December 17-18 2002 Winter Storm, Southeast Arizona - A WES Case

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Introduction

In what started from an almost zonal flow, the mountains of Southeast Arizona received significant snowfall from a strong Pacific storm on December 17th and 18th of 2002. While the overall large scale geometry of the system was rather open (no closed low) and not as well defined as many winter storms, strong and deep jet streaks guided a series of impulses off the Pacific and through Arizona with snowfall amounts reported as high as 20 inches.

Summary

On December 15, as a ridge was shifting east from the southwestern U.S., a strong storm was digging toward the Pacific Northwest coast from origins near the Gulf of Alaska. On the 16th, it became clear that a strong upper jet approaching 160 KTS (Figure 1) coupled with a strong 50+ kt low level jet (Figure 2) would help to bring significant synoptic-scale forcing and deep moisture to the desert Southwest. This first impulse sagged far enough south to cause significant upslope problems for Arizona on Tuesday the 17th. Initial jet dynamics aimed at the Mogollon Rim during the morning gradually shifted south as the day progressed (Figure 3). As the jet nosed into the region during the early morning hours of the 17th, southeast Arizona was still fairly dry in the surface to 700mb layer with precipitable water values under 0.4 inches. However, the airmass moistened up very quickly with an effective combination of deep moisture advection and a quick moistening from the top-down. The combination of jet dynamics and deepening moisture subsequently generated widespread convective bands enhanced by strong upslope flow from the west and southwest by daybreak on the 17th. This resulted in significant terrain-enhanced precipitation. An early sign of this was a quick 5 inches reported by Hannagan Meadow by 8 AM MST on the 17th. Initial snow levels near 8000 feet were noted from spotter reports and RAWS data, and were observed to fall to near 5500 to 6000 feet during the day Tuesday with strong cold air advection.

As the jet sagged and initial dynamics shifted through the CWA from the north during the day of the 17th, the focus from the first impulse shifted from northern Greenlee County into the mountains farther south and west in Graham and southern Greenlee Counties. ADOT personnel reported 4 to 6 inches above 6000 feet on Mt. Graham (Graham County) at 11 AM MST. During the afternoon, strong convective bands (Figure 4) continued to be helped along by upslope, deepening moisture, and jet dynamics to generate significant snow over the other mountains of southeast Arizona by late in the day. A subsidence field and mid-level drying behind this first impulse caused a temporary clearing trend by early evening on the 17th.. A second impulse carving into the back side of the mean trough position then dove through Southeast Arizona after midnight on the 18th, and brought additional snowfall as it easily tapped into the residual lower and mid level moisture (Figure 5). Radiational cooling from the temporary clearing and drying helped bring snow levels down to near 3500 feet followed by additional snow accumulations above 4000 to 5000 feet in the early morning hours of the 18th.

Verification and Conclusions

This was a well advertised storm, with snowfall totals of 20 inches at Hannagan Meadow, 13 inches at Mt. Graham, 8 inches at Mt. Lemmon, and 4 to 6 inches on the other mountains of southeast Arizona. WFO Tucson had excellent lead-time with Special Weather Statements three days in advance and a winter storm watch the day before. Then there was a nice adjustment by the evening shift on Tuesday night to emphasize later redevelopment as the subsidence field between the impulses temporarily squashed precipitation development. This event shows that it doesn't take a closed low digging down from the Gulf of Alaska to bring in significant snowfall for the Southeast Arizona mountains.

Figures:

Figure 1: GFS initialization, 1200 UTC, December 17, 2002; 300mb wind, height and isotachs. GFS and Eta both advertised the arrival of strong upper- and lower-level jets for several days prior to the this initialization.

