August 5 2002 Central Montana Severe Weather Event

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Introduction

August 5, 2002 was a severe weather day for central Montana. This event occurred after the peak severe weather season for the area, which climatologically runs from mid-June through mid-July. There were numerous reports of large hail, as well as, two reports of tornadoes. Severe weather reports extended from the late afternoon in Lincoln MT, which is in the far western portion of the county warning area (CWA) to mid-evening at Winifred MT, which is in the far eastern portion of the CWA. Hail larger than a golf-ball is a rare occurrence in central Montana. For this event there was a report of baseball-sized (2.75 inch) hail in northern Fergus county and a report of grapefruit-sized (4 inch) hail in Judith Basin county. At 0020Z (620 pm MDT) a multi-vortex tornado was spotted in northern Judith Basin county while at 0200Z a tornado was observed over northwest Fergus county. Both tornadoes occurred in rural areas and no damage was reported.

Synoptic Environment

At 12Z 05 Aug 2002 a deep trough was near the Pacific Northwest coast with a moderate southwest flow aloft over western Montana (Fig. 1).

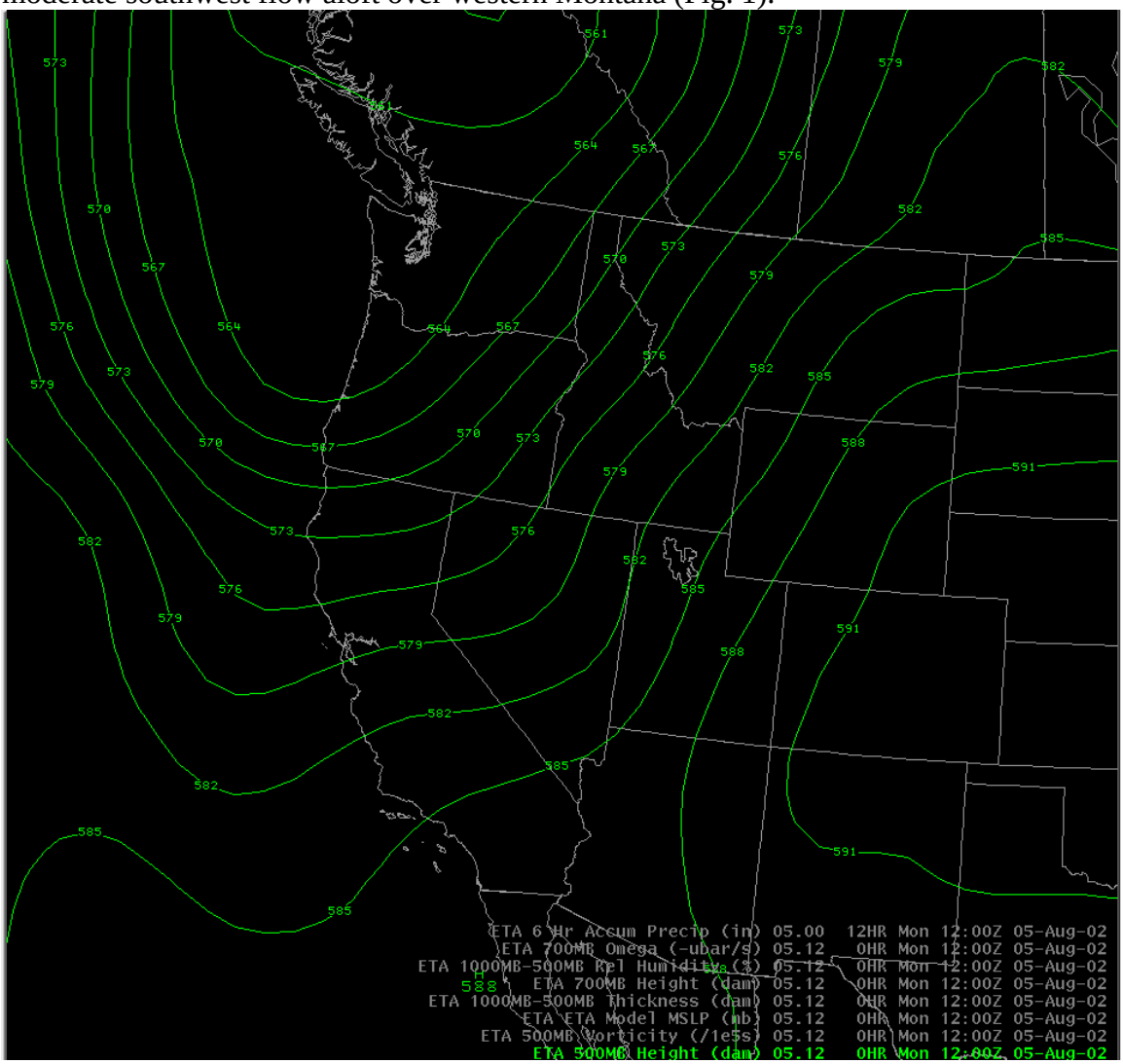

Figure 1 - 500 mb 12z August 5 2002

At the surface a broad trough was centered over central Montana (Fig. 2).

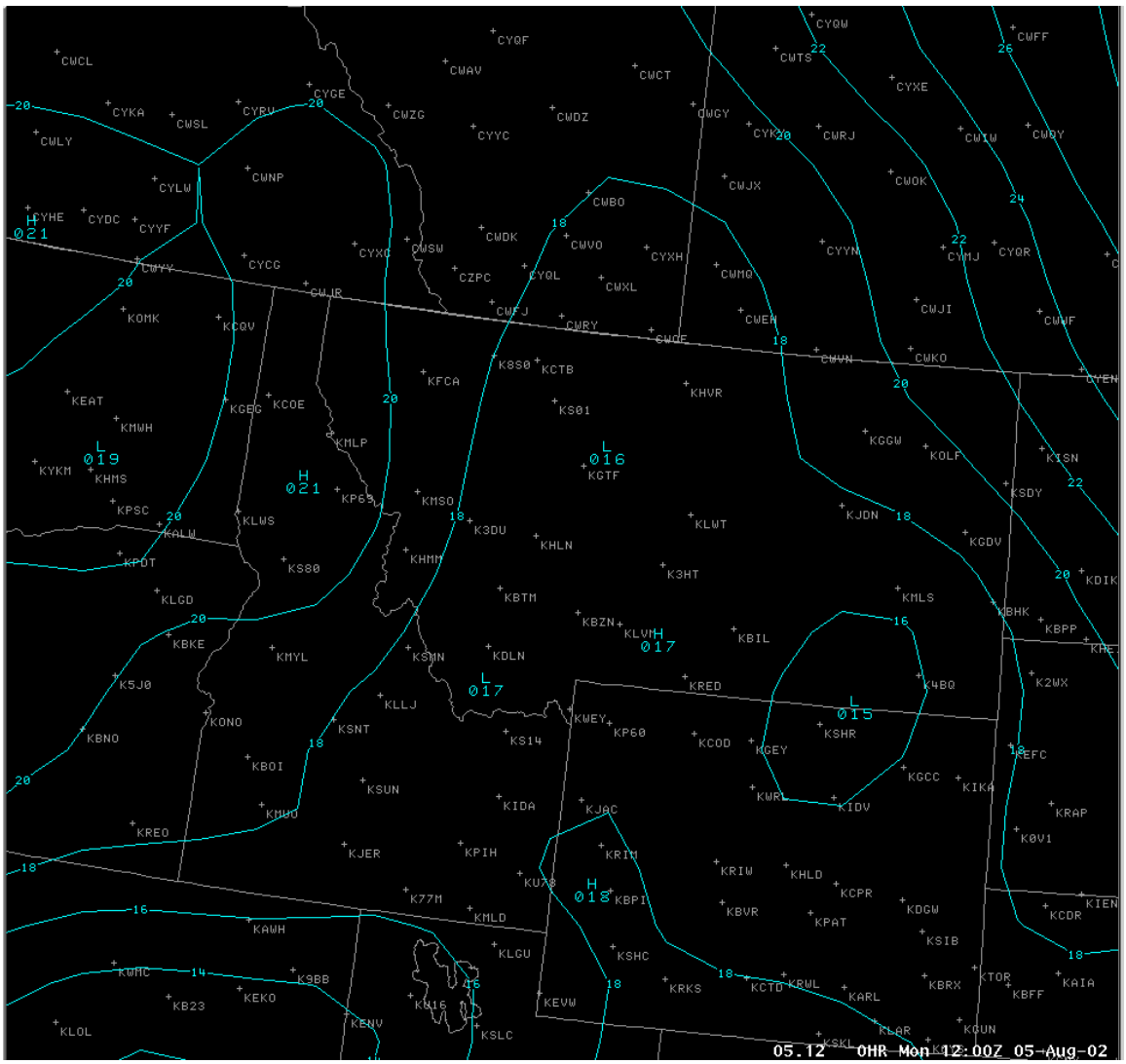

Figure 2 - SFC 12z August 5 2002

The 12Z 05 August run of the ETA was forecasting a shortwave at 500 mb to move northeast through central Montana that evening (Figs. 3 and 4).

