Elevated Convection over Northwest California

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Introduction

A weakening frontal boundary moved through the coastal waters of Eureka, California on the evening of 10 October 2005. Weak convection developed over the coastal waters and continued a track into the WFO Eureka CWA. Thunderstorms generated over the coastal waters typically weaken as they migrate towards the coast. This weakening of convection results from the more stable lapse rates driven by the cooler sea surface temperatures associated with cold upwelling along the coast. This paper will investigate that in this case elevated convection was primarily triggered by dynamic forcing in the mid and upper levels and sustained by mid level instability.

Synoptic Features

A weak upper level trough was moving into the Pacific Northwest with its associated weakening cold front extending southwest over the offshore waters of northern California shown in figure 1.

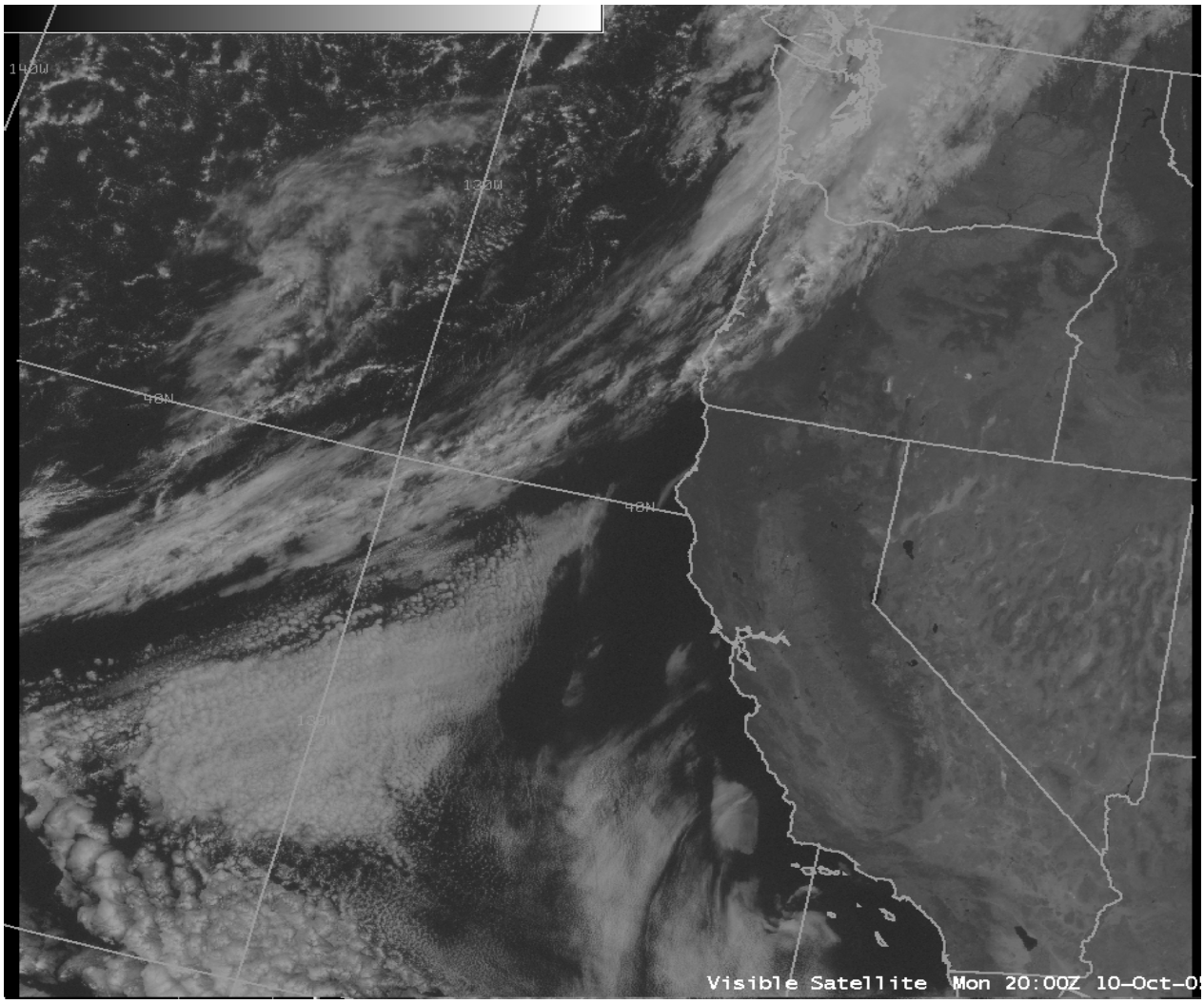

Figure 1. Visible satellite imagery 10 October 2005 2000 UTC (1300 PM PDT).

