HIGH WIND EVENT OF FEBRUARY 21-22 2002
FOR NORTHCENTRAL AND SOUTHWEST MONTANA

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Introduction

This high wind event covered all of North Central Montana, as well as, a portion of Southwest Montana. It began on the afternoon of February 21, 2002 and ended by late afternoon on the 22nd. Sustained winds of 45-55 mph were common across much of North Central Montana, with gusts between 60 and 80 mph. Locations along the Rocky Mountain Front reported wind gusts in excess of 110 mph. Figure 1 shows some of the high wind reports from the event.

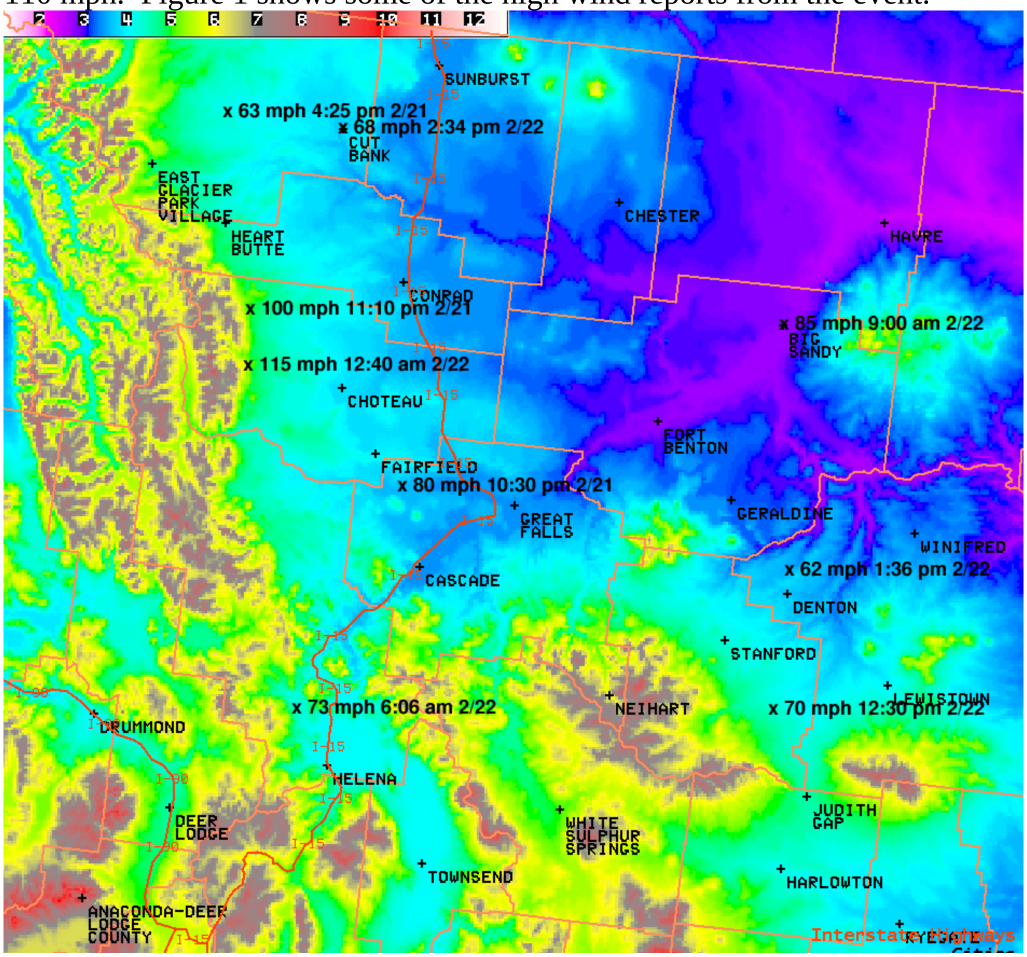

Figure 1 – selected high wind reports February 21-22, 2002.

The high winds caused scattered power outages over the plains. One downed power line southwest of Choteau sparked a grass fire which burned 6000 acres and destroyed a farm. Other effects from the high winds included a few vehicles being blown off Interstate 15; windshields cracked from stones being blown into them; and visibilities reduced to near zero in blowing dust.

Although high wind events are not uncommon along the northern east slopes of the Rocky Mountains, this event was unusual in that it affected a widespread area and spanned one full day. Winds in excess of 100 mph along the Rocky Mountain Front typically occur once every couple of years. In the next part the general synoptic situation will be discussed along with how it related to the general high wind event. Then the focus will shift to the extremely strong winds in excess of 100 mph.

Discussion

The pattern forecasted by the models was similar to a frontal Chinook pattern for high winds along the northern east slopes of the Montana Rocky Mountains . In this pattern a broad upper ridge is over the western U.S. with surface high pressure in the Great Basin and lower pressures in Canada. A vigorous shortwave is then forecast to flatten the upper ridge. An associated surface low moving across southern Canada increases the surface downslope pressure gradient. The event ends as the passage of the surface cold front associated with the surface low results in weaker downslope pressure gradients, and the flow aloft becomes less perpendicular to the Rocky Mountains. This event differed from the typical pattern in that the shortwaves moving across southern Canada during the period of highest winds were relatively weak. This situation also differed from the typical pattern in that the cold front that resulted in the ending of the event was not associated with these shortwaves, but with a stronger shortwave late on the 22nd.

The 12z February 21 model runs of the ETA and AVN were in good agreement on general forecast trends through the wind event. The models forecast one 500mb vorticity center over southeastern British Columbia at 06z February 22 with a second one over southern Alberta (figure 2). At 12z February 22 the vorticity centers were over southern Alberta and southern Saskatchewan, respectively (figure 3).

