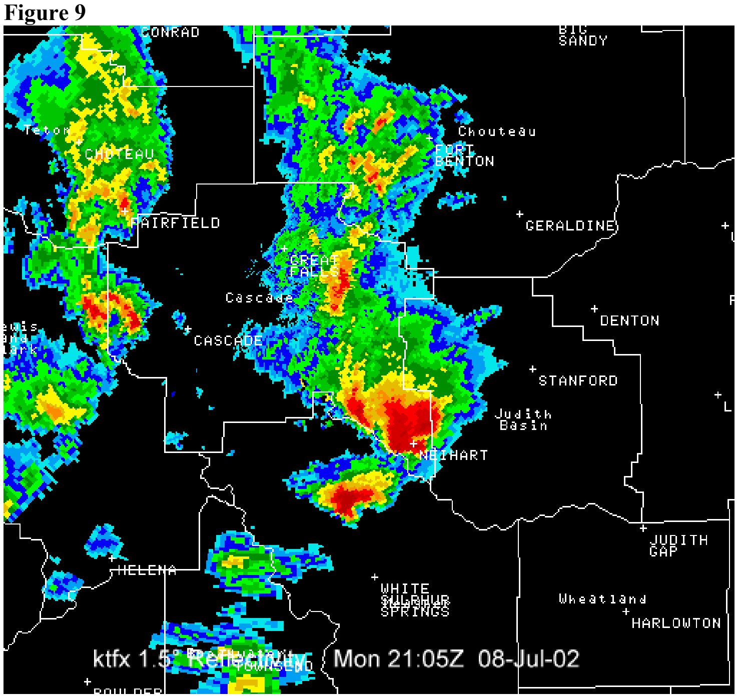


Figure 10

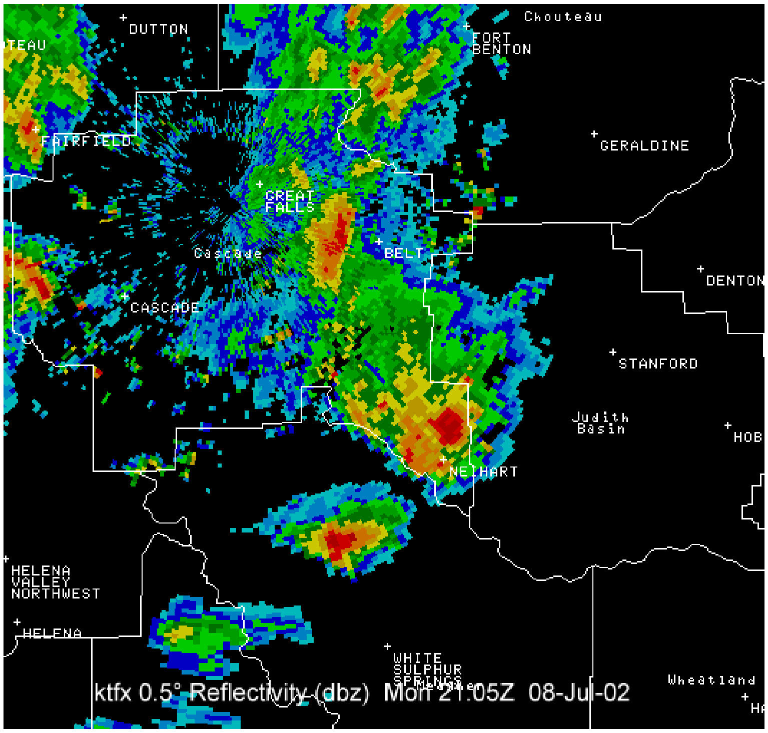


Figure 11

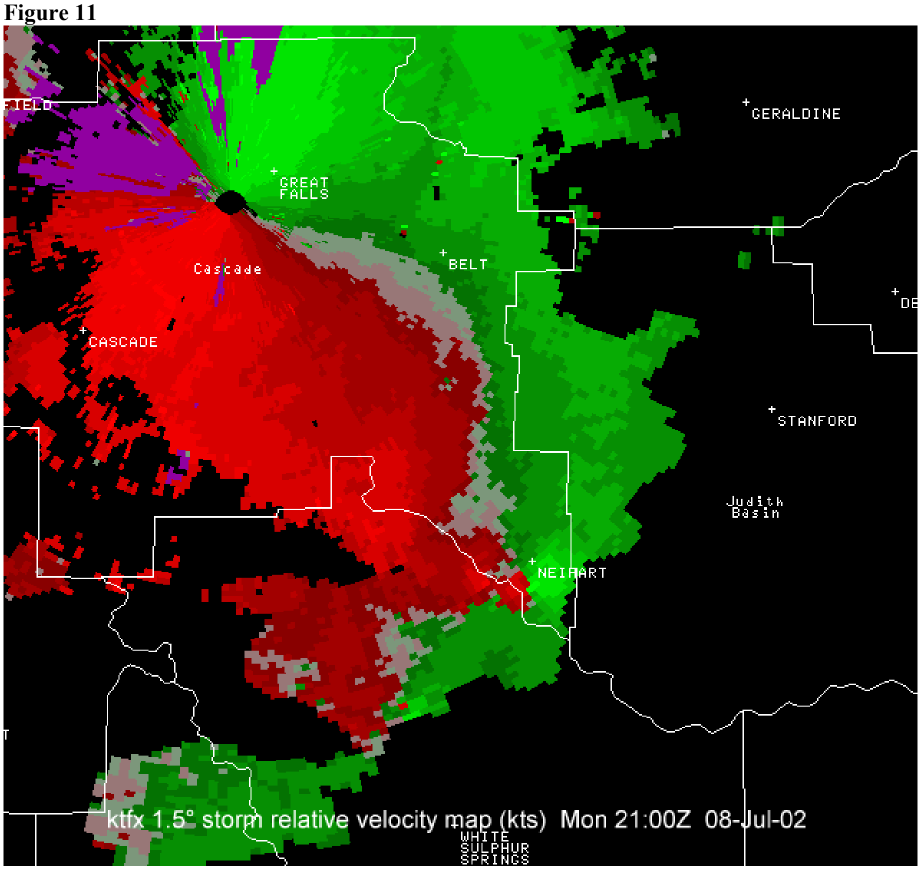


Figure 12

