A Squall Line Event on Oct 26, 2004
Over Northwest California

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Synopsis

A strong 500-hPa trough was digging south over the eastern Pacific. Northern California was in the diffluent region to the east of the trough axis, in the left front exit region of a 170 kt jet streak that was rounding the upstream side of the trough. This was providing excellent upper support for an intensifying surface feature, a 994 hPa low off the Oregon Coast (fig. 1). A strong Pacific cold front trailed to the south of the low center, and good subsidence was evident in visible satellite imagery behind the front (fig. 2).

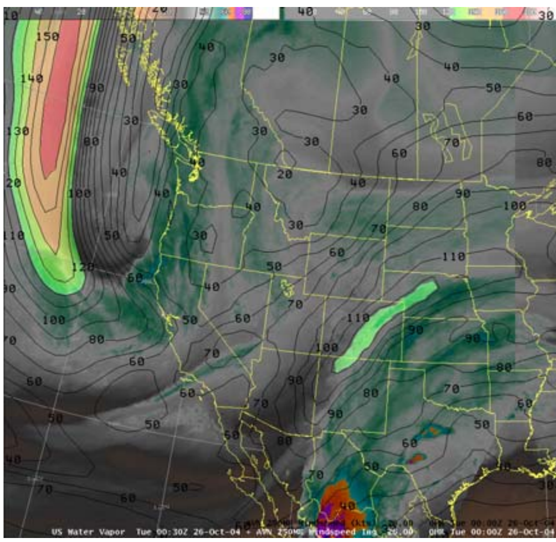

Figure 1: WV satellite imagery for 0000 UTC, GFS 250 MB Isotachs initialization for 0000 UTC, 26 October 2004.

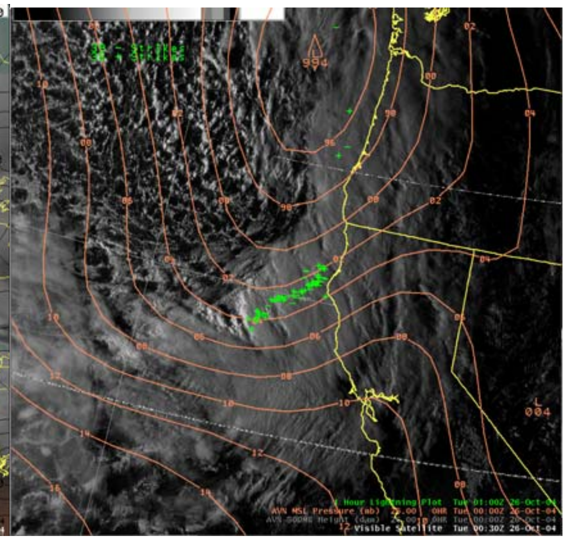

Figure 2: VIS satellite imagery, GFS MSL Pres initialization and 1hr Lightning Plot for 0000 UTC, 26 October 2004.

Mesoscale observations

Bright cloud tops on visible satellite imagery (fig. 2) and cooling tops on IR imagery indicated a line of intensifying convection along the cold front. Cloud tops cooled to –56 deg C (fig. 3). Surface observations (fig. 4) and VAD wind profiles (fig. 5) indicated low-level southerly wind of 30 to 40 kts in advance of the front and mid level flow was 40 to 50 kt from the west-southwest. This provided an environment of good deep-layer sheer. Model soundings from the Eta and observed RAOBs suggest that the environment was marginally stable to neutral, with surface based Lifted Indices of between 0 to 2 degrees Celsius.