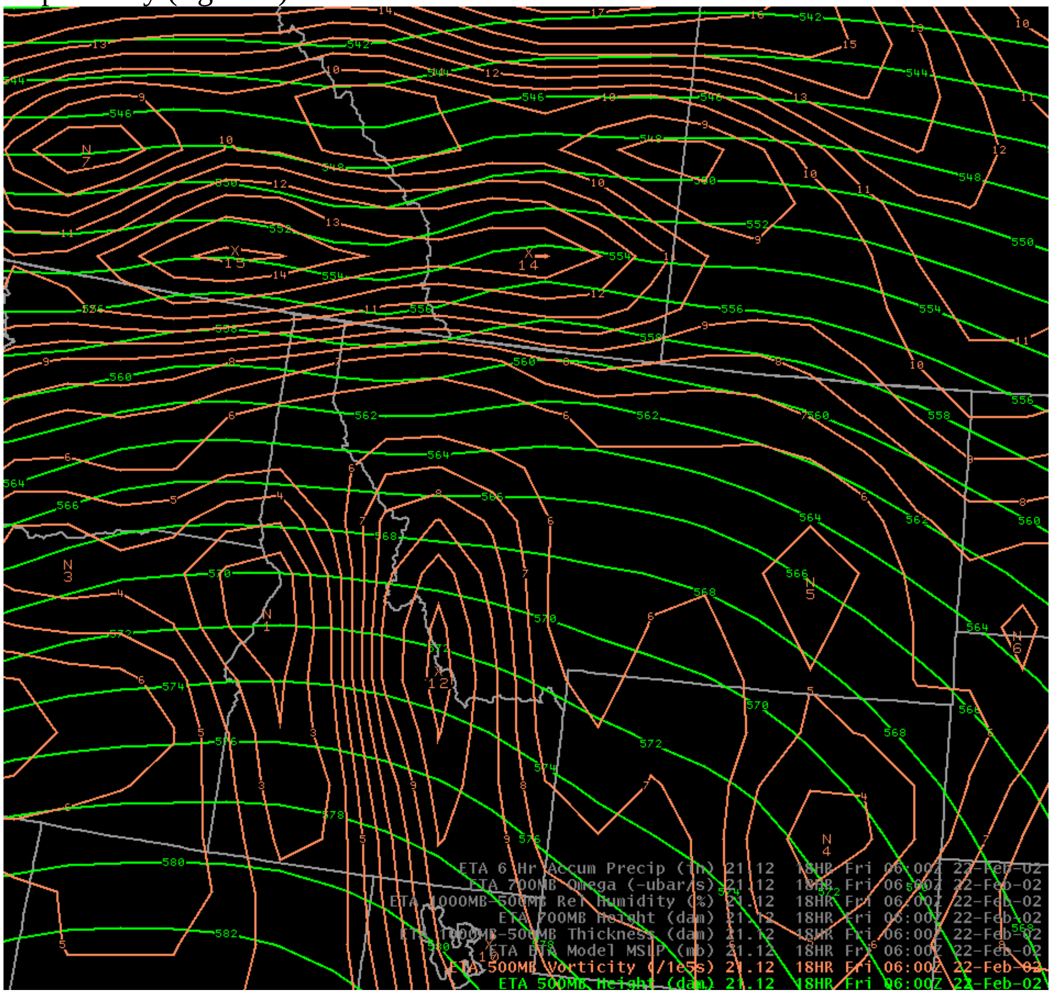

Figure 2 – 18hr ETA height and vorticity forecast valid 06z February 22

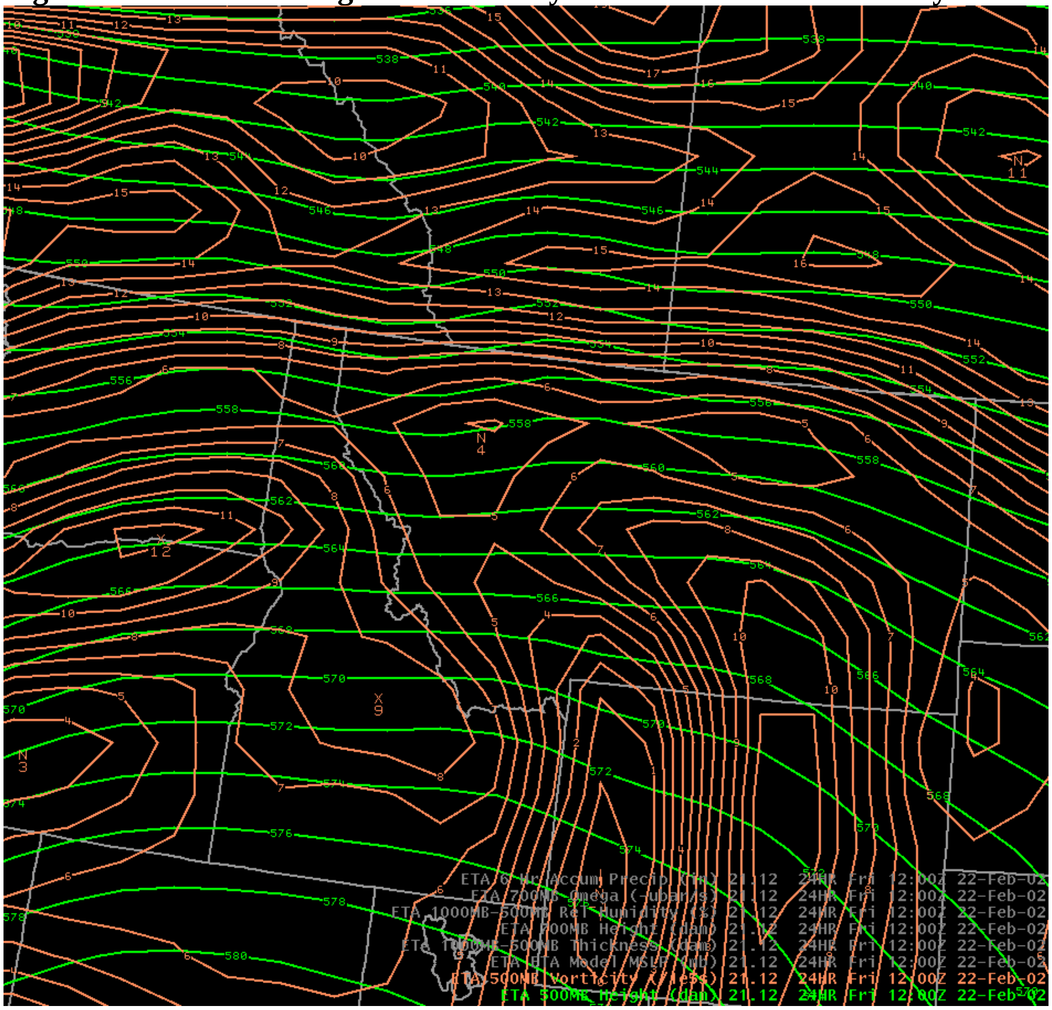

Figure 3 – 18hr ETA 500mb height and vorticity forecast valid 12z February 22

The accompanying surface low was forecast to move to southern Alberta at 06z (figure 4) then to southwest Saskatchewan at 12z (figure 5) and to southeastern Saskatchewan at 18z (figure 6).