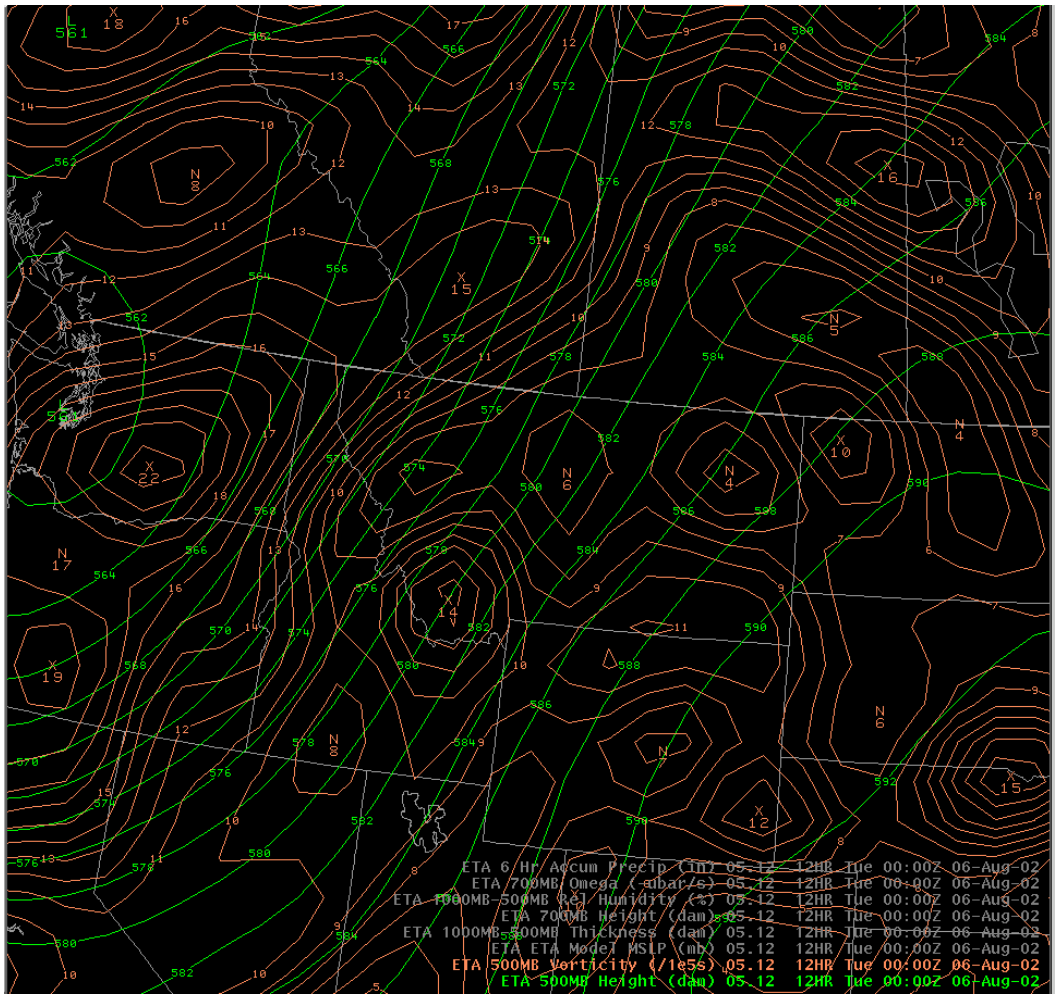

Figure 3 - 12hr ETA 500 mb forecast valid 00z August 6 2002

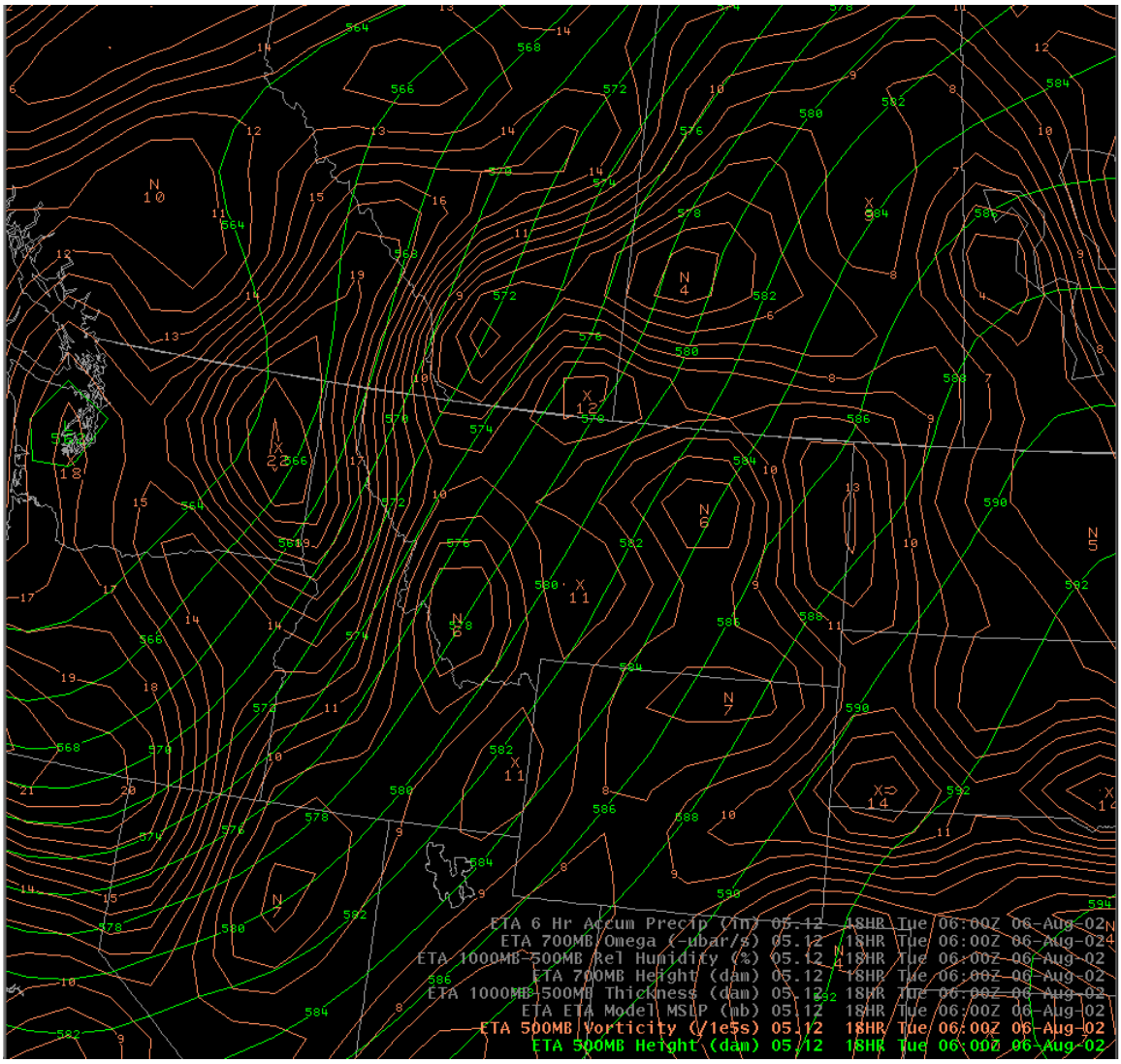

Figure 4 - 18hr ETA 500 mb forecast valid 06z August 6 2002

At 700 mb the ETA had a shortwave intensifying as it moved through central Montana during the same time (Figs. 5 and 6).

