P.192 **Forecasting Heavy Wintertime Precipitation Events in Southern California**

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1. INTRODUCTION

Much of southern California's annual precipitation occurs through heavy wintertime rain. As a result of the flooding threat associated with these significant weather events, the potential socioeconomic impact is large. Therefore, it is important to forecast heavy wintertime rainfall as accurately and with as much advance notice as possible. The goal of this study is to investigate using standardized anomalies of various meteorological parameters in order to meet this forecast challenge.

2. METHODOLOGY

We examined 34 cases of 4-inch or greater rainfall events over southern California that occurred between December and March 1991-2000. Certain meteorological variables were compared to climatological norms in order to determine the magnitudes of the standardized anomalies, defined as the number of standard deviations by which the anomaly departed from the climatological mean. The following parameters were included in this study: heights at 250-, 500-, and 700 hPa; winds at 250-, 500-, 700-, and 850 hPa; precipitable water; moisture flux at 850 hPa and within the 1000 – 700 hPa layer; and mean sea level pressure.

The climatological norms of the parameters outlined above were based on the National Centers for Environmental Prediction (NCEP) reanalysis dataset. This dataset has a 2.5 x 2.5 degree resolution at 17 pressure levels. Although this dataset extends from 1948 to August 2000, it was the data from the 30-year period 1961-2000 that were used to determine the local climatology at each grid point. As outlined in Grumm and Hart (2001), standardized anomalies, N, can be defined by $N = (X-\mu)/ \sigma$, where X is a grid point value, μ is the grid point 21-day running mean, and σ is the 21-day running standard deviation. For 34 cases of heavy wintertime rainfall events over southern California, composites of the standardized anomalies of the parameters under investigation were generated and plotted using the Grid Analysis and Display System (GrADS).

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3. RESULTS

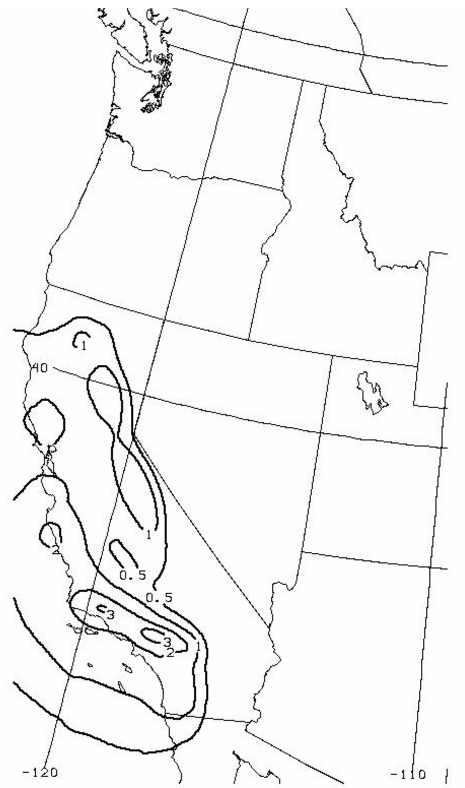

Figure 1. Composite of 24-hour precipitation totals.

Using 24-hour rainfall totals archived by the Hydrometeorlogical Prediction Center (HPC) quantitative precipitation forecast (qpf) verification team, a composite was created of the precipitation that actually occurred for a large number of the cases under review. This composite represents a typical rainfall pattern associated with 4-inch or greater rainfall events over southern California. Notice the precipitation maxima in the vicinity of the San Rafael and San Bernardino mountains. The area of heavier rainfall noted over the northern Sierra is not a focus of this study.

3.1 *Heights and Mean Sea Level Pressure*

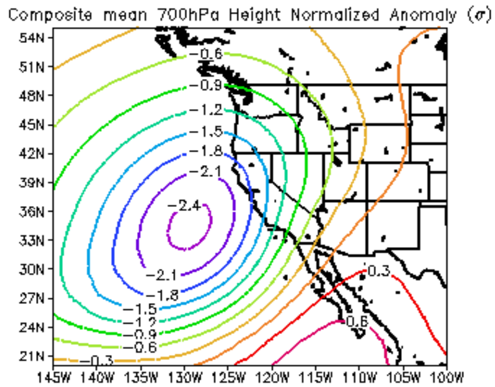

Figure 2. Composite of standardized anomalies in 700 hPa heights; number of standard deviations by which the composite mean varied from normal.

