August 16 2002 High Wind, Thunderstorm, and Snow Event for North Central Montana

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Overview

Very strong winds developed over the Great Falls county warning area during the morning of 16 August 2002. The strong winds were associated with a rapidly-moving upper level shortwave and attendant surface cold front. Wind gusts of 55-75 mph were fairly common as the cold front raced across the area.

In Great Falls the strong winds caused considerable tree damage and the loss of power to over 5000 customers as power lines snapped. Power outages also affected towns surrounding Great Falls and major tree damage was reported in Cascade, Teton, and Lewis and Clark counties (fig. 1). In many areas, visibilities were greatly reduced due to blowing dirt. Just south of Great Falls visibility was reported as near zero, with dirt blown high into the air.

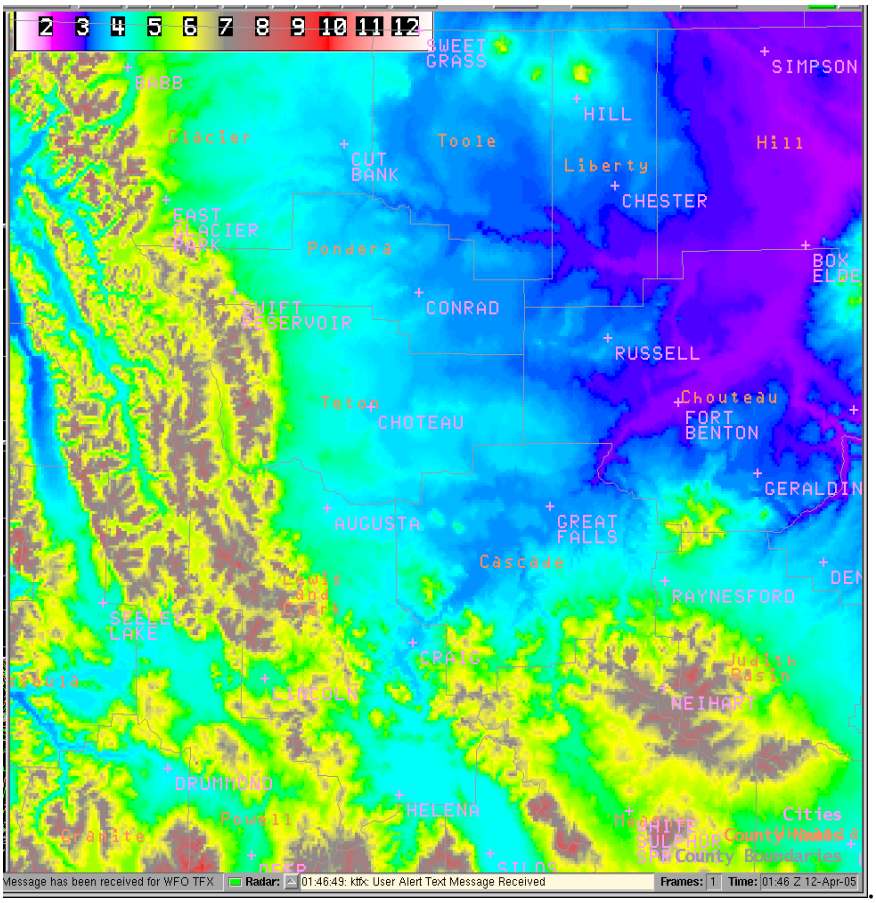

Figure 1 – Map of area of interest

In addition to the very strong winds, the weather system produced other diverse weather phenomena. Thunderstorms were reported early in the day along the Rocky Mountain Front, then spread east over counties bordering Canada. Snow is almost unheard of over the plains of northern Montana in August, but with this system snow was reported on grassy surfaces from Cut Bank north to the Canadian border. Snow fell as far south as 30 miles north of Great Falls. Localized frost was reported in many areas the morning of 17 August.

Synoptic Environment

The ETA and GFS models were in good agreement with their forecast of the 500 mb shortwave. The 00 UTC 16 August ETA80 run initialized the shortwave over central British Columbia (Fig. 2a), then forecast it to intensify as it moved to eastern Washington and southeast British Columbia by 12 UTC (Fig. 2b). The shortwave was then forecast to accelerate to eastern Montana by 00 UTC August 17 (Fig. 2c).

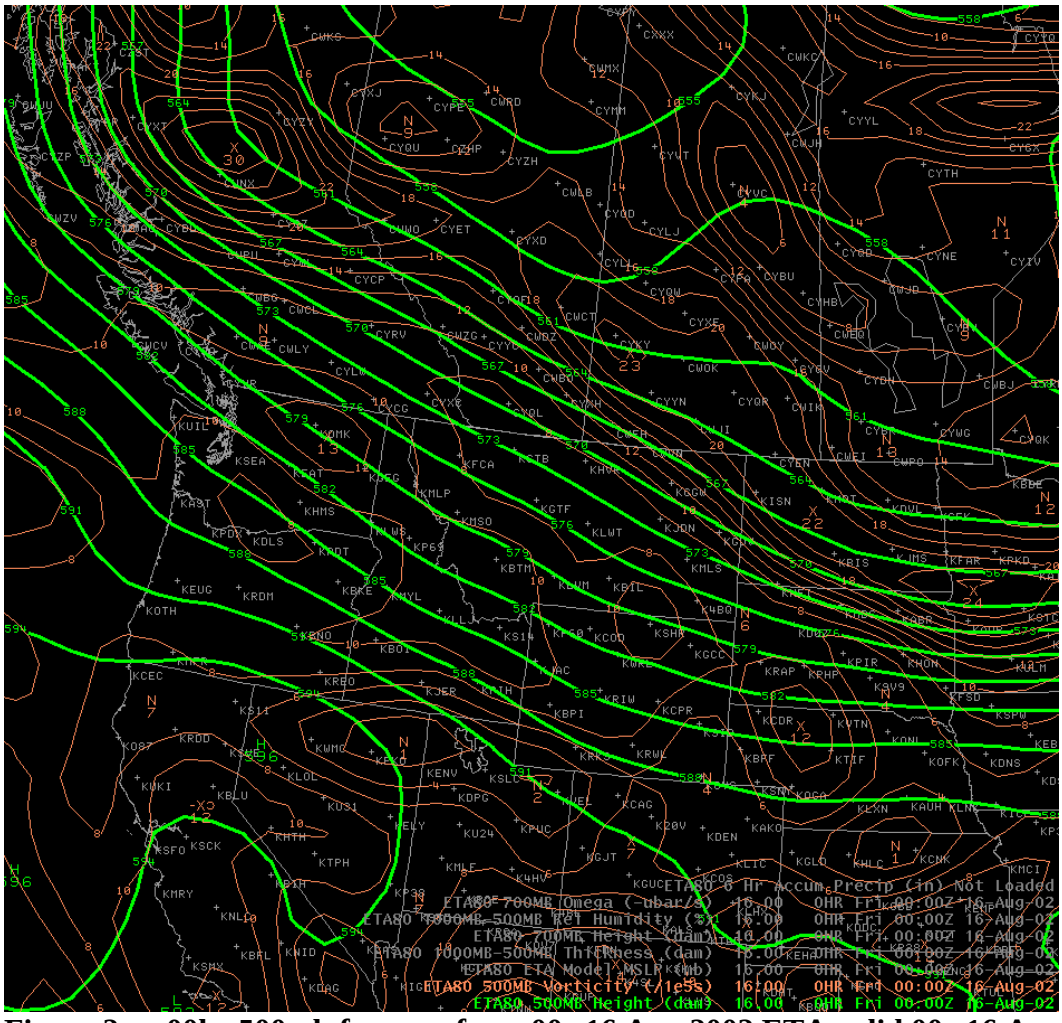

Figure 2a – 00hr 500mb forecast from 00z 16 Aug 2002 ETA valid 00z 16 Aug 2002.

