A Study of the Treasure Valley Heavy Snow Event of January 20, 2002

Matthew Fugazzi

On January 20, 2002 a pacific storm system moved through southwestern Idaho with widespread heavy snow. While the 1 to 2 feet of snow which fell over the mountains was not unusual for this time of year, the Treasure Valley located in the lower elevations of the Snake River Valley also received up to 10 inches of snow fall from this storm. For Boise, the climatological city of record for the Treasure Valley, this storm ranked as the eighth heaviest 24 hour snow fall on record. Below is the final snow accumulation plot from this storm overlaid on a topographical relief map of the Treasure Valley.

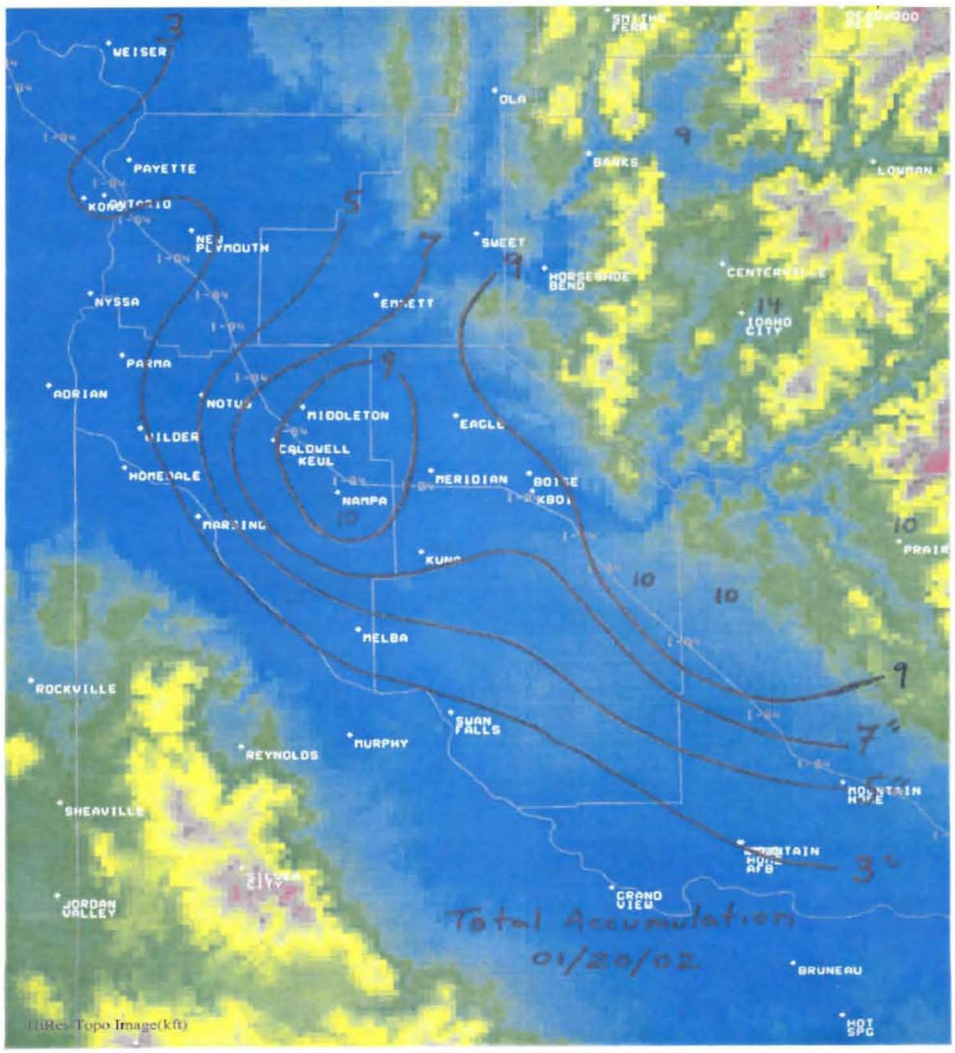

Figure 1. Total snow accumulation for Jan. 20, 2002

While heavy snow was the norm over the mountainous region in the upper right quadrant, relative maximums are apparent over eastern Canyon and western Ada counties and in the valley along the Boise Mountain front .

Synoptic Situation:

The overall synoptic weather pattern on January 20, 2002 was a fairly common winter pattern conducive to heavy snow in Idaho's central mountains. At 500mb moist zonal flow off the pacific with an embedded vorticity lobe moved across the region.