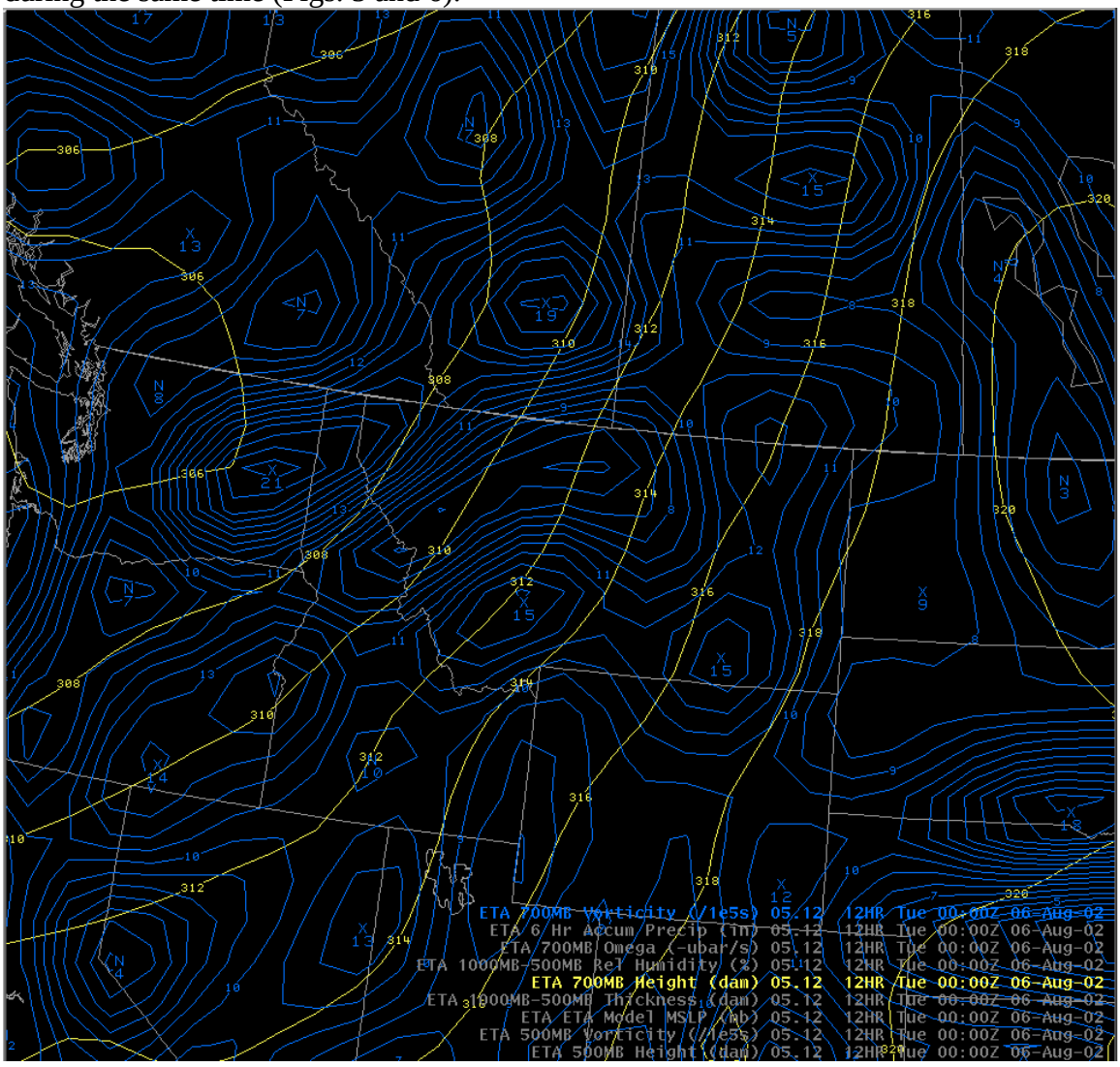

Figure 5 - 12hr ETA 700 mb forecast valid 00z August 6 2002

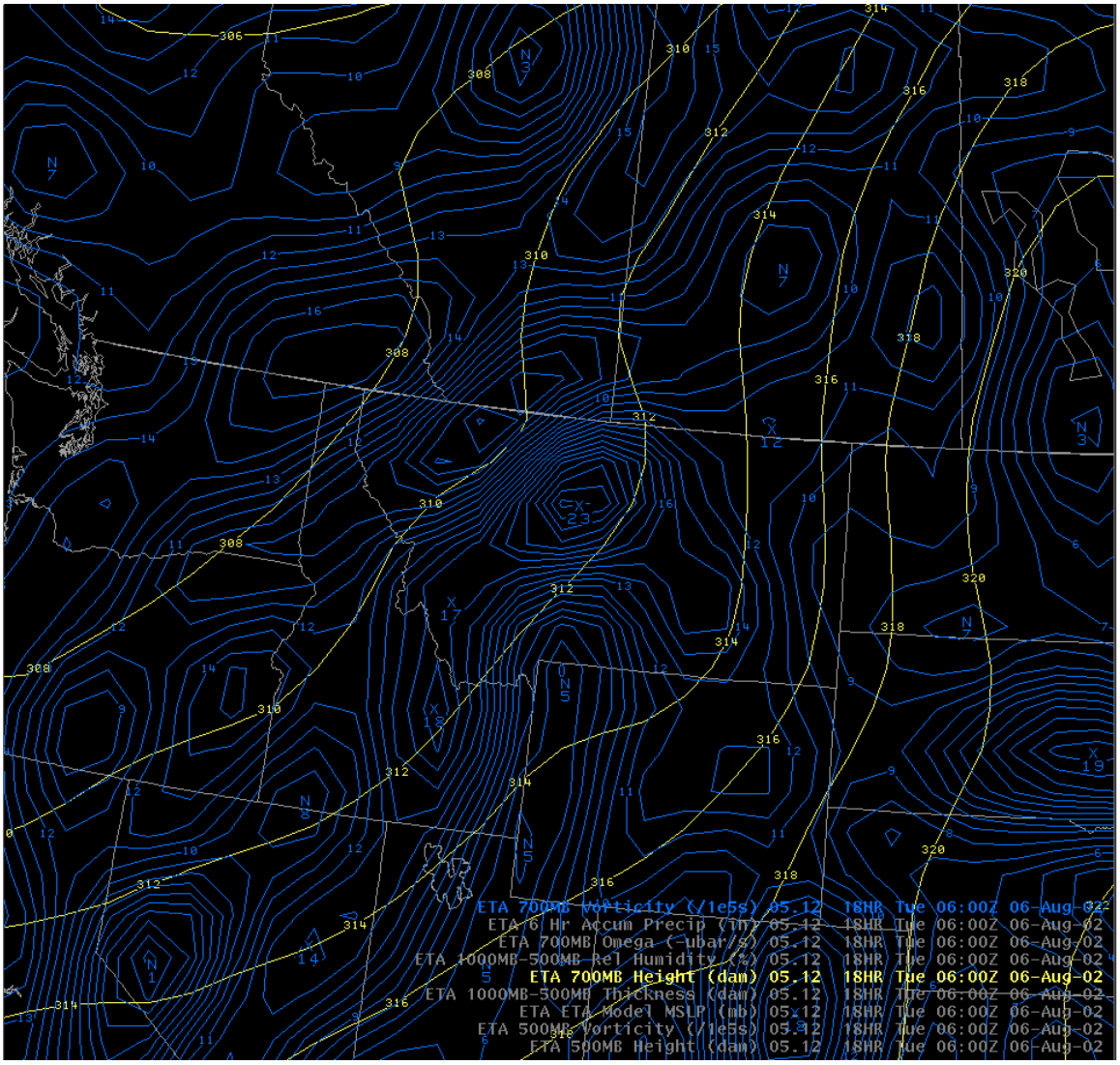

Figure 6 - 18hr ETA 700 mb forecast valid 06z August 6 2002

At 200 mb the ETA had a jet streak propagating from western Montana at 00Z to southeast Alberta at 06Z. This put central Montana under the right entrance region of the jet streak during the evening. A check of time/height cross-sections for central Montana indicated lift from this feature was not a major contributor to the severe weather. At the surface a low was forecast to develop over southwest Montana during the afternoon then move to south central Montana by 06Z (Figs. 7-9).