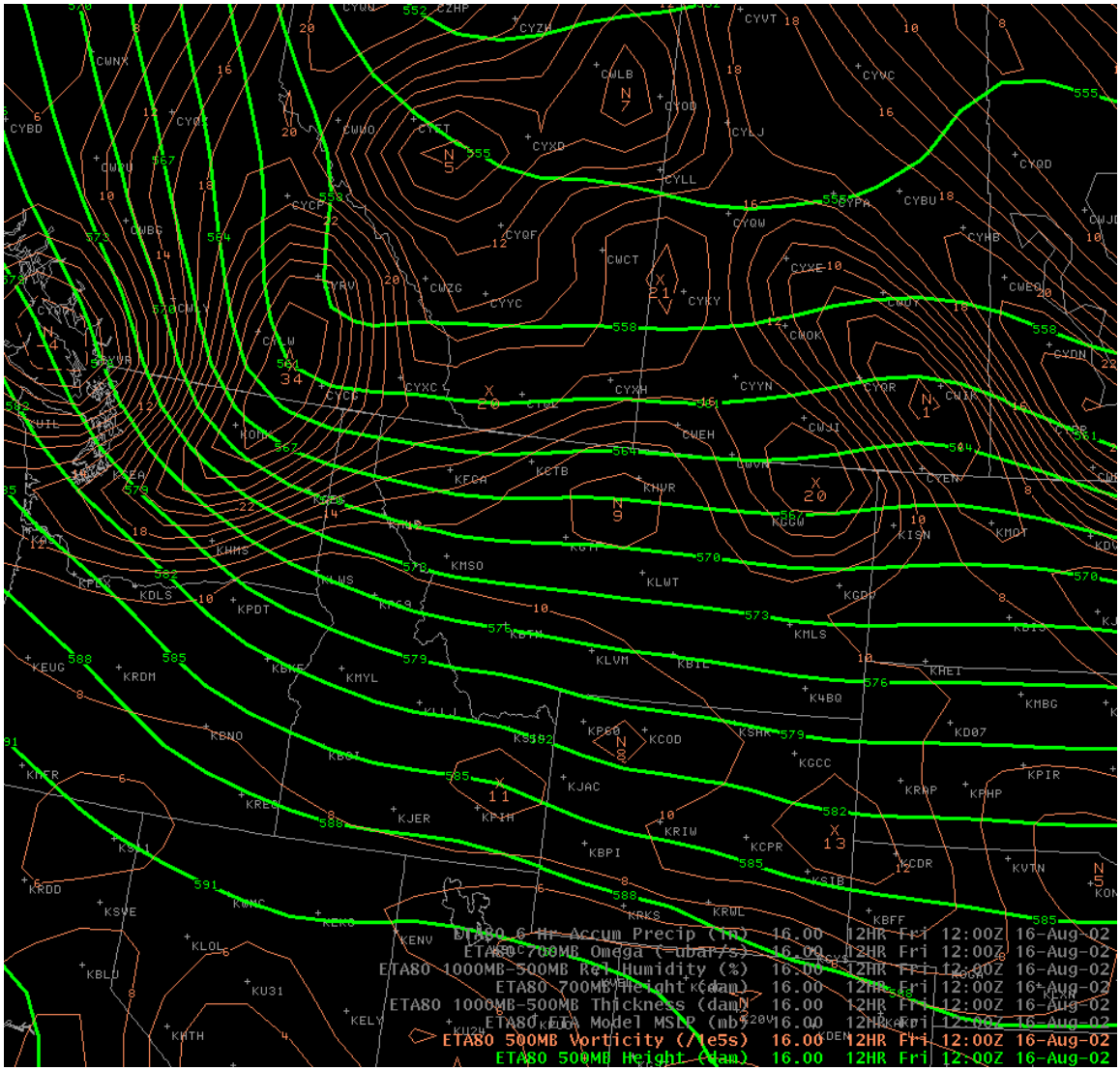

Figure 2b – 12hr 500mb forecast from 00 UTC 16 Aug 2002 ETA run valid 12 UTC 16 Aug 2002.

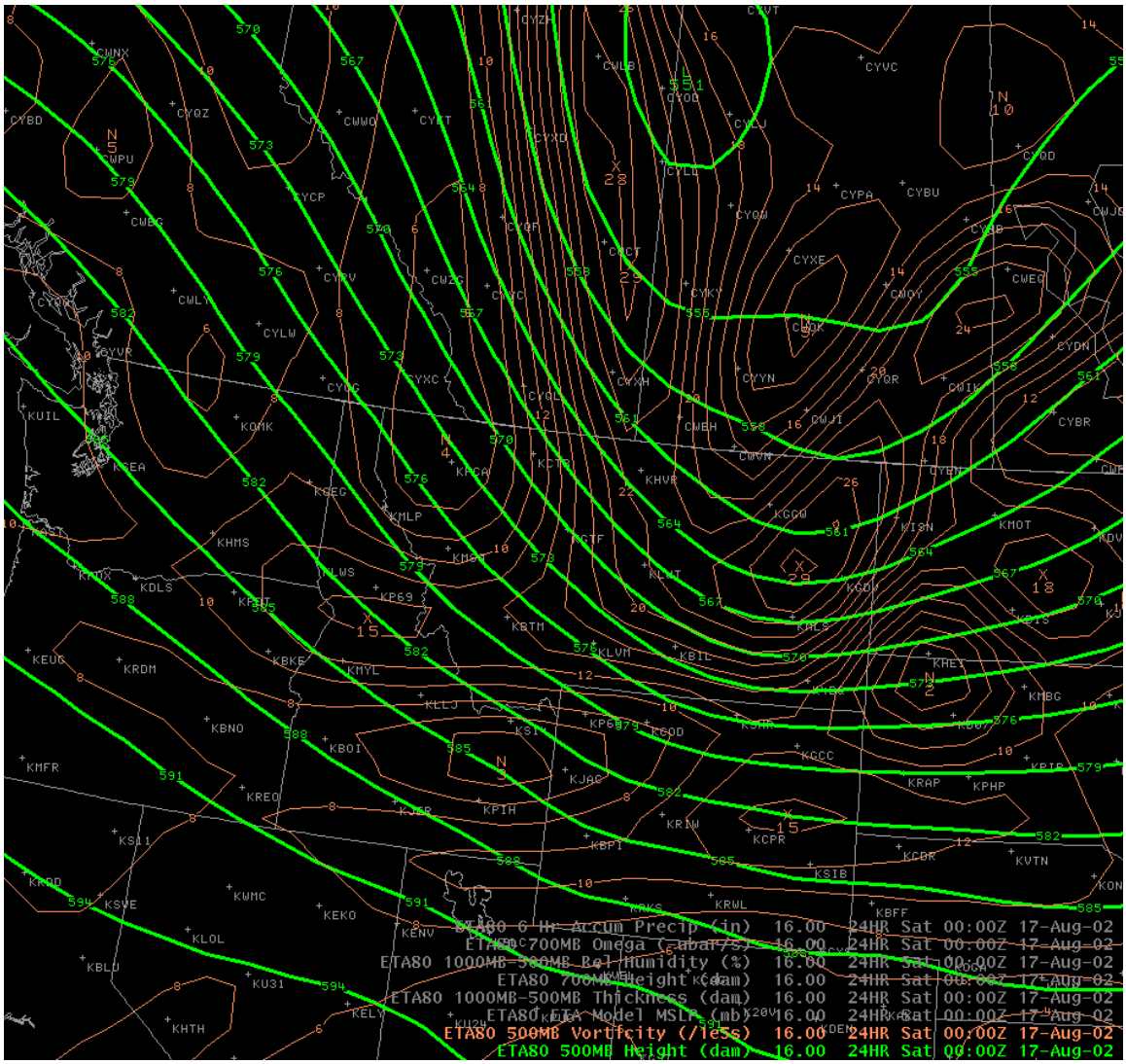

Figure 2c – 24hr 500mb forecast from 0 UTC 16 Aug 2002 ETA run valid 00 UTC 17 Aug 2002.

Mean Sea Level pressure (MSLP) forecasts depicted an inverted trough from eastern Washington to eastern Oregon (Fig. 3a). ETA forecasts developed this trough into a low pressure area over northwest Montana by 12 UTC 16 August (Fig. 3b) then intensifies as it moves rapidly to central South Dakota by 00 UTC 17 August (Fig. 3c).