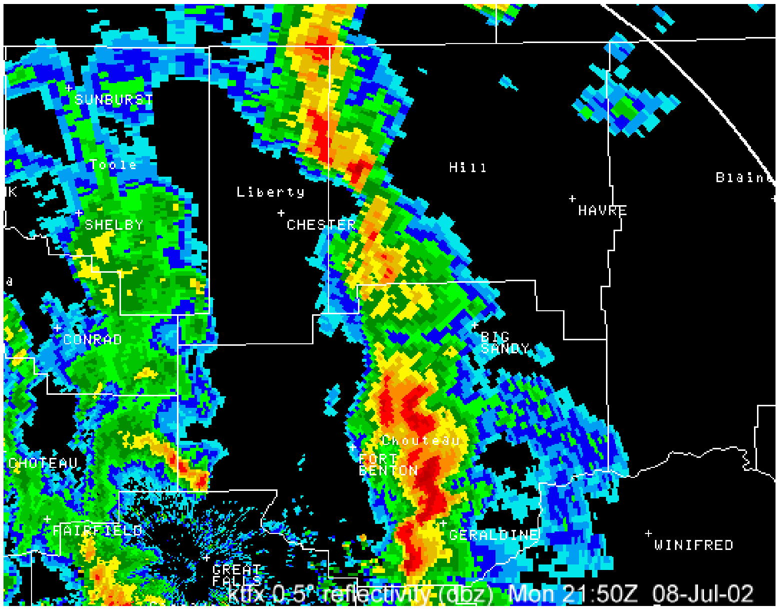


Figure 13

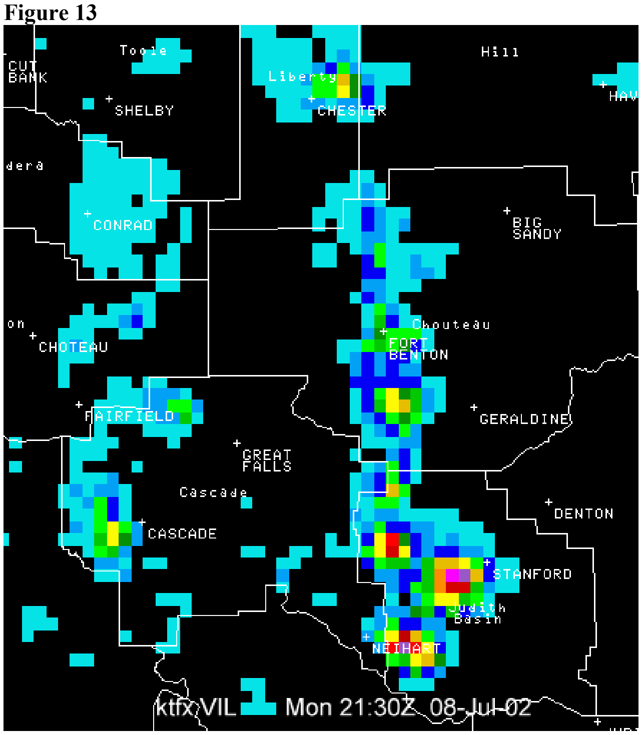


Figure 14

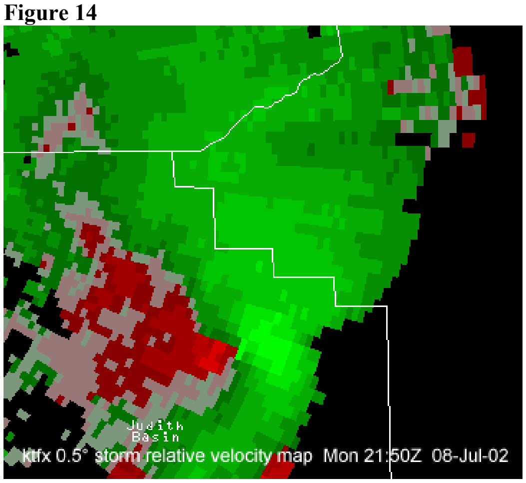


Figure 15a

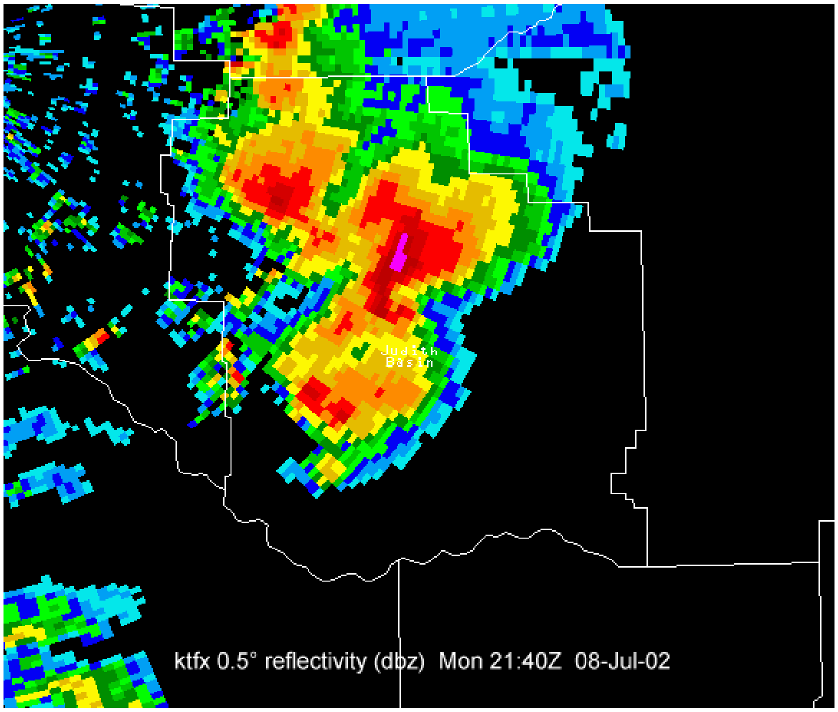