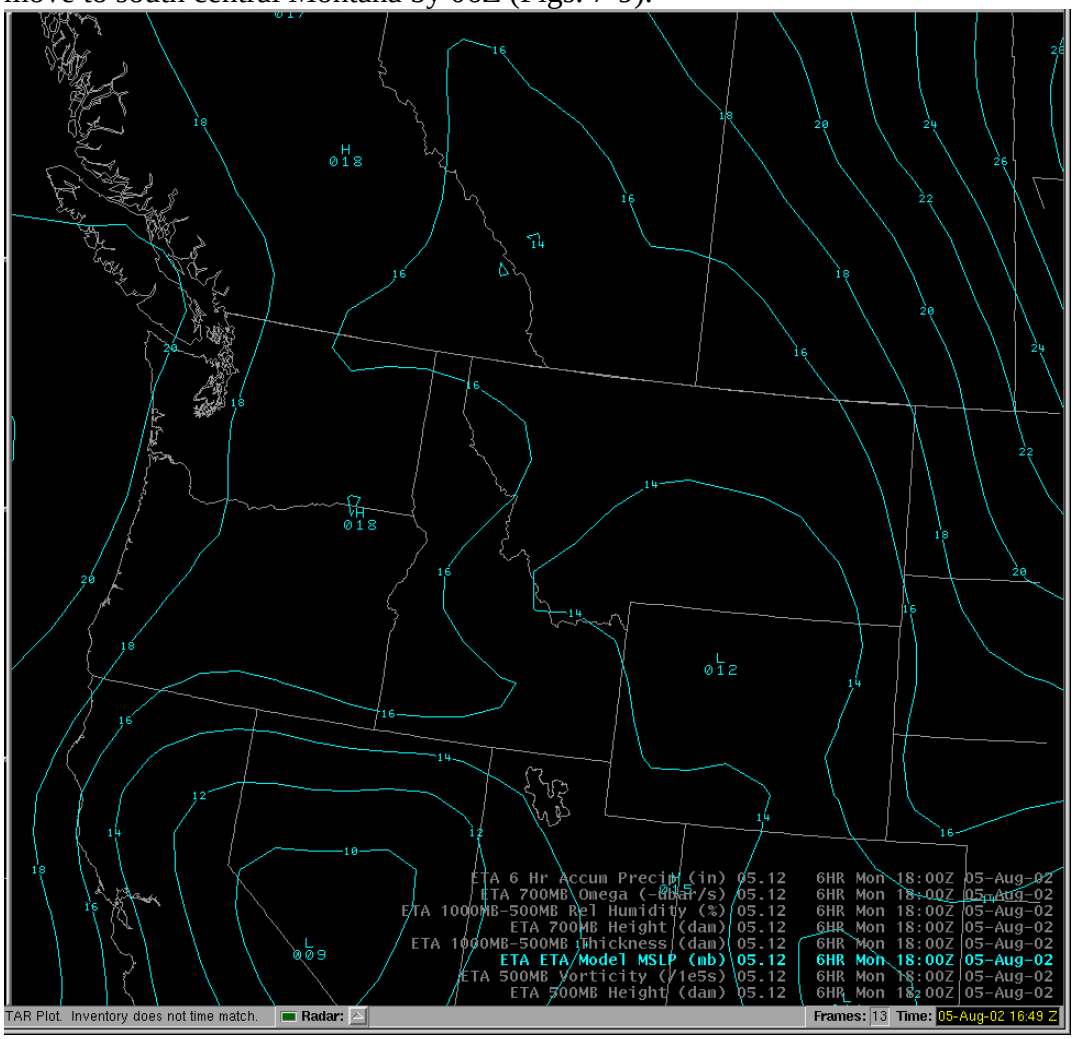

Figure 7 - 6hr ETA Mean Sea Level Pressure forecast valid 18z August 5 2002

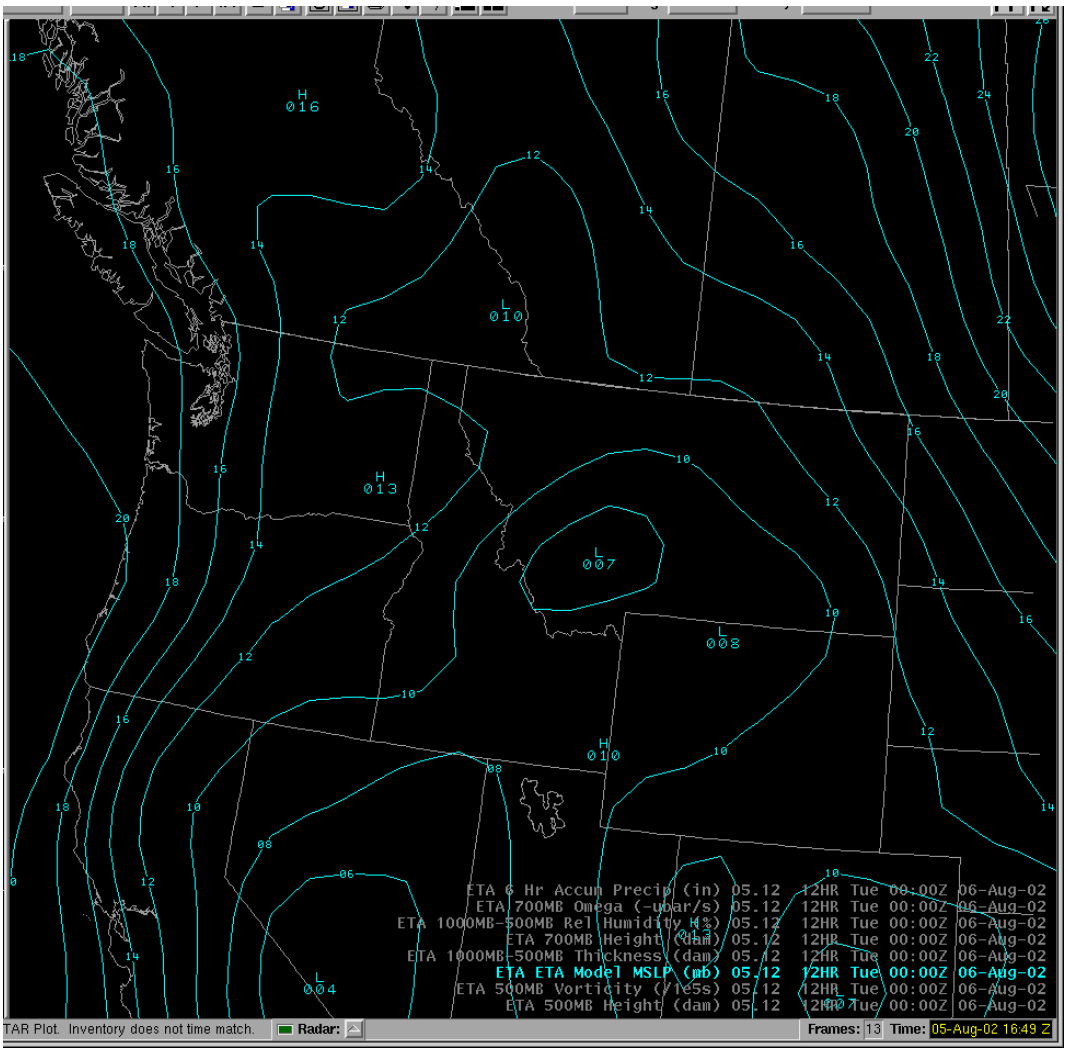

Figure 8 - 12hr ETA Mean Sea Level Pressure forecast valid 00z August 6 2002

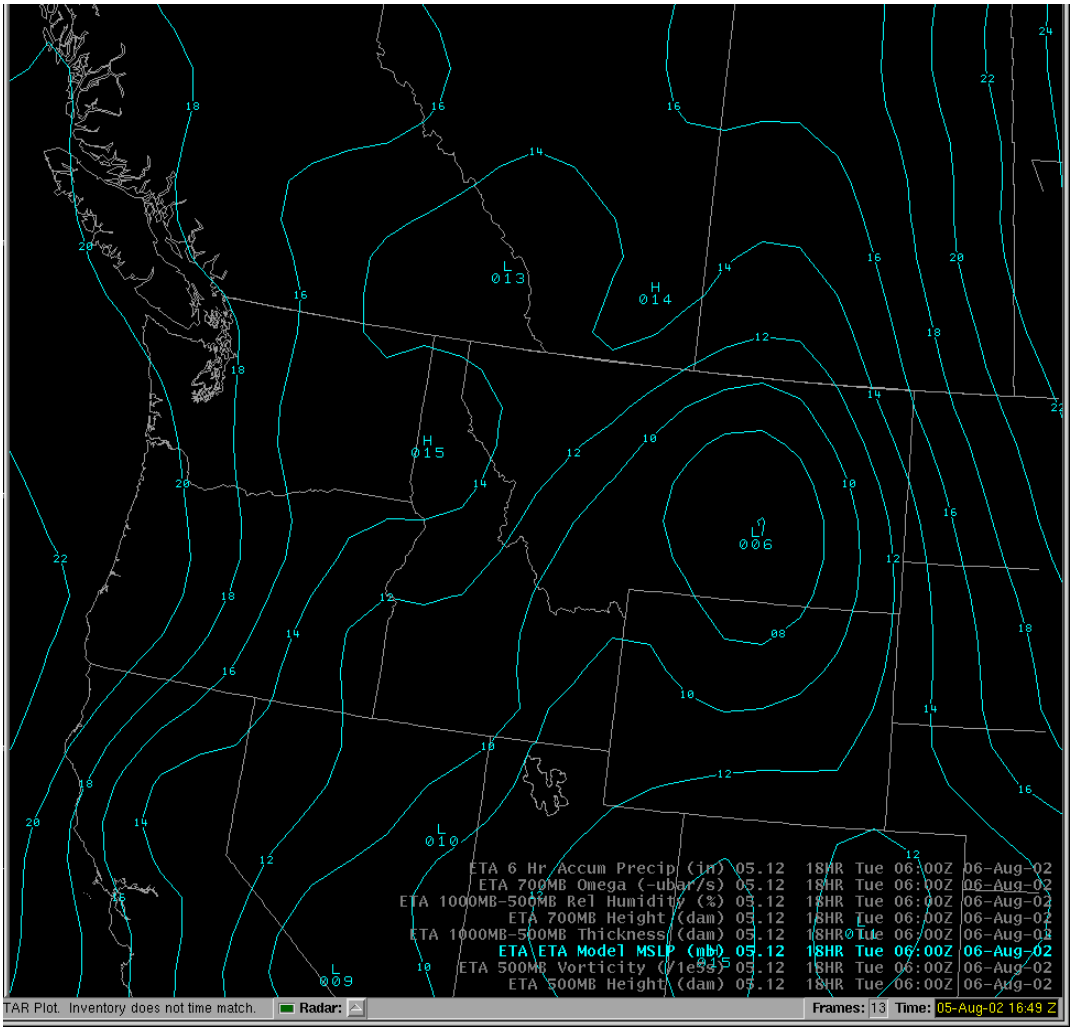

Figure 9 - 18hr ETA Mean Sea Level Pressure forecast valid 06z August 6 2002

The increasing easterly winds associated with the developing low would increase the low-level directional shear over central Montana. Figure 10 shows a time/height cross-section of omega for GTF from the ETA. Note the 6 microbar/sec lift between 750 mb and 600 mb during the evening.

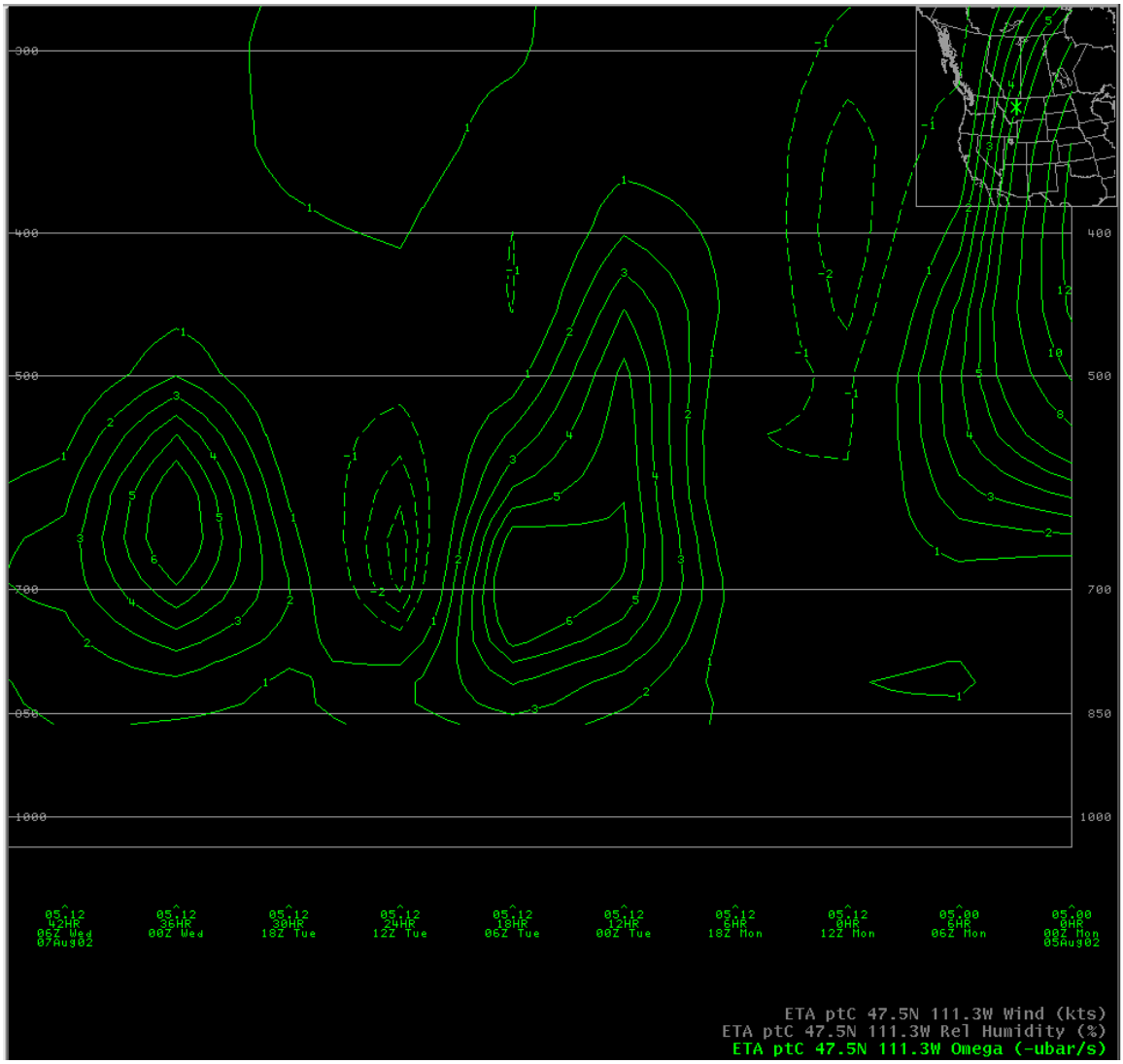

Figure 10 - Time/height cross-section of omega from 12z ETA run of August 5 2002

The corresponding GFS run for 12Z 05 August 2002 also had a shortwave moving northeast through central Montana during the evening but was weaker than the ETA. The GFS was much farther south than the ETA with the forecast surface low during the early evening (not shown).