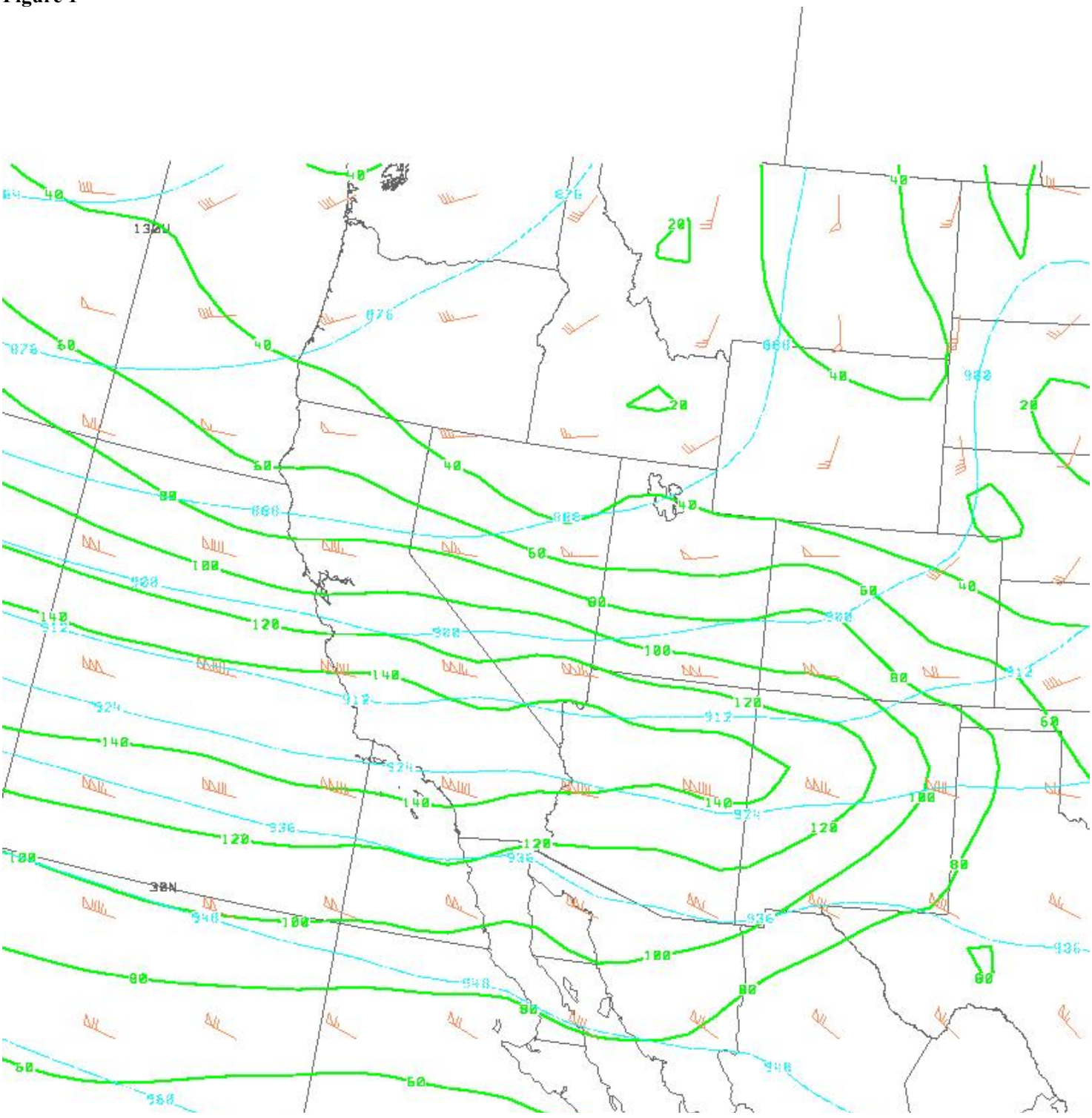
Figure 2: GFS initialization, 1200 UTC, December 17, 2002; 700mb wind and isotachs, and 850-500mb mean relative humidity. Highest mean RH was still north and west of the TWC CWA.