Surface high pressure was building over the east Pacific with a ridge axis extending into the Washington/Oregon border while a thermal trough was deepening along the central California coast. This pattern was initialized by the 11 October 2005 00 UTC run of the Global Forecast Systems model (GFS) in Figure 2a. Based on anticyclonic low-level cloud motion from satellite imagery, building high pressure at the surface was apparent and shown by the GFS initialization of surface streamlines in Figure 2b. Convection was unfavorable with the lower levels stabilizing as high pressure was building into the Pacific Northwest.

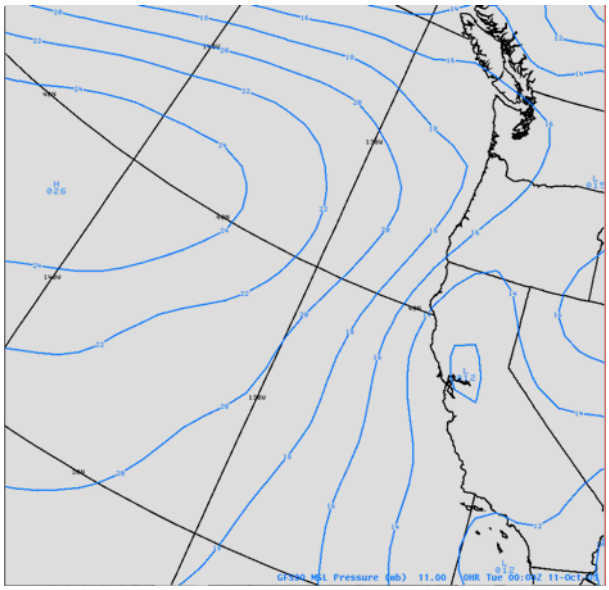

Figure 2a. 1026 mb surface high pressure over Northeast Pacific and thermal trough over California initialized by 11 October 2005 0000 UTC model run.

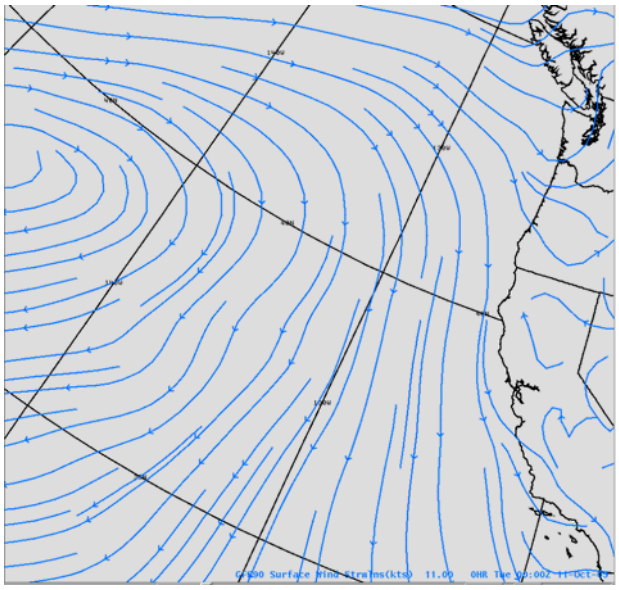

Figure 2b. Anticyclonic flow over Northeast Pacific initialized by 11 October 2005 0000 UTC model run.