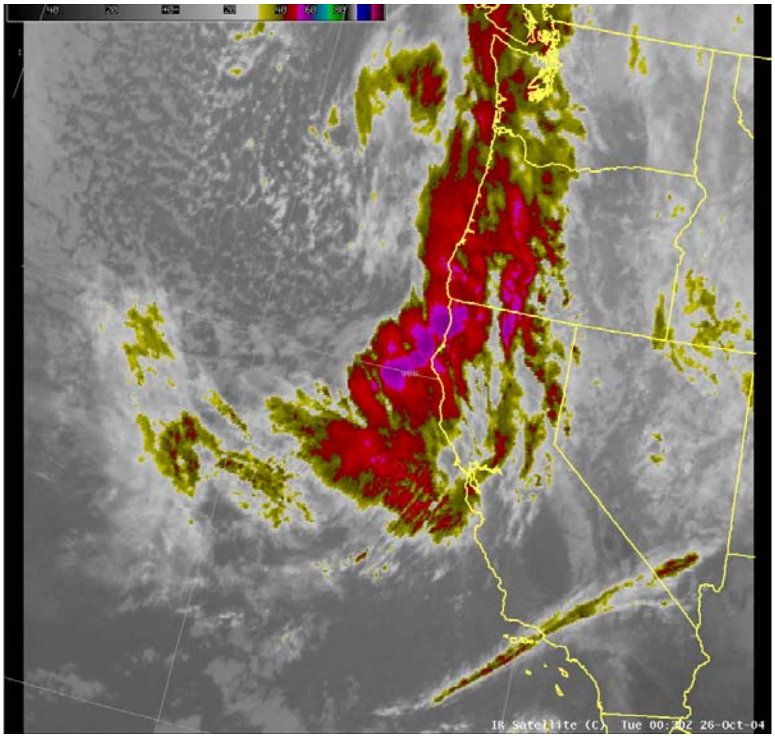

Figure 3: IR satellite imagery for 0030 UTC, 26 October 2004.

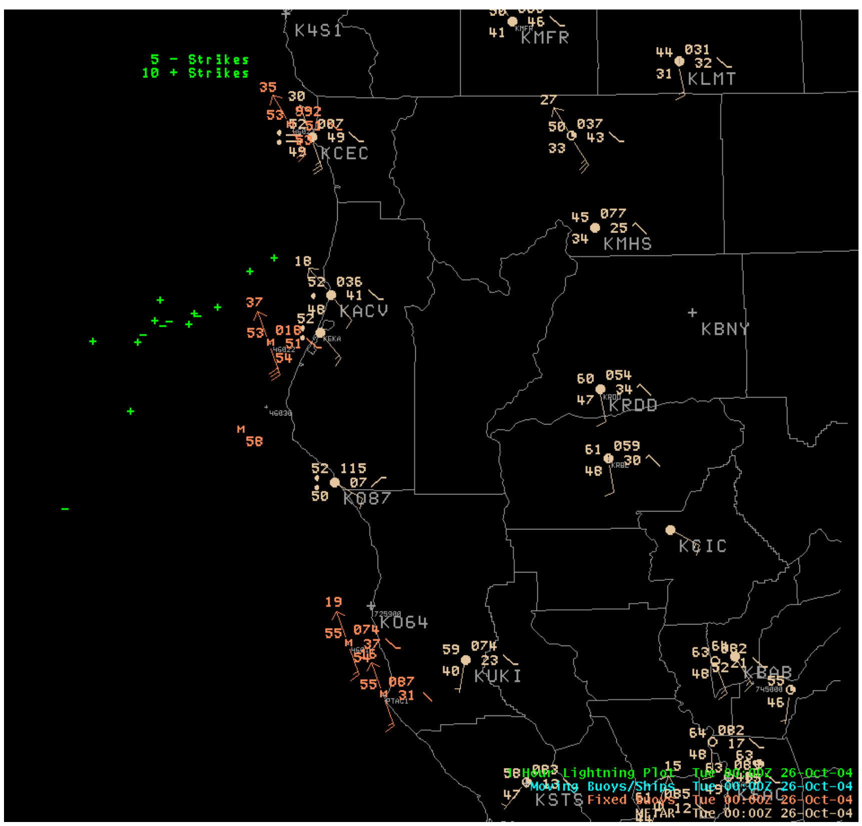

Figure 4: METAR, Buoy, and 1hr Lightning Plots for 0000 UTC, 26 October 2004.