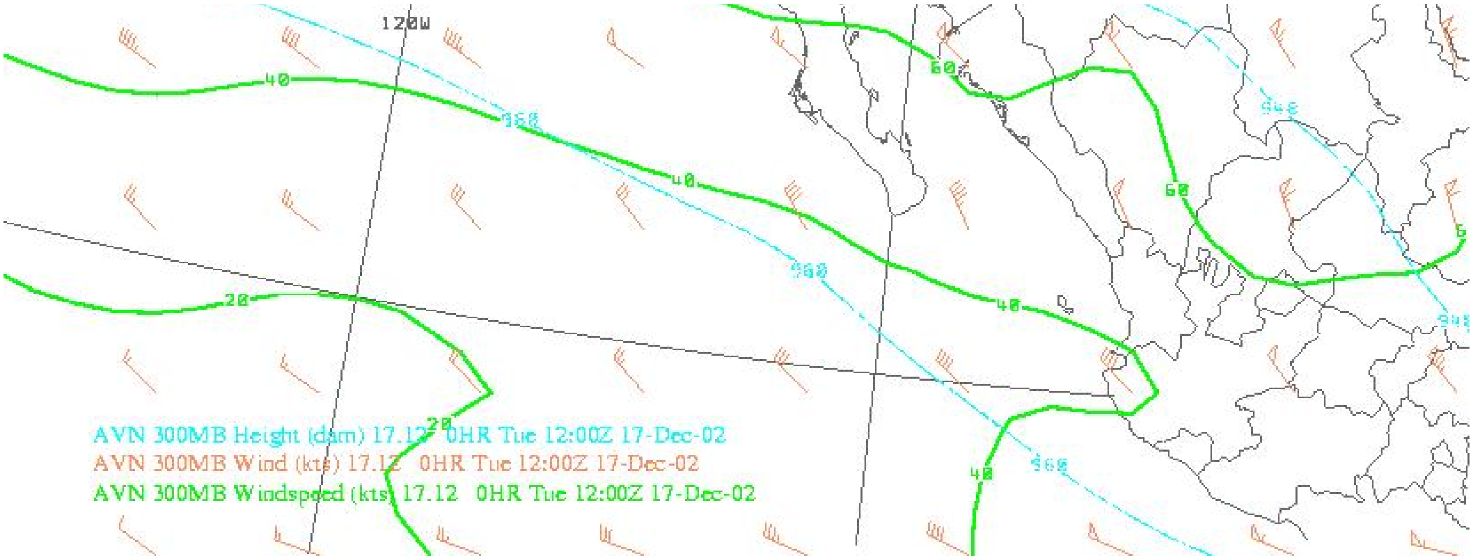
Figure 3: H+06 GFS forecast from 1200 UTC, December 17, 2002, valid 1800 UTC December 17; 300mb isotachs, 850-500mb omega and mean RH.

Figure 4: GOES-10 IR satellite image, 1800 UTC December 17, 2002. By this time, several NW-SE oriented cloud bands normal to the mountain ranges had developed over southeast Arizona and west central New Mexico

Figure 5: H+18 GFS forecast from 1200 UTC December 17. 2002, valid 0600 UTC December 18; 300mb isotachs, 850-500mb omega and mean RH. Note the lingering moisture over southeast Arizona as the next impulse approached.