Evolution of Weak Convection

The pre-existing cloud elements associated with the southern end of the weak cold front moved northeastward towards Northern California and showed signs of intensification by late afternoon. Cloud enhancement was triggered by a strengthening upper level shortwave detected in water vapor imagery, as darkening and buckling of the dry air feature at 0030 UTC (1730 PDT) seen in Figure 3a. Infrared imagery at 0300 UTC (2000 PDT) measured cloud tops near -51 degrees Celsius in Figure 3b.

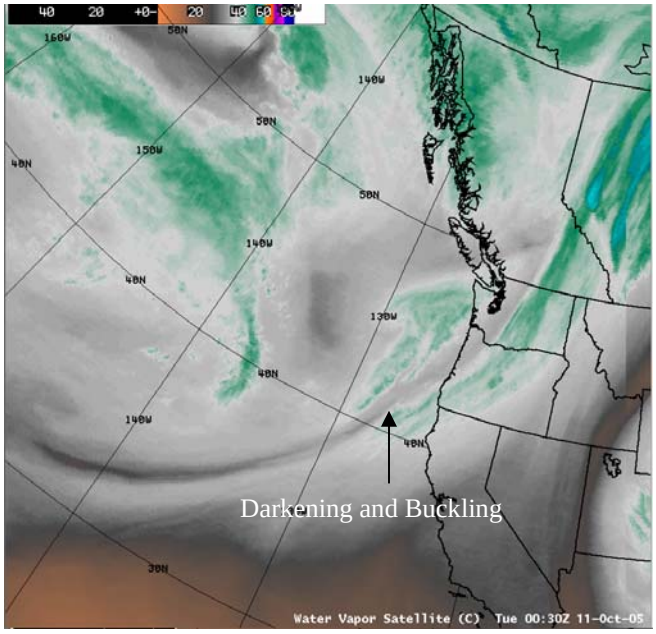

Figure 3a. Water vapor imagery 11 October 2005 0030Z showing weak shortwave intensifying off the coast of northern California.

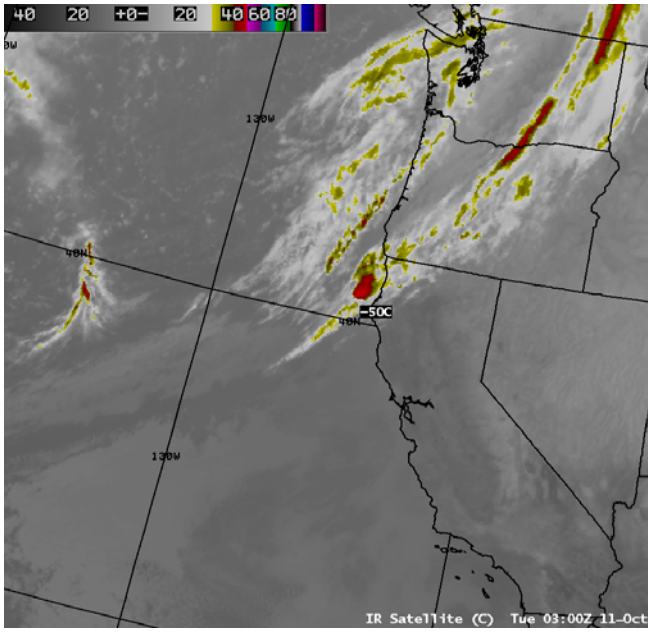

Figure 3b. Infrared imagery 11 October 2005 0300Z showing cloud tops cooling to -51 degrees Celsius off the coast of northern California.

National Weather Service 88D radar site KBHX 0.5 degree reflectivity began detecting echoes of precipitation around 02Z. As vertical development intensified, the lightning detection network detected the first strikes around 02Z over the coastal waters. Lightning strikes were detected around 0346 UTC offshore of Eureka, CA shown in Figure 4a and 4b. The thunderstorms continued to move ashore and inland before weakening. A second round of convection developed and moved into the CWA 3 hours later as shown in Figure 4c. This isolated cell of convection quickly moved inland and intensified inland most likely aided by additional upward forcing caused by orographics (Figure 4d).