ETA 0-6 km bulk shear values were forecast to increase from 40-50 kts at 12z to 55-65 kts at 00Z (Figs. 11 and12).

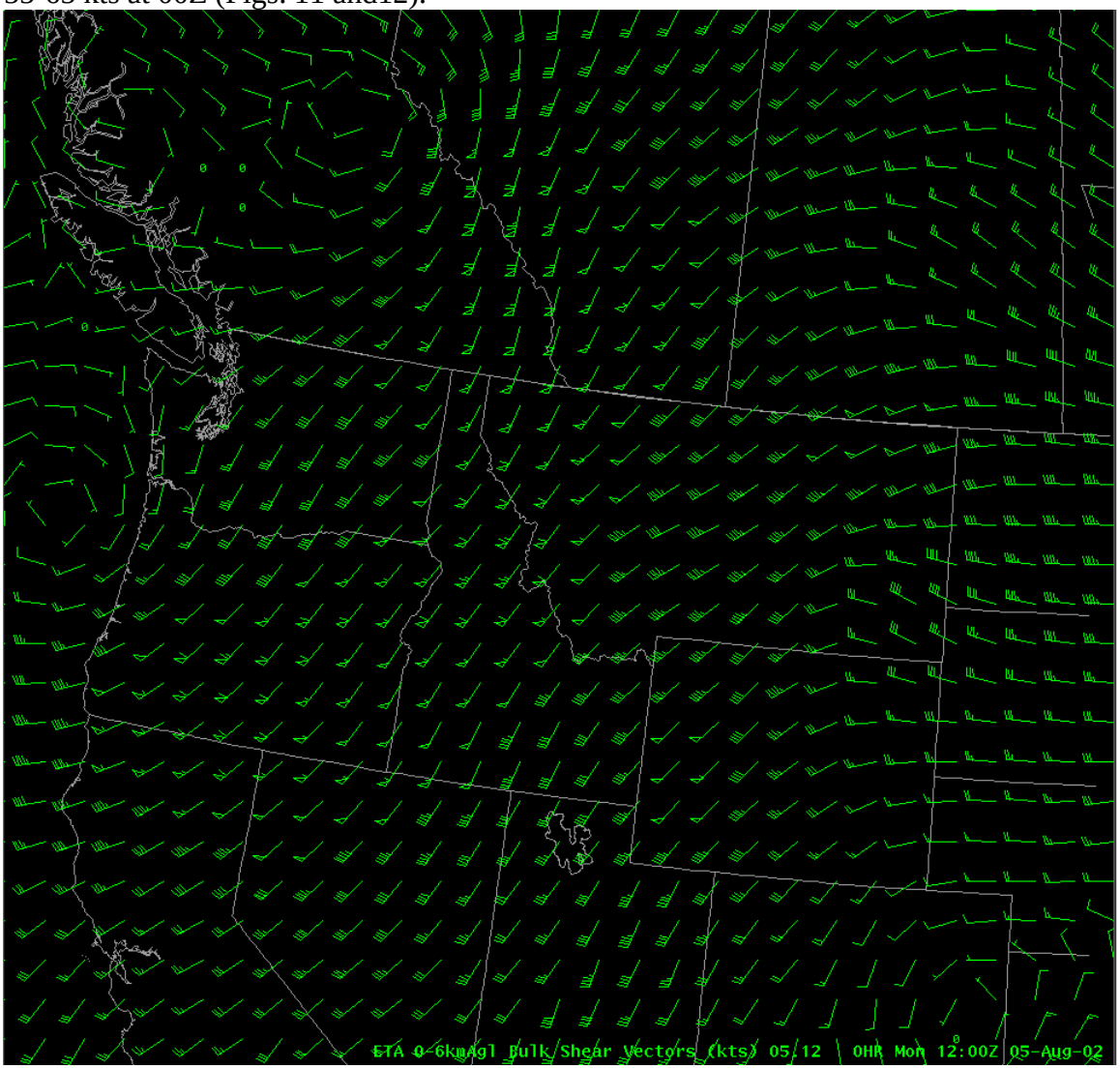

Figure 11 - 00hr ETA 0-6km bulk shear forecast valid 12z August 5 2002

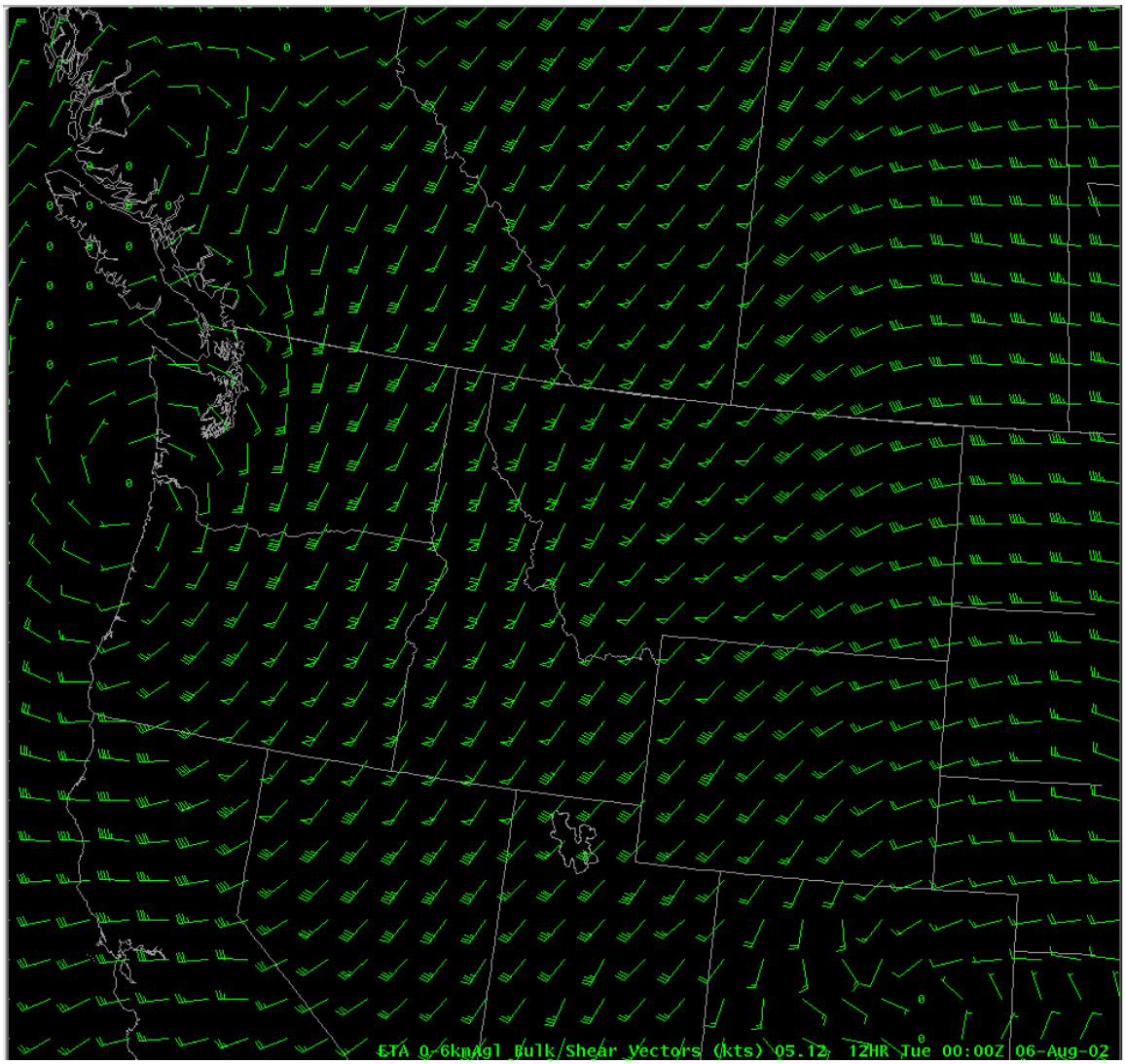

Figure 12 - 12hr ETA 0-6km bulk shear forecast valid 00z August 6 2002

ETA forecast soundings over central Montana during the evening indicated moderately unstable CAPE values of 1000-2500 joules/kg. The same soundings indicated 0-3 km helicity values from 100-200 m2/sec2. Although CAPE values were not forecast to be that high, with the forecast strong shear, supercells could certainly be expected.

Considering the dynamic and thermodynamic environments, there definitely was the potential for a severe weather outbreak.

Discussion

Although the first report of severe weather occurred shortly after 2300Z in Lewis and Clark county, most of the severe weather occurred during the early evening hours farther east. Shortly before 0000Z a supercell near Raynesford in northwest Judith Basin county produced exceptionally large 4-inch hail. Vertically integrated liquid (VIL) values of 61 kg/m2 were reported with the storm shortly after 0000Z (Fig. 13).