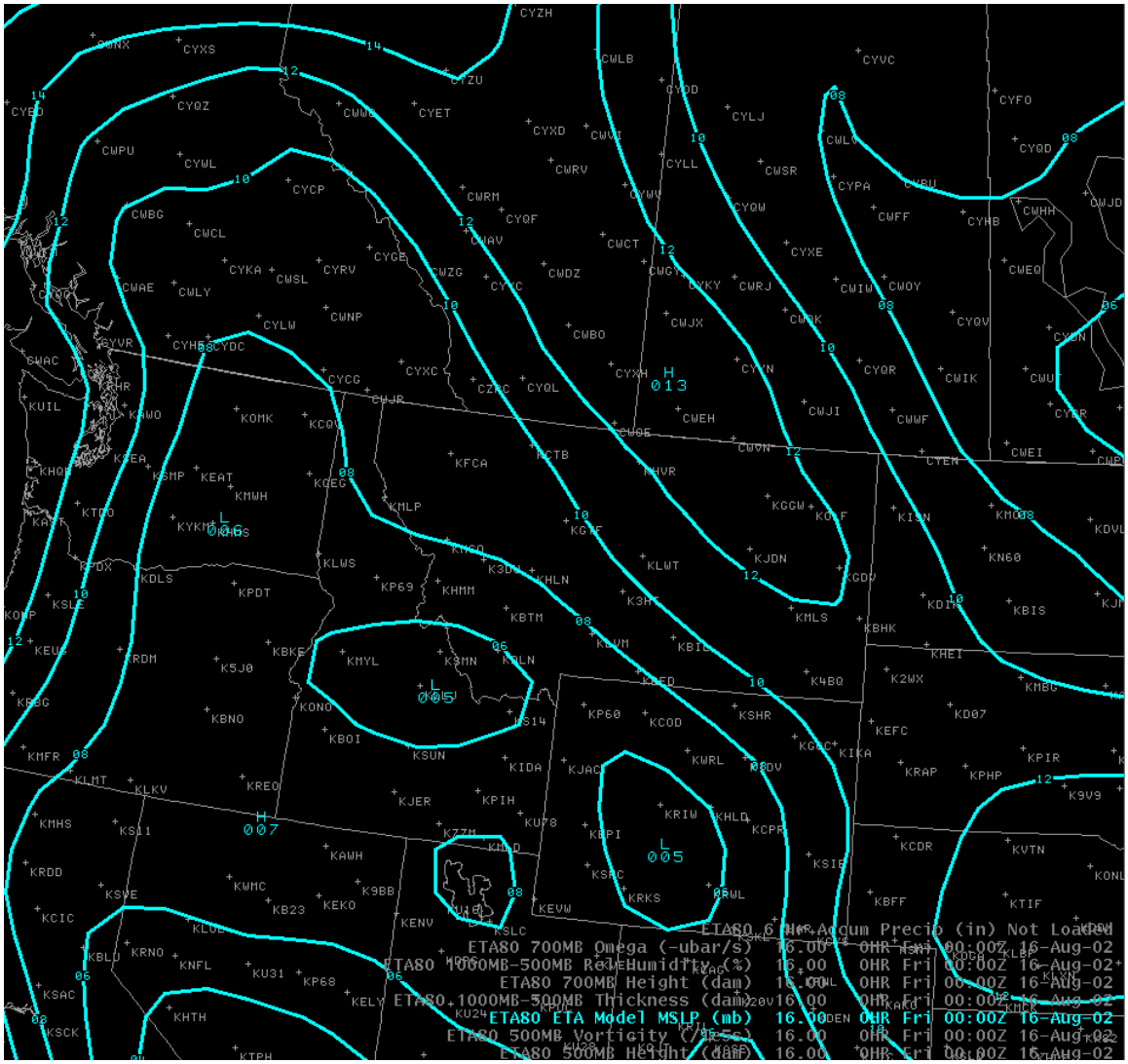

Figure 3a – 00hr MSLP forecast from 00 UTC 16 Aug 2002 ETA valid 00 UTC 16 Aug 2002.

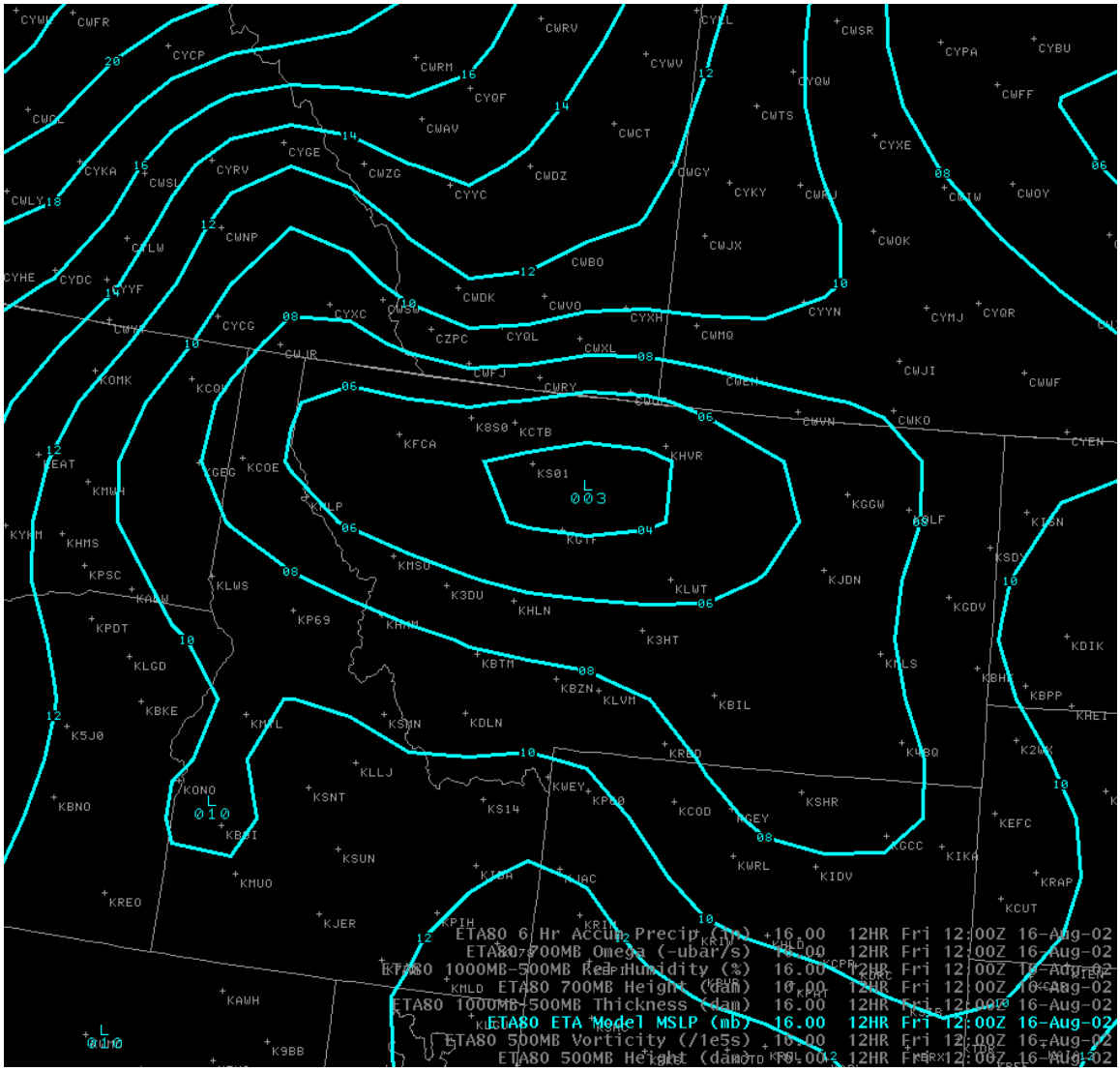

Figure 3b – 12hr forecast from 00z 16 Aug 2002 ETA valid 12 UTC 16 Aug 2002.

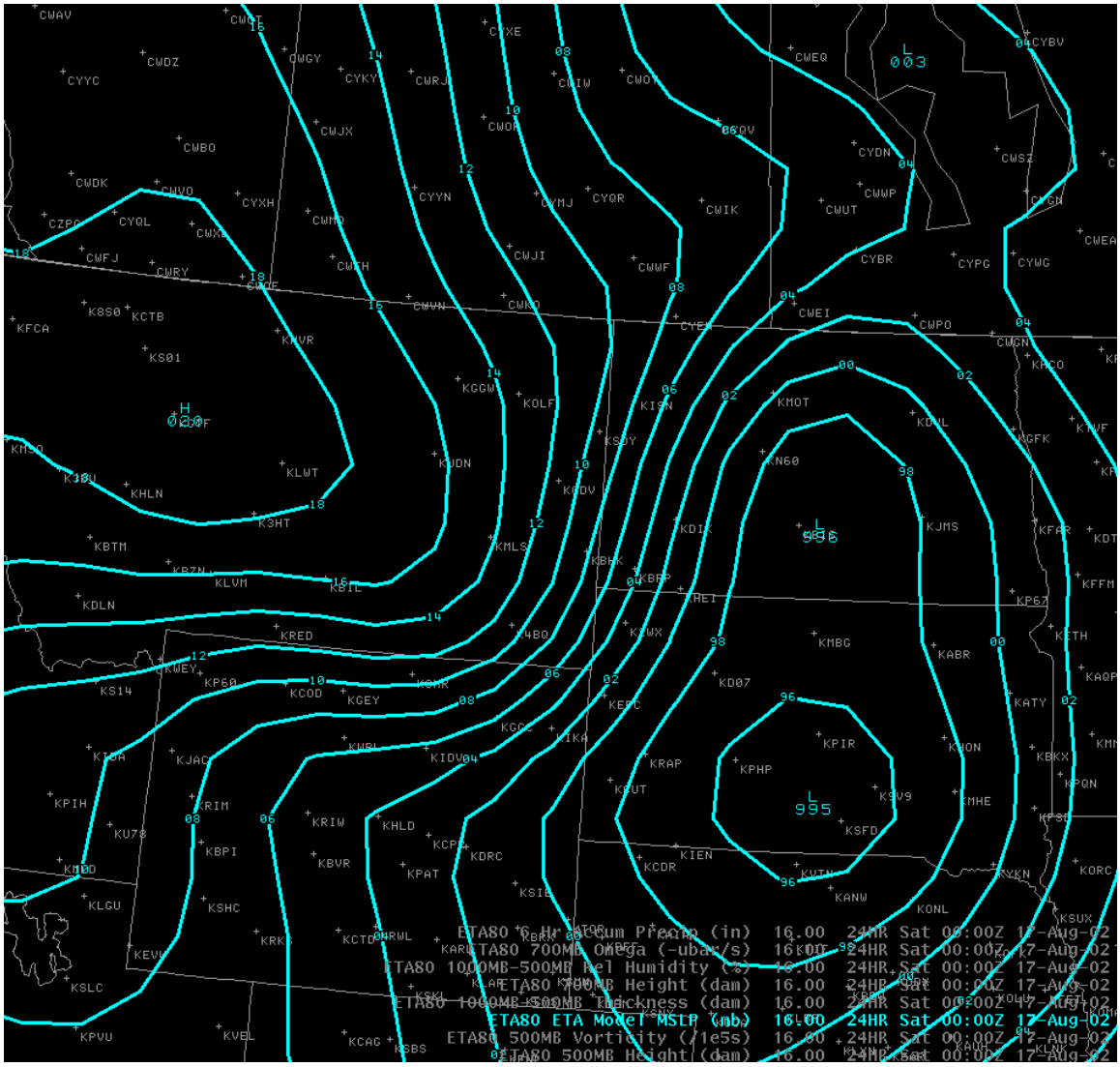

Figure 3c – 24hr MSLP forecast from 00 UTC 16 Aug 2002 ETA valid 00 UTC 17 Aug 2002.