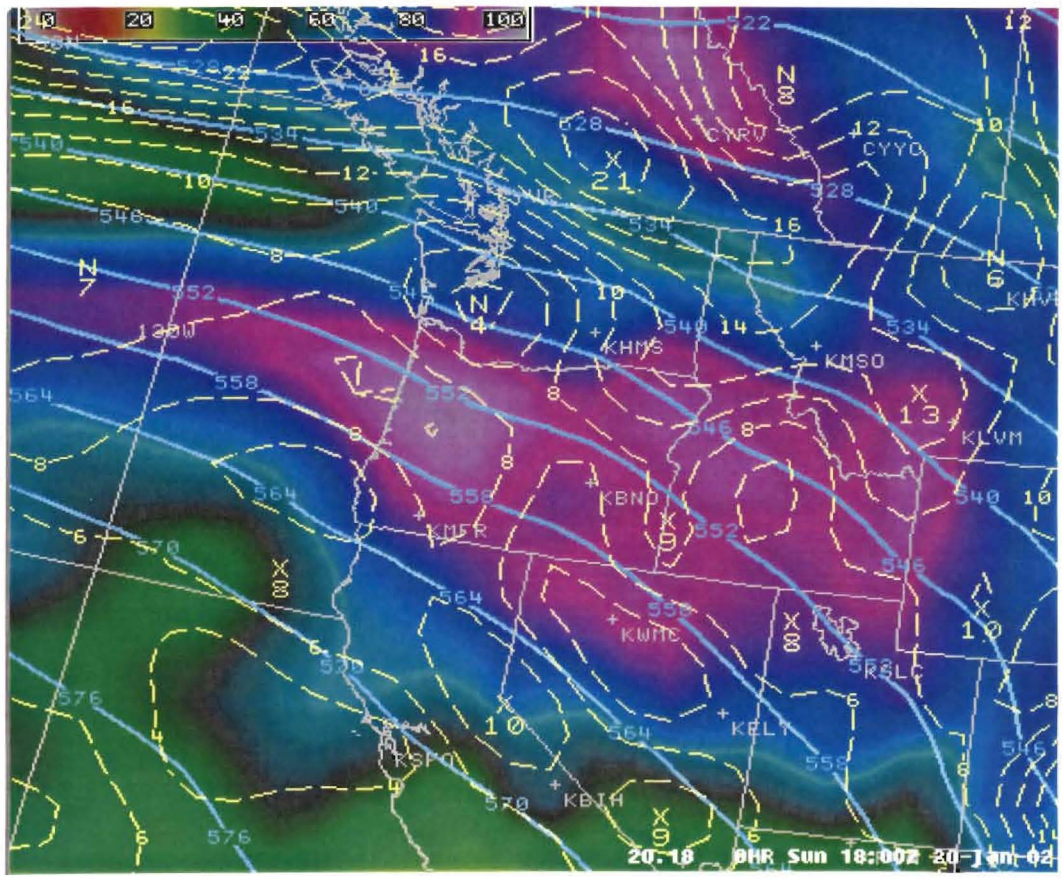

Figure 2. 18Z 01/20/02 AVN initialization 500mb heights, 500 mb vorticity. 1000-500mb RH.

Moisture for the storm spread over the region from a deep Pacific moisture fetch crashing into the Oregon coast and crossing the Cascades. This west to east fetch orientation is recognized as the most favorable for heavy snow over Idaho. There is a shorter over land trajectory with this "zonal" orientation to attenuate the moisture than with a pre-upper level trough southwest to northeast orientation which must cross the Sierra Nevada and the high plateau of the Great Basin before reaching Idaho. The intensity of the fetch was moderate with 6 to 9 tenths of an inch of precipitable water encountering the Cascades and slightly less than 5 tenths of an inch making it to Idaho. This was not a "Pineapple Express" tropical moisture plume which is normally associated with heavy precipitation in the inter-mountain west. At 00Z 01/21/02 as the event winded down the HPC analysis showed Boise with only 0.41 inches of precipitable water. Unusually strong forcing appears to be the deciding factor in the heavy snow accumulations associated with this event.

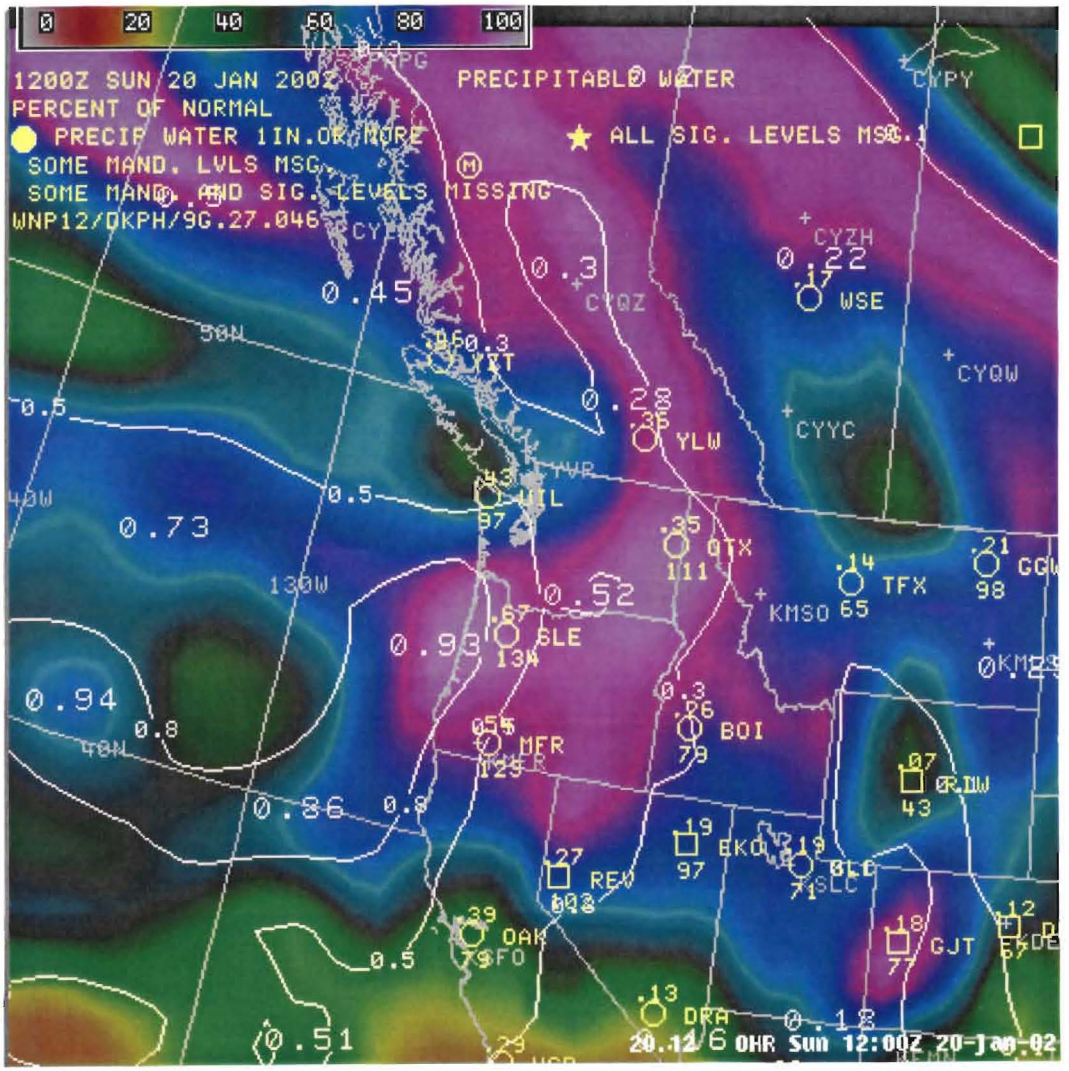

Figure 3. 850-500mb RH (image) Layer Precipitable Water contours and HPC 12Z RAOB Precitpitable Water analysis.

