The Impact of Evaporational Cooling
on the Las Vegas Valley Snowfall of 30 December 2003

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Introduction

Significant snowfall at lower elevations in southern Nevada is rare with snowfall of an inch or more occurring once every four to five years (Cordero, 1998). During the evening of December 29, 2003 an area of light rain and snow developed across much of Clark County. This area of rain and snow continued into the early morning hours of December 30, 2003 with snow levels gradually falling to approximately 2000 feet or to the floor of much of the Las Vegas Valley.

Discussion

On the evening of December 29 a positively tilted long-wave trough was digging down the California coast (Fig. 1). A shortwave raced to the northeast along a southwest-to-northeast oriented baroclinic zone from the Santa Barbara coast at 06 UTC on December 30 to Las Vegas at 12 UTC on December 30.

The 06 UTC run of the RUC captured the areal location of negative omega (Fig. 2a, 2b, and 2c) and precipitation on December 30th. This area coincided with the right entrance region of an exiting 80-knot jet maximum. Additionally, the location of the -12 to -18C temperature band was co-located with a moist layer centered on the region of negative omega just below 500-mb (Fig. 3). This combination would support significant dendritic crystal growth and aggregation of snow. Hence, heavy snow would be anticipated, although due to the fast progression of the short wave the period of heavy snow would be expected to be brief.

As can be seen in Figure 4, low levels were extremely dry with an area of 850-mb dewpoint depressions of 20-40C stretching from southeast California into extreme southern Nevada at 00Z on December 30. Surface dewpoint depressions in the same areas were also low and averaged 10-15C. Low-level southerly flow continued to aid in enhanced evaporative cooling by continuing to deliver this low level dry air into the Las Vegas Valley.

The closest radiosonde to the Las Vegas Valley is released 60 miles to the northwest at Desert Rock, NV (KDRA). Synoptically, conditions between Las Vegas and Desert Rock were similar on December 30th, but because Desert Rock is located on the opposite side of a significant barrier, the extremely dry low-levels in the Las Vegas Valley and points south were not properly represented in the 00Z sounding at KDRA. Additionally, the surface dewpoint depression at 00 UTC was 10C at KDRA and 14C at McCarran International Airport (KLAS).

Cordero et al. (1998) developed a climatology of 700-mb temperatures and 850-500-mb thickness values for forecasting snow levels in the Las Vegas Valley. This climatology has been very useful in operations, but in this case snow levels were erroneously too high due to the dramatic impact of evaporative cooling. Between 06 and 12 UTC 700-mb temperatures were between -5C and -6C with 850-500mb thicknesses of 4110-4130 meters. These values correspond to a snow level of 5000-6000 feet (Table 1).

The 00 UTC sounding at KDRA indicated a Wet-Bulb Zero (WBZ) level of 3303 feet MSL (Fig. 5). Considering the differences in low level moisture and temperature (and evaporative cooling) one would estimate the WBZ level would be below 3000 feet MSL in the Las Vegas Valley. In this event, the 00 UTC runs of the ETA, GFS and the RUC all indicated the shallower layer 850-700mb thickness values would fall below the critical rain/snow 1540m thickness value between 06 and 12 UTC.

Snow and Snow Levels

The Las Vegas valley slopes from west to east with the highest elevations on the northwest side of the valley in Summerlin (averaging 2700-3200 feet) gradually lowering to the east in Henderson (1890 feet) and Nellis AFB (1867 feet).

Rain began at 0809Z at KLAS (2180 feet elevation) with a temperature of 2C and a dewpoint of 1C. At 1200 UTC KLAS reported a changeover to all snow and had an ambient and dewpoint temperature of 1C. The North Las Vegas airport (KVGT, at an elevation of 2268 feet), which is northwest of KLAS observed a similar rain to snow progression, while Nellis AFB (KLSV) to the northeast of KLAS at a slightly lower elevation never had a mix or changeover to snow.

Since the commissioning of ASOS at McCarran International Airport in 1995 snowfall and snow depth are no longer recorded. The official liquid equivalent for the event on December 30th was 0.25 inches with about half falling as snow. Much of the Las Veags Valley above 2000 feet in elevation received 1 to 2 inches of snow with up to 5 inches falling over the higher terrain in Summerlin over northwest portion of the valley.