There were slight differences between the ETA and GFS MSL pressure patterns. The MSL pressure differences between the ETA and GFS 00 UTC and 12 UTC 16 August runs were as follows: The ETA developed a slightly stronger low than the GFS; also the ETA had a tight pressure gradient north of the low extending into northern Montana whereas the GFS had a tighter MSL pressure gradient north of the international border. As it turned out the ETA was more accurate than the GFS with these aspects of the pressure forecast. Although one would certainly expect gusty winds and showers with this weather system, the fact that there were 55-75 mph winds, thunderstorms, and snow was not immediately obvious looking at the prognostic charts.

High Winds

At 700mb, winds from both the 00 UTC and 06 UTC 16 August runs of the ETA and GFS were forecast not to exceed 45 knots during the day over northwest and central Montana. At 850mb winds from the 00 UTC 16 August runs of the GFS and ETA were

not forecast to exceed 35 knots while from the 06 UTC 16 August runs of the GFS and ETA 850mb winds were not forecast to exceed 40 knots. The 00 UTC 16 August ETA forecast surface winds for northwest and central Montana not to exceed 25 knots and not to exceed 30 knots from its 06 UTC run. Looking at these fields one might not expect surface winds as strong as what was observed. The strength and rapid movement of the weather system might have prompted one to look at MSL pressure changes. Figure 4 shows the 6hr MSL change from the 00 UTC 16 August ETA valid at 18 UTC 16 August.

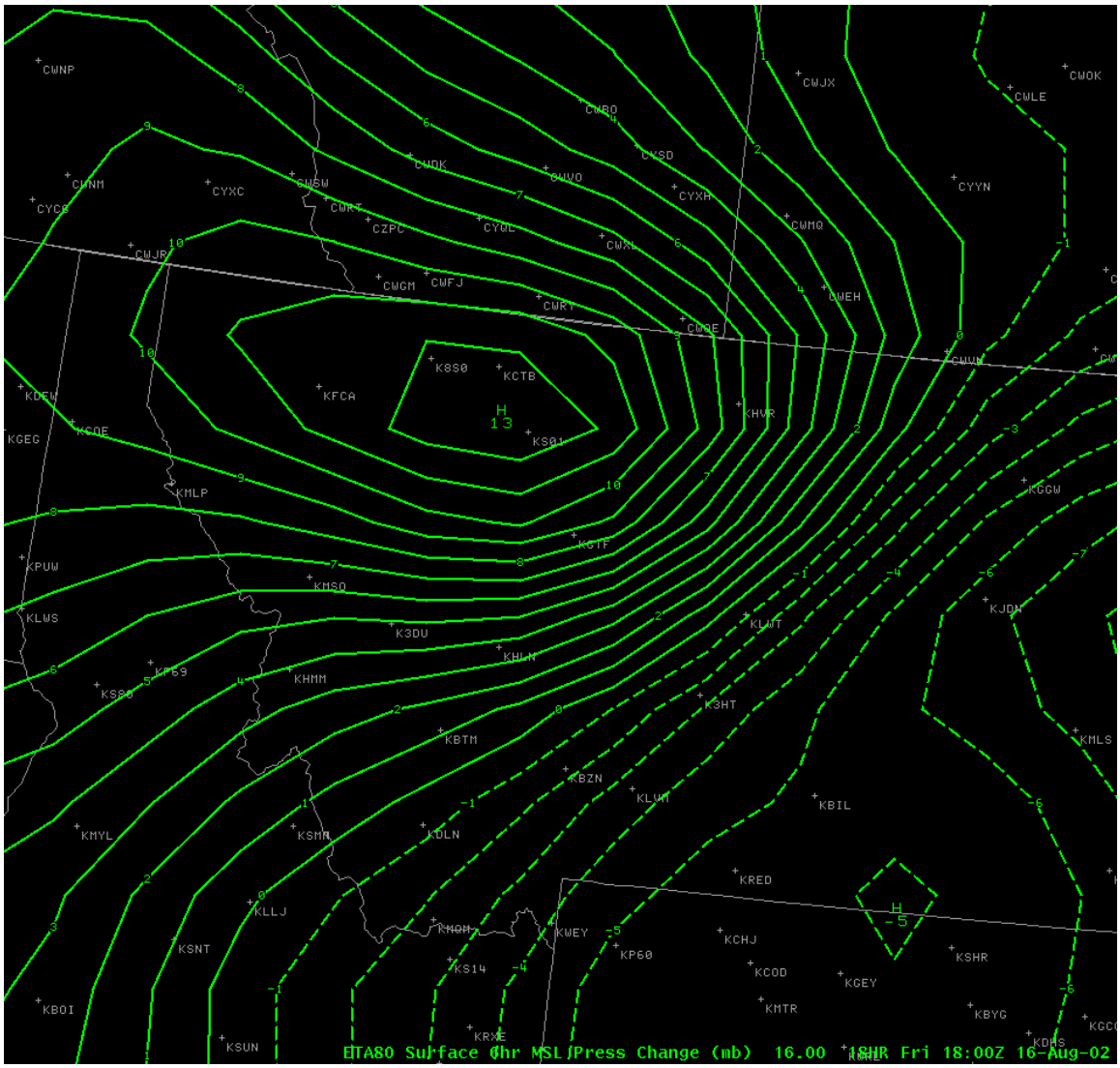

Figure 4 – 6hr MSL pressure change forecast from 00 UTC 16 Aug 2002 ETA valid 18 UTC 16 Aug 2002.

Note the extremely tight gradient over central Montana. Certainly one would expect significant acceleration of the surface wind due to isallobaric effects. Figures 5a-5d show observed 3hr MSL pressure changes from 15 UTC-18 UTC.

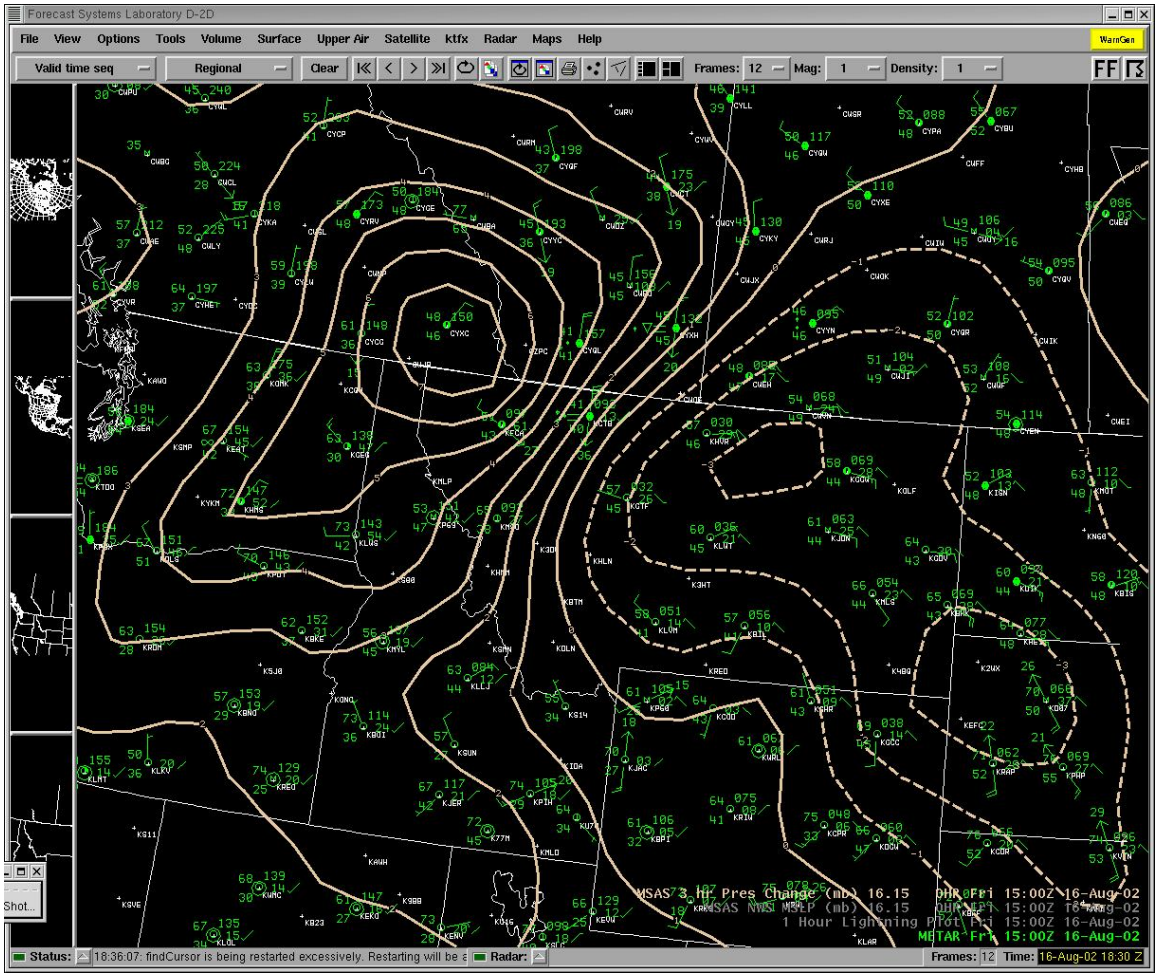

Figure 5a – 3hr MSL pressure change 15 UTC 16 Aug 2002.