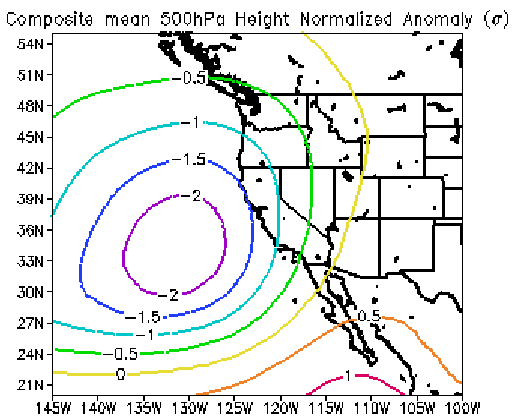

Figure 3. Composite of standardized anomalies in 500 hPa heights; number of standard deviations by which the composite mean varied from normal.

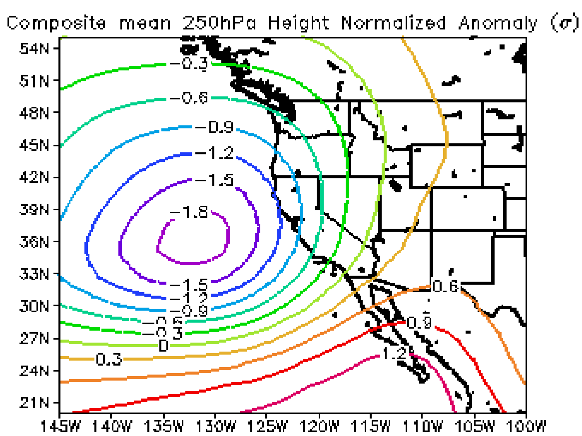

Figure 4. Composite of standardized anomalies in 250 hPa heights; number of standard deviations by which the composite mean varied from normal.

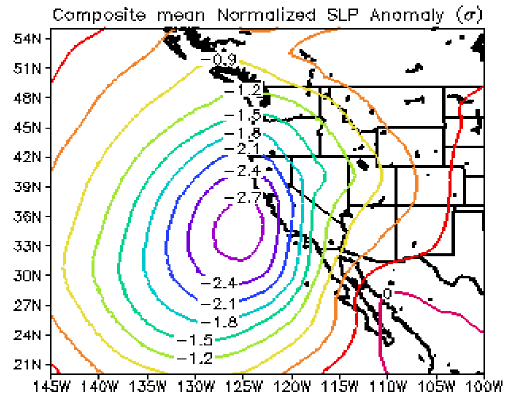

Figure 5. Composite of standardized anomalies in MSLP; number of standard deviations by which the composite mean varied from normal.

We can see from the composites of standardized anomalies of 700-, 500-, and 250 hPa heights that a pocket of significantly below normal heights off the northern California coast is associated with these rainfall events. This is not an unexpected synoptic pattern. There is also an area of below normal mean sea level pressure centered off the northern California coast. This pocket of lower sea level pressures is more than 2.7 standard deviations below normal.

3.2 *Winds*

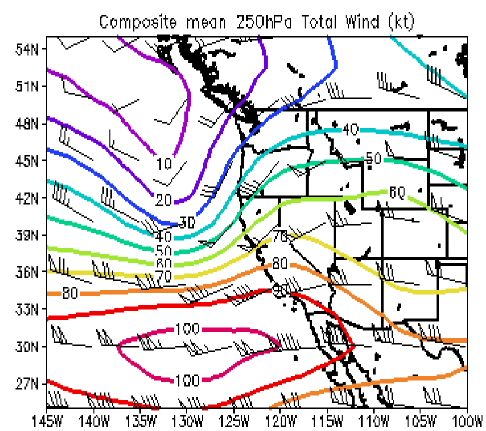

Figure 6. Composite of the 250 hPa total wind.