During this event the jet axis lay along the USA-Canada border as shown by the wind barbs in Figure 4. Upper level dynamic lift was relatively weak over southwest Idaho with this system but strong mid level warm air advection provided plenty of synoptic lift with a 20C /12hr bulls eye over the West Central Mountain Zone.

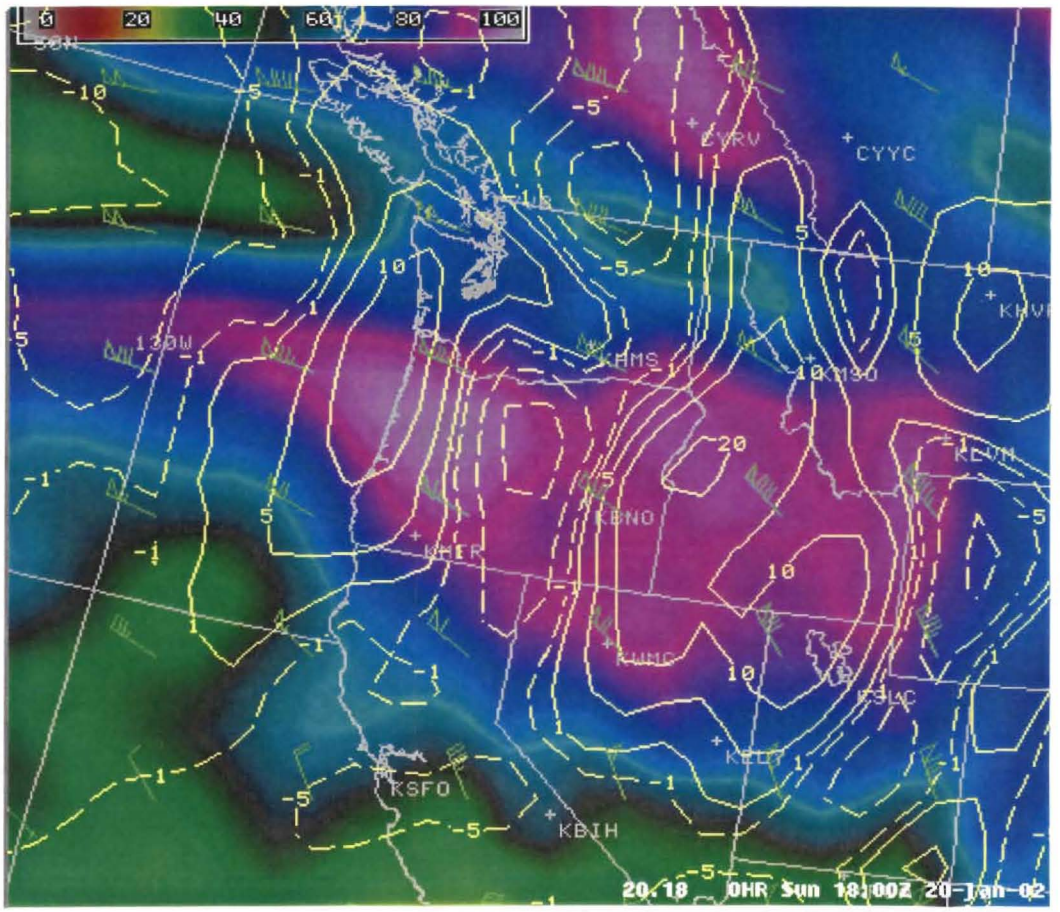

Figure 4. 18Z 01/20/02 AVN initialized 300mb wind barbs, 700mb WAA, and 1000-500mb RH

At the surface a warm front identified by the thickness packing in Figure 5 below, extended north to south through eastern Oregon. The AVN model terrain does not adequately resolve the snow covered high terrain over eastern Oregon and therefor tends to advance the front too quickly.