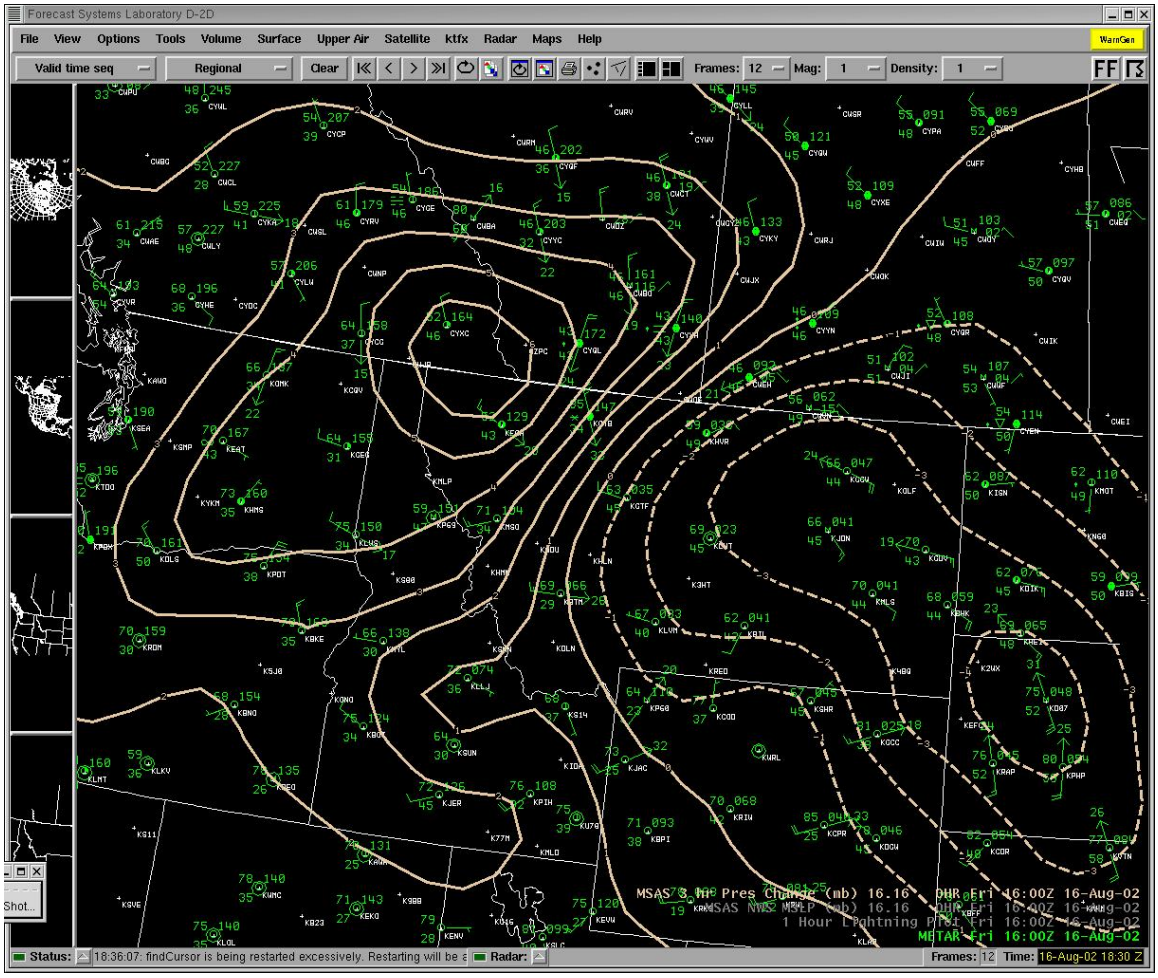

Figure 5b – 3hr MSL pressure change 16 UTC 16 Aug 2002.

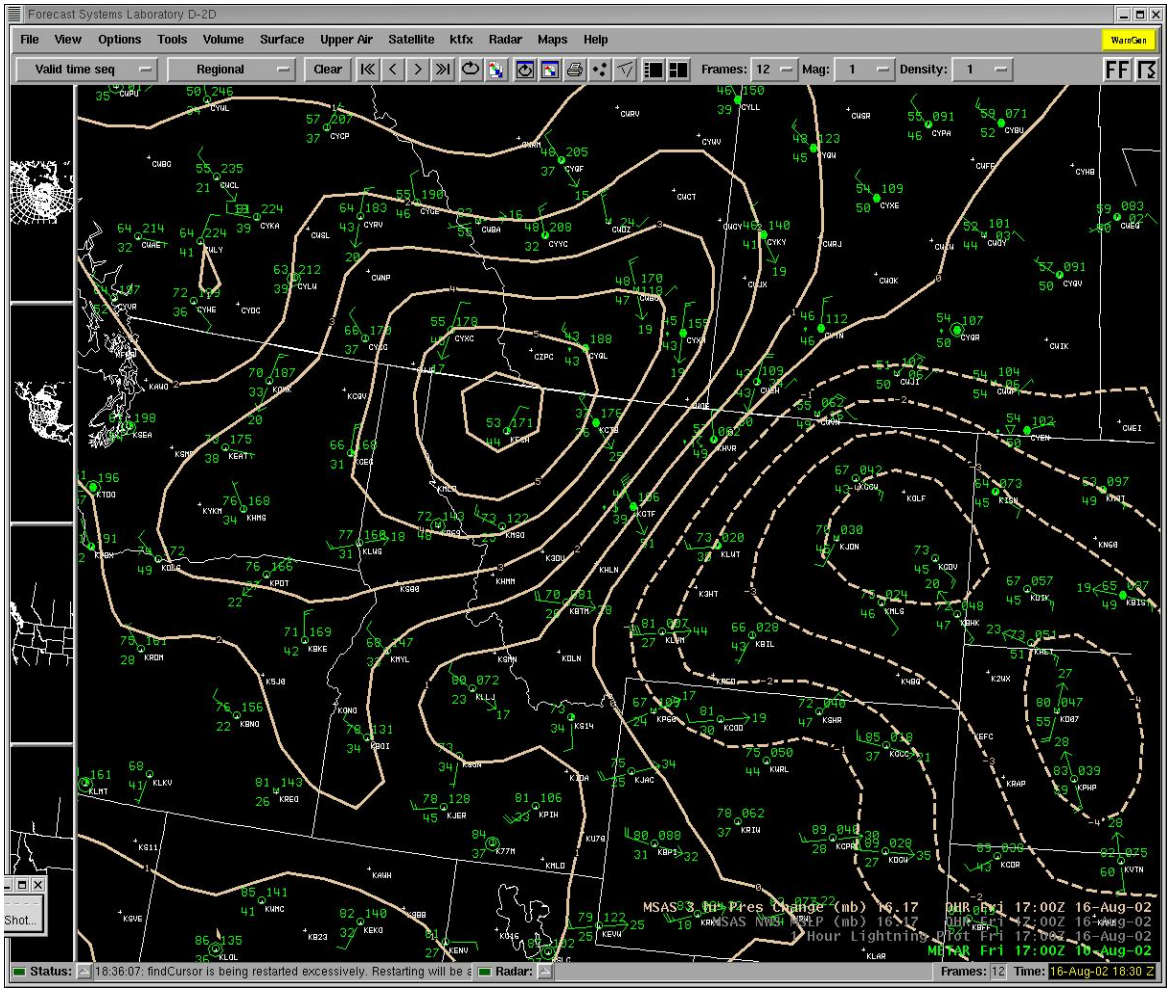

Figure 5c – 3hr MSL pressure change 17 UTC 16 Aug 2002.

