Analysis of a MesoScale High Wind Event in Carson City, Nevada
January 7th, 2006
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On the evening of January 7th, 2006, a wind gust of 98 mph was recorded by a radio station in Carson City at 800 PM LST. The instrumentation was destroyed and there was damage to several buildings in a two block area down wind from the radio station. A fitness center was also damaged and 8 cars in the parking lot had their windows blown out. The damage was very localized (Fig. 1).

The National Weather Service Office in Reno had issued a short term forecast for the area at 709 PM LST for frequent winds gusts over 50 MPH. In addition, a Wind Advisory was issued for the affected area at 738 PM LST. Gusts of 55-60 MPH were highlighted in this product. Winds at the Western Nevada Community College, approximately 5 miles northeast of the damage area, had been gusting to over 50 MPH since 510 PM LST, but other sensors in the area mostly had wind gusts less than 40 MPH. There were three sensors, Washoe Valley NDOT (Fig. 2), Western Nevada Community College (Fig. 3), and NDOT Jct395/50 (Fig 4), that all had maximum wind gusts during the event just prior to the damaging winds report in Carson City. Any damage that may have occurred near these other sensors was not reported to the NWS. The Mount Rose wind sensor, not pictured in the Figure 1, is located on a 9600 foot peak 15 miles to the north northwest of Carson City also had wind gusts to 70 MPH (Fig. 5).

A strong jet stream over northern California and southern Oregon was crossing a cold front which was moving southeast through northern California into western Nevada. The visible and IR satellite picture (Fig. 6 and 7), at 22Z shows the well defined cold front and the crossing jet streak clouds. The IR (Fig. 8) satellite at 0245Z, just prior to the event shows the front and jet streak less well defined.

An analysis of the jet wind speeds over northern California and southern Oregon (Fig. 9) indicated 115 KTS at 35K feet from an aircraft over northern California and 80 KTS from the 00z 8 January 2006 sounding at Reno. The wind speed at Medford was missing at 250 MB but was 100 KTS at 400 MB (Fig. 10). The RUC maximum wind speed forecast for 03Z from the 07/21Z run (Fig. 11) seems to depict the strength of the winds over northern California and southern Oregon quite well.

Soundings from Reno, approximately 40 miles north of Carson City, at 07/12Z (Fig. 12) show strong cooling from the previous 24 hours above 800 MB and a critical level, the mid level inversion, between 700-650 MB, which is near the Sierra Nevada ridge top. The 08/00Z sounding (Fig. 13) shows strong cooling below 800 MB, which is near the surface. Also, there is significant drying with PW's dropping from .30 to .17 between 07/12Z and 08/00Z. The critical level has lowered to 750 MB which would be below ridge top. Forecasters have noticed this lowering critical level, an indication of descending mid level winds, in other wind events.

Looking at a cross section of the 07/21Z RUC valid at 08/01Z (Fig. 14), significant negative omega is evident on the east side of the Sierra over western Nevada. The cross section is oriented parallel to the front and perpendicular to the jet. There is also an 80 KT wind max northeast of Reno. This suggests that the Reno and Carson City area was to the right of the exit region of the jet.

The forecast problem was getting lead time on a small scale wind event when the forecaster's analysis of the large scale meteorology that went into the afternoon forecasts indicated only wind gusts to 35 mph. Looking at the 07/21Z RUC forecast for wind gusts (Fig. 15) valid at 08/00Z an area of 30 to 35 MPH gusts do show up as a maximum in the area where the damaging winds occurred. But by 03Z (Fig. 16), one hour prior to the wind damage, the RUC is forecasting wind gusts less than 25 over the entire area. This has also been noticed by forecasts as a diurnal characteristic of the models, lowering the boundary layer winds after 00Z.

As shown in Fig. 6, there was cloud pattern wave activity in the area. Topography seems to have played a strong role in the wave activity dropping to the surface. Carson City is at an elevation of approximately 4200 feet and the terrain rises rapidly westward to between 8000 and 9000 feet along the east shore of Lake Tahoe. The localized nature of the high winds also suggests wave activity.

In conclusion, the combination of a strong jet creating wave activity and a cold front making the temperature profile favorable for mountain wave activity to mix to the ground contributed to the local high winds. The RUC and other models did not forecast the strength of the boundary layer winds, although they did give the forecaster direction as to where the strongest winds might be. This event does, however, provide clues to look for in anticipating high wind events in the lee of the Sierra Nevada, e.g. a passing cold front to destabilize the atmosphere, a strong mid and high level jet oriented to produce dynamic downward motion, and a descending critical level. The forecasting of breaking mountain waves creating high wind events in the western valleys of Nevada continues to be a problem that requires more study.

Figure 1. Area of Damage and relationship to other high wind reports on evening of January 7, 2006.

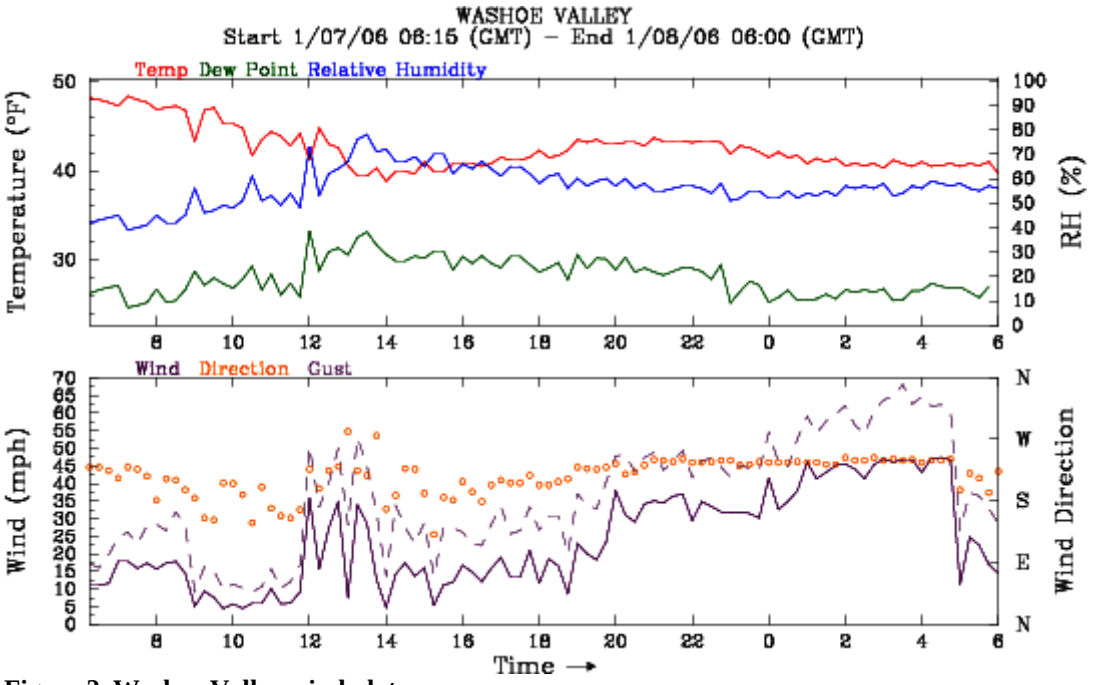

Figure 2. Washoe Valley wind plot.