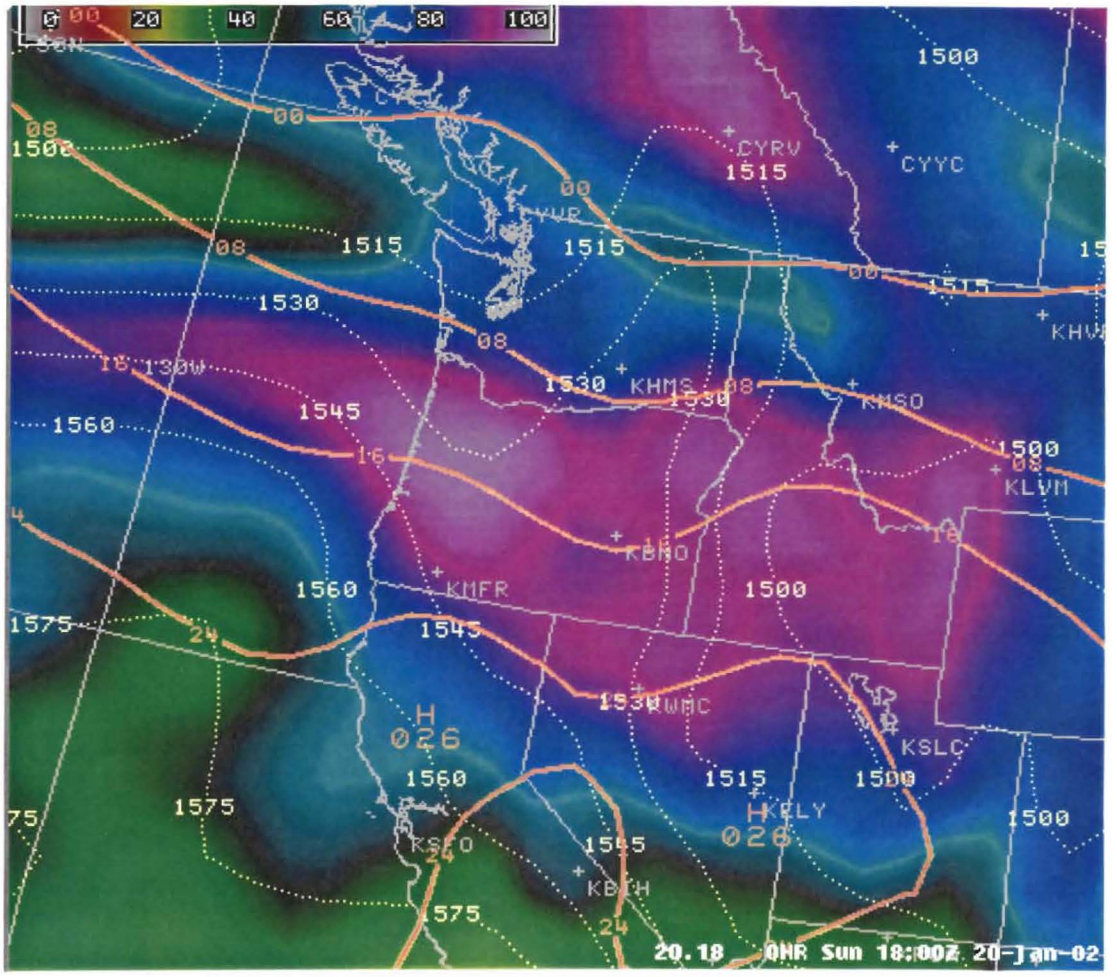

Figure 5. 18Z 01/20/02 AVN initialized MSLP, 850-700mb Thickness and 1000-500mb RH

The 18Z actual surface analysis below more accurately represents the warm front position. The buckle westward towards Redmond, Oregon reflects the warm air and relatively light air mass encountering the cold dense air mass over the snow covered mountains and retarding the forward movement of the front. This is a common occurrence during deep winter and may have contributed to the unusually heavy snow amounts over the Treasure Valley by prolonging the period of warm over-running and precipitation.

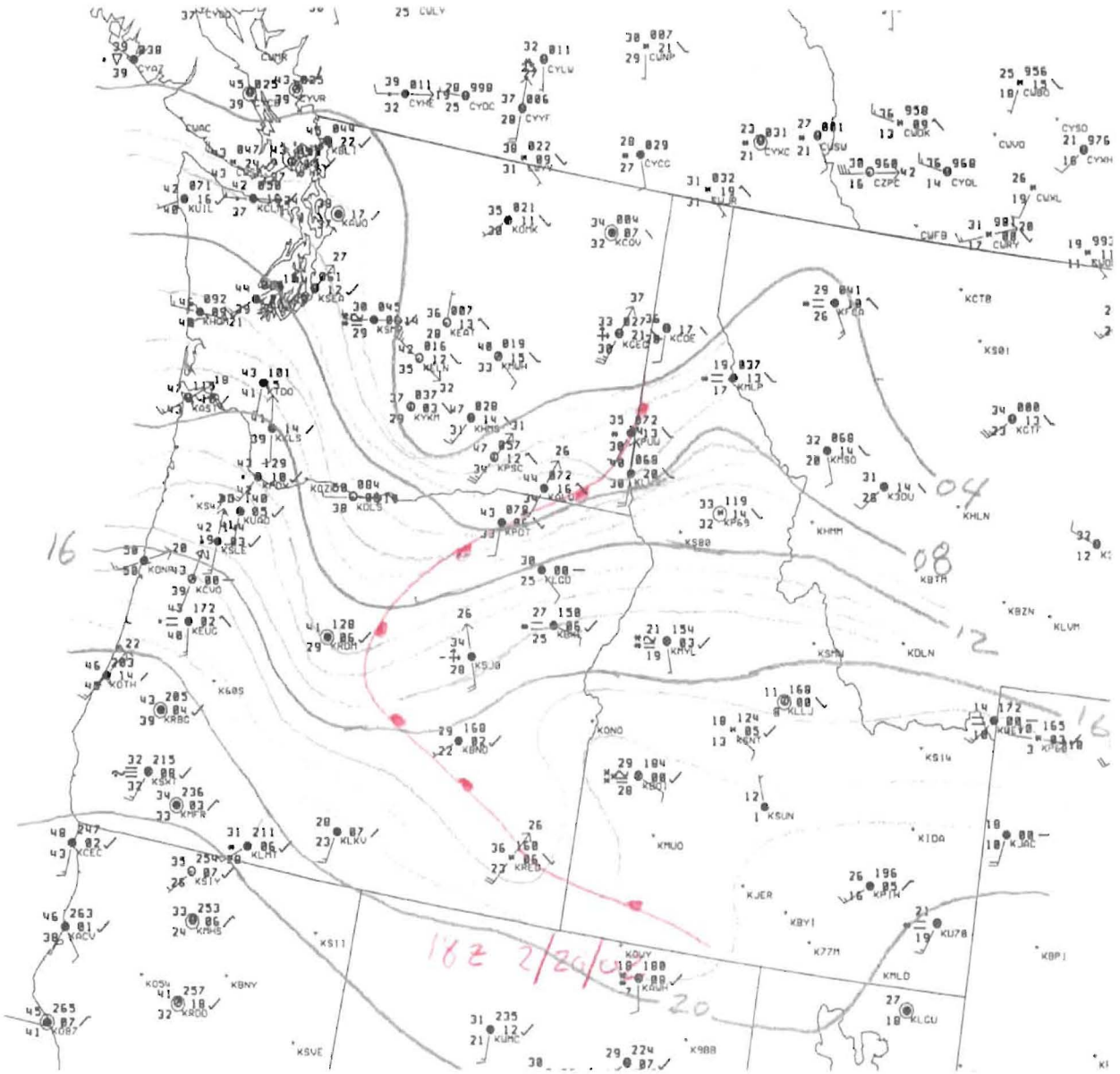

Figure 6. 18Z 01/20/2002 Mean Sea Level Pressure Analysis

The 850mb Potential Temperature plot in Figure 7 better defines the model warm front as isopleth packing over eastern Oregon. Westerly mid level flow at 700mb impinged upon the mountain massif adding an orographic component to the overall lift.