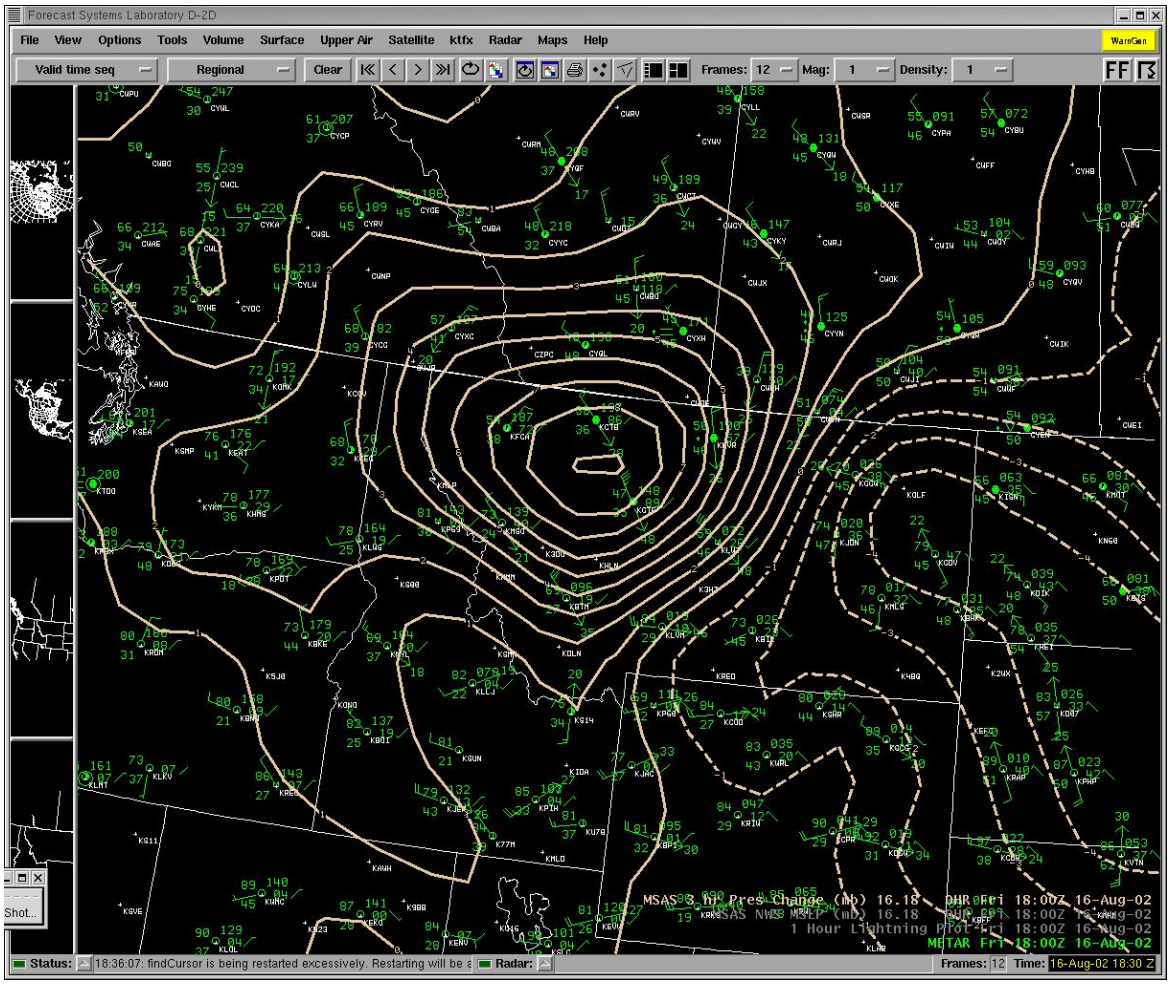

Figure 5d – 3hr MSL pressure change 18 UTC 16 Aug 2002. Note how the tightest pressure change gradient shifted from northwest Montana at 15 UTC to central Montana at 18 UTC.

It is likely that a gust front trigged by the convection contributed to some of the higher wind gusts. The 0.5 degree radar reflectivity slice for 1552 UTC indicated a fine line which was the gust front (Fig. 6).

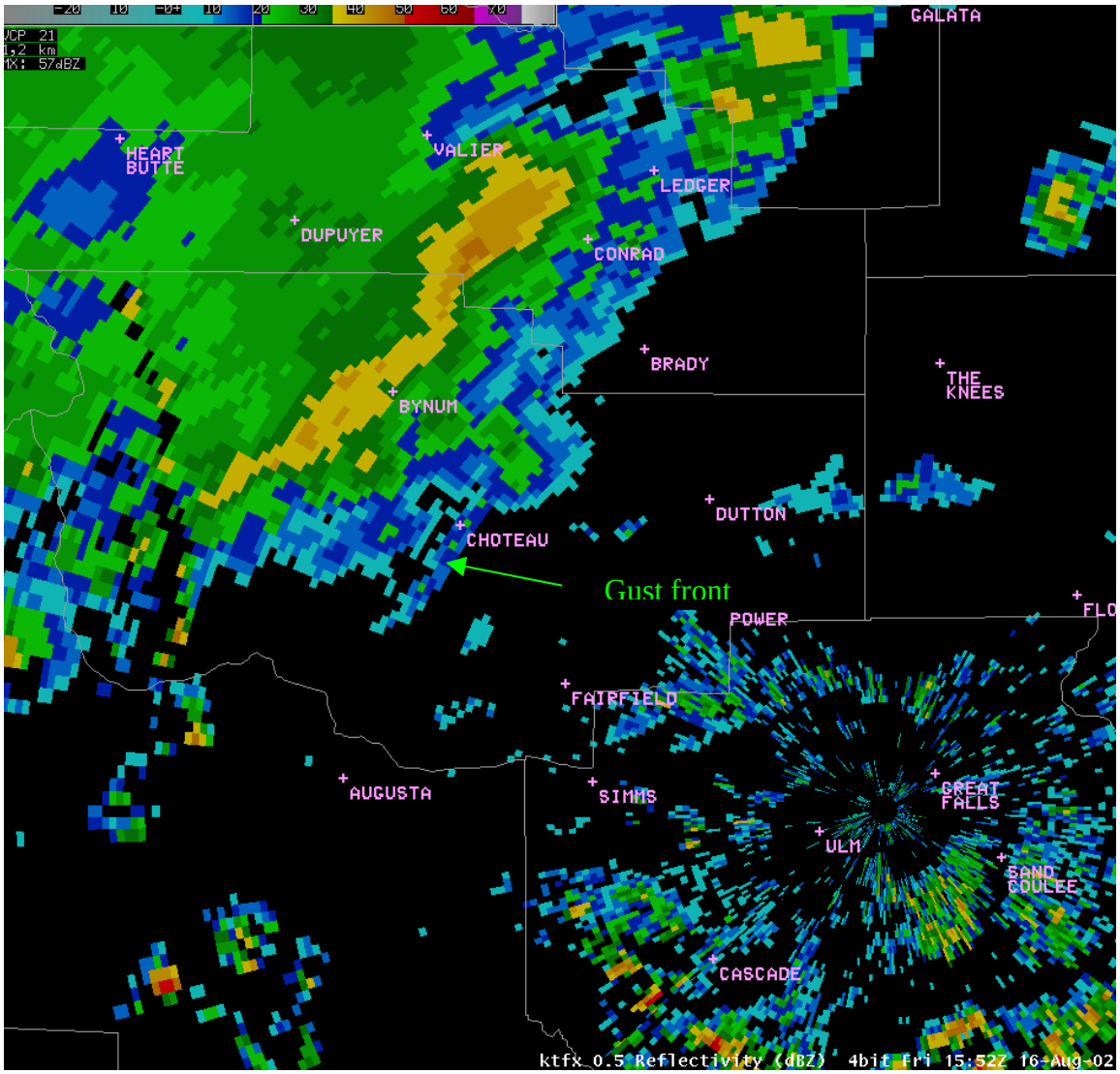

Figure 6 – 1552 UTC KTFX Reflectivity 0.5 elevation slice 16 August 2002.

It was near this time that Choteau recorded a wind gust to 73 mph. The 0.5 velocity slice at 1557 UTC (fig. 7) indicated a few bins of 50-64 kt inbound velocities.

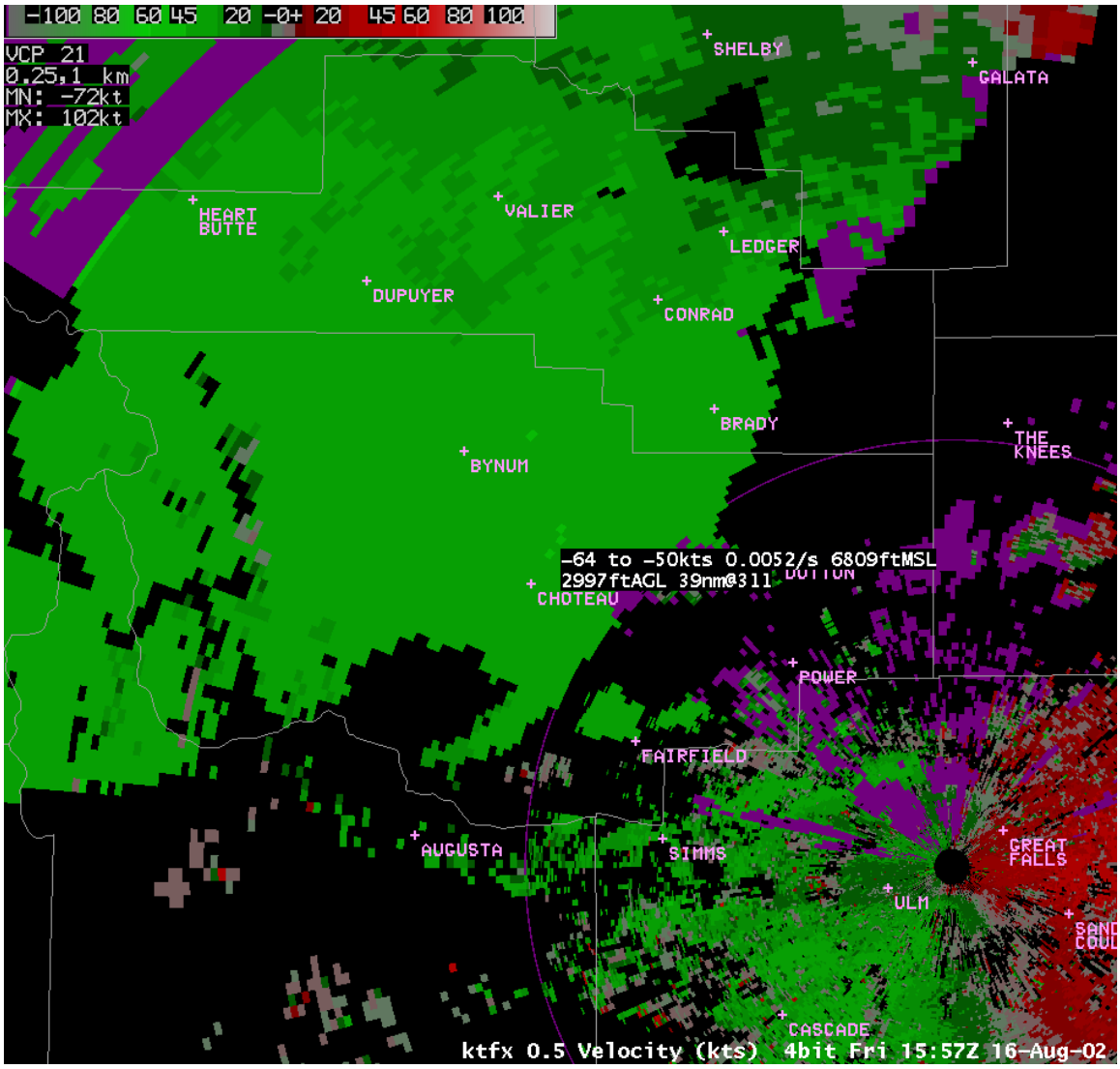

Figure 7 – 1557 UTC KTFX Velocity 0.5 elevation slice 16 August 2002.