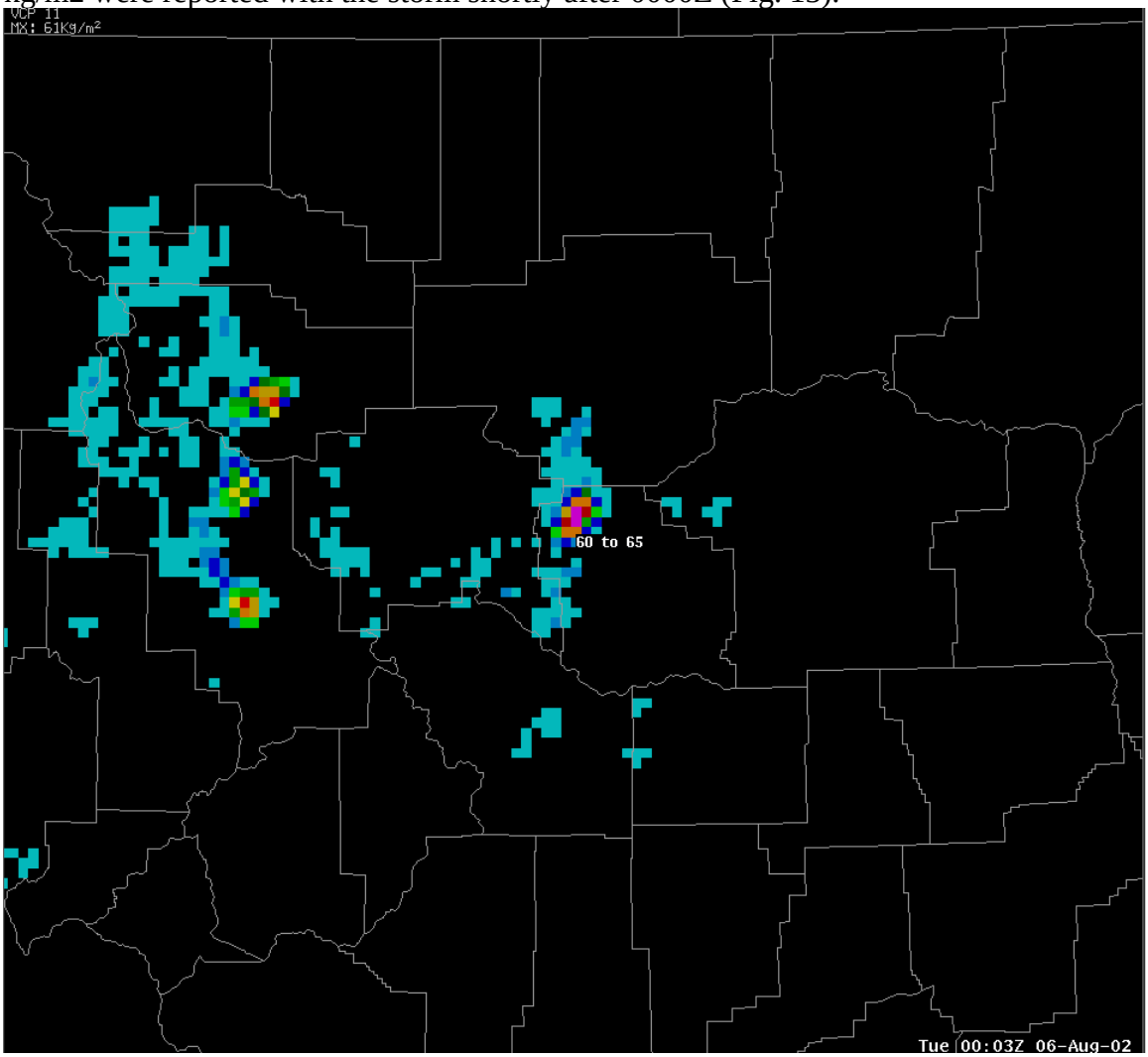

Figure 13 - 0003z KTFX VIL

Associated echo tops were 47 thousand feet. By VIL density considerations large hail in excess of 1 inch would certainly be expected. About 20 minutes later this same supercell produced a multi-vortex tornado farther east in northern Judith Basin county as the mesocyclone increased in intensity and depth. Strong shear of 0.0337 /sec from 40-50 kt inbound velocities adjacent to 40-50 kt outbound velocities can be seen in the 0.5 degree elevation SRM product (Fig. 14).