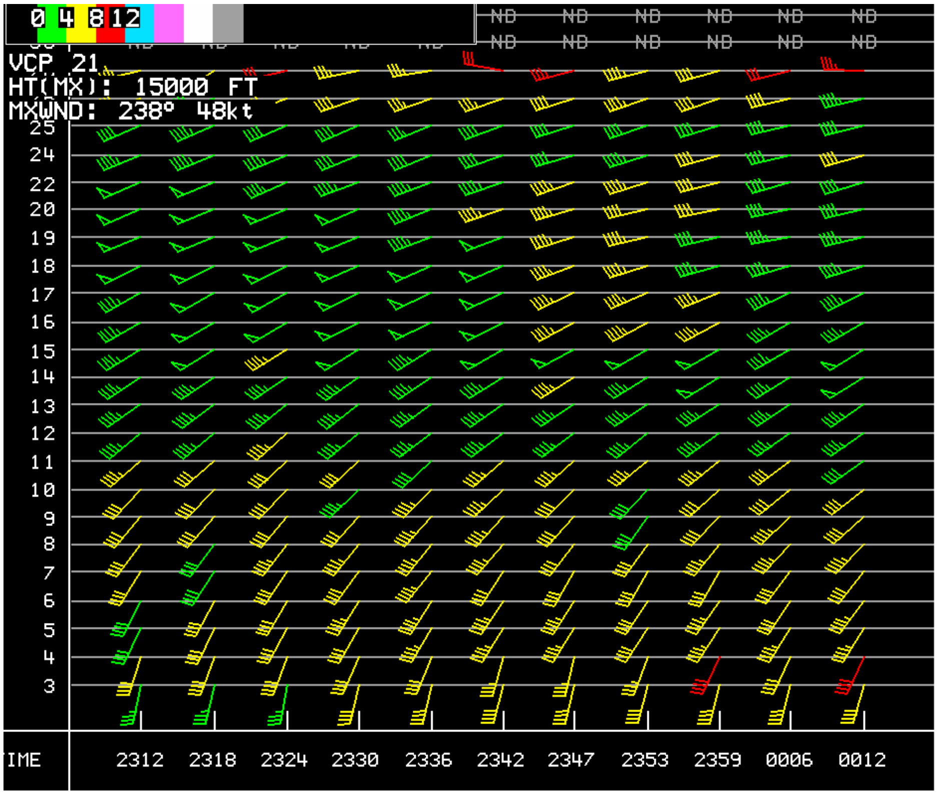

Figure 5: VWP for 2312 UTC through 0012 UTC, 26 October 2004.

Radar Observations

By late Monday afternoon, NWS-88D radar surveillance was picking up a narrow line of convection (fig. 6) coincident with the cooling cloud tops seen in IR satellite imagery (fig. 3), indicating a narrow cold-frontal band. Lightning detection indicated numerous strikes in association with the line (initially an equal number of negative and positive strikes, transitioning to predominately positive strikes when the line made landfall).

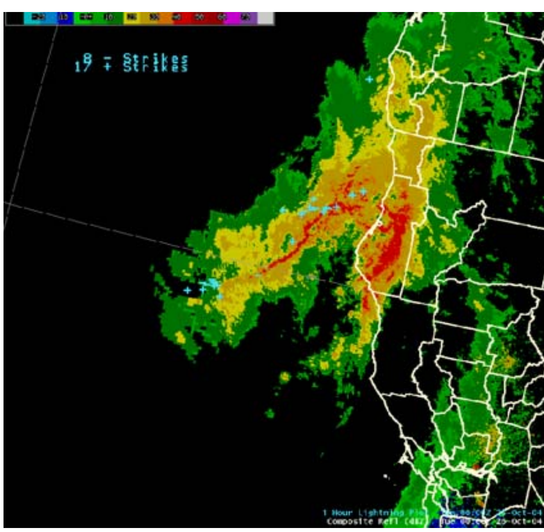

Figure 6: Composite Reflectivity. and 1 hr. Lightning Plot for 0000 UTC, 26 October 2004.

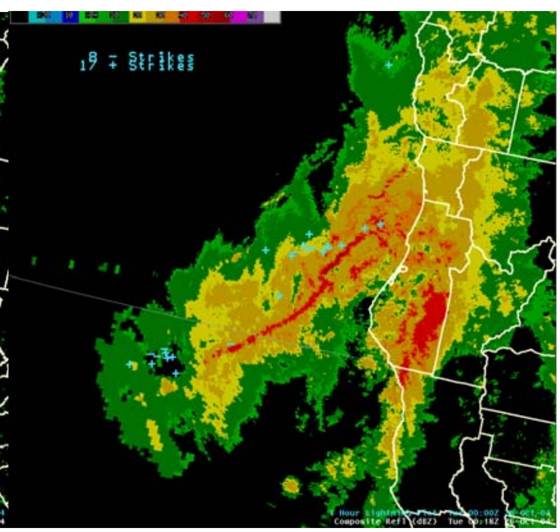

Figure 7: Composite Reflectivity. and 1 hr. Lightning Plot for 0018 UTC, 26 October 2004.