This area of 50-64 kt inbound velocities continued to expand in coverage as the gust front accelerated ahead of the convection and reached Great Falls at 1644 UTC (Figs. 8 and 9). At that time the NWS office in Great Falls recorded a wind gust to 67 mph.

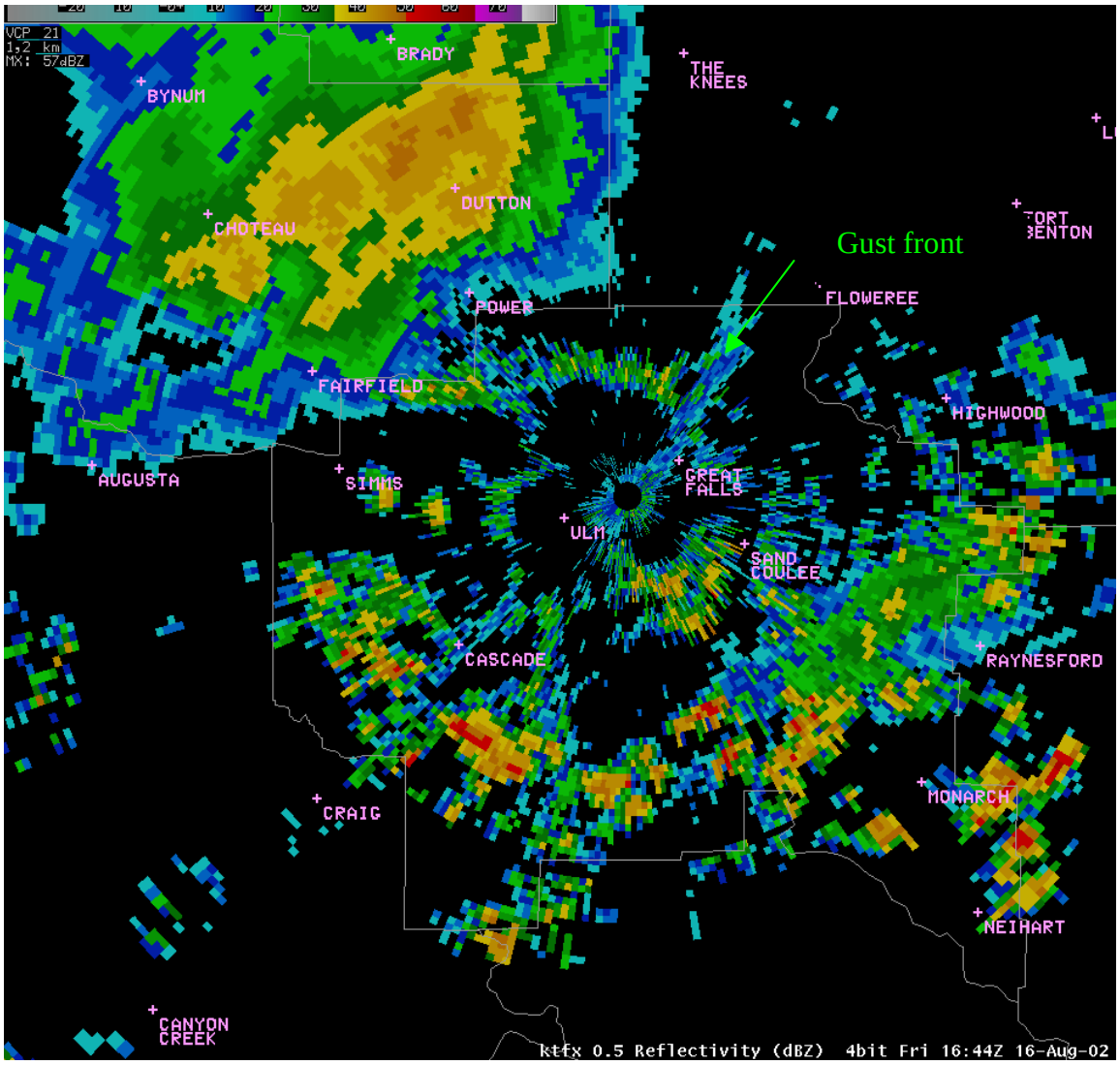

Figure 8 – 1644 UTC KTFX Reflectivity 0.5 elevation slice 16 August 2002.

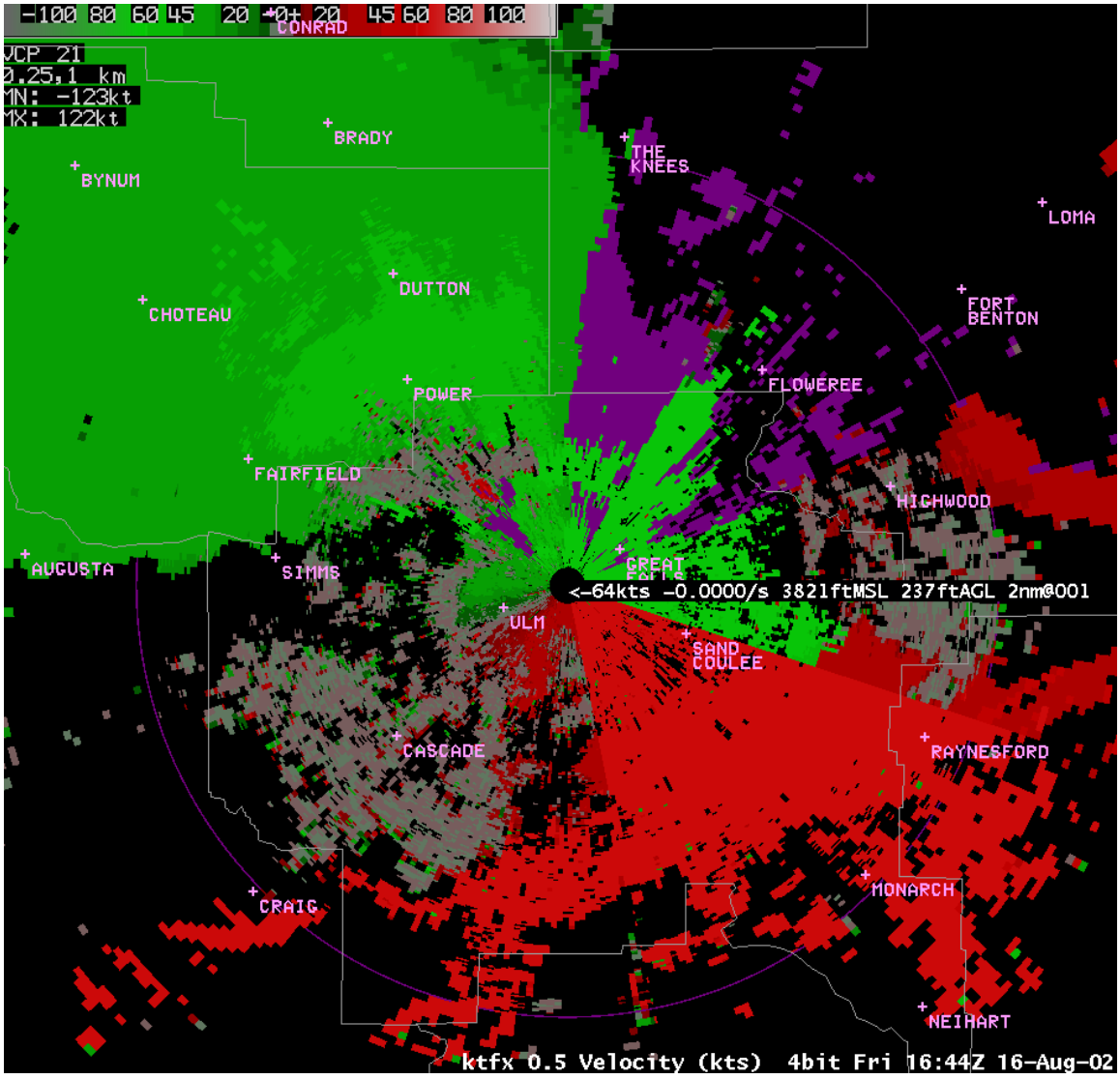

Figure 9 – 1644 UTC KTFX Velocity 0.5 elevation slice 16 August 2002.