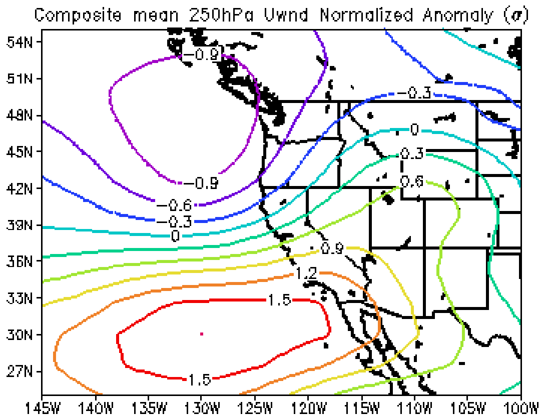

Figure 7. Composite of the standardized anomalies of the 250 hPa u-component of the wind; number of standard deviations by which the composite mean varied from normal.

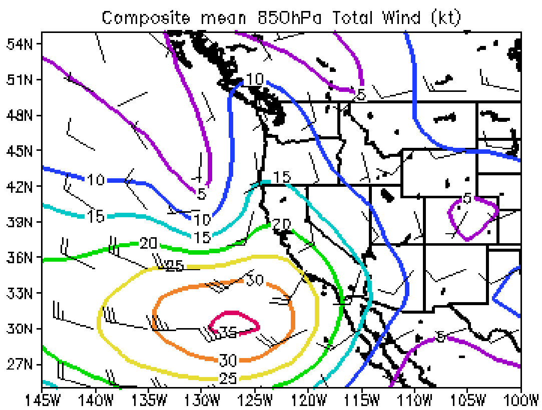

Figure 8. Composite of the 850 hPa total wind.

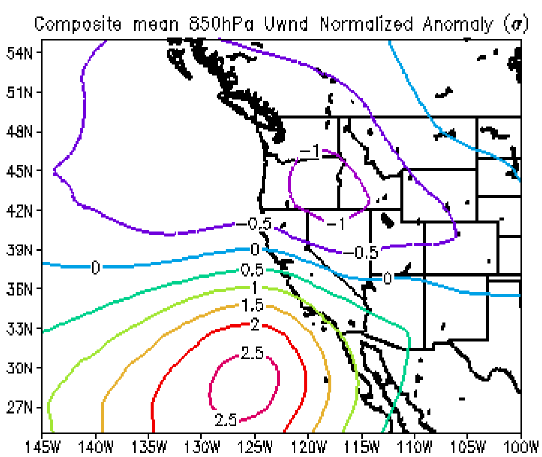

Figure 9. Composite of the standardized anomalies of the 850 hPa u-component of the wind; number of standard deviations by which the composite mean varied from normal.

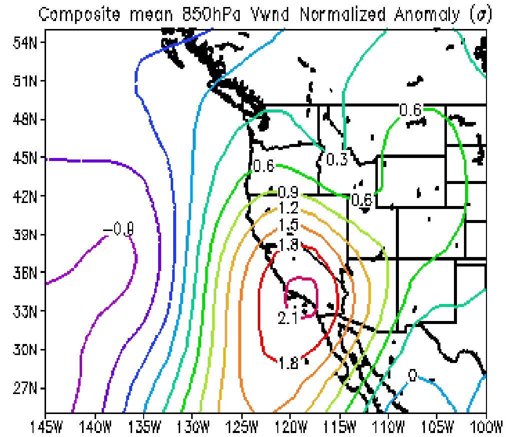

Figure 10. Composite of the standardized anomalies of the 850 hPa v-component of the wind; number of standard deviations by which the composite mean varied from normal.

Composites were generated of the total wind as well as the u- and v-components of the wind at 250-, 500-, 700-, and 850 hPa. Not all of these composites will be shown here; the figures included are thought to be representative.

Looking at the 250 hPa total wind, we can see that southern California is under the influence of left exit region jet dynamics, enhancing vertical motion. The entrance region of a jet streak is directed into northern California. The 250 hPa composite mean of the u-component of the wind reveals a negative anomaly off the Pacific Northwest coast, and a positive anomaly centered off of southern California and northern Baja. The juxtaposition of these positive and negative wind anomalies sets up an enhanced gradient, directing stronger flow into central and southern California.