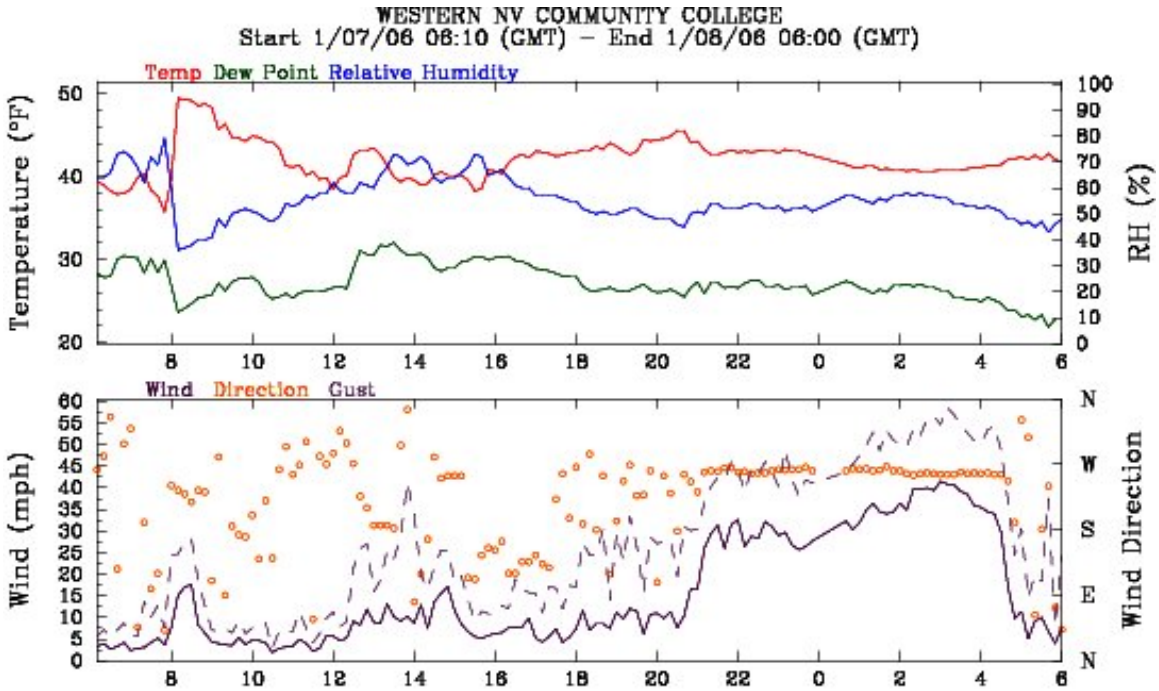

Figure 3. Western Nevada Community College wind plot.

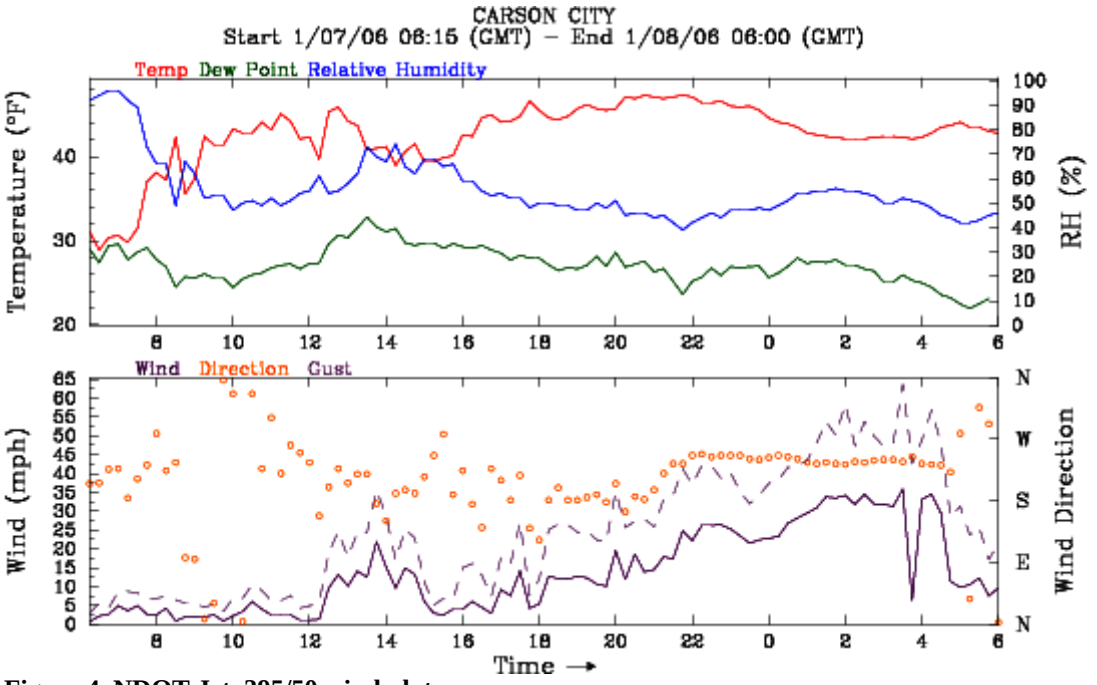

Figure 4. NDOT Jct 395/50 wind plot.