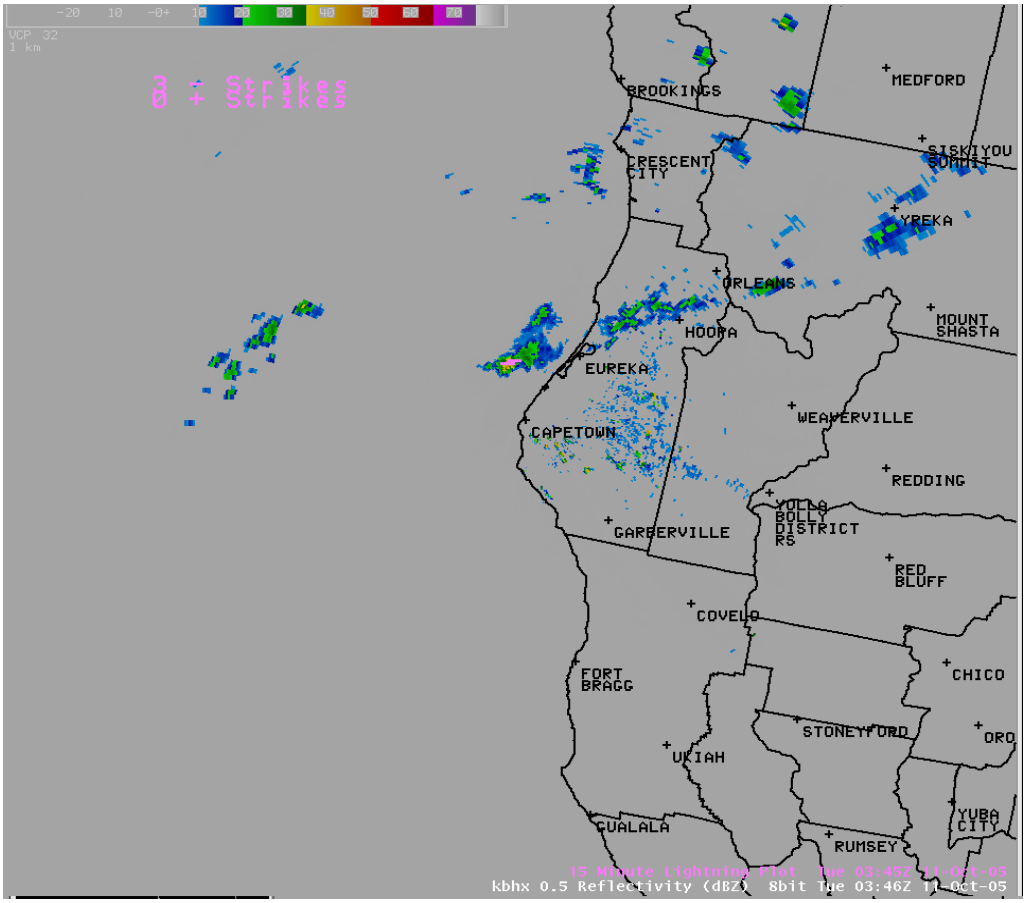

Figure 4a. NWS Doppler Radar KBHX with lightning strikes overlaid at 0346 UTC (2046 PDT) 11 October 2005.