Summary

Snow in the Las Vegas Valley is a rare occurrence and the presence of anomalously dry, low-level conditions makes the accurate prediction of snow levels an even more difficult task. Utilization of both the wet-bulb zero height and the shallower 850-700mb thickness layer would have provided additional, valuable resources in development of a more precise prediction of snow levels. The utilization of both of these parameters will be implemented into operations at WFO Las Vegas.

References

Cordero, S., Skrbac, P., and Kosier, D., 1998: NWS Western Region Technical Attachment No. 98-17

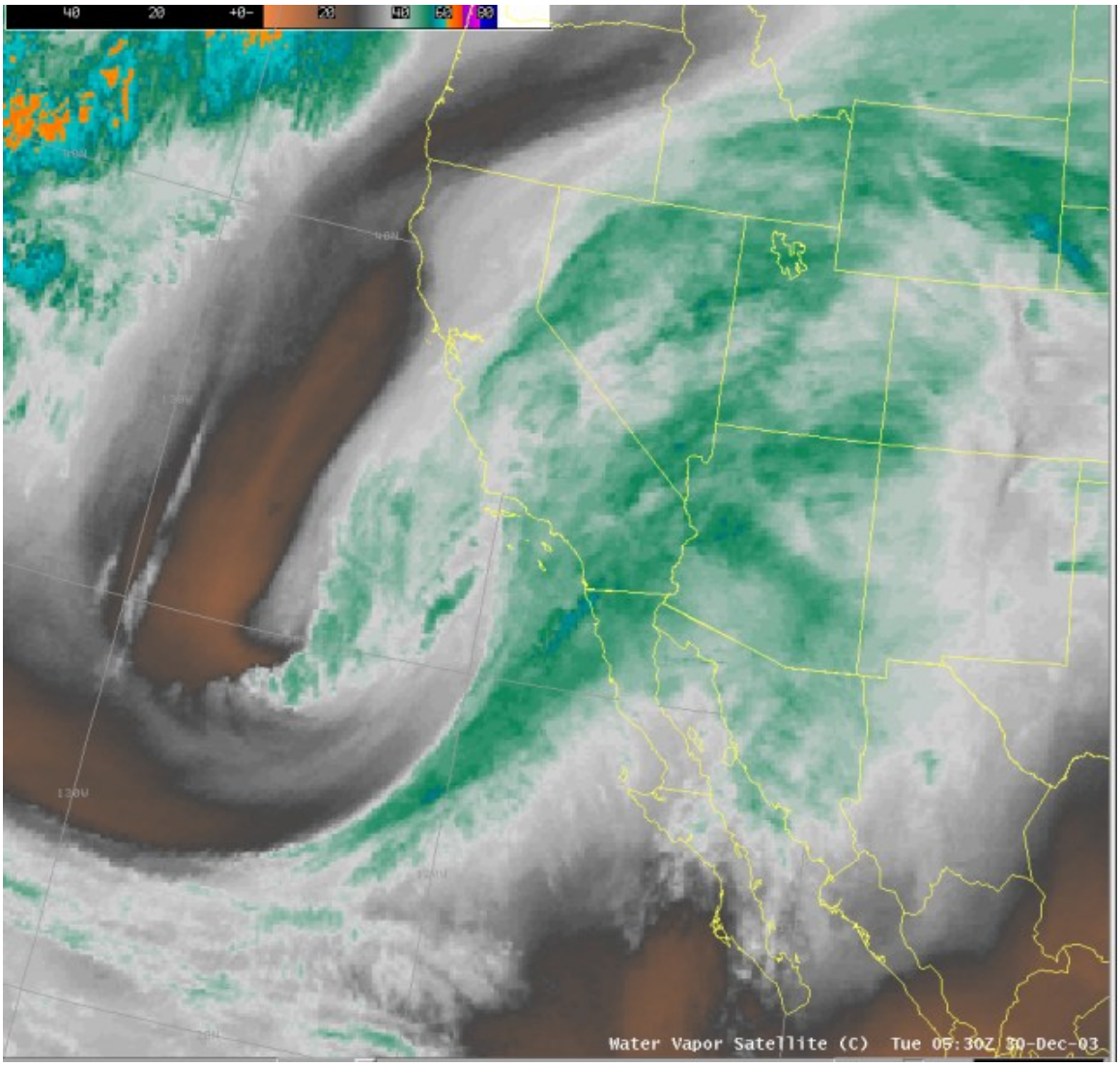

Figure 1. 0530 UTC December 30, 2003 Water Vapor Image

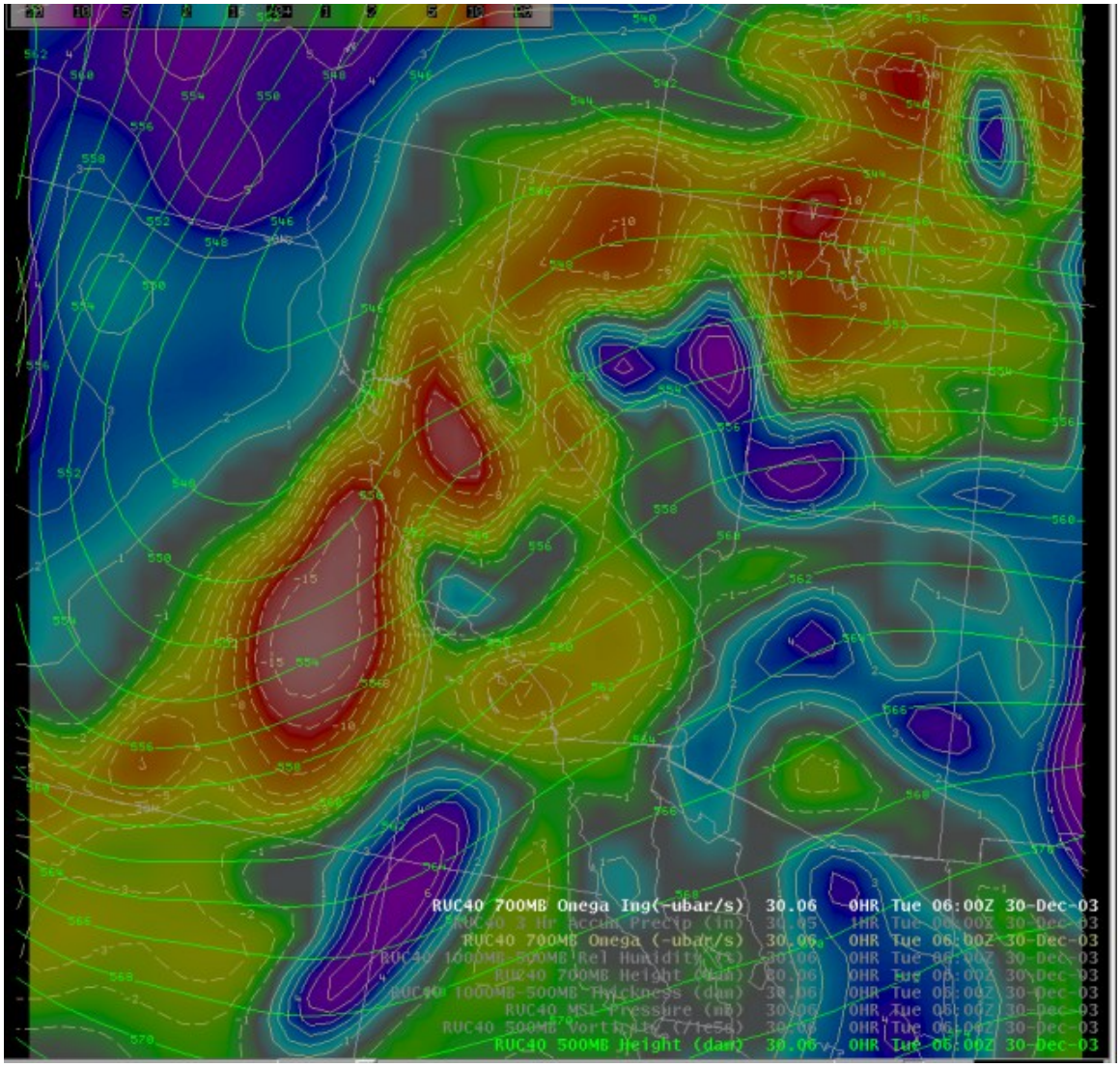

Figure 2a. 0-hr RUC forecast 06 UTC December 30, 2004. 500-mb heights and 700-mb Omega