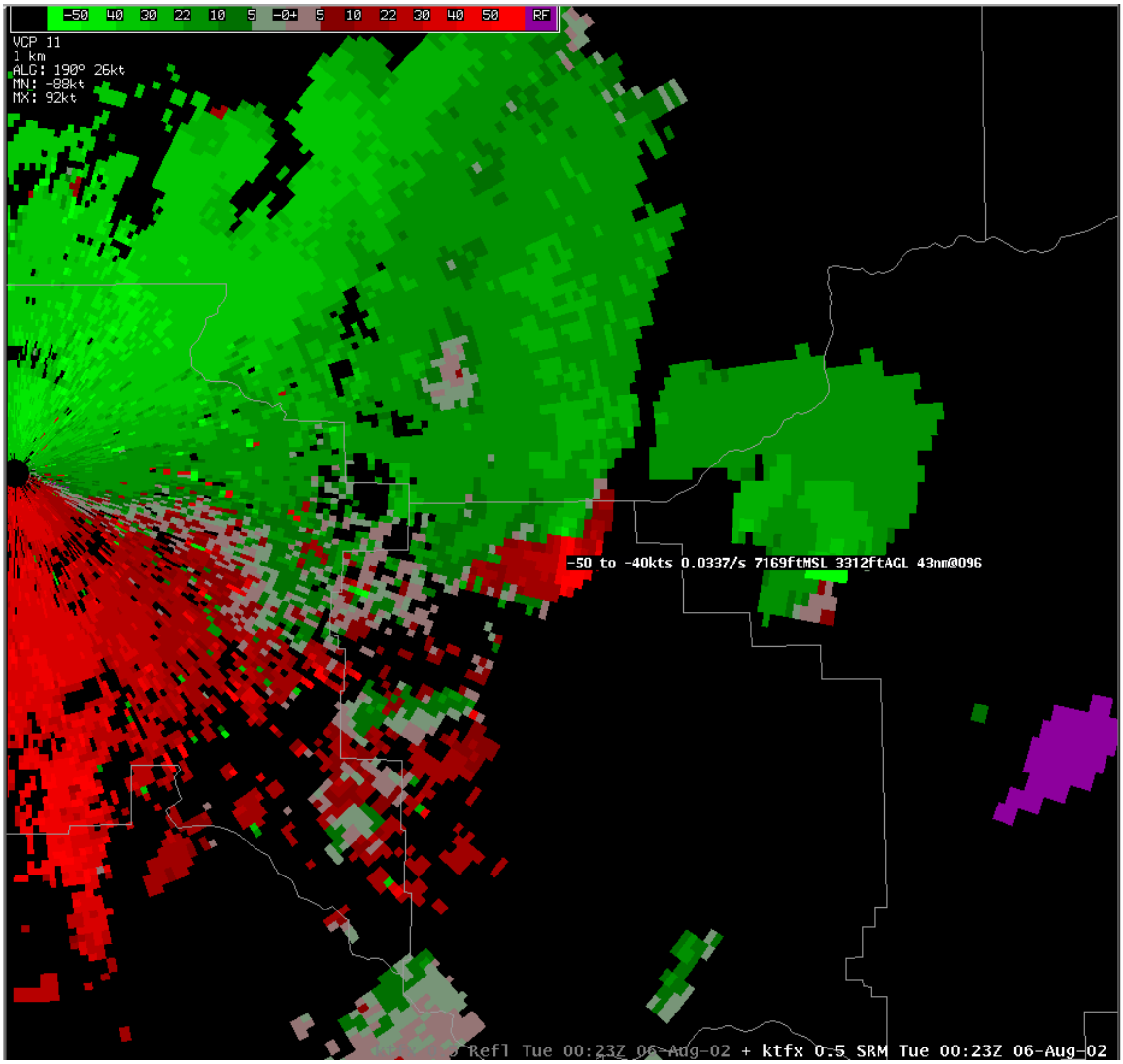

Figure 14 - 0023z KTFX SRM 0.5 degree elevation slice

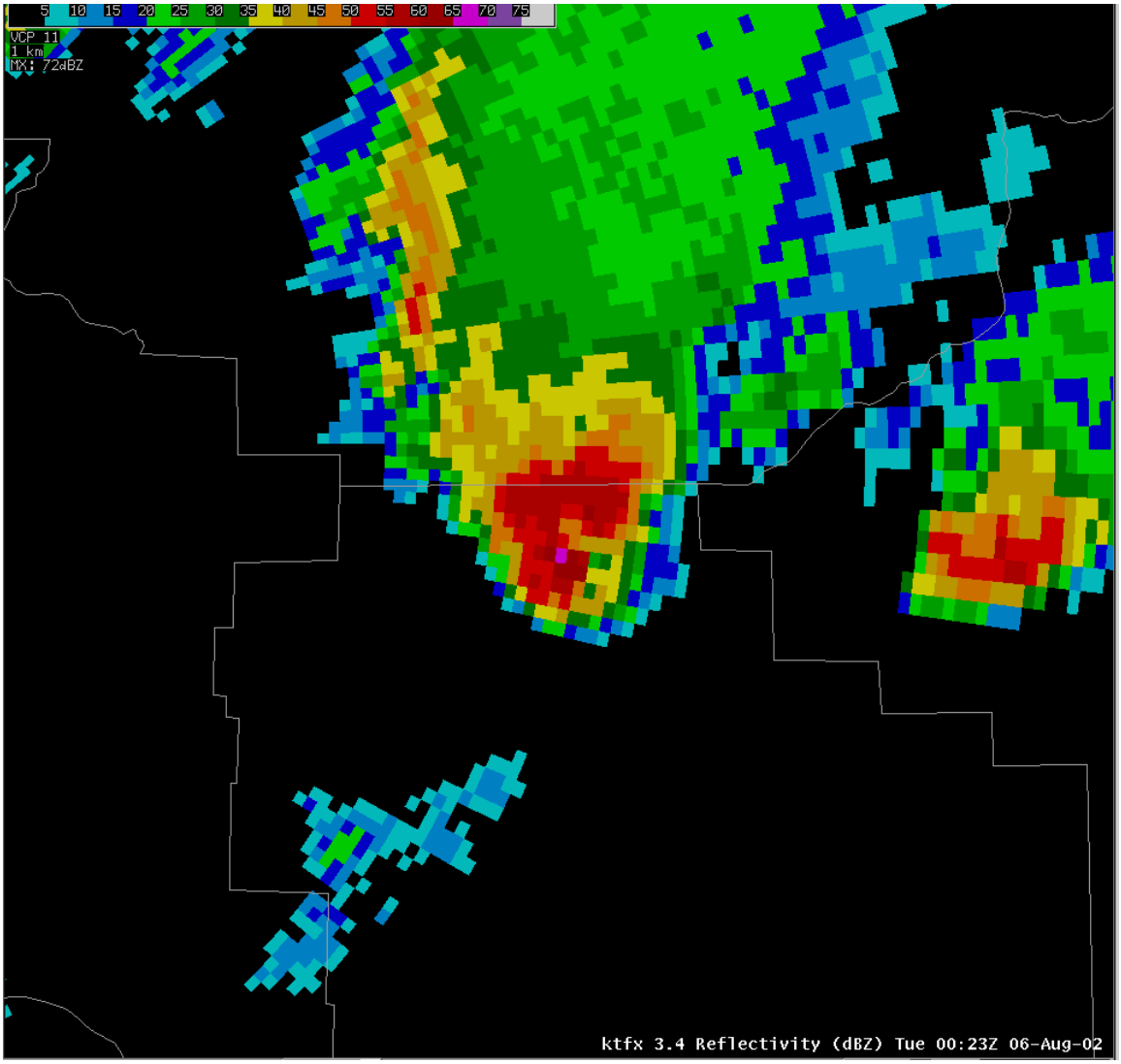

Figure 15 - 0023z KTFX Reflectivity 3.4 degree elevation slice

The 3.4 degree elevation reflectivity product for the same time (Fig. 15) shows a nearly bounded weak echo region (BWER). This weak echo region is indicative of the strong updraft associated with this storm.

As this supercell was producing the tornado, another supercell developed in northwest Fergus county. The mesocyclone associated with this supercell went through several cycles of organization/strength. There were two problems with detecting a tornado with this latter storm. First the storm was over 80 miles from the radar at Great Falls, and secondly, there was beam blockage from a mountain range east of Great Falls. Roughly 45 minutes before the reported sighting of the tornado with this storm, radar was indicating possible tornadic activity.

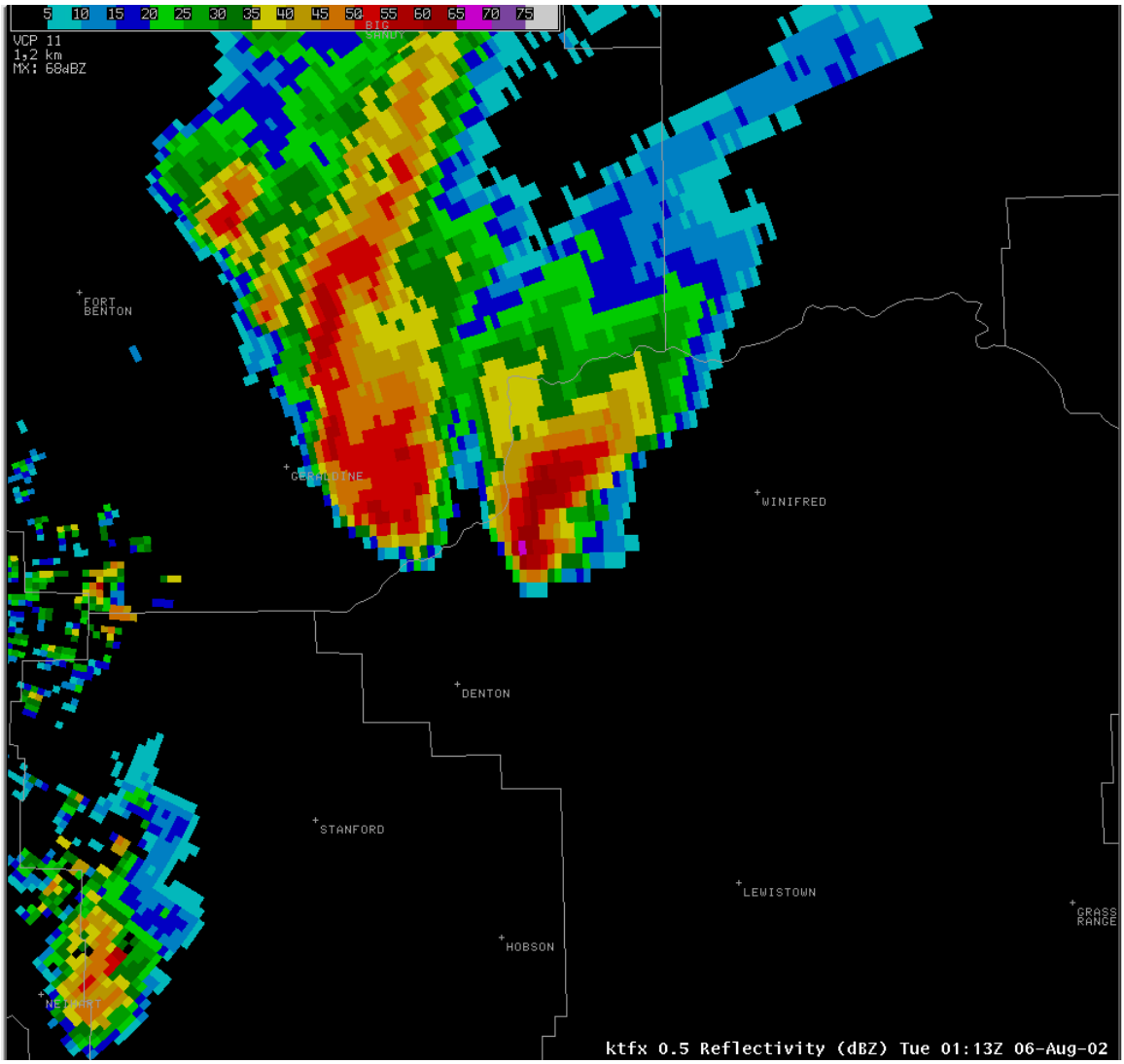

Figure 16 - 0113z KTFX Reflectivity 0.5 degree elevation slice

The 0.5 degree elevation reflectivity product indicated a hook echo (Figure 16) in the same area as a well-developed mesocyclone. At 0200Z a tornado was sighted 10 miles south of Winifred in northwest Fergus county. The mesocyclone at this time appeared weak on radar, but there were other indications that this storm had the potential to produce a tornado. At 0203Z the 1.5 degree elevation reflectivity product gave some indication of a hook echo (Fig. 17), while the 2.4 elevation reflectivity product gave some indication of a BWER (Fig. 18).