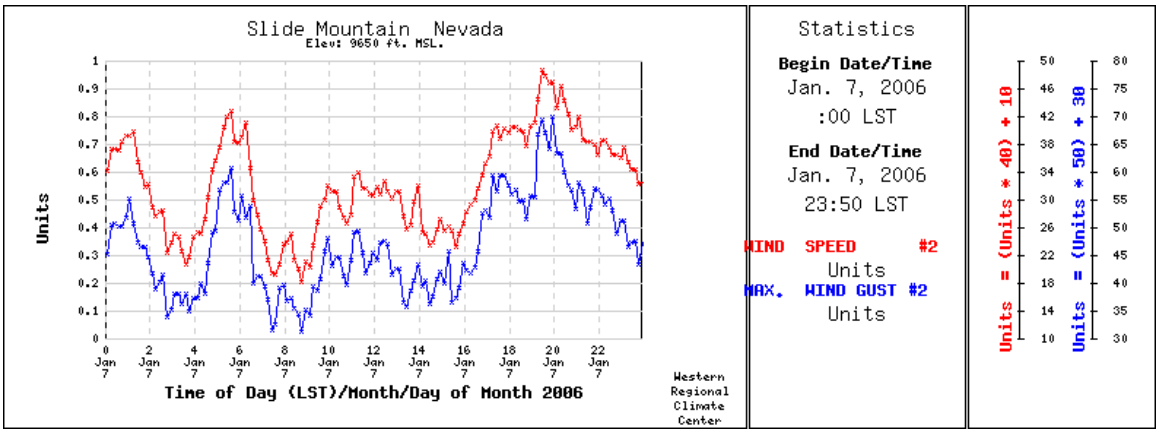

Figure 5. Slide Mountain wind plot. On the gust scale, 0.8 units equals 70 mph.

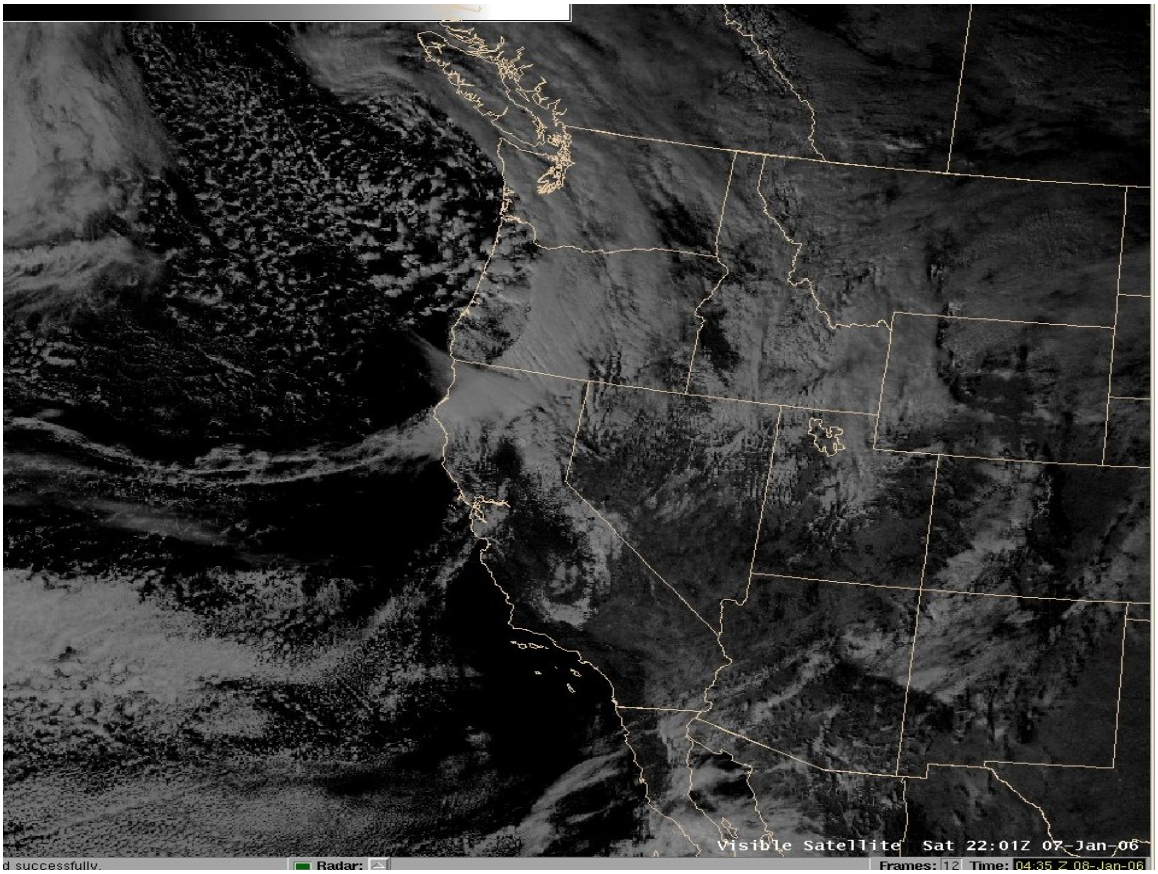

Figure 6. 07/22Z visible satellite image. Jet streak cross frontal boundary.