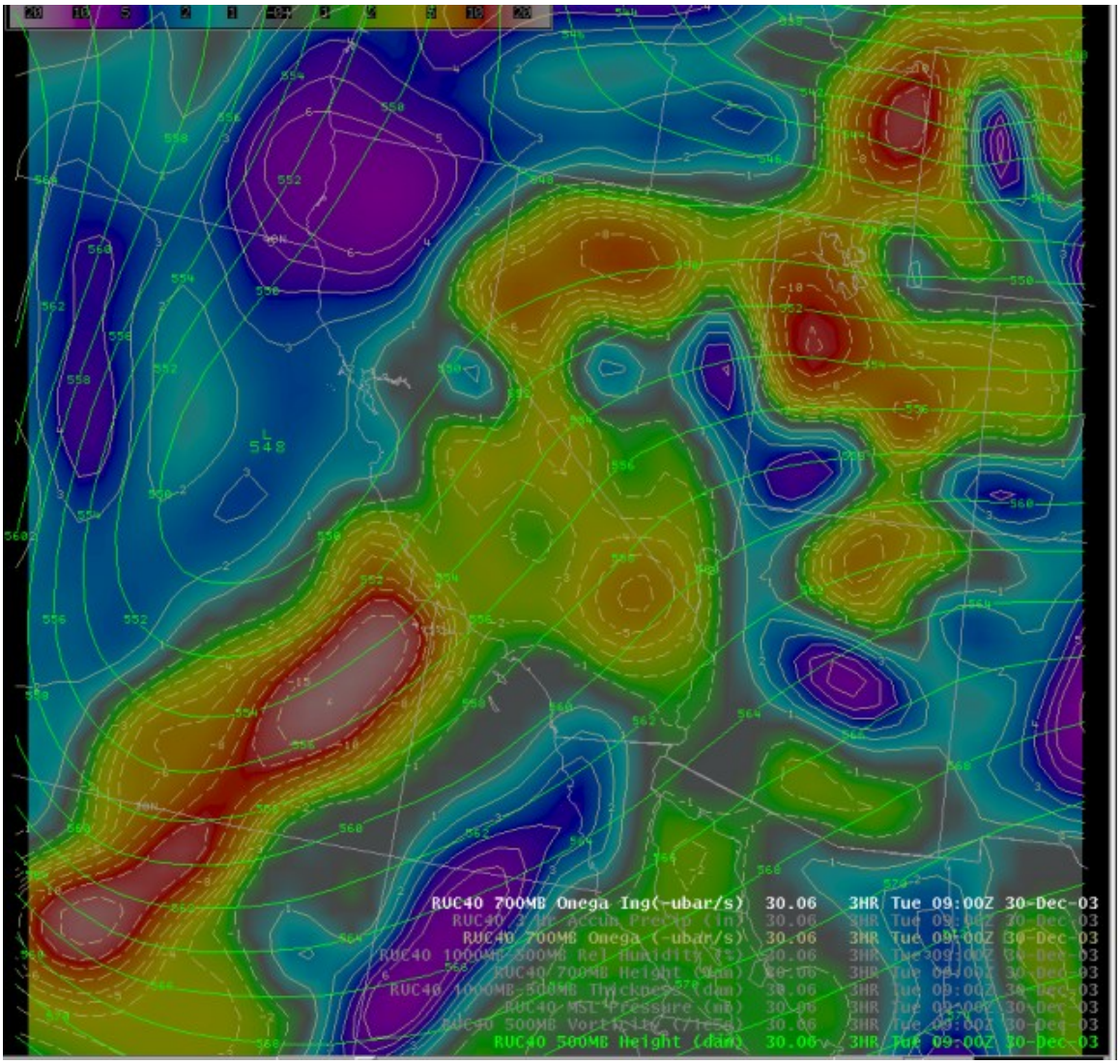

Figure 2b. 3-hr RUC forecast 09 UTC December 30, 2004. 500-mb heights and 700-mb Omega