While the line was more than 50 miles offshore most of the strikes were in the northern portion of the line. The frequency of strikes was increasing with time. The most intense cells in the line had a maximum reflectivity of 57-59 dBZ in several line segments in the middle of the line (which was approximately 150 km long). These intense segments were just north of an apparent “break” in the line (fig. 7). As the line moved within 20 miles of shore intensification shifted to the southern portion (south of the “break”) where lightning strike frequency was increasing (fig. 8).

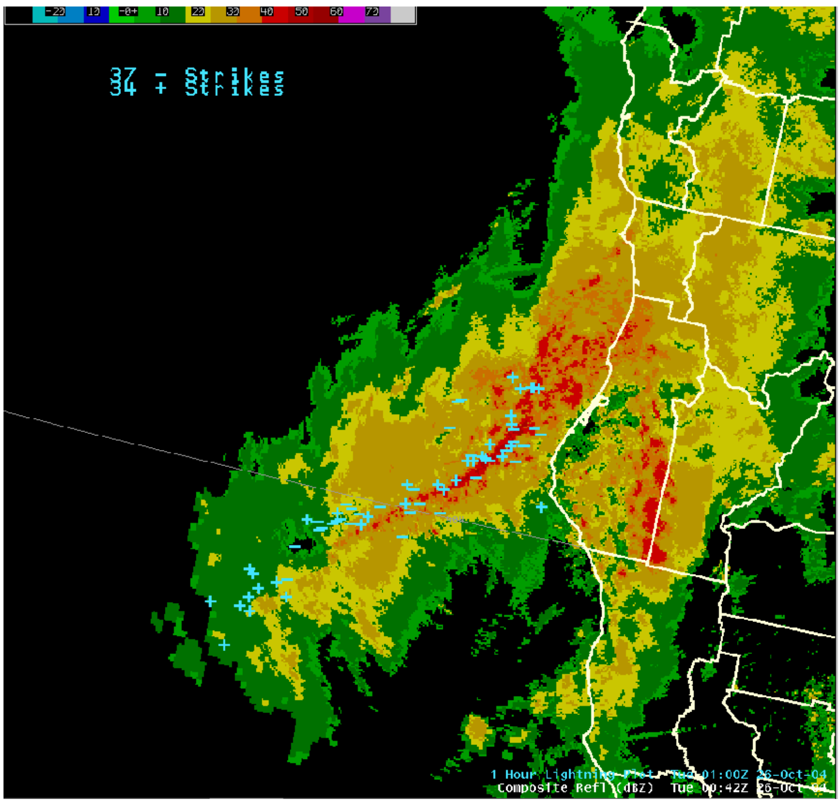

Figure 8: Composite Reflectivity for 0042 UTC and 1 hr. Lightning Plot for 0100 UTC, 26 October 2004.

At about the same time, SRM indicated three circulations developing in the most intense portion of the line, now located just south of the apparent break (fig. 9). SCAN indicated two correlated mesocyclones. The strongest of the two (the southern cell) had outbound velocities of 45 kt and inbound velocities of 35 kt, and this circulation was evident in .5, 1.5, and 2.4 degree scans. These circulations lasted approximately 15 minutes but dissipated rapidly just before the line reached shore north of Cape Mendocino.