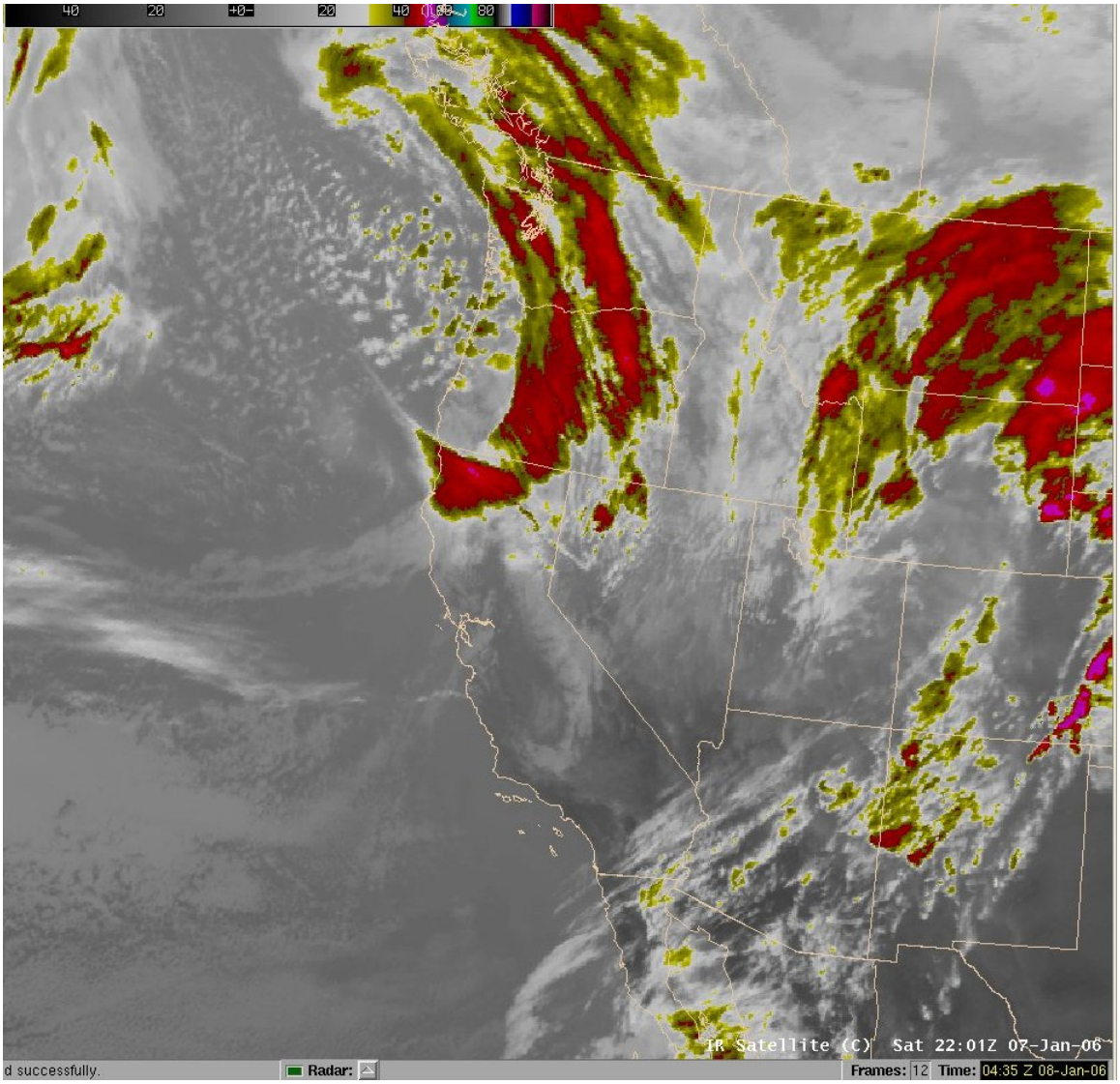

Figure 7. 07/22Z IR satellite picture. Jet streak crossing frontal boundary.

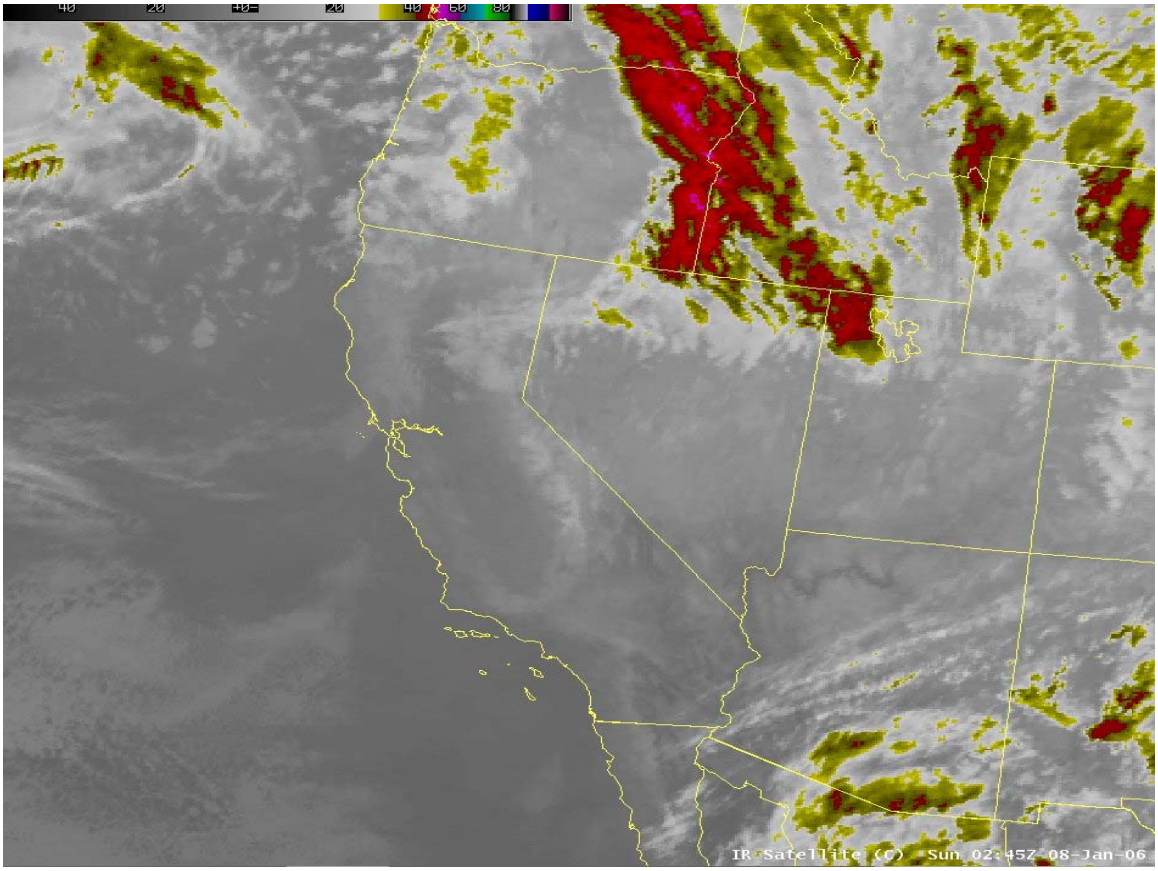

Figure 8. 08/03Z IR satellite pictures. Frontal boundary and jet streak less organized.