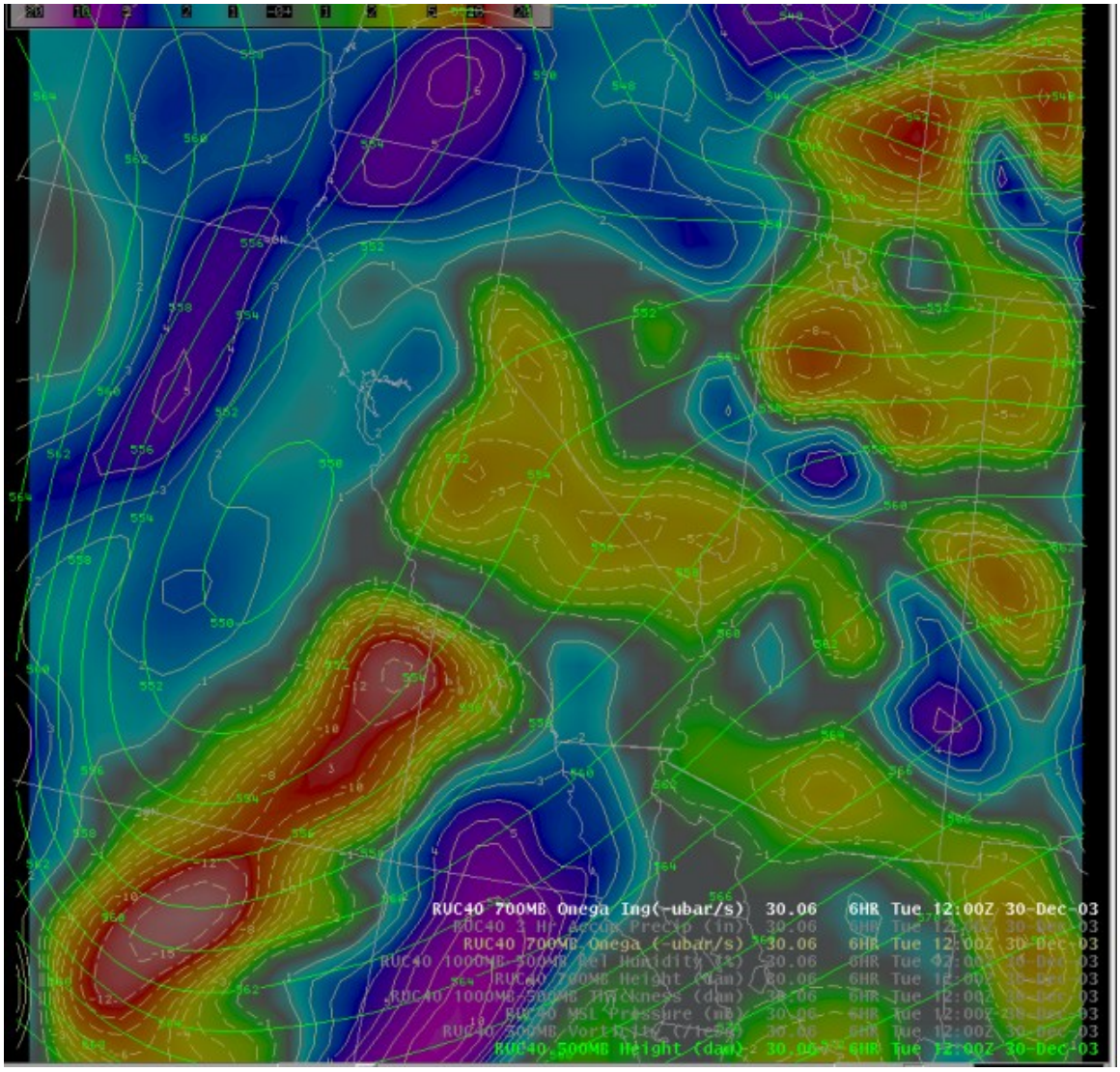

Figure 2c. 6-hr RUC forecast 12 UTC December 30, 2004. 500-mb heights and 700-mb Omega