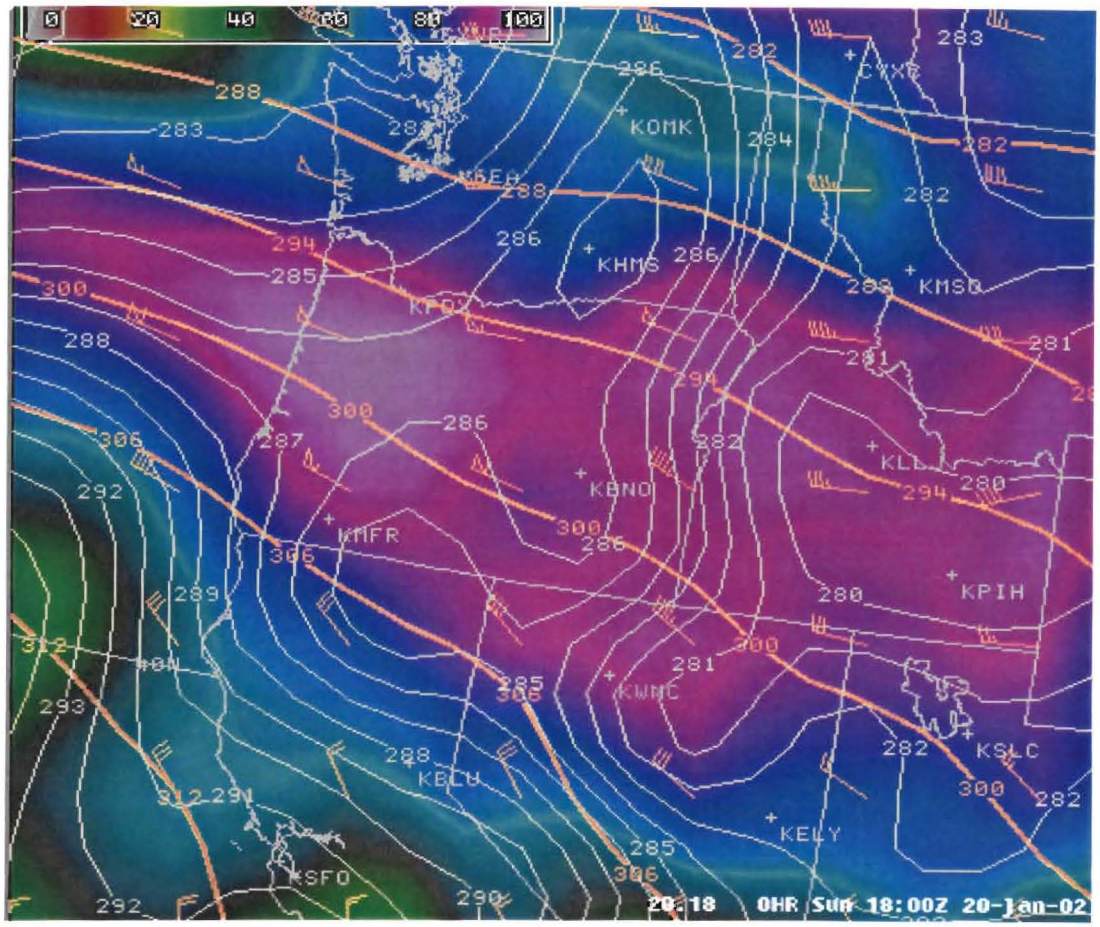

Figure 7. 18Z 01/20/2002 AVN initialized 700mb heights, 700mb wind barbs, 850mb Potential Temperature and 1000-500mb RH.

The favorably oriented zonal moisture feed, frontal focusing, orographic uplifting and strong mid level warm air advection all conspired to produce heavy snow throughout the central mountains of southwest Idaho. The slowing of the surface warm front as it encountered the cold dome of air sitting over the snow covered higher terrain of the northern Rockies probably prolonged the precipitation over the Treasure Valley, but this often happens during a deep winter warm frontal precipitation event. Another factor may have played a significant role in the unusually heavy snow amounts in the lower valley locations during this storm.

A look at the 12Z 01/20/02 RAOB sounding reveals winds in the 850mb to 700 mb layer to be just north of west. The 00Z 01/21/02 RAOB indicated little change in direction, but about 10 to 15 knots stronger.