Figure 1




120W
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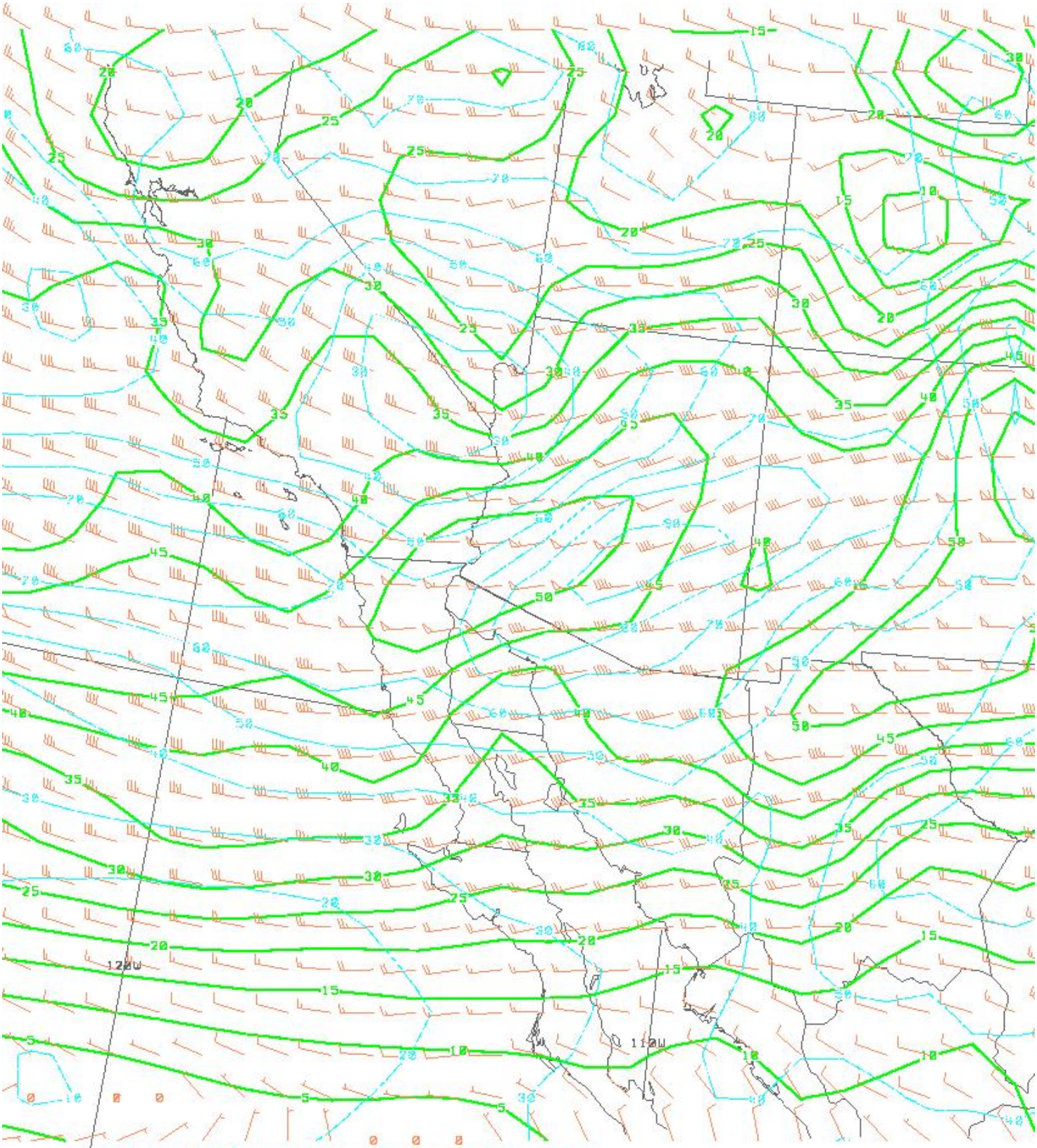
AVN 300MB Wind (kts) 17.12 0HR Tue 12:00Z 17-Dec-02
AVN 300MB Windspeed (kts) 17.12 0HR Tue 12:00Z 17-Dec-02

Figure 2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AVN 700MB Wind (kts) 17.12 0HR Tue 12:00Z 17-Dec-02
AVN 700MB Windspeed (kts) 17.12 0HR Tue 12:00Z 17-Dec-02