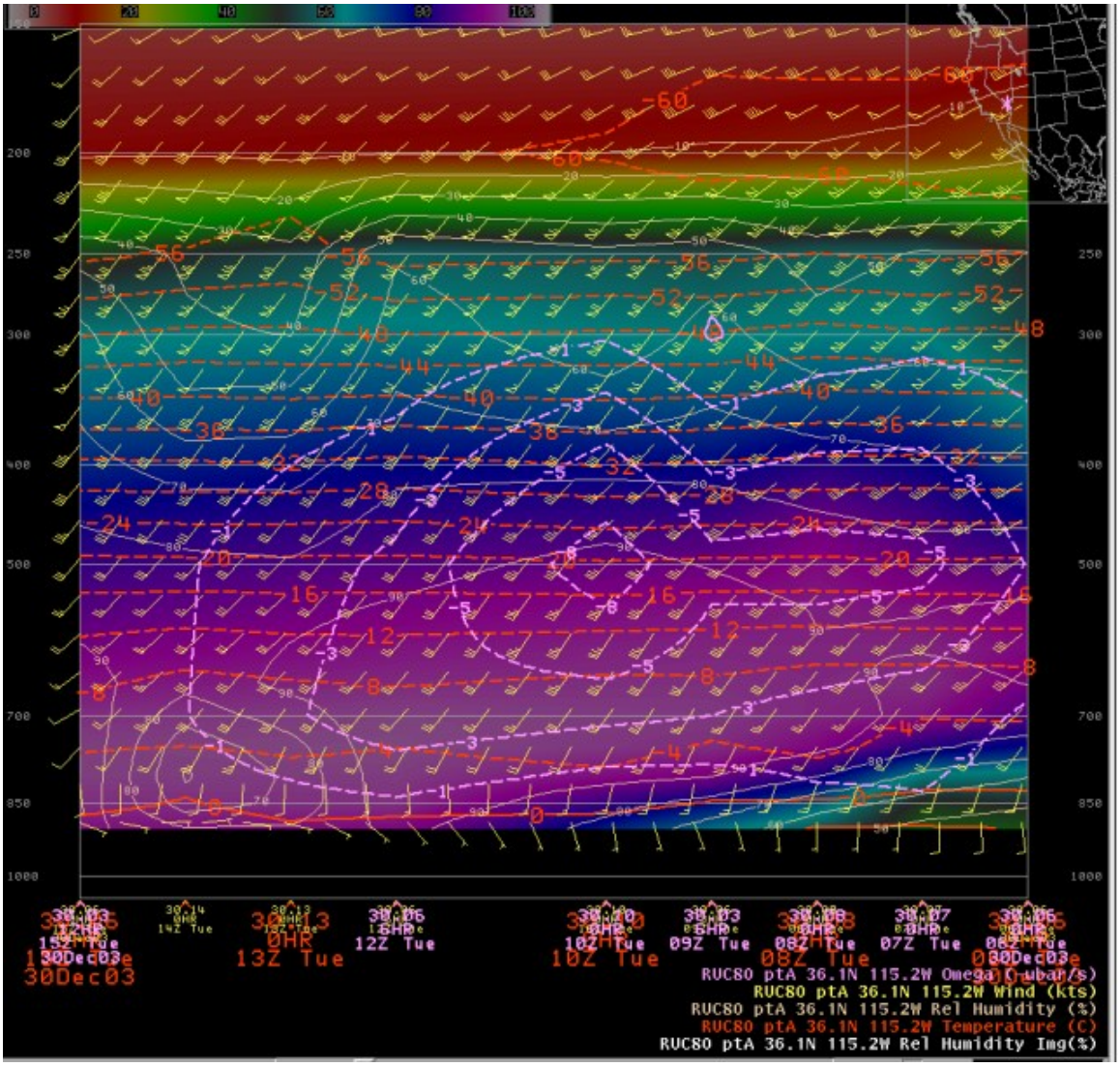

Figure 3. 06 UTC run of the RUC time-height cross section center over the Las Vegas Valley.