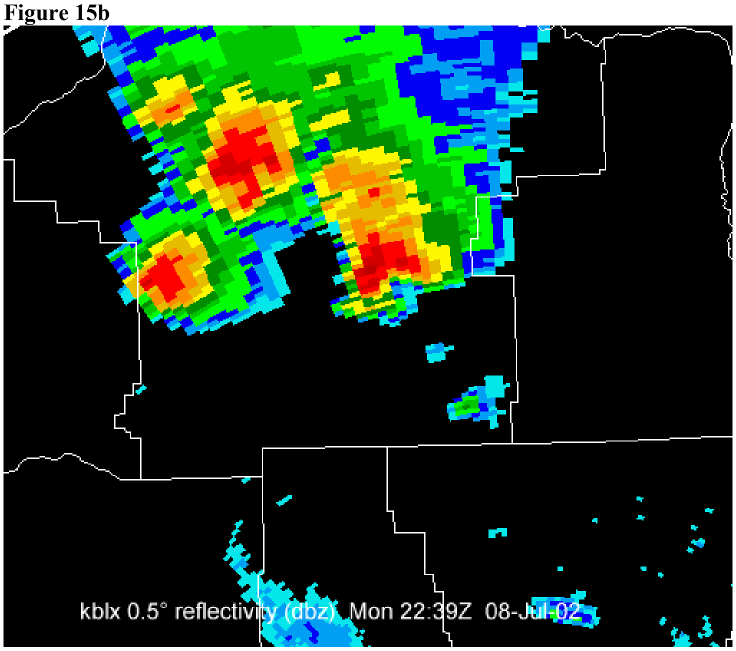

Judith
Basin
ktfx 0.5° reflectivity (dbz) Mon 21:40Z 08-Jul-02

Figure 15b


kblx 0.5° reflectivity (dbz) Mon 22:39Z 08-Jul-02