Figure 3

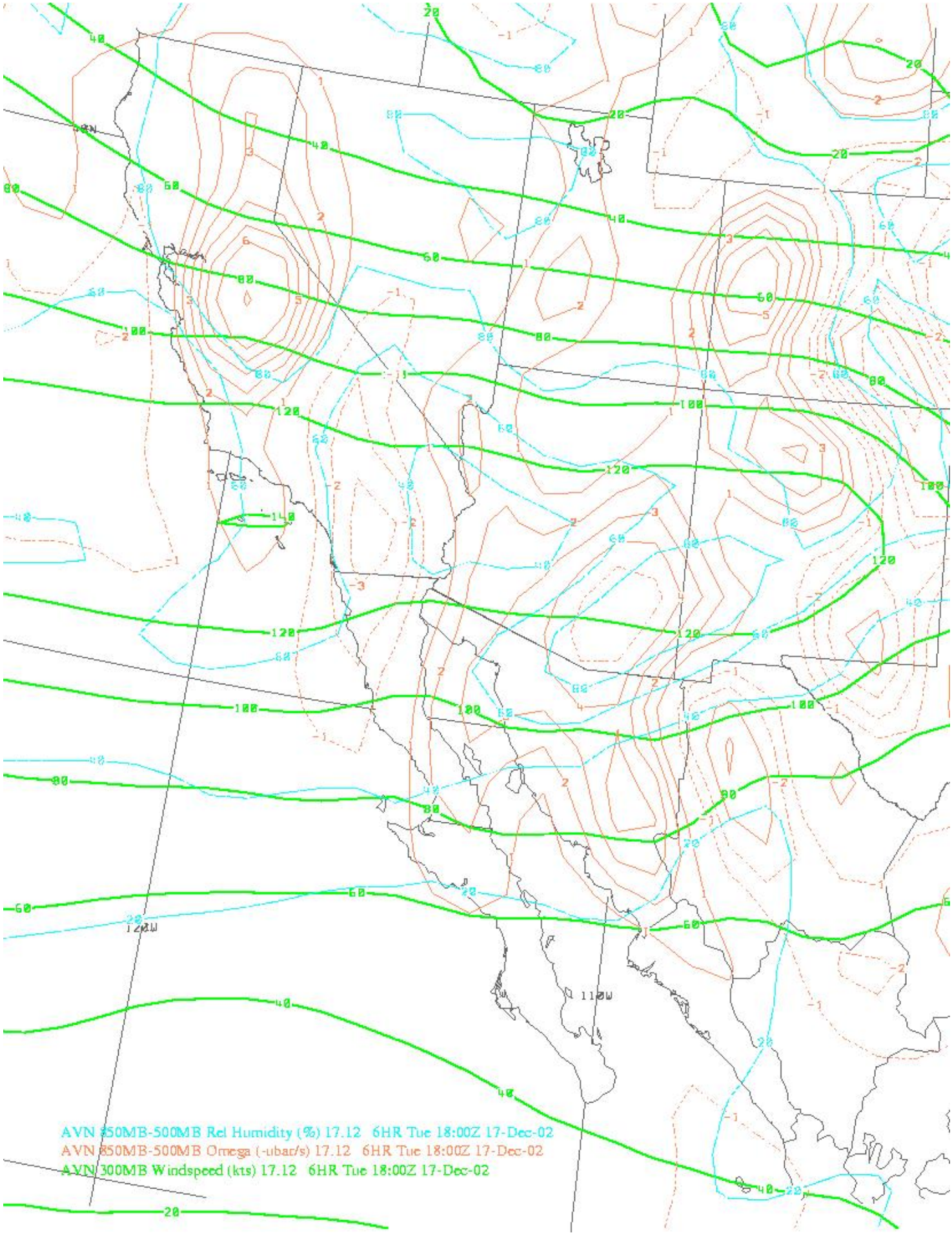

AVN 850MB-500MB Rel Humidity (%) 17.12 6HR Tue 18:00Z 17-Dec-02
AVN 850MB-500MB Omega (-ubar/s) 17.12 6HR Tue 18:00Z 17-Dec-02
AVN 300MB Windspeed (kts) 17.12 6HR Tue 18:00Z 17-Dec-02
120W
110W