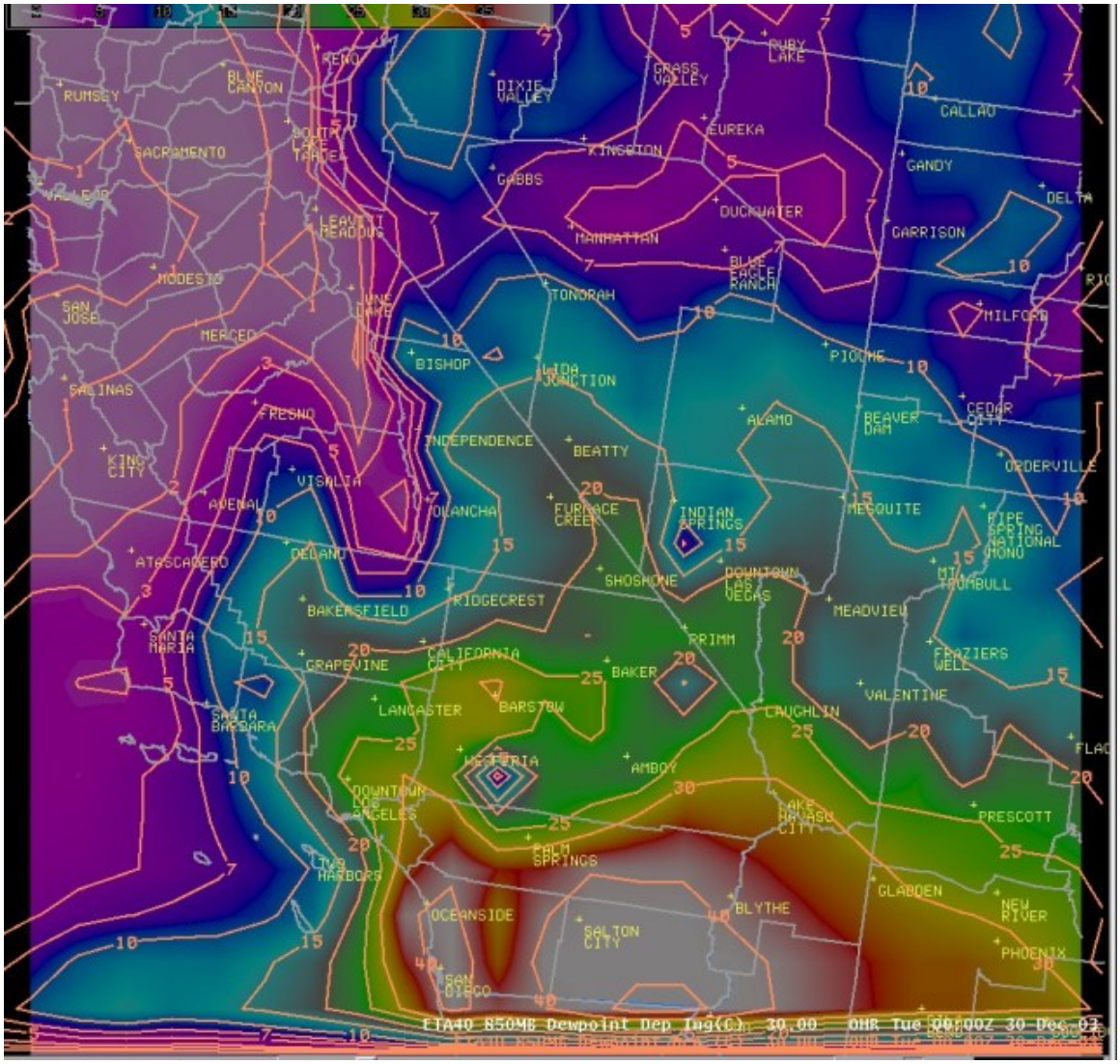

Figure 4. ETA 850-mb dewpoint depressions 0-hr forecast for 00 UTC December 30, 2003.