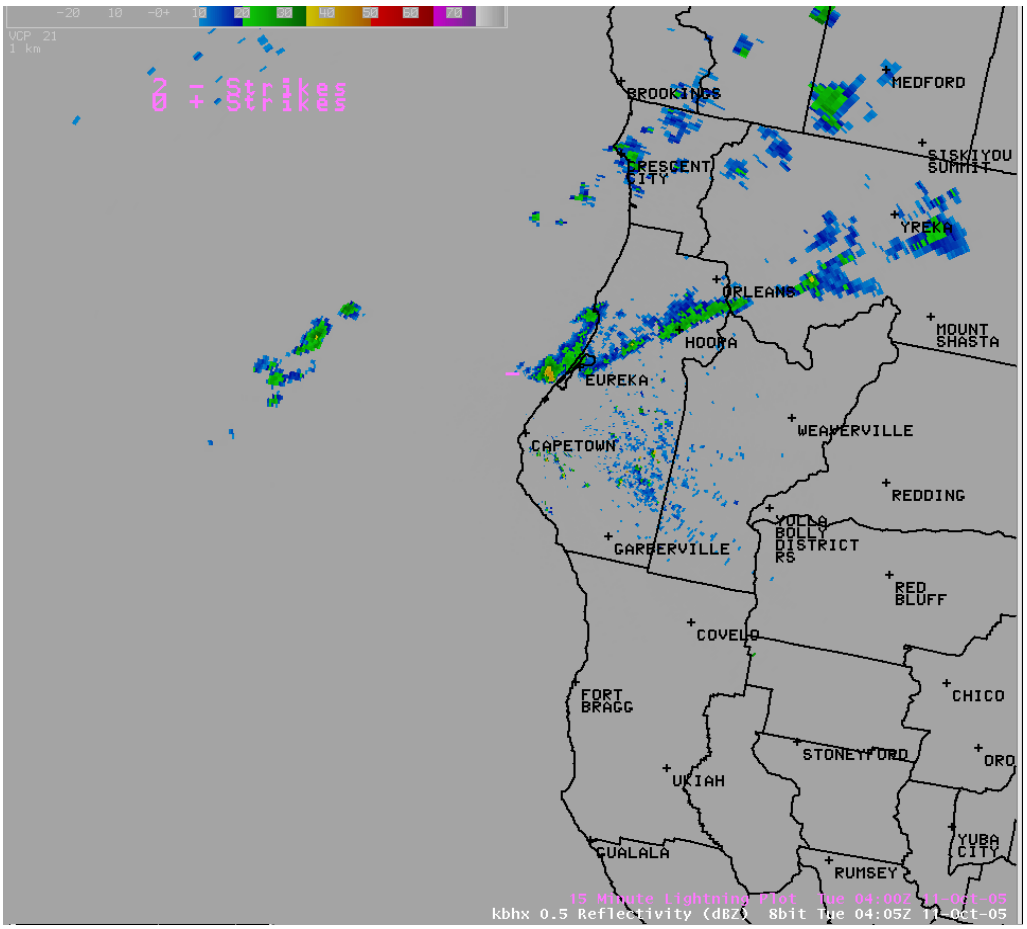

Figure 4b. NWS Doppler Radar KBHX with lightning strikes overlaid at 0405 UTC (2105 PDT) 11 October 2005.