Thunderstorms

The 00 UTC 16 August runs of both the ETA and GFS were forecasting Lifted Indices to fall to near zero by 18 UTC 16 August over central Montana. The ETA forecast CAPEs to be near 100 j kg^{-1}. The 06 UTC 16 August run of the GFS forecasted Lifted Indices to fall to near –1 while the MesoETA forecast lifted indices over central Montana to fall to near –4 with CAPES of 300 j kg^{-1}. (fig. 10).

With ETA and GFS forecasts of Lifted Indices and CAPEs from the 00 UTC run one would not necessarily have expected thunderstorms over central Montana. However, ETA forecast soundings near the lowest forecast Lifted Indices indicated Lifted Indices near –2 with CAPEs near 200 j kg^{-1}. CAPES of 200 j kg^{-1} are sufficient to sustain thunderstorms in this area.

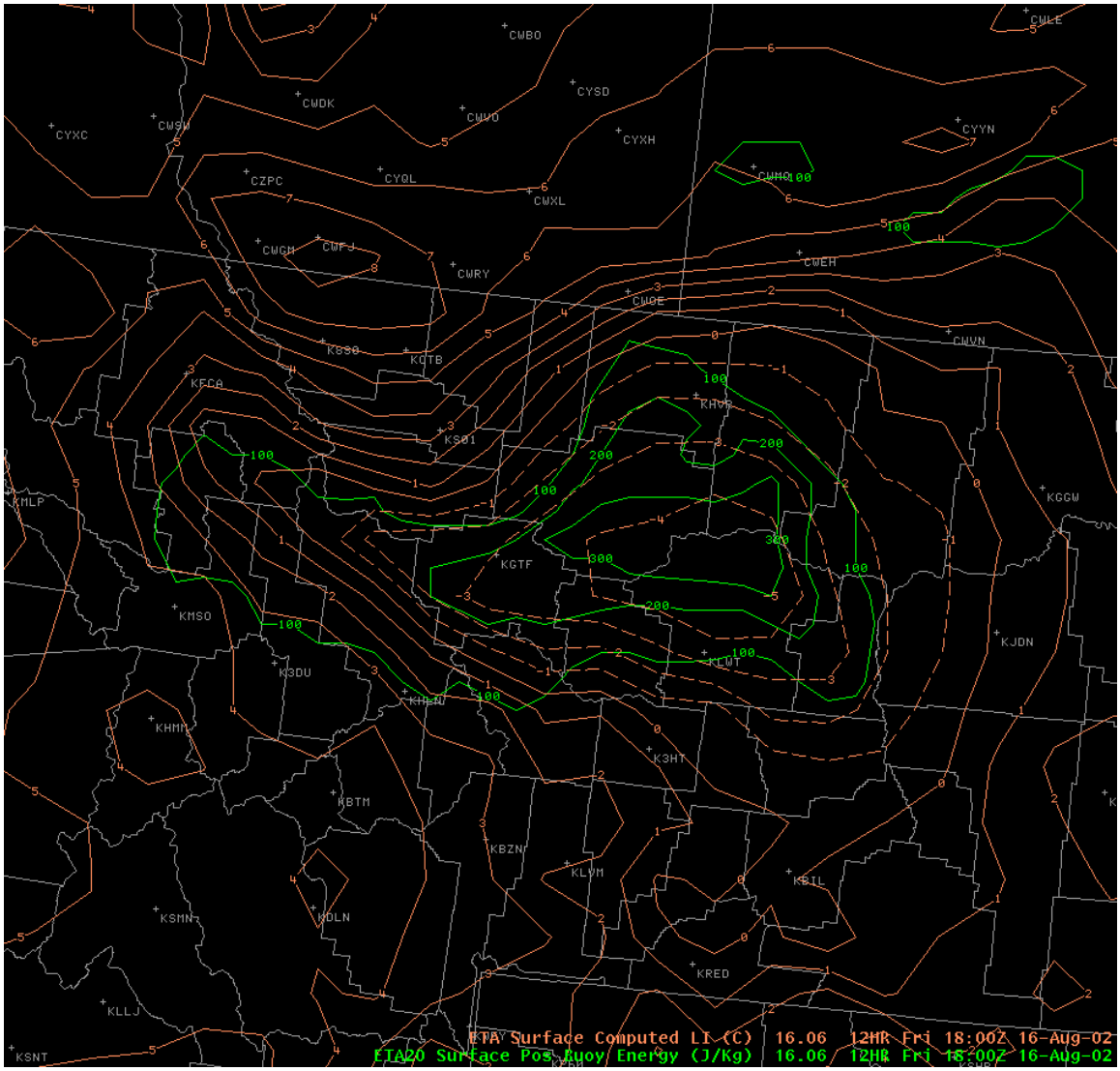

Figure 10 – 12hr forecast surface LI and CAPE from 06 UTC 16 August MesoETA valid 18 UTC 16 August.

Snow

Thicknesses from 1000 to 500mb from the 00 UTC 16 August runs of the ETA and GFS were forecast to fall to 546 dm over northern Montana by 18 UTC. For this same time 850mb temperatures were forecast to be around 2°C by the ETA and near 0°C by the GFS. Forecast soundings from the ETA for CTB indicated that the surface temperature would fall to near 41°F while the dew point would fall to near 36°F by 18 UTC. Dynamic cooling associated with the lift from the low level cool air moving in could have aided in the changeover from rain to snow. Figure 11 shows a time/height cross-section for Cut Bank from the ETA. Note the enhanced lift around 15 UTC near 800mb.

Observations from Cut Bank indicated moderate rain with a temperature of 41°F and a dew point of 40°F at 15 UTC. By 16 UTC the temperature had fallen to 35°F with a dew point of 34°F with light snow falling.

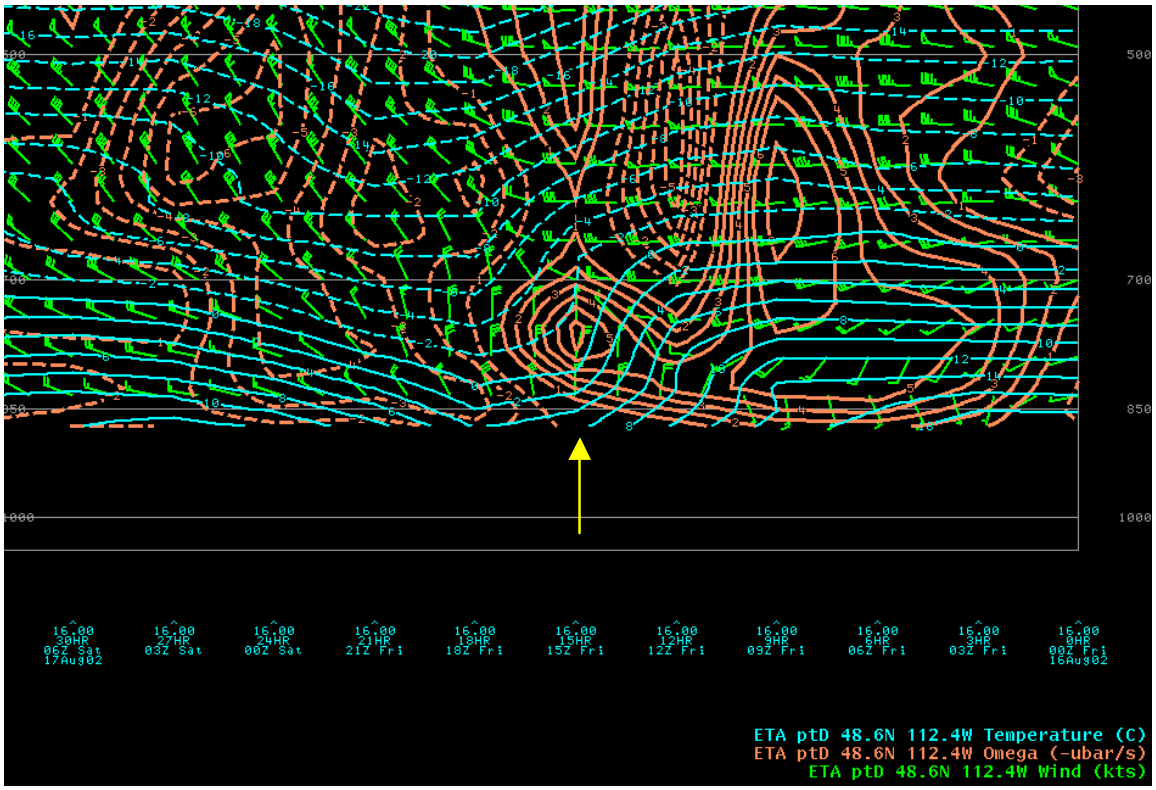

Figure 11 – Time/Height Cross-section of temperature, omega, and wind from 00 UTC 16 August ETA.

Lessons Learned

One lesson learned from this case is that forecasters should not get too caught up in climatology. Never rule out forecasting certain weather phenomena just from time-of-year considerations. Another lesson learned from this case is that, if certain prognostic charts indicate values approaching those typically associated with a certain weather phenomena, it behooves the forecaster to investigate the situation further in order to determine if there is an increased threat of the phenomena. Finally do not neglect convective and isallobaric effects when forecasting wind speeds with cold frontal passages.