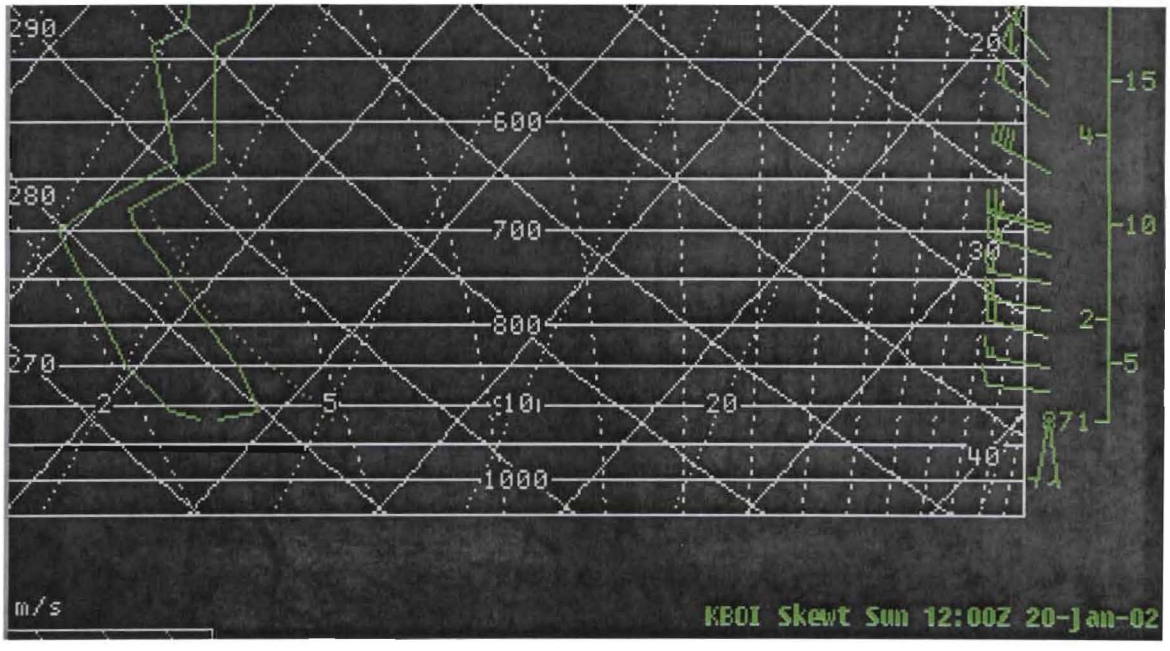

Figure 8. 12Z 01/20/02 BOI Radiosonde Skew-T

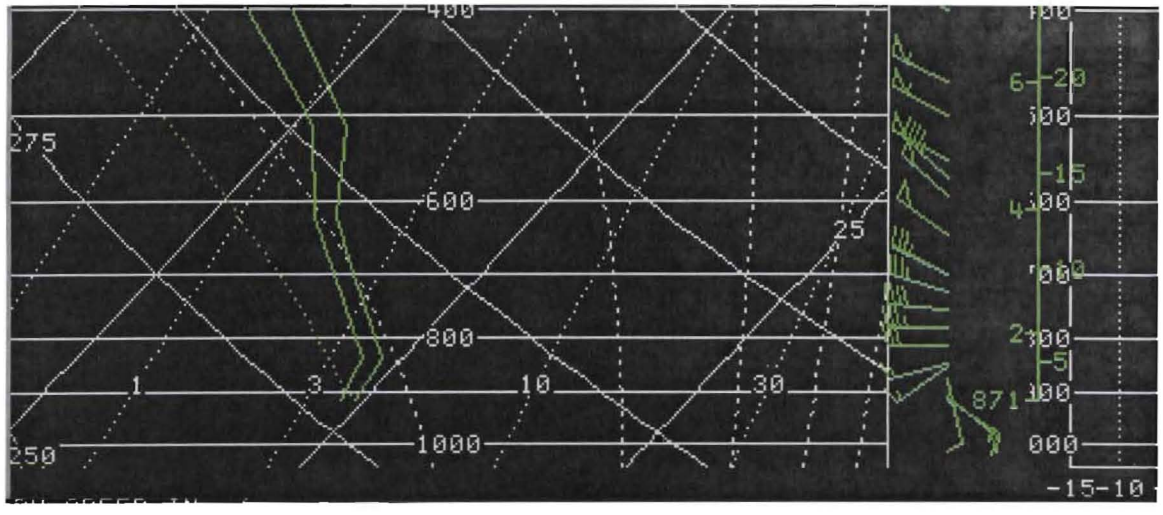

Figure 9. 00Z 01/21/02 BOI Radiosonde Skew-T

Given the northwest to southeast orientation of the front range of the Boise Mountains along the northern edge of the Treasure Valley (see Figure 1), this directional orientation is favorable for terrain constriction of the flow over the Treasure Valley. The surface observations for BOI show the most intense hourly snow falls occurred between 16Z and 21Z. When streamlines are

produced from the likely 850 to 700 mb winds interpolated for 18Z from the soundings above, and taking into account likely topographic constriction, a possible explanation for the unusually heavy snow fall amounts over a portion of the Upper Treasure Valley becomes apparent. Inspection of the 00Z sounding implies that the main cloud base was at the 850mb level with a saturated moist adiabatic lapse rate above this level. Within the 850 to 700mb layer streamline convergence was occurring and locally enhancing the lift generated by the synoptic storm system.