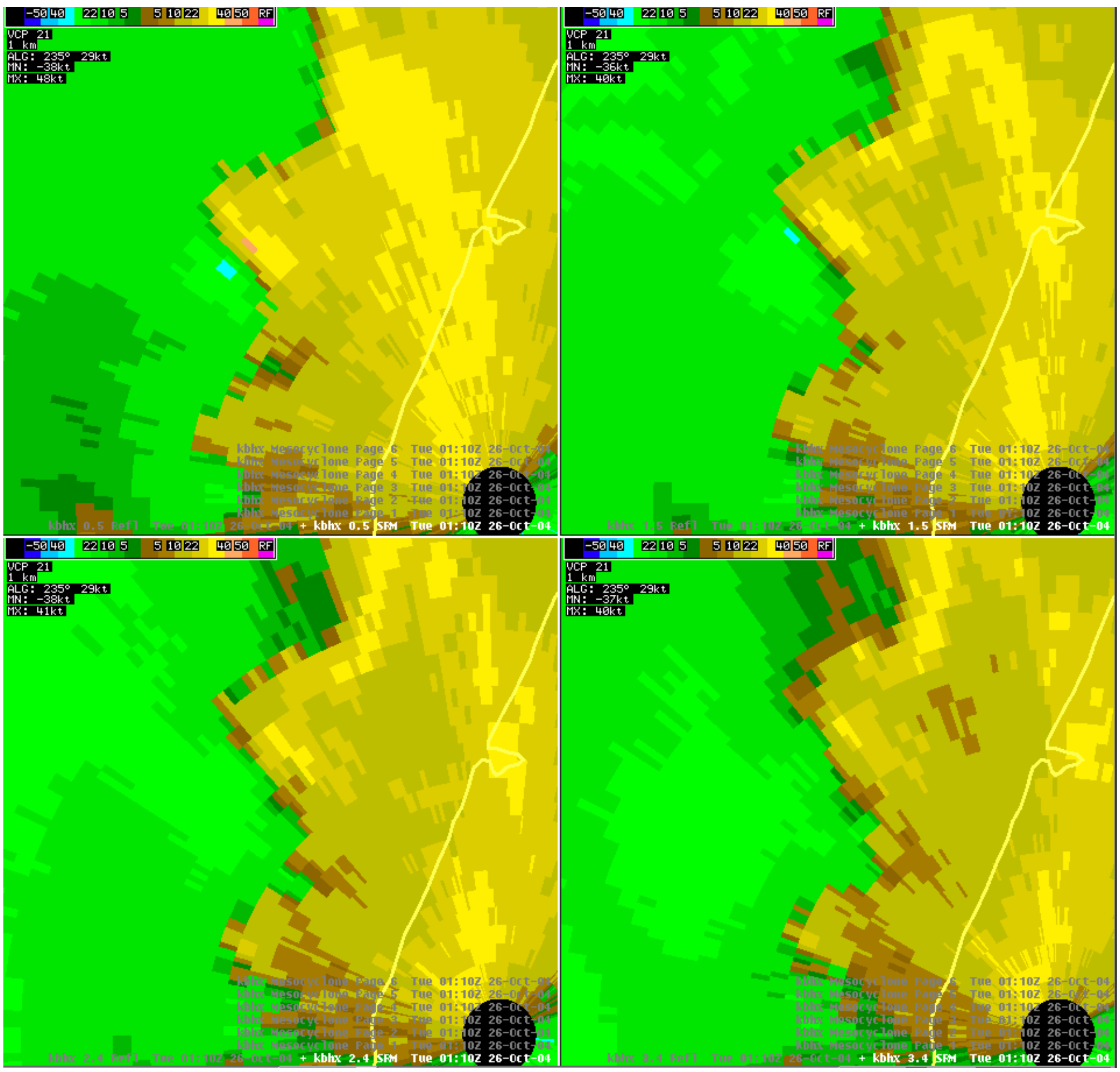

Figure 9: 0.5, 1.5, 2.4, 3.4 degree 4-Panel SRM for 0110 UTC, 26 October 2004

Reflectivity also fell rapidly before the cells made landfall. At this time (~1:10 Zulu) the line was oriented in approximately a N-S direction at about a 30-degree angle to the coastline. The individual cells were moving to the ENE at about 20 kt. A stratiform shield to the rear of the leading edge of high reflectivity was also evident, suggestive of a maturing MCS (fig. 10).