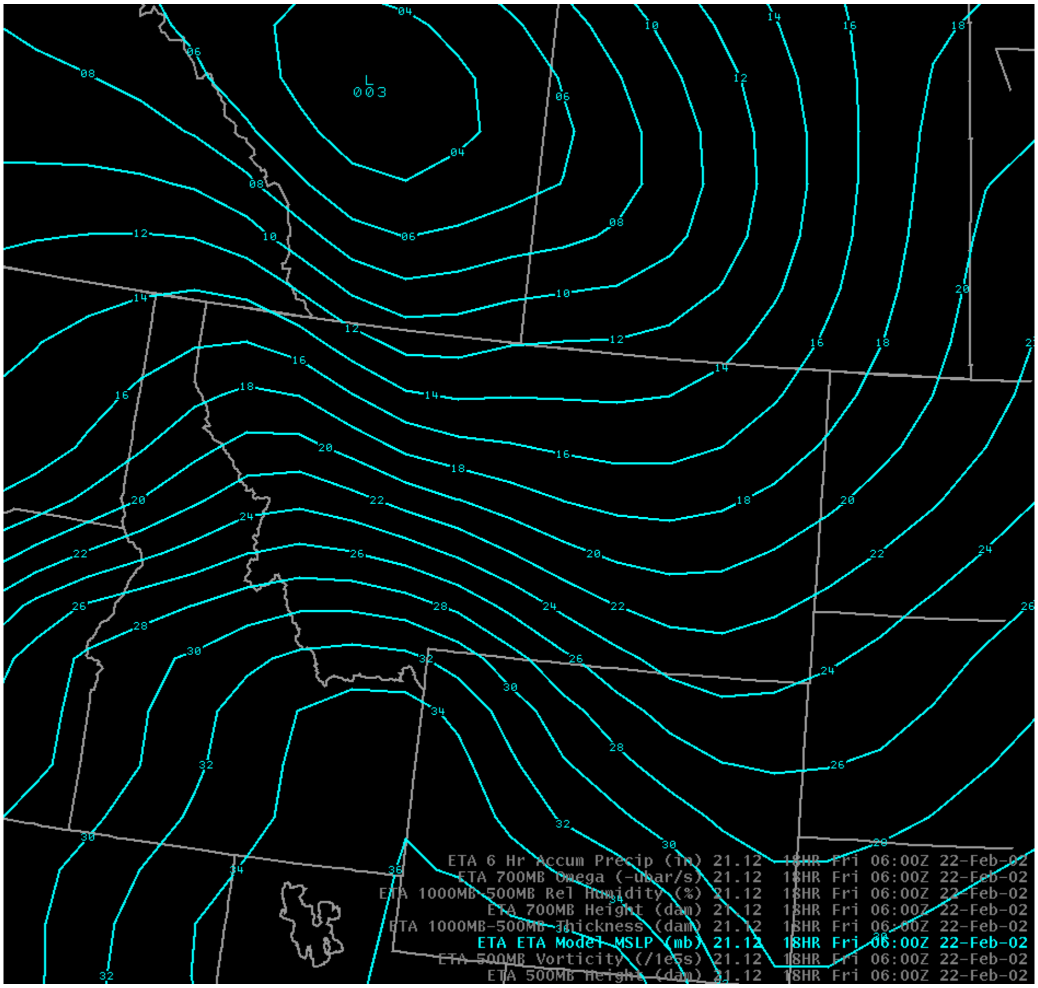

Figure 4 – 18hr ETA Mean Sea Level pressure forecast valid 06z February 22

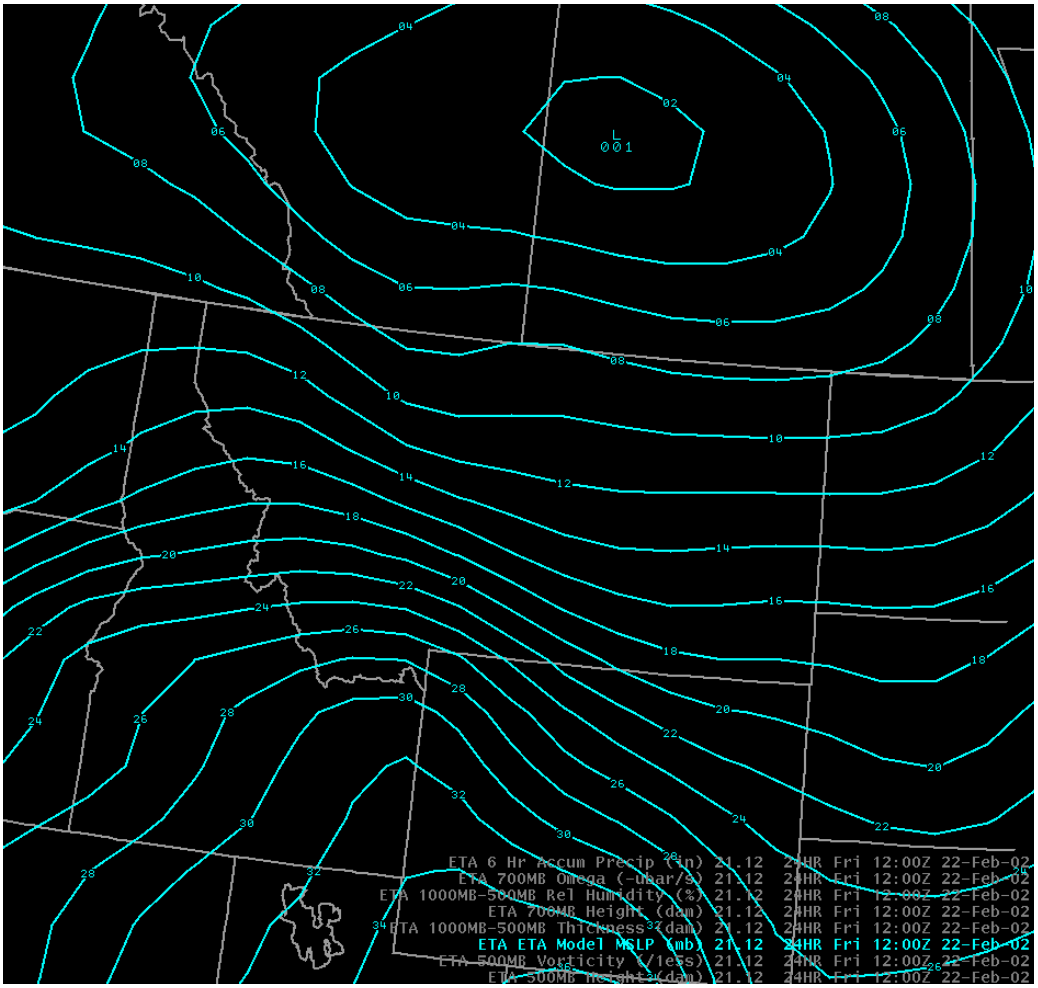

Figure 5 – 24hr ETA Mean Sea Level pressure forecast valid 12z February 22

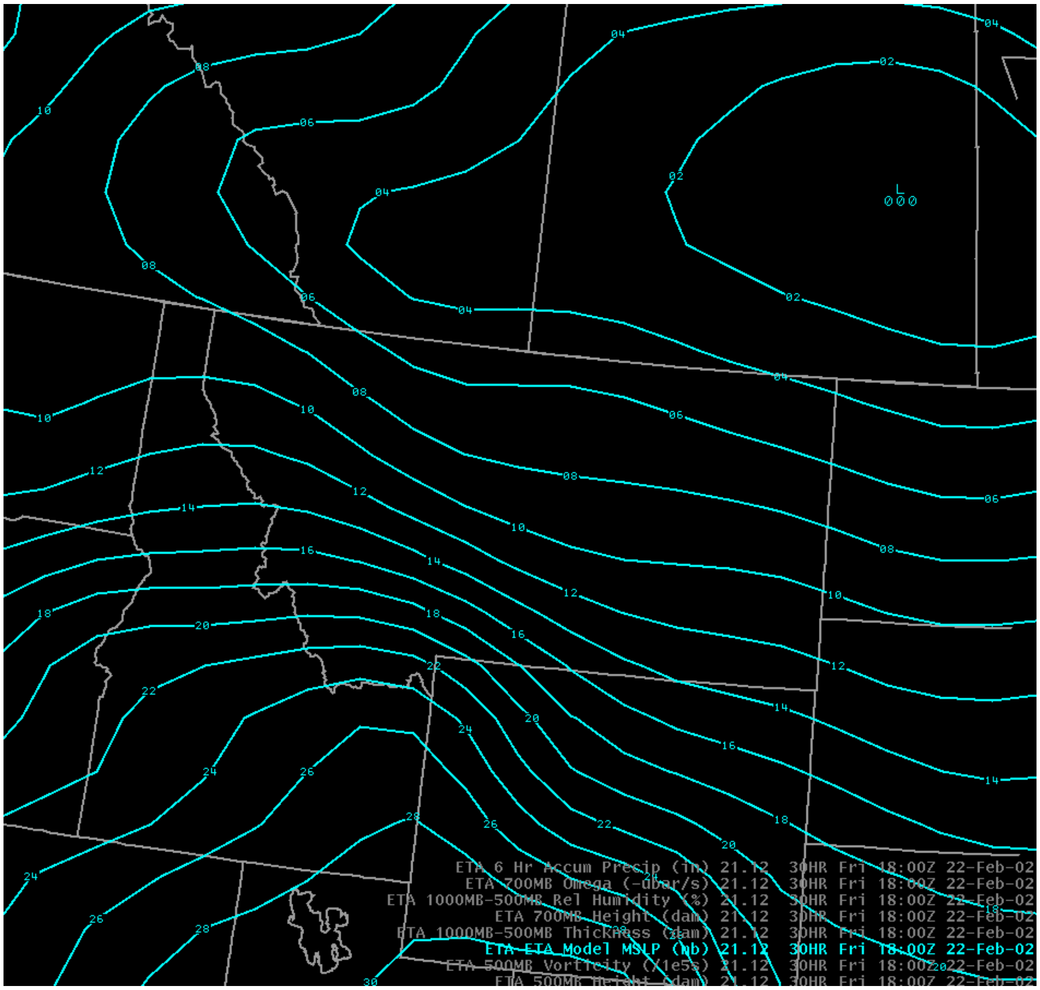

Figure 6 – 30hr ETA Mean Sea Level pressure forecast valid 18z February 22

At 700mb an area of winds in excess of 60kts was forecast to move into northwest Montana at 00z February 22 and extend back to Washington (figure 7). By 06z the band was to move a little farther east and south over northwest Montana (figure 8). By 12z the models forecast an area of winds in excess of 70kts over central Montana (figure 9).