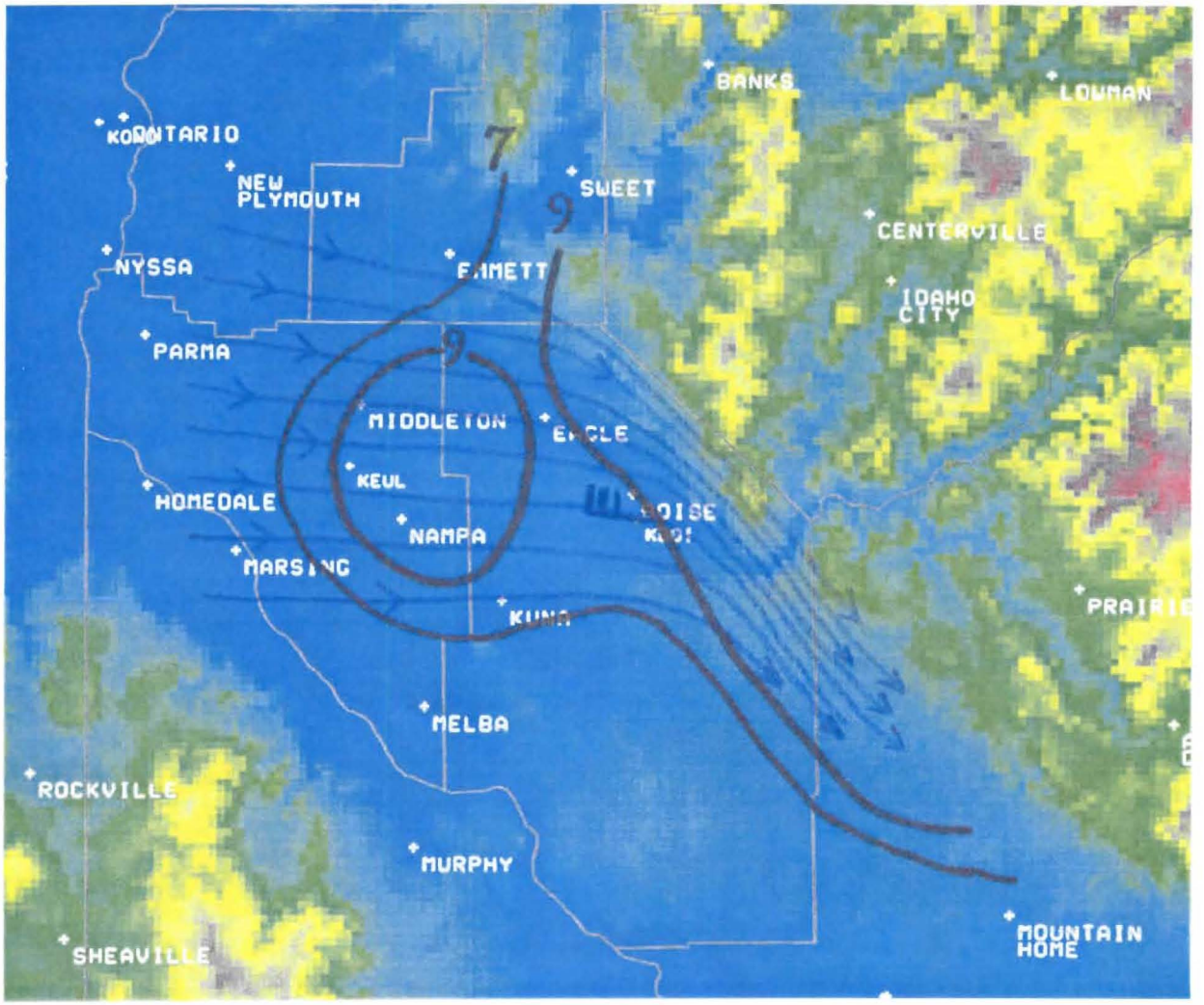

Figure 10. 850-700mb flow streamlines for 18Z 01/20/02.

The 20 January 2355Z Composite Reflectivity Radar image below shows highest reflectivity over the region of maximum streamline convergence shown above and supports this hypothesis..

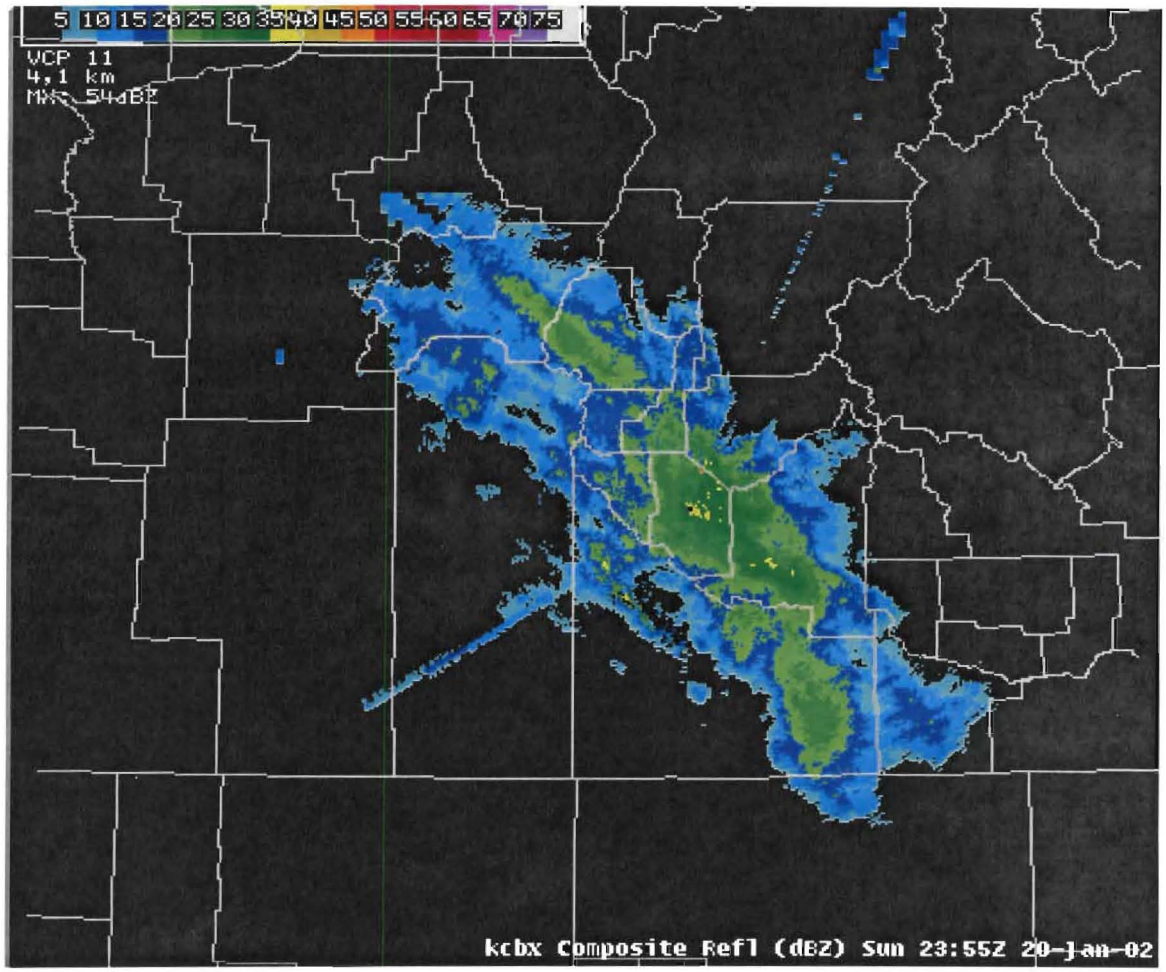

Figure 11. 2355Z 01/20/02 Composite Reflectivity WSR88D image.

This explains the finger of heavy snow along the I-84 corridor southeast of Boise, and also may help explain why on average the Boise area has the highest annual snow fall of the entire Upper Treasure Valley zone.