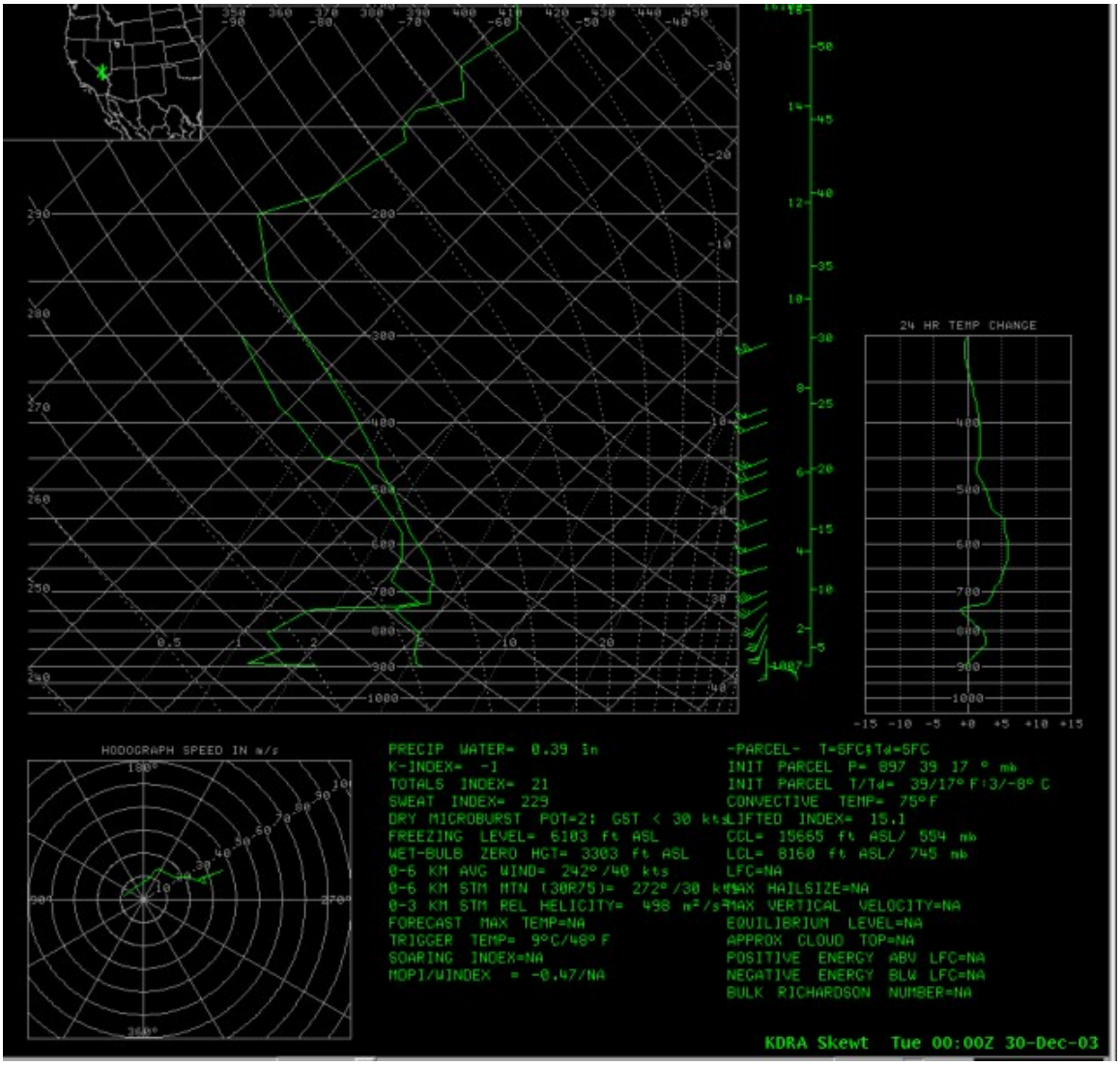

Figure 5. 00 UTC December 30, 2004 KDRA sounding.

Snow Levels Associated with Specific Values of 850-500 mb Thickness and 700-mb Temperatures		
Snow Levels	700-mb Temperatures	850-500 mb ΔZ
0	-17C	400 dm
1000 feet	-15C	402 dm
2000 feet	-13C	404 dm
3000 feet	-11C	406 dm
4000 feet	-9C	408 dm
5000 feet	-7C	410 dm
6000 feet	-5C	412 dm
7000 feet	-3C	414 dm
8000 feet	-1C	416 dm

Table 1. Snow Level Estimates for the Las Vegas Valley.