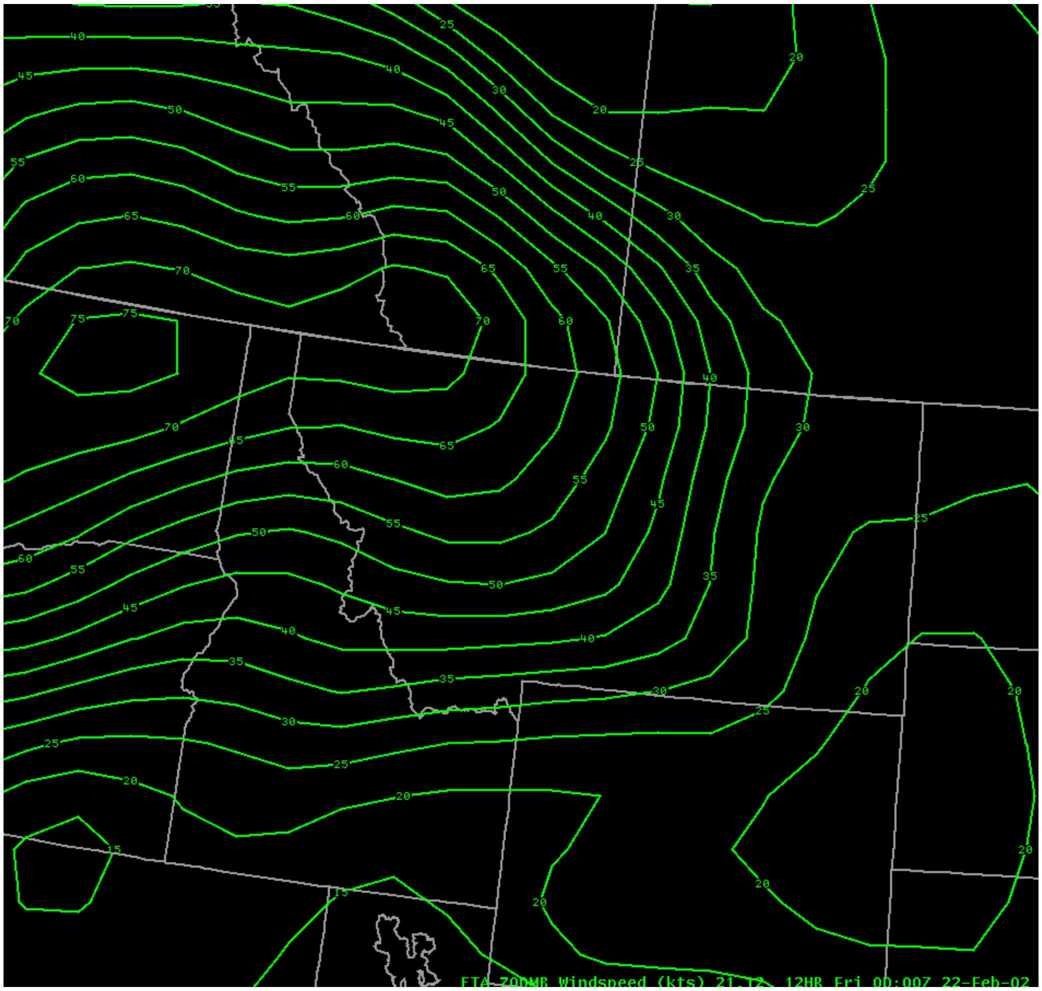

Figure 7 – 12hr ETA 700mb isotachs forecast valid 00z February 22

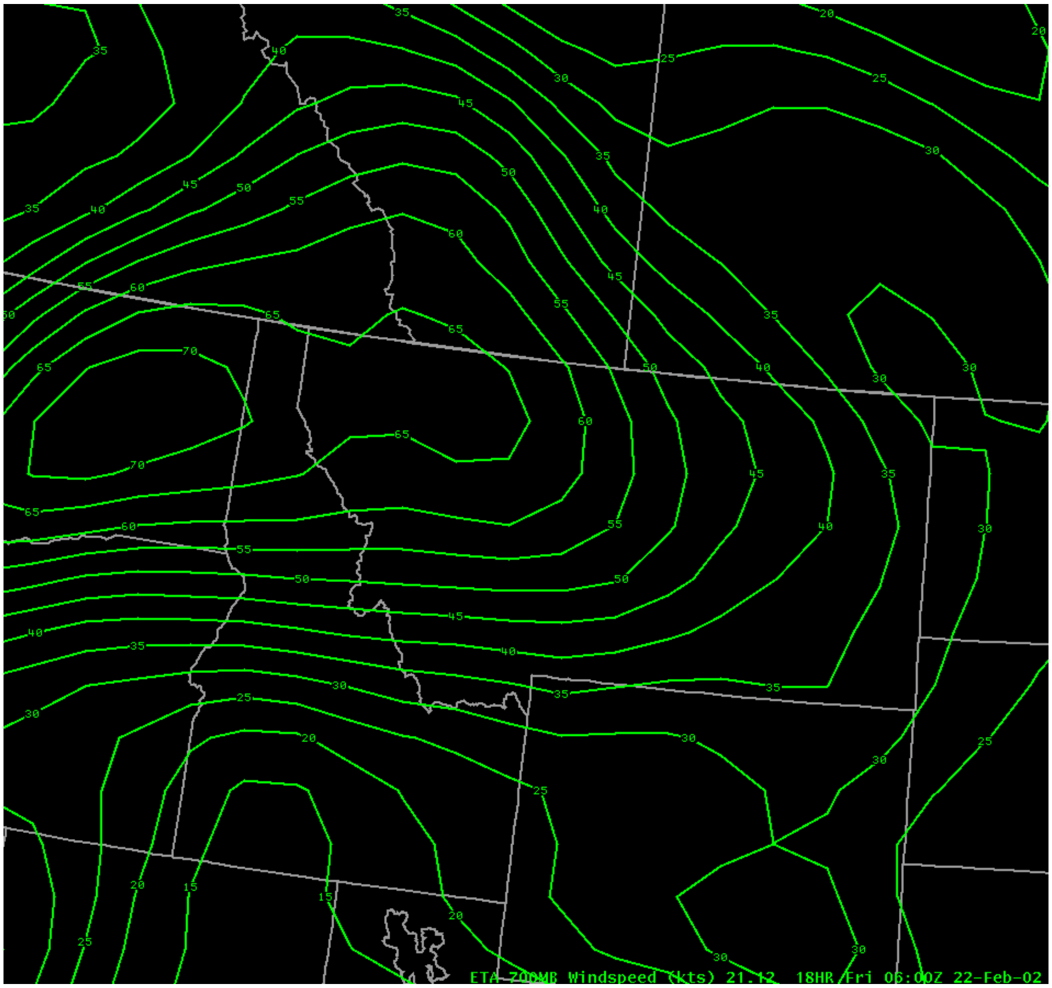

Figure 8 – 18hr ETA 700mb isotachs valid 06z February 22

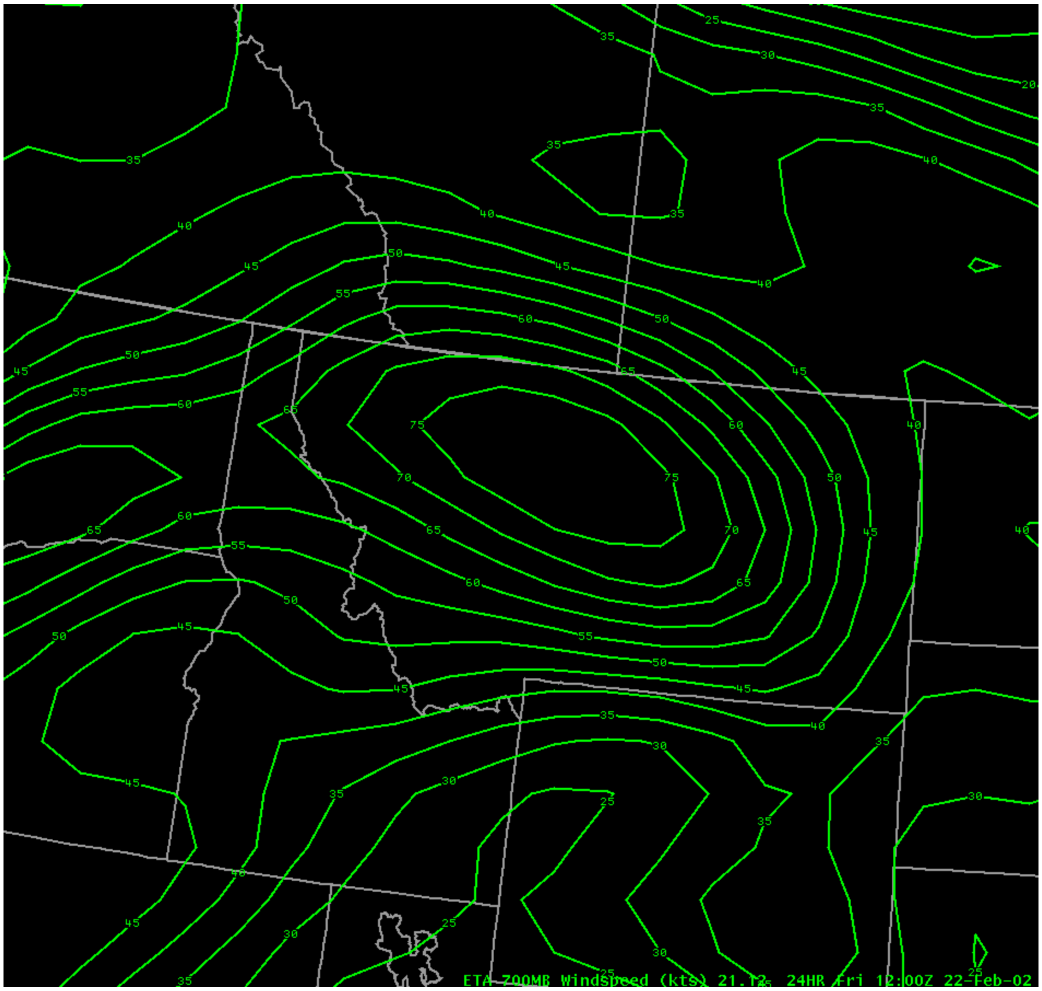

Figure 9 – 24hr ETA 700mb isotachs valid 12z February 22

This band was forecast to remain over central Montana during the day. One significant difference between the 2 models was the AVN forecast winds at 700mb to be about 10kts stronger than those of the ETA over northwest Montana at 06z. The 00z runs of the ETA and AVN were again similar to one another in a general sense with their forecasts of surface and upper air features. Both models were a little slower than their corresponding runs from 12z with the shortwaves and the surface low but had similar intensities with both shortwaves and the surface low. The model runs now were in good agreement with their forecasts of 700mb winds over northwest Montana. These winds were a compromise between the stronger winds of the 12z run of the AVN and the relatively weaker winds of the 12z run of the ETA.

