An Example of Cold Air Damming Over the Sacramento Valley

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Introduction

On January 25, 2008, a complex weather pattern evolved over the West Coast resulting in rather unusual phenomena over the Sacramento Valley. Mesoscale analysis showed that despite a strong warm air advection pattern over interior northern California, cold air remained trapped over much of the west side of the Sacramento Valley. While this "cold air damming" pattern is relatively common over the far northern end of the Sacramento Valley, it's very difficult to say if and when the cold air has infiltrated the valley as far south as Sacramento. This is mainly due to the sparseness of surface data west of Interstate 5 in the Sacramento Valley.

Synoptic Pattern

The synoptic pattern on January 25, 2008 was dominated by a nearly stationary 532 DM closed low centered near 37N 130W (figure 1) with a 29.95 mb surface low centered about a degree east of the upper low. Further north, ridging, both at the surface and aloft, was analyzed over the Pacific Northwest. A strong east-west surface pressure gradient developed over northern California with a peak San Francisco to Reno pressure difference approaching 10 mbs (9.8 mbs) at 15Z. Upper level wind support was strong with KDAX WSR-88D velocity data showing over 60 kts of southwesterly flow at 2500 ft AGL (figure 2). Further north, ridging at the surface and aloft was analyzed over eastern Washington and Oregon. This surface pressure pattern resulted in north to northeast surface flow over the northern portion of the WFO Sacramento forecast area. Based on the available data a wind advisory was issued for much of the WFO Sacramento forecast area.

Anomalies

A significant temperature and dew point discontinuity was analyzed with a persistent 10 degree temperature difference and as much as a 5 degree dew point difference between KSMF (SAC AP)and KSAC (approximately 15 miles south of KSMF) throughout the day (fig. 4). Despite the strong surface pressure gradient and upper level support, surface winds remained light northwest at KSMF through the day. Meanwhile, KSAC reported persistent southeast winds with gusts as high as 28 kts. Light north winds were also reported in Vacaville (KVCB) through the afternoon while Suisun (approximately 7 miles south of KVCB) reported southeast winds gusting as high as 26 kts. Streamline analysis of this event was problematic due to the aforementioned scarcity of data along the west side of the Sacramento Valley. Bill Mork (retired State Climatologist) has been credited with suggesting that the confluence of surface winds in the Fairfield area is indicative of a kind of "reverse gap flow" or accelerated easterly flow through the Carquinez Strait (figure 3). This conceptual model "evacuates" the confluent surface flow

through the gap enhancing wind speeds west of the coastal gaps through the San Pablo Bay and the Petaluma Valley. It should also be noted that throughout the morning and early afternoon of the 25th, RAWS reports from Lake County revealed widespread moderate to strong southeast winds with gusts as high as 49 mph at Lyons Valley (3200 ft). This illustrates the shallow depth of the cold air and associated northerly flow over the west side of the Sacramento Valley. This shallow cold layer was reinforced by conductively cooled air draining off of the Coastal Range which was covered with an unseasonably deep snowpack (dashed blue arrow in figure 4).

Forecast Implications

This rare wind pattern resulted in a few forecast challenges, the most significant of which was the wind forecast for the west side of the Sacramento Valley including the largest airport in the WFO Sacramento forecast area (KSMF). Despite many forecast indicators that suggested a high likelihood of advisory criteria winds over much of the WFO Sacramento forecast area, the winds remained light northerly over the west side of the valley (at least at KSMF and KVCB) through the day. From an aviation forecasting standpoint, there was a high probability of low-level wind shear (LLWS) at KSMF with light northerly flow at the surface and strong southeasterly flow aloft as was indicated by KDAX wind data. Finally, and perhaps least significant but most interesting, the resultant large temperature gradient wreaked havoc on the gridded forecast process with large temperature discontinuities over very small areas.

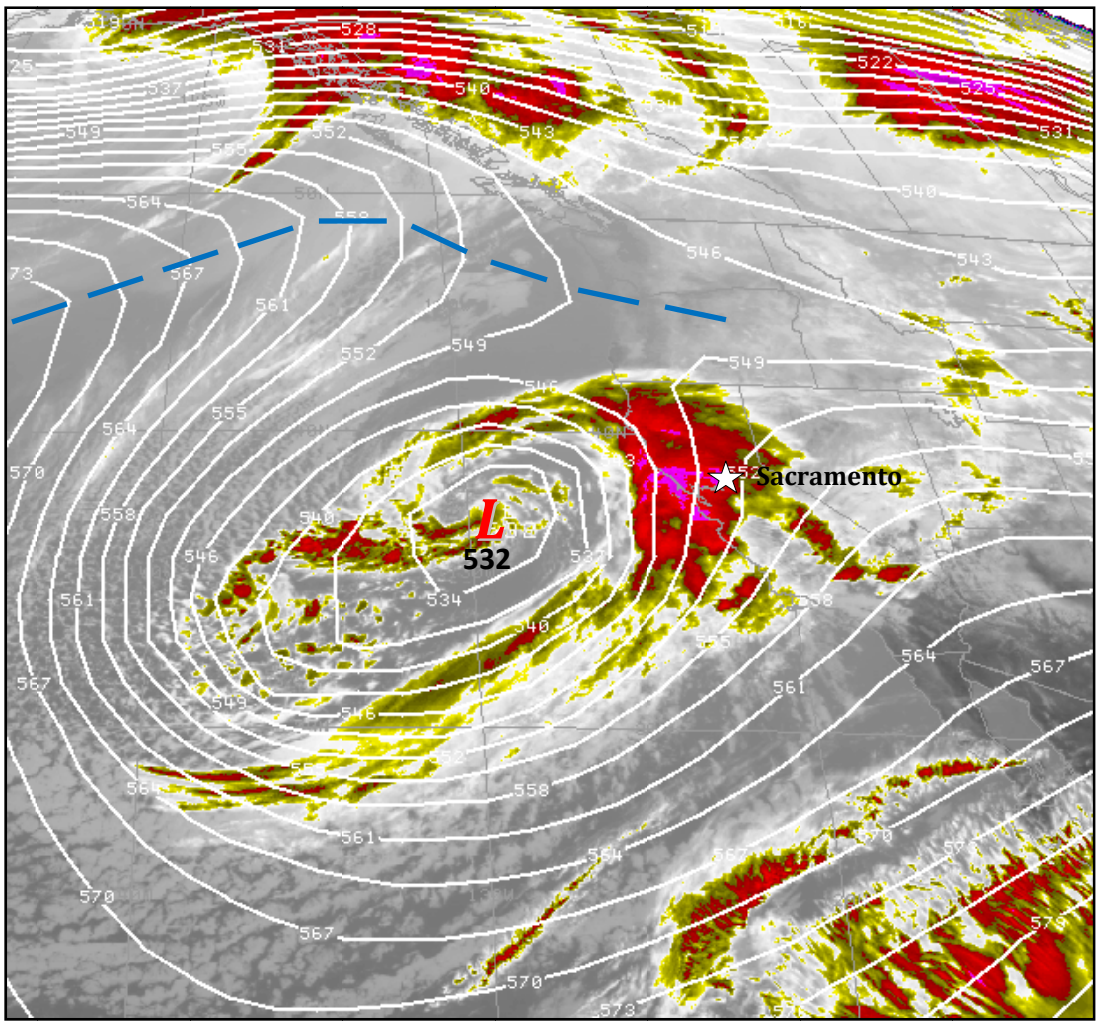

Figure 1. GFS 500 mb Heights and IR Satellite Image from 18Z