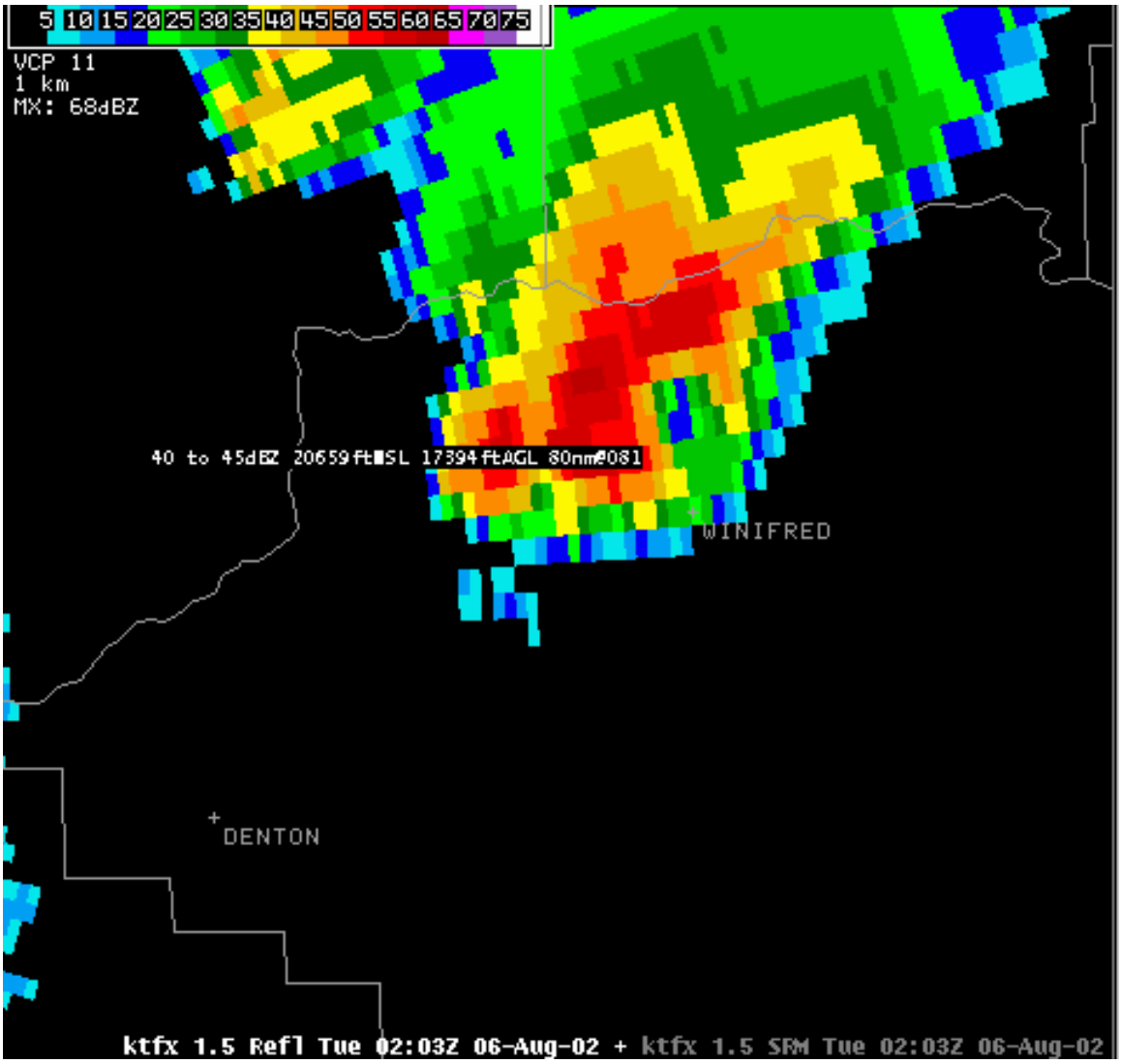

Figure 17 - 0203z KTFX Reflectivity 1.5 degree elevation slice

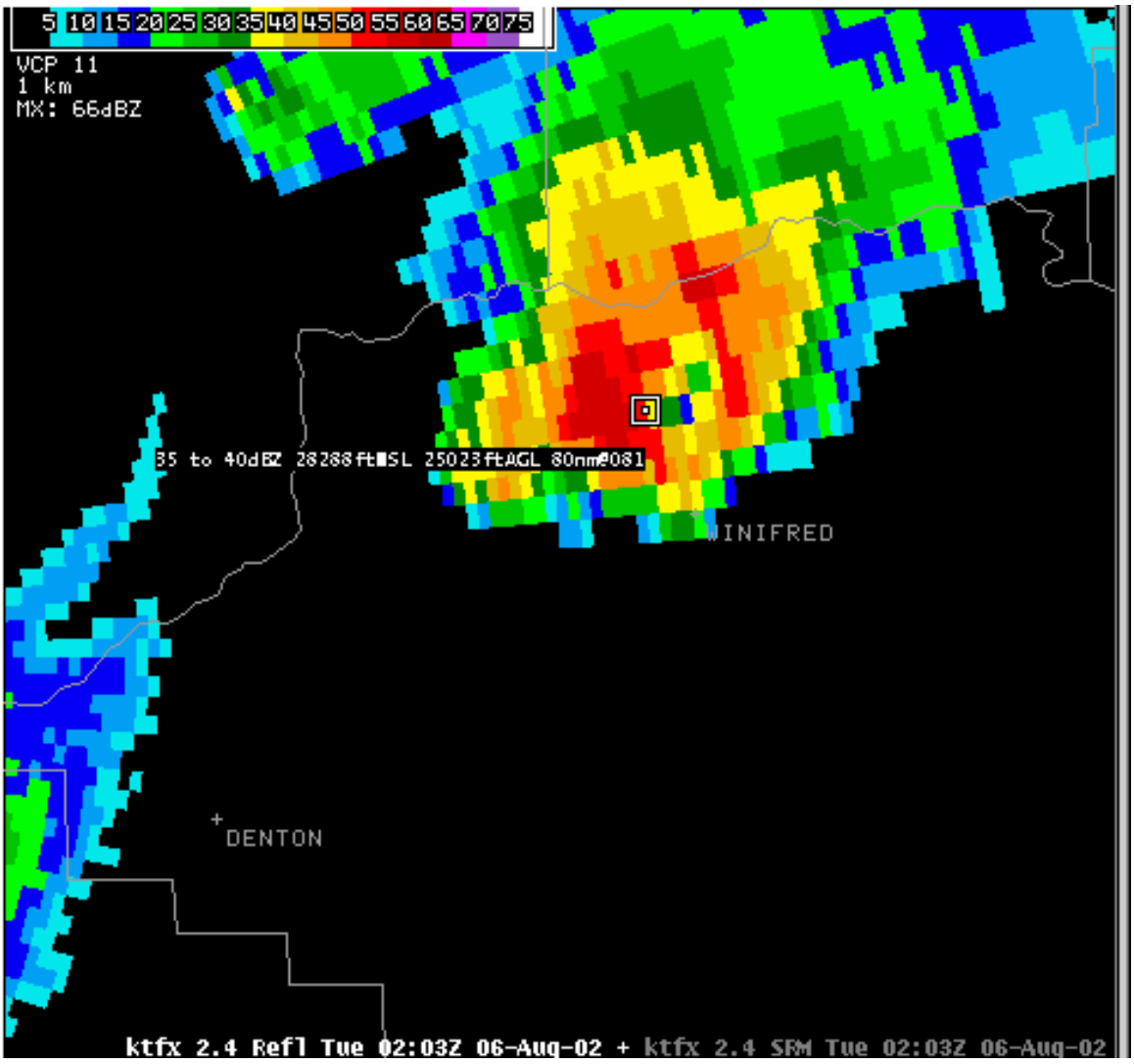

Figure 18 - 0203z KTFX Reflectivity 2.4 degree elevation slice

Also IR satellite imagery at 0200Z indicated a definite V-notch signature with the storm (Fig. 19).

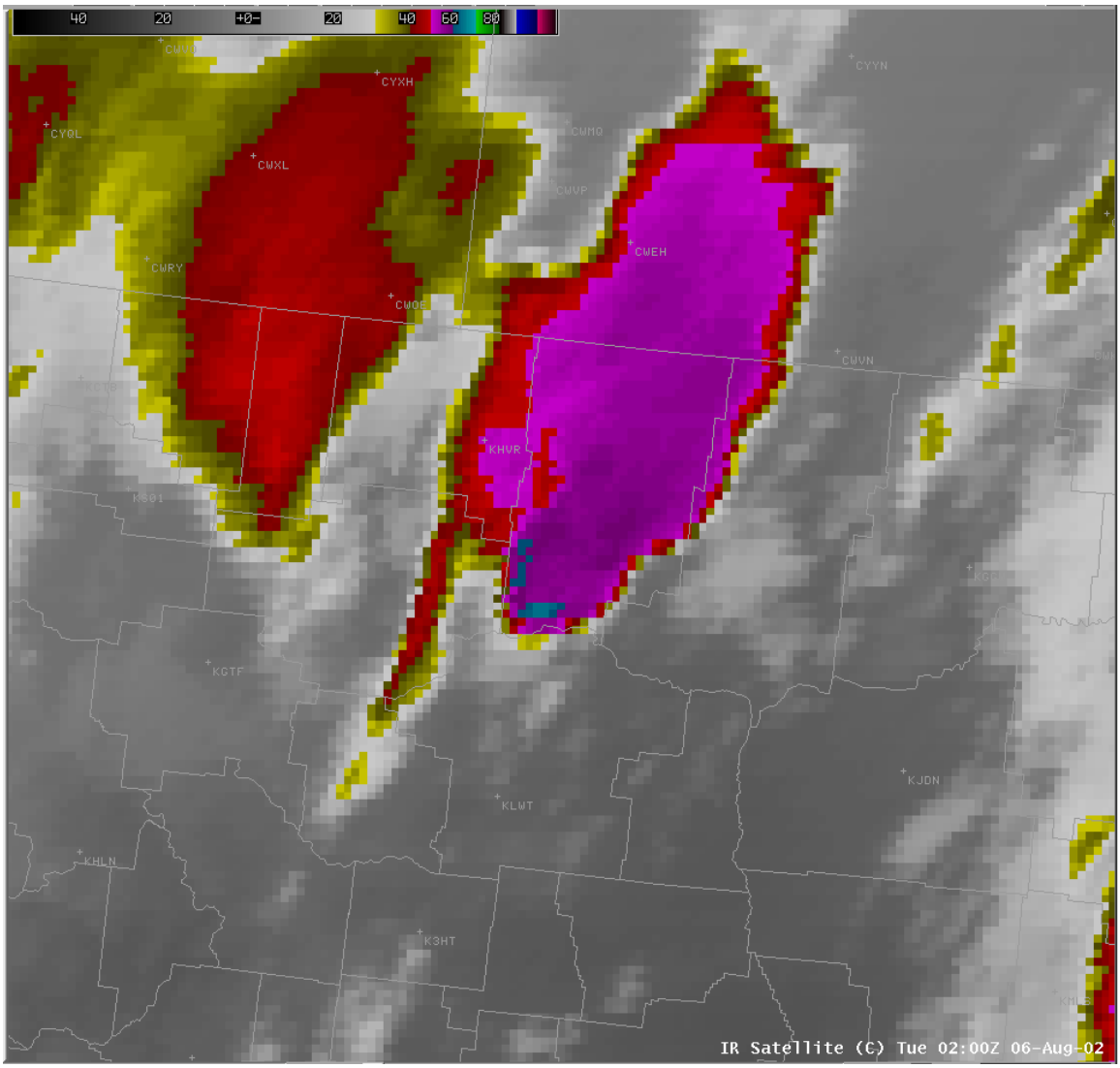

Figure 19 - 0200z IR Satellite Imagery

Also during the early evening, a line of severe storms over Lewis and Clark county and Teton county moved northeast. Other severe storms developed over western Chouteau county and moved into Liberty county. These storms produced hail from 0.75 inch to 1.75 inch. Although persistent mesocyclones were reported with most of these storms, no funnel clouds or tornados were reported.

Conclusions

One of the lessons to be learned from this WES case is that the forecaster must not put too much emphasis on climatology when assessing the potential for severe weather. Although severe thunderstorms are not unheard of in August, if they do occur, the severe weather they usually produce is strong gusty winds rather than large hail. Another lesson from this case is that when the models differ significantly in their forecasts, it is important for the forecaster to accurately gauge via situational and

observational awareness which model will be most accurate. For this case the ETA forecast had more potential for severe weather than the GFS forecast and overall was more accurate than the GFS during the early evening hours, especially with the mean sea level pressure forecast. Finally, the forecaster should utilize all tools available when determining whether to issue severe thunderstorm/tornado warnings. Although IR imagery cannot detect a tornado, for this case it did help to confirm the severity of the storm that was well away from the local radar.