Although the reports of high winds covered the period from the afternoon of the 21st to the afternoon of the 22nd, the strongest winds were concentrated during the period from late in the evening on the 21st to the early morning of the 22nd and were located along the Rocky Mountain Front. These high winds were likely the result of mountain waves.

Mountain wave theory postulates that mountain waves form above and downwind of topographic barriers when strong winds blow with a significant vector component perpendicular to the barrier in a stable environment. If this stable environment is above the topographic barrier a critical layer can be formed which will not allow the vertically propagating energy associated with the mountain wave to continue upward. Instead the energy is deflected off the critical layer back toward the surface.   This can lead to the development and/or strengthening of downslope windstorms. Forecast soundings and cross-sections from the 12Z ETA model run indicated that a stable layer was forecast near the mountaintops of the Rocky Mountain Front along with strong winds nearly perpendicular to the Rocky Mountain Front. A 9hr forecast sounding from the RUC for a point west of Chouteau at 06z on the 22nd is shown in figure 10. This was about the time and location of a report of wind gusts in excess of 100 mph (figure 10.)

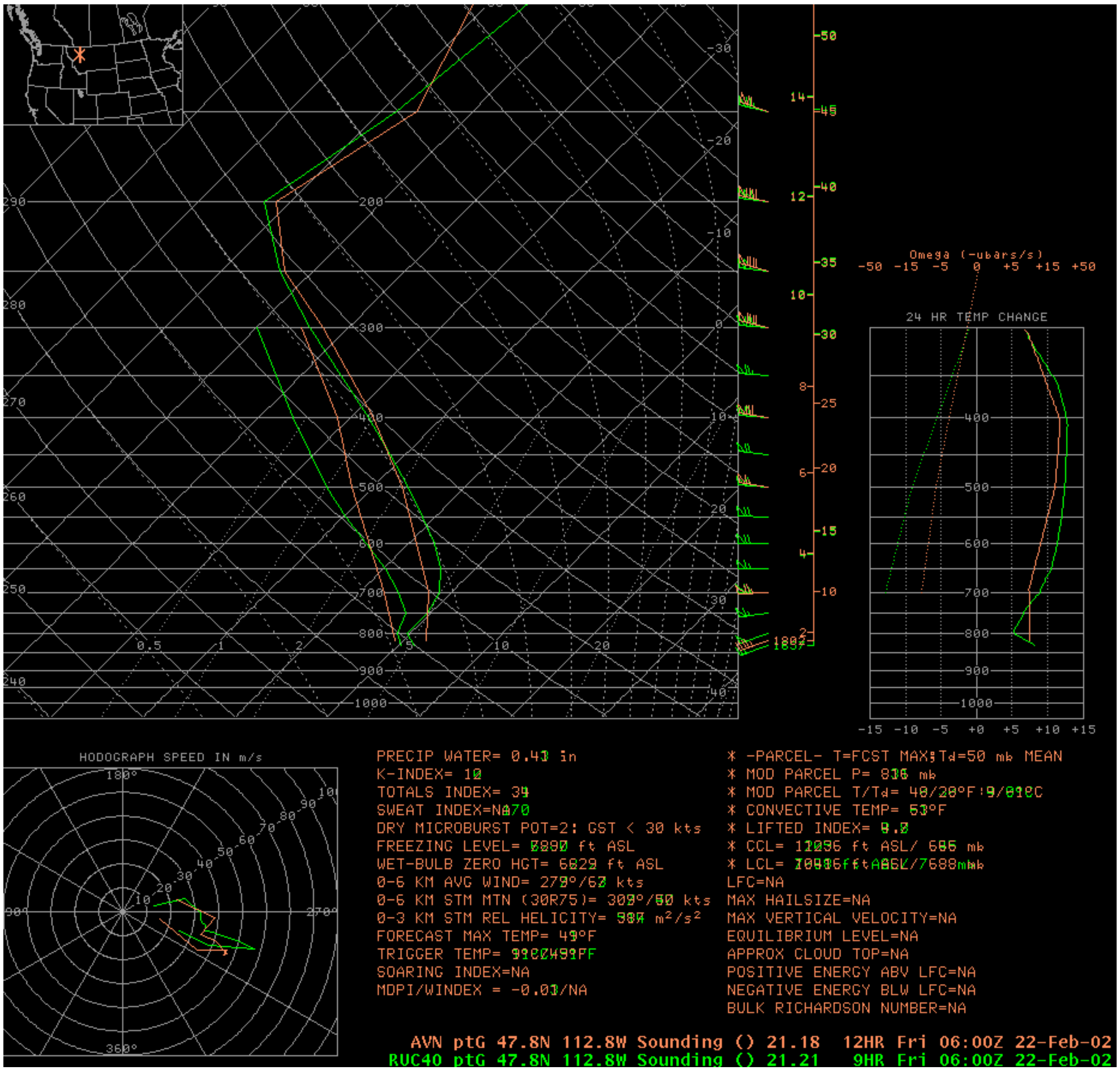

Figure 10 – 9hr forecast sounding from the RUC and 12hr forecast sounding from the AVN west of Chouteau, Montana, both valid 06z February 22

This sounding shows the two conditions mentioned above. In addition it shows a nearly adiabatic lapse rate below the more stable layer. This condition has also been noted in some down slope windstorms. It is important to note the ETA and AVN models had a more "smoothed" forecast sounding than the RUC forecast sounding and did not indicate as strong a threat for high winds. In particular they did not indicate as stable an airmass over the mountaintops as the RUC.