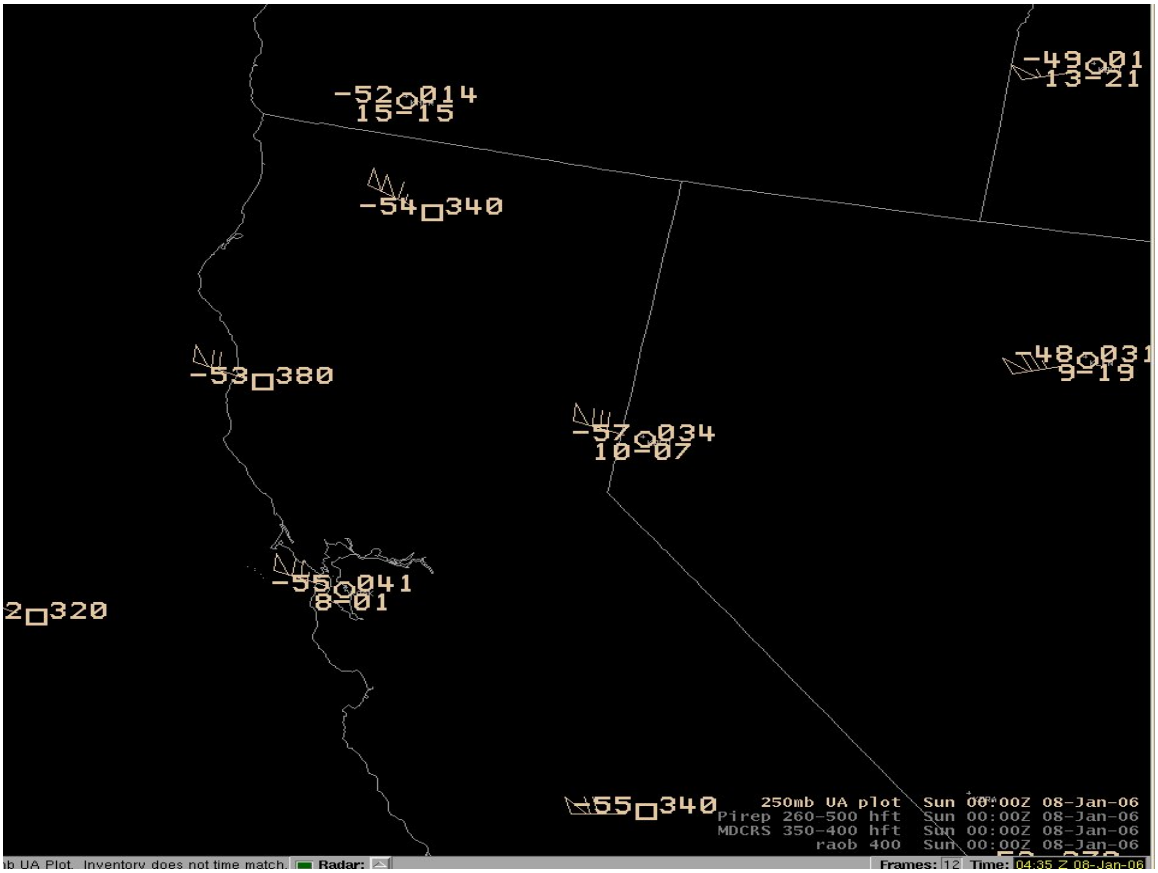

Figure 9. 250 MB winds and aircraft reports.

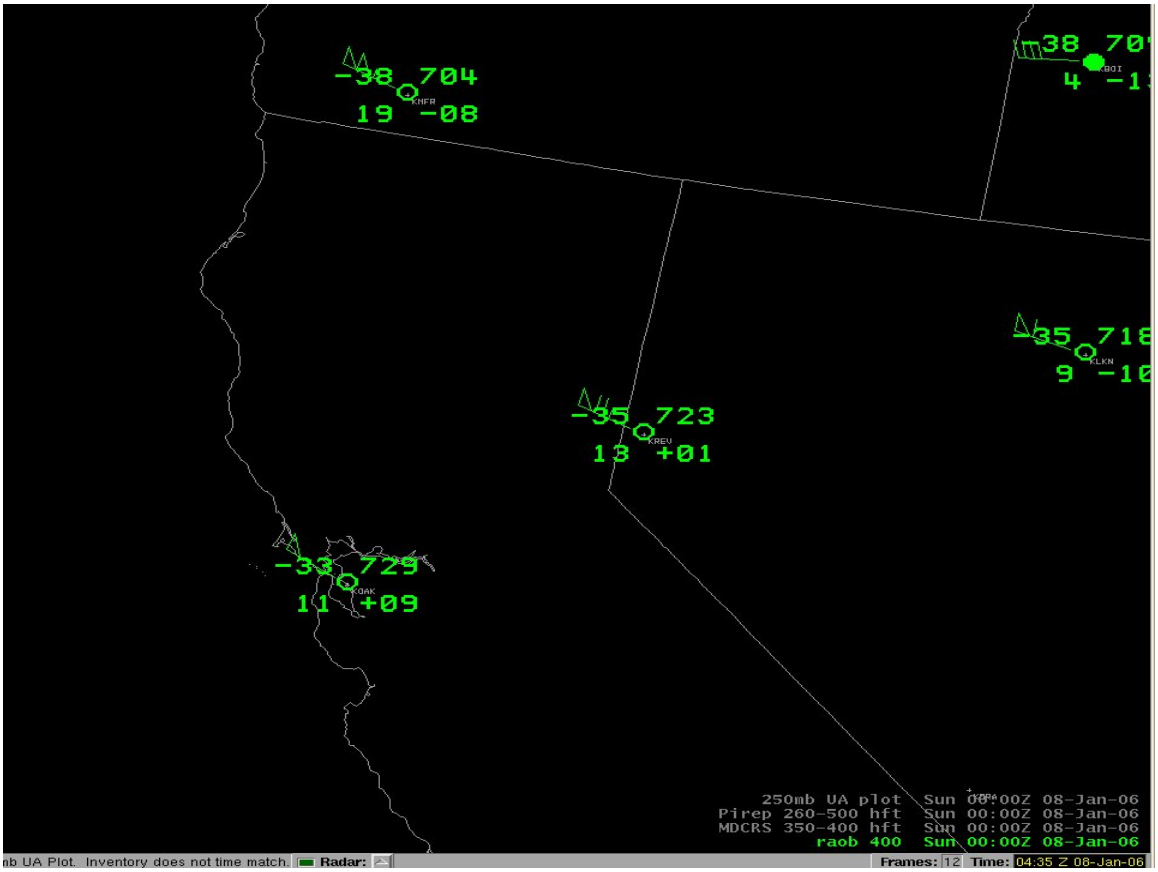

Figure 10. 400 MB winds.