Figure 4

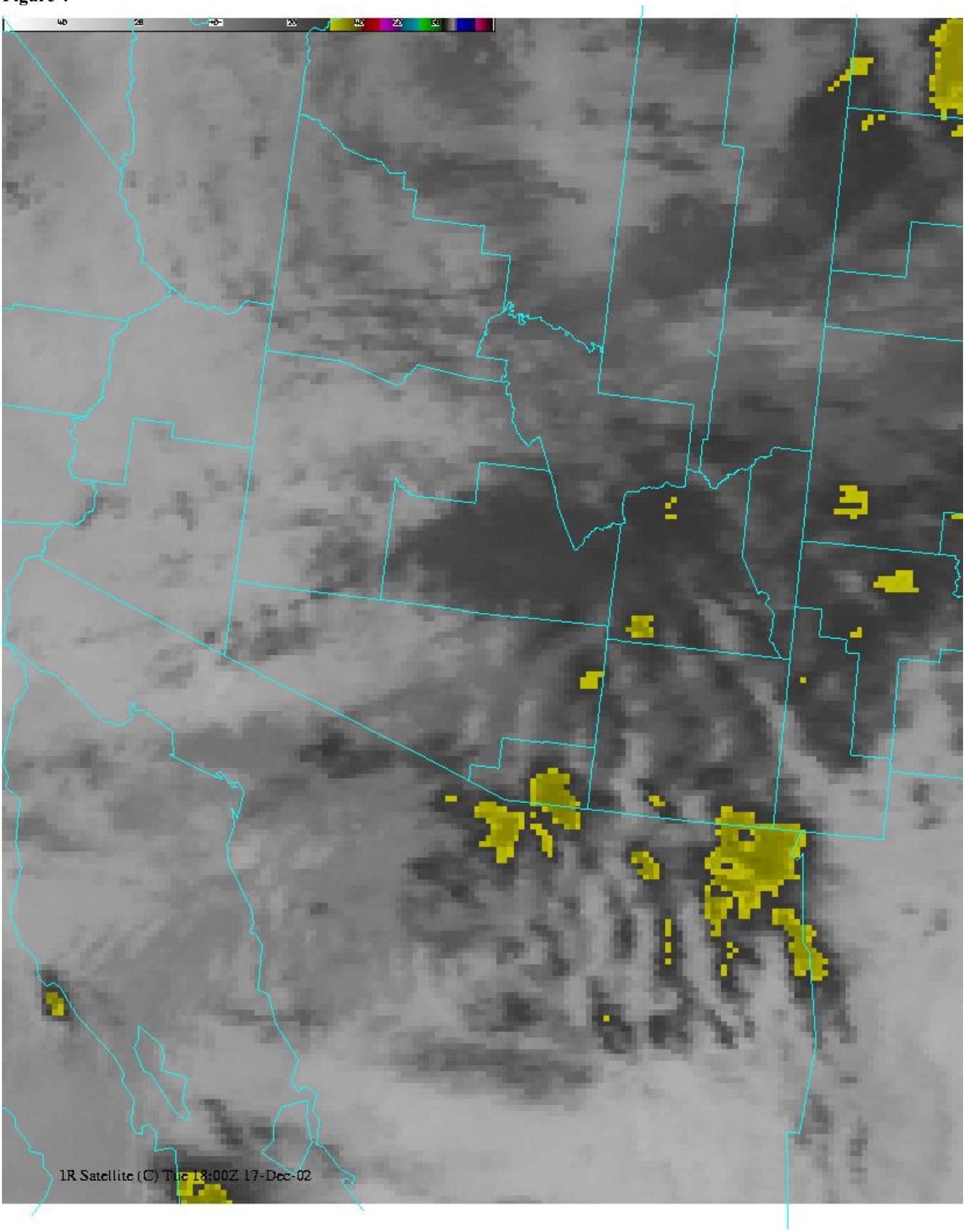
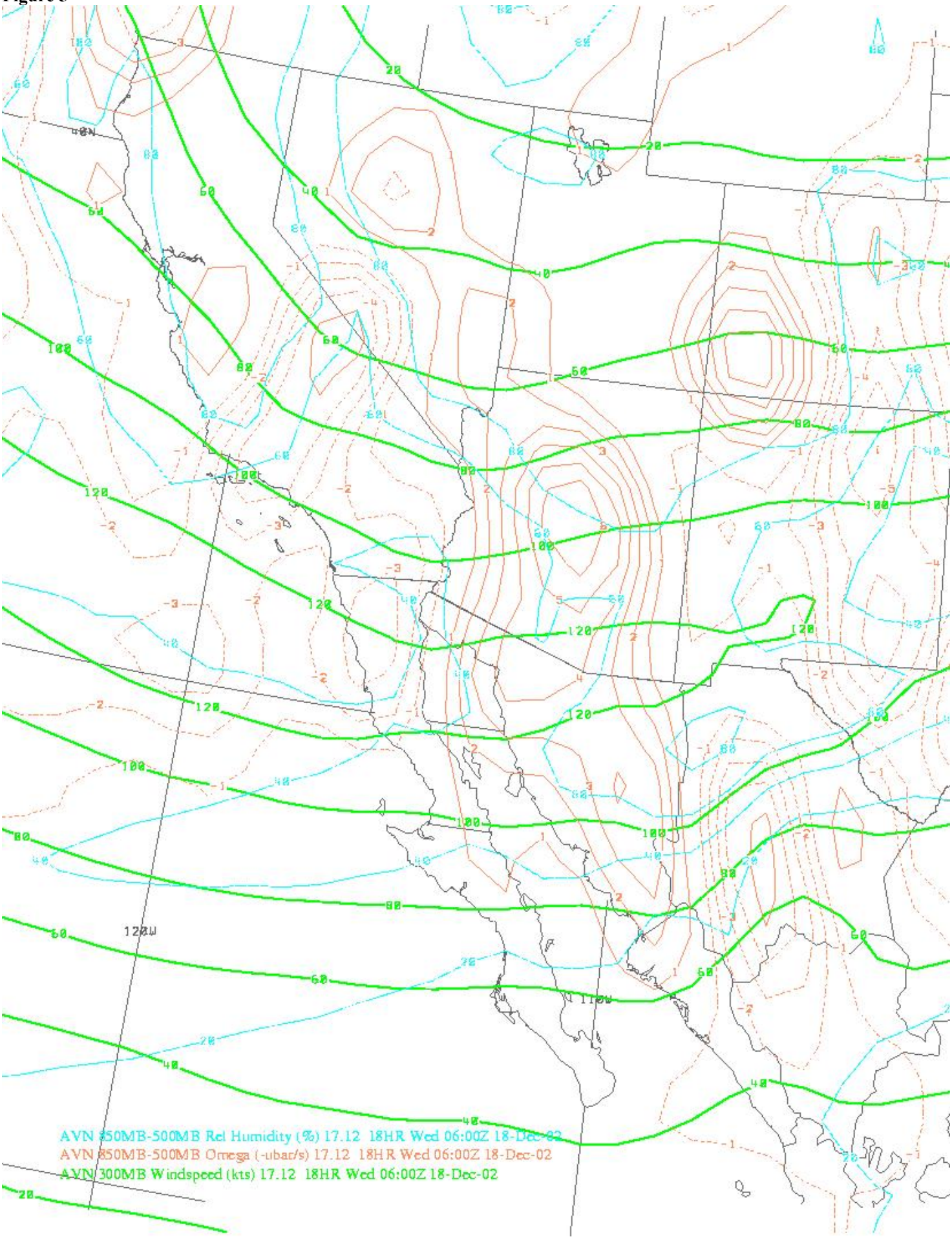


Figure 5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AVN 850MB-500MB Omega (-ubar/s) 17.12 18HR Wed 06:00Z 18-Dec-02
AVN 300MB Windspeed (kts) 17.12 18HR Wed 06:00Z 18-Dec-02
40N
120W
110W