The Froude number has been used to indicate the potential for mountain wave activity. The Froude number expresses the ratio between kinetic energy (wind speed) and potential energy (stability times mountain height). Froude numbers equal to or slightly larger than one, indicate that there is the likelihood of mountain wave activity. From the above RUC forecast sounding the wind speed near the mountaintops (approx. 8000 feet MSL) is 65 kts and the sounding indicates a nearly isothermal layer. The height of the mountains above the surrounding terrain is 4500 feet. Using these values a Froude number of 1.27 was computed. This indicates mountain waves would certainly be expected.

Although most of the high wind reports were likely the result of mountain waves, some of the reports from the afternoon of the 22nd were likely due to the mixing of stronger winds aloft to the surface in an unstable lower atmosphere. Figure 11 shows the 9hr forecast sounding for Cut Bank (CTB) from the 12z February 22 run of the MESOETA adjusted for a surface temperature of 53 degrees.

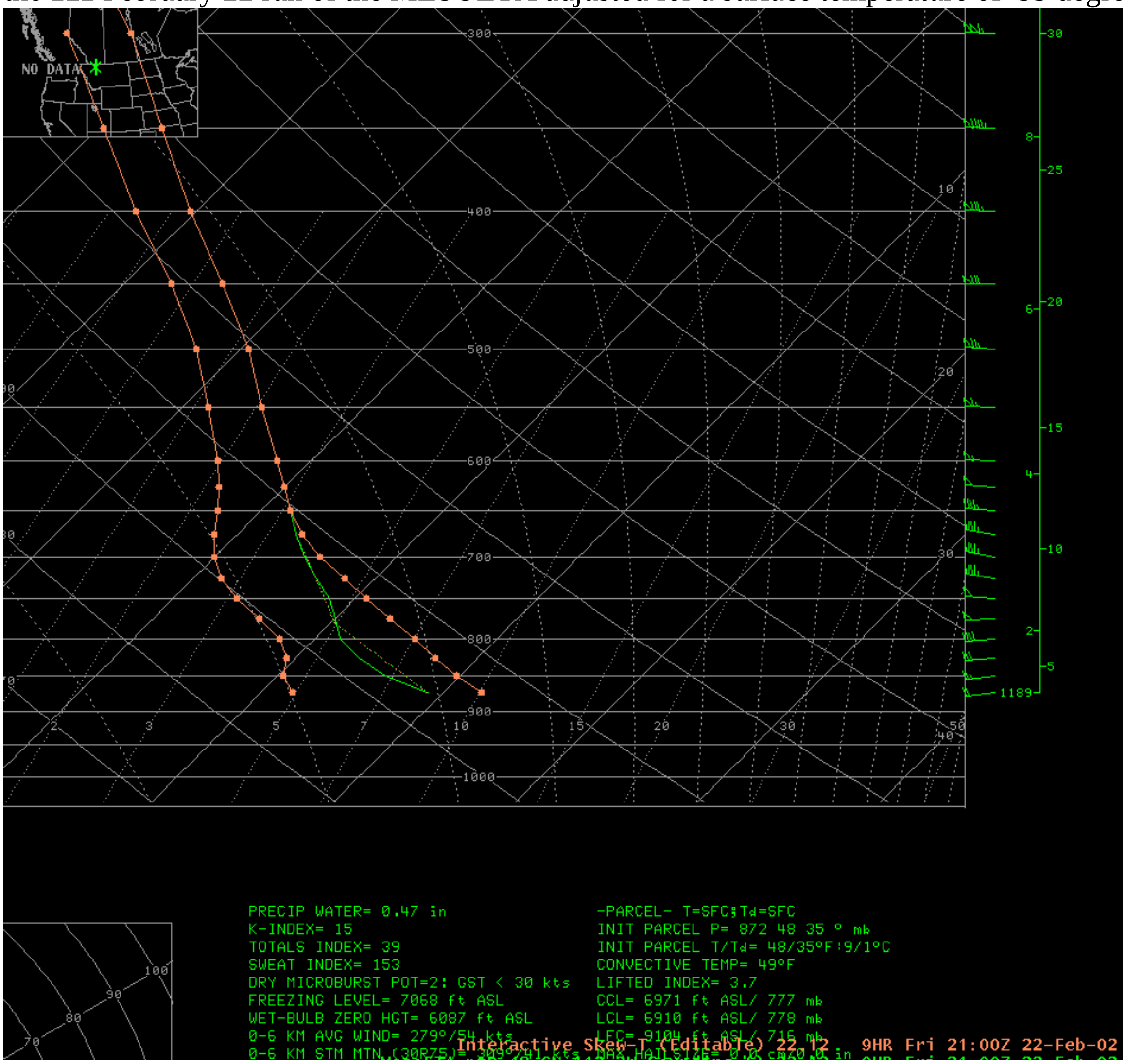

Figure 11 – 9hr forecast sounding from the MESOETA for Cut Bank valid 21z February 22

Note the winds of 50 kts above and below 750 mb and the nearly adiabatic lapse rate through 700mb.

Summary

The problem for the forecaster becomes how to determine when strong winds blowing perpendicular, or nearly perpendicular, to the mountains will generate downslope windstorms. Models used by operational meteorologists do not have the resolution to adequately resolve mountain waves. Forecasters need to realize that the stronger the winds blow perpendicular to the mountains, does not necessarily mean the stronger the lee slope winds will be. Stability plays an important role in determining how strong the lee slope winds will be. It appears from this case that the stable layer near the tops of the mountains of the Rocky Mountain Front contributed to this downslope windstorm. Although the RUC model available to the forecaster on AWIPS only goes out 12hrs, it can, at times, better depict temperature details in the lower troposphere. This event also shows that more than one mechanism can occur in a high wind episode. The mixing down of stronger winds aloft in a nearly unstable airmass was the likely cause of a few reports of high winds towards the end of the event.