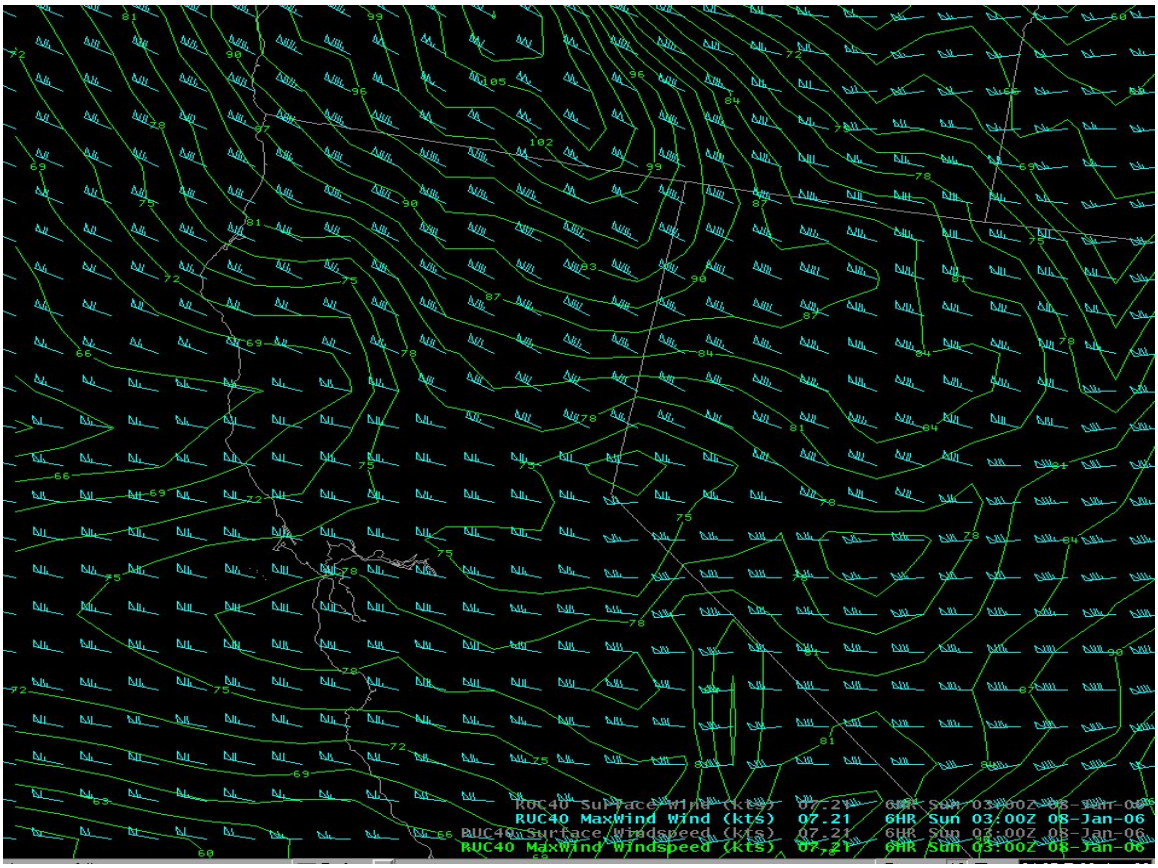

Figure 11. 07/21Z RUC 6 hour maximum wind forecast valid 03Z January 8, 2006.

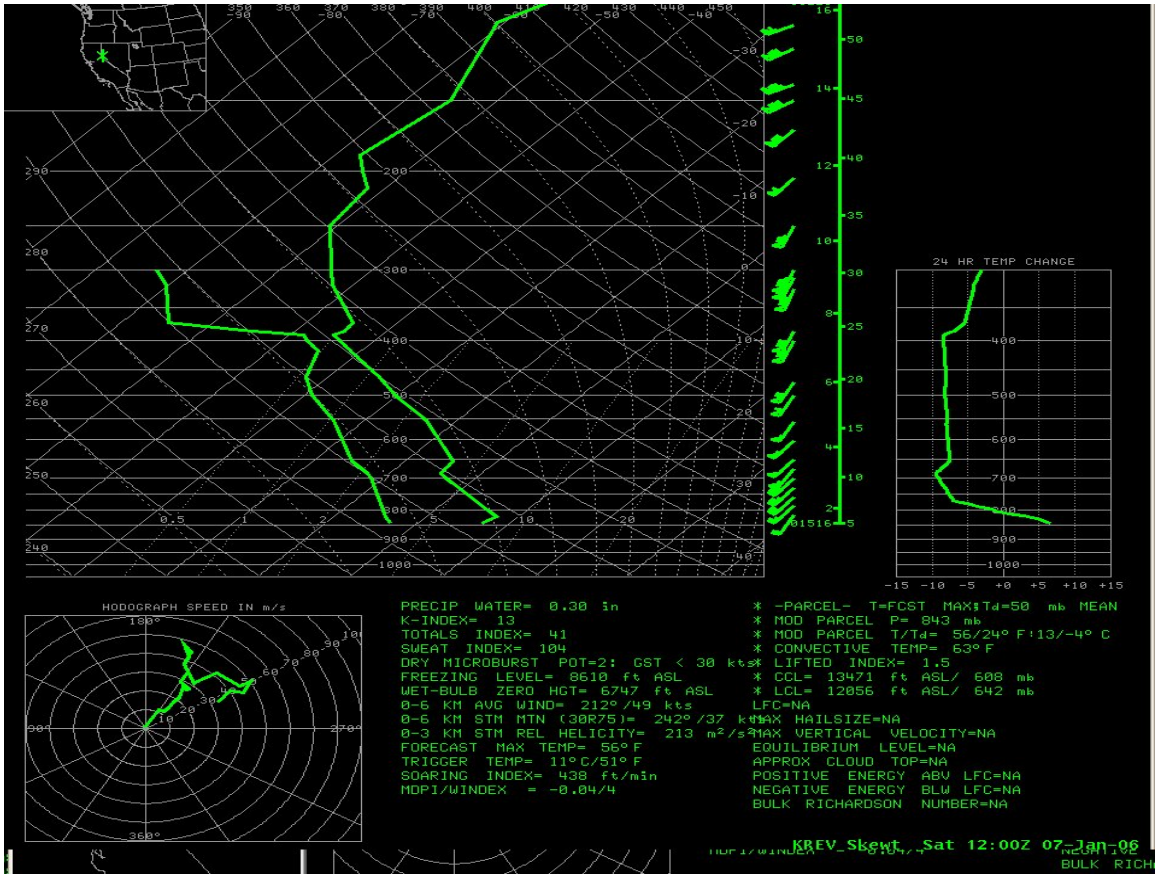

Figure 12. Reno 07/12Z sounding.