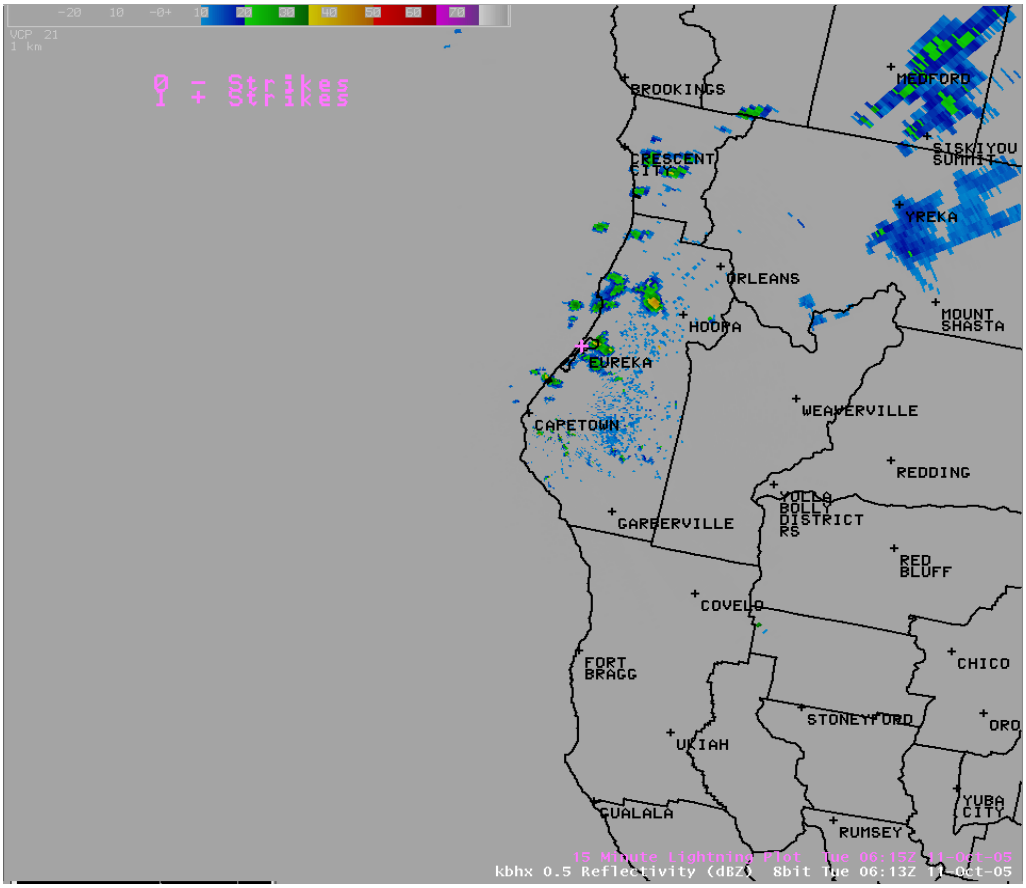

Figure 4c. NWS Doppler Radar KBHX with lightning strikes overlaid at 0613 UTC (2313 PDT) 11 October 2005.

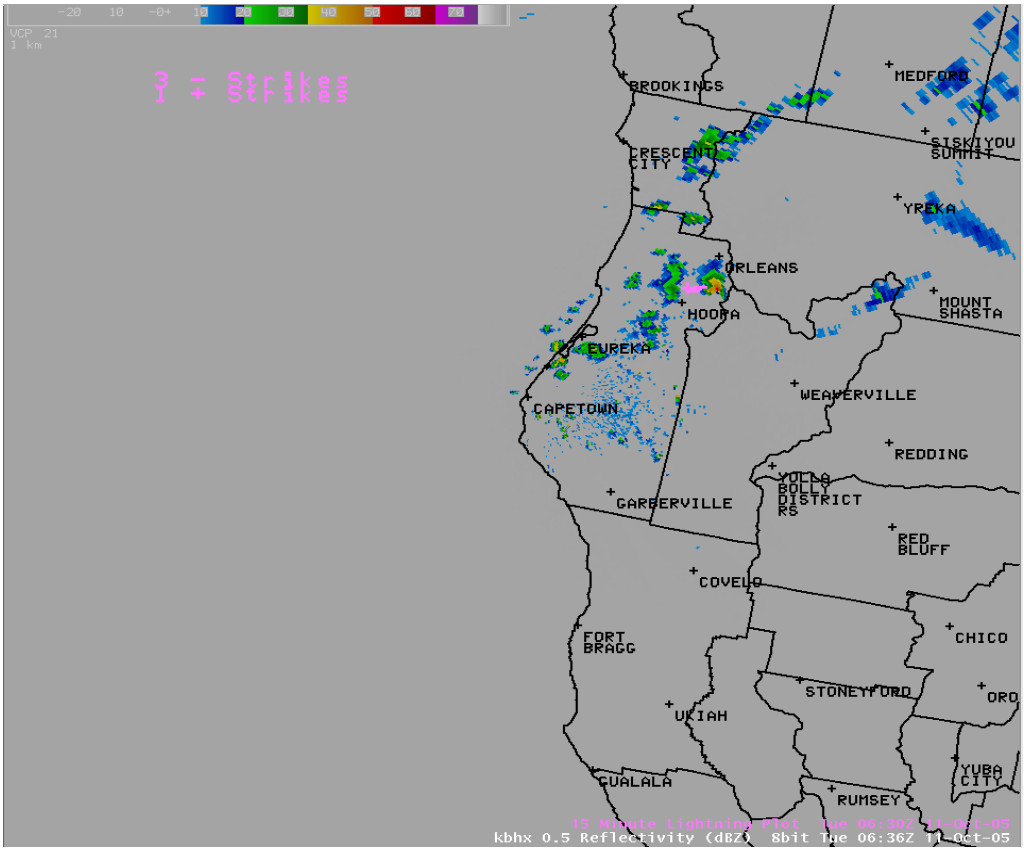

Figure 4d. NWS Doppler Radar KBHX with lightning strikes overlaid at 0636 UTC (2336 PDT) 11 October 2005