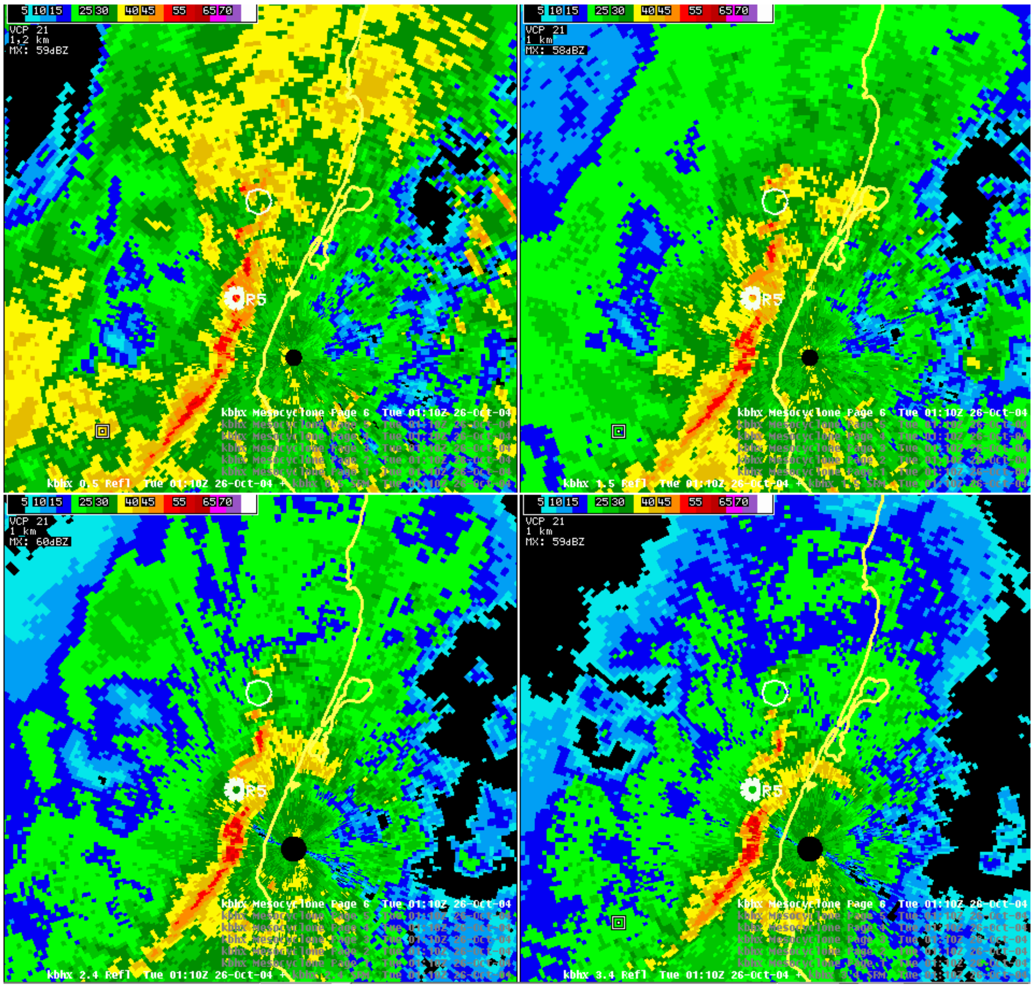

Figure 10: 0.5, 1.5, 2.4, 3.4 degree 4-Panel Reflectivity and MESO for 0110 UTC, 26 October 2004

Discussion

During winter, fast moving, convectively active, cold fronts commonly make landfall along the north coast of California. It is typical during these events for the convective lines to develop into a series of segments with semi-persistent rotational radar signatures at the break points between the segments. The squall line of October 26, 2004 represented the strong end of the spectrum of this type of event. Rotational velocities during these events normally do not exceed 30 knots. During the October 26, 2004 event, rotational storm relative inbound and outbound velocities exceeded 40 knots. The 40 knots of rotational velocity at the 0.5-degree elevation scan indicated strong boundary layer winds. These boundary layer winds, superimposed upon a 20-knot translational velocity, resulted in the issuance of a Special Marine Warning for straight-line winds in excess of 50 knots. As is normally observed of cold fronts making landfall to the north of coastal headlands, upon reaching Cape Mendocino, the associated organized convective squall line became disorganized and weakened rapidly.