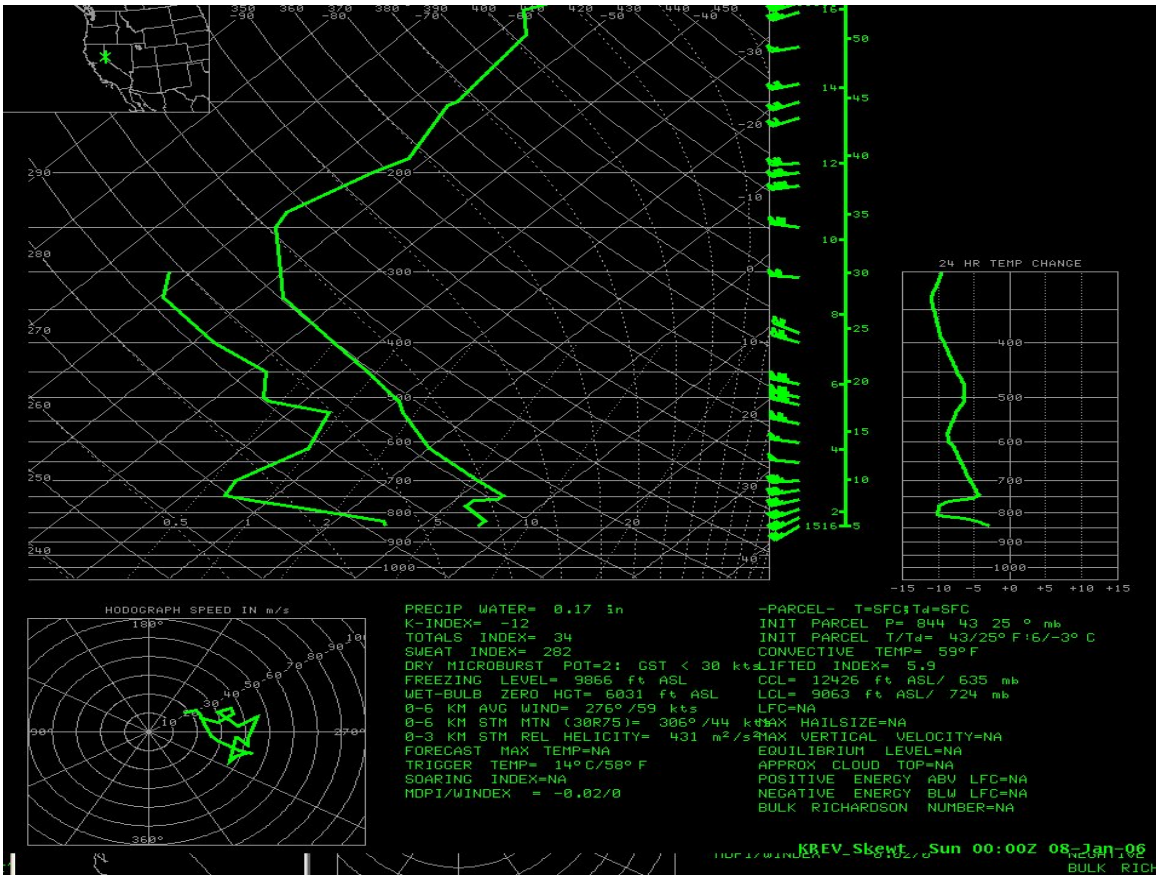

Figure 13. Reno 08/00Z sounding.

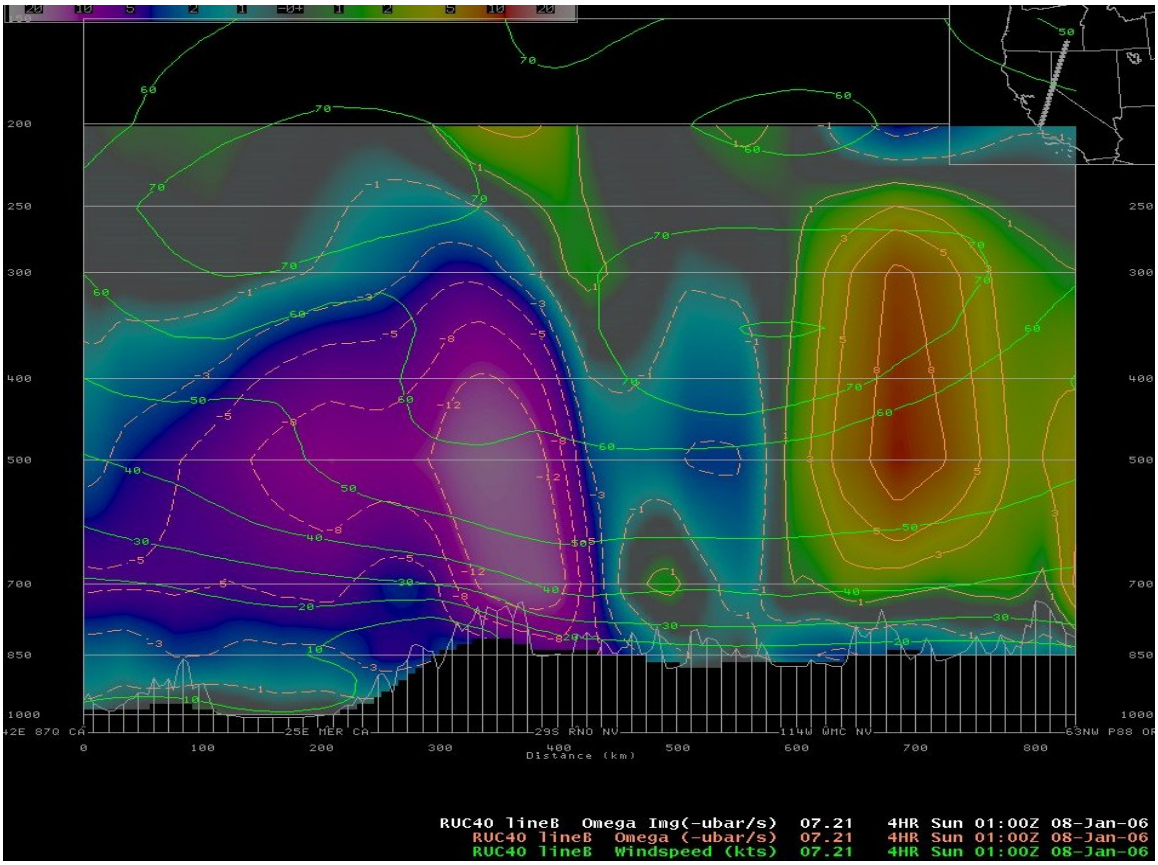

Figure 14. 07/21Z RUC valid 08/01Z.