Station	Elev.	Annual	Monthly												Max
Zone 14	Upper Treasure Valley														
Swan Falls	2325	4.4	2.4	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.2	22.5
Grandview 2W	2400	6.1	2.9	1.1	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.9	35.0
Glenns Ferry	2510	13.2	5.7	1.7	0.8	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.0	3.8	35.0
Bruneau	2530	5.2	2.0	0.8	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.6	15.7
Kuna	2690	11.9	4.3	1.7	0.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0	1.5	3.4	28.7
BoiseWFO	2838	20.6	6.5	3.6	1.6	0.6	0.1	0.0	0.0	0.0	0.0	0.1	2.2	5.8	41.7
Mountain Home	3190	12.4	5.2	2.1	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.1	3.6	26.6
Boise 7N	3885	55.3	12.7	10.1	6.7	3.2	0.4	0.0	0.0	0.0	0.0	0.4	8.9	12.9	98.0

Figure 12. Annual average snow climatology for Upper Treasure Valley reporting stations.

But the total snow plot indicates a relative maximum over the Nampa-Middleton area under the zone of weak streamline convergence. The reports used in the total snow plot were gathered from spotters immediately after the event. Most of the spotter reports were estimated snow totals which were not measured with a ruler. Blowing and drifting was also a problem noted by a number of spotters. These conditions could easily introduce errors of an inch or so high or low in the reports. However, the consistency of higher reports in this area make it likely that there was a relative maximum of snow fall in this area.

Examining the surface observations for Ontario, Oregon and Boise during the hours of heavy snow reveals a difference in wind speeds of 2 to 5 knots with little directional change between the stations. Also, Ontario displayed a consistently higher surface pressure during the period. This difference is most pronounced in the 23Z plot below.

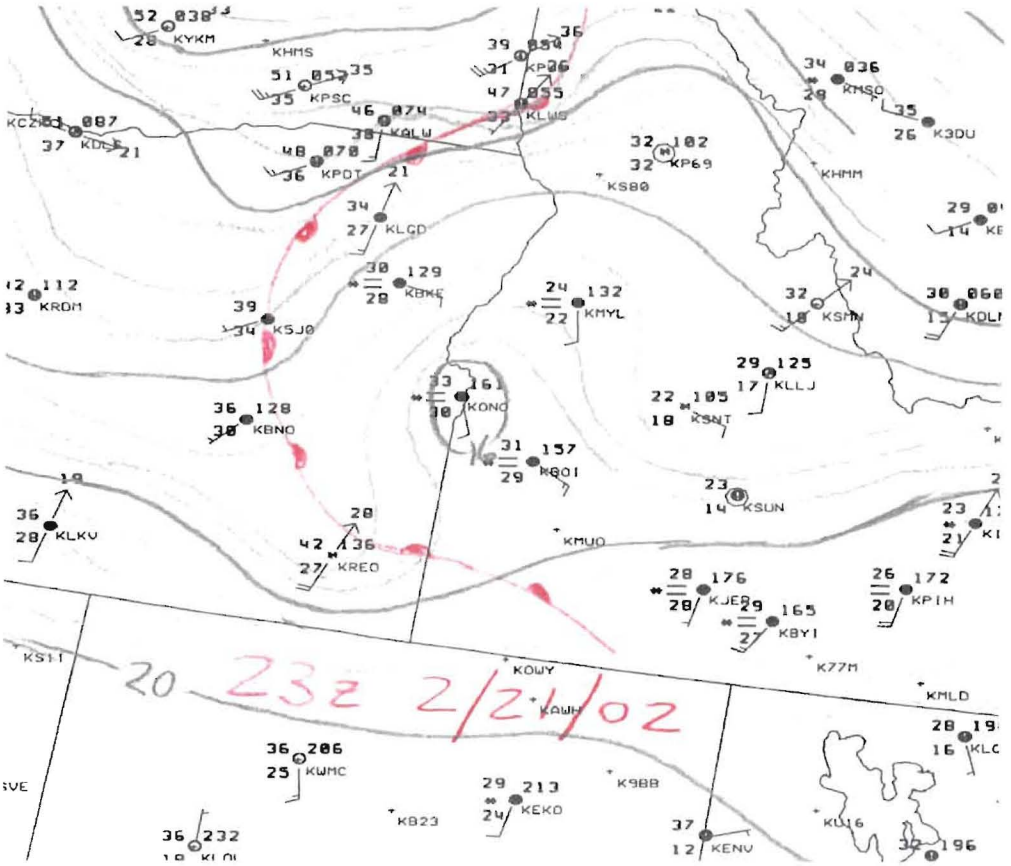

Figure 13. 23Z 01/20/02 Mean Sea Level Pressure analysis.

When the temperatures and dew points of Boise and Ontario are converted to equivalent Potential Temperatures at 1000 mb for the 18Z and 00Z observations, colder values are revealed at the lower elevation Ontario station . The relatively colder and denser air in the Lower Treasure Valley manifested itself as a dome of high pressure centered over Ontario. This is also a common situation during the winter as gravity drains cold air from the upper Snake River Valley during the benign weather days before the precipitation onset. The only outlet is the very narrow Hells Canyon reach of the Snake River. This constriction creates a cold pool of relatively dense high pressure air at the foot of the Treasure Valley. Southeast winds at the surface during the storm probably encountered this dome of denser air and lifted over it, causing enhanced and prolonged snow fall between Boise and Ontario, where the snow fall maximum occurred. This hypothesis also explains the loss in surface wind speed between the two stations.

On January 20, 2002 a heavy snow event occurred over portions of southwest Idaho. While the synoptic situation was a typical and common pattern for heavy snow in the mountains, unusually heavy snow also blanketed portions of the Treasure Valley. This study explored possible mesoscale reasons for this anomaly including orographically created mid level flow convergence along the Boise Mountains front range, and low level flow convergence along a sub-synoptic air

mass boundary as a result of cold air drainage and pooling in a confined basin at the foot of the Treasure Valley. While other and more complex processes may have contributed to this event, the plausible hypotheses presented above can be identified for future forecasts by examining model mid level wind fields and studying mesoscale surface air mass characteristics in addition to the over-all synoptic situation.