Discussion

What appeared to be a front going through frontolysis, the southern end of this front was influenced by terrain and maintained by upper level features that also aided upward motion. The initialization of the 00Z 11 October 2005 GFS model run showed weak upper diffluence at 300 hPa as seen in the wind field in Figure 5a. Figure 5b shows an area of positive vorticity advection at 500 hPa off northwest California also captured by the 00Z GFS run. Morning forecast model solutions did not appear to have a good handle on the situation as compared to the afternoon solutions. Thunderstorm activity is rare in Northwest California, but thunderstorms still do occur. This particular case was triggered in response to the destabilization of the mid levels of the atmosphere caused by ageostrophic circulations in the right rear entrance region of the upper level jet across the Pacific Northwest and southwest Canada. As forecast models do not have the ability to handle the subtle and small scale features of the atmosphere, this case illustrates the need for forecasters to maintain situational awareness of ongoing weather developments to catch features that models cannot pick up.

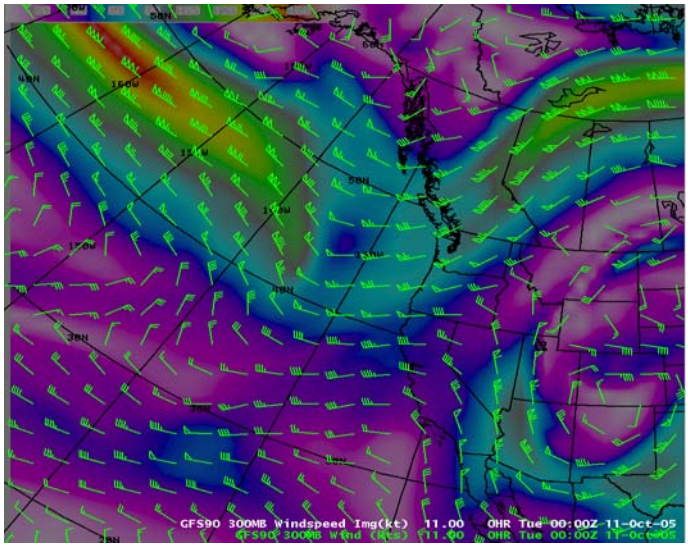

Figure 5a. 11 October 2005 GFS initialization of 300 hPa wind speed and wind barbs.

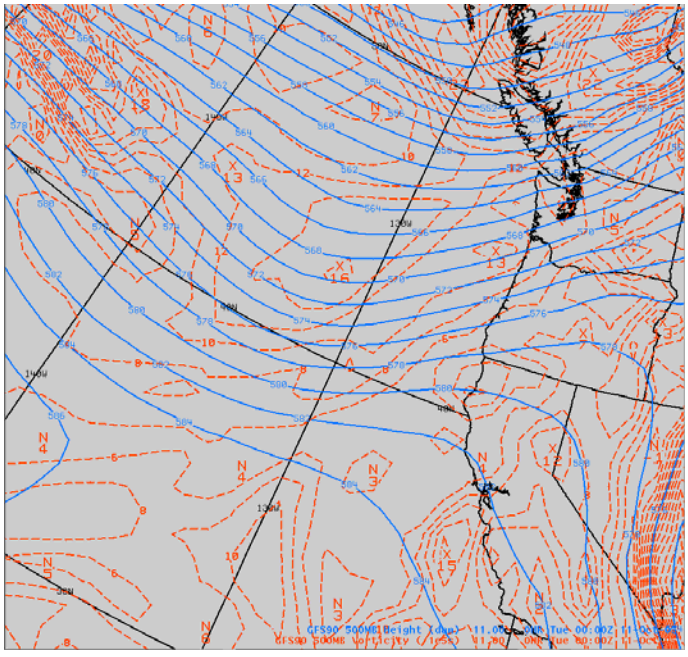

Figure 5b. 11 October 2005 GFS initialization of 500 hPa heights (blue lines) and vorticity (orange dotted lines).