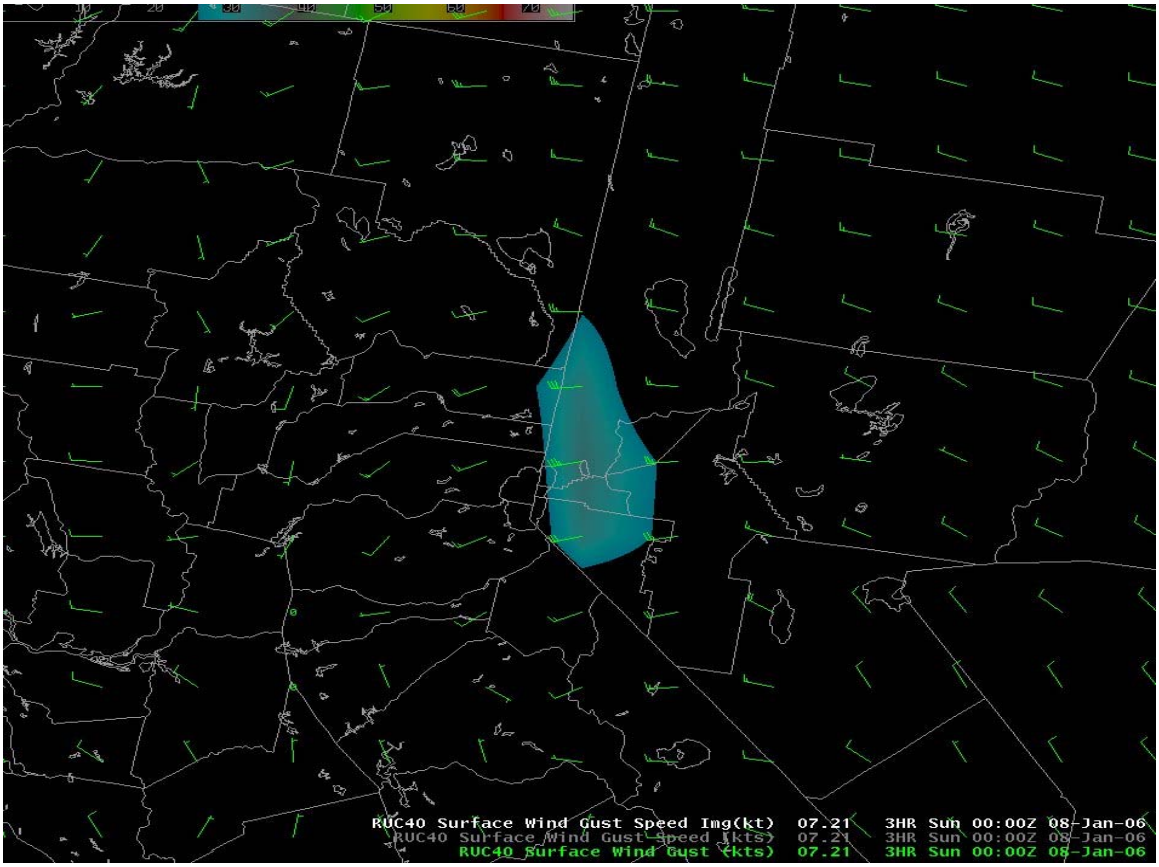

Figure 15. 07/21Z RUC surface wind gusts forecast valid 08/00Z.

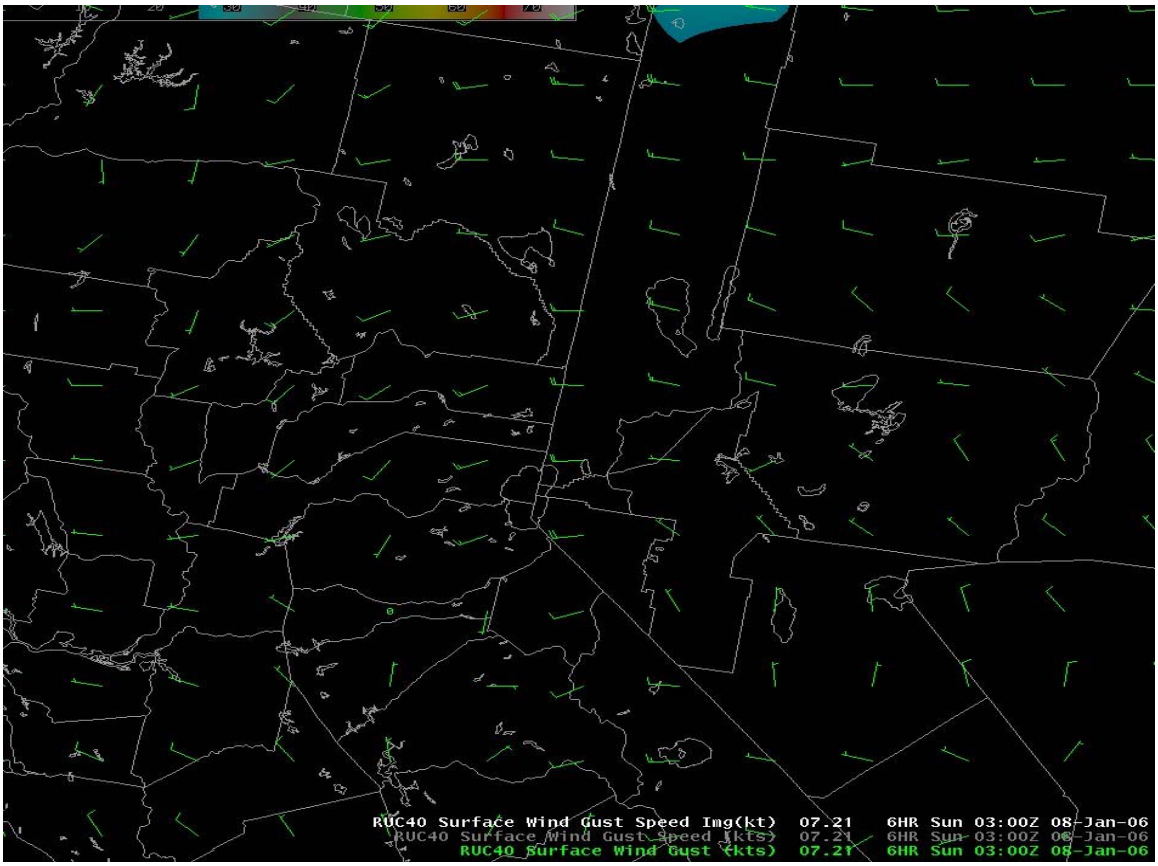

Figure 16. 07/21Z RUC surface wind gusts valid 08/03Z.