The 850 hPa total wind composite shows a strong southwesterly jet directed into southern California. According to Pandey et al. (1999), this direction is the most favorable for transporting subtropical moisture from the east Pacific. In addition, the u- and v-components of the 850 hPa wind during the cases under examination were more than two standard deviations stronger than normal. The southerly component of the low level flow directs moisture into the San Rafael and San Bernardino mountains, where orographic enhancement of precipitation then accounts for the rainfall maxima in this region noted on the precipitation composite above. Strong westerly flow is often associated with heavy rainfall in the west as oceanic moisture impinges on higher terrain (Grumm et al., 2002).

3.3 *Available Moisture*

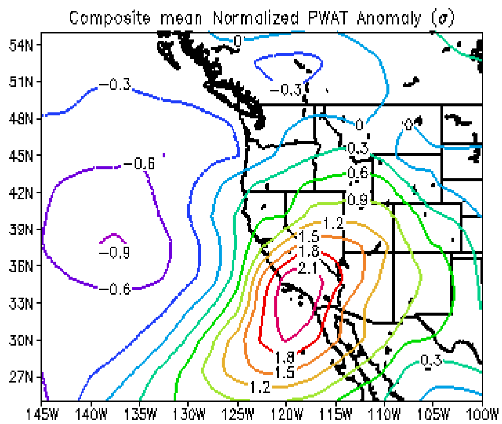

Figure 11. Composite of standardized anomaly in precipitable water; number of standard deviations by which the composite mean varied from normal.

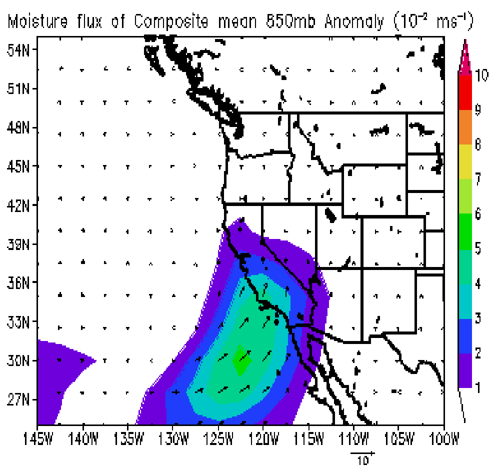

Figure 12. Composite of standardized anomaly in moisture flux at 850 hPa; number of standard deviations by which the composite mean varied from normal.

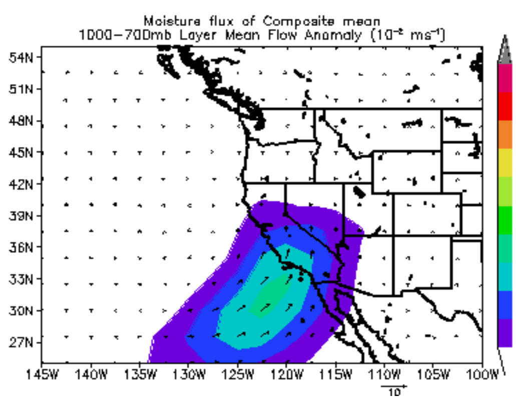

Figure 13. Composite of standardized anomaly in the 1000 – 700 hPa layer moisture flux; number of standard deviations by which the composite mean varied from normal.

Anomalously strong precipitable water values were centered over southern California during these significant rainfall events, signifying an abundance of subtropical moisture available for fueling heavy rains.

Strong moisture flux anomalies, both at 850 hPa and within the 1000-700 hPa layer, were nosing into southern California, highlighting the importance of moisture transport for sustaining significant rainfall events.

4. CONCLUSIONS

We propose an integration of numerical weather prediction models and local climatology as a tool for forecasting heavy rainfall events over southern California a few days in advance. The standardized anomalies in heights, winds, precipitable water, and moisture flux as outlined above seem to offer the most promise, although an ensemble approach would probably provide the optimal forecast utility.

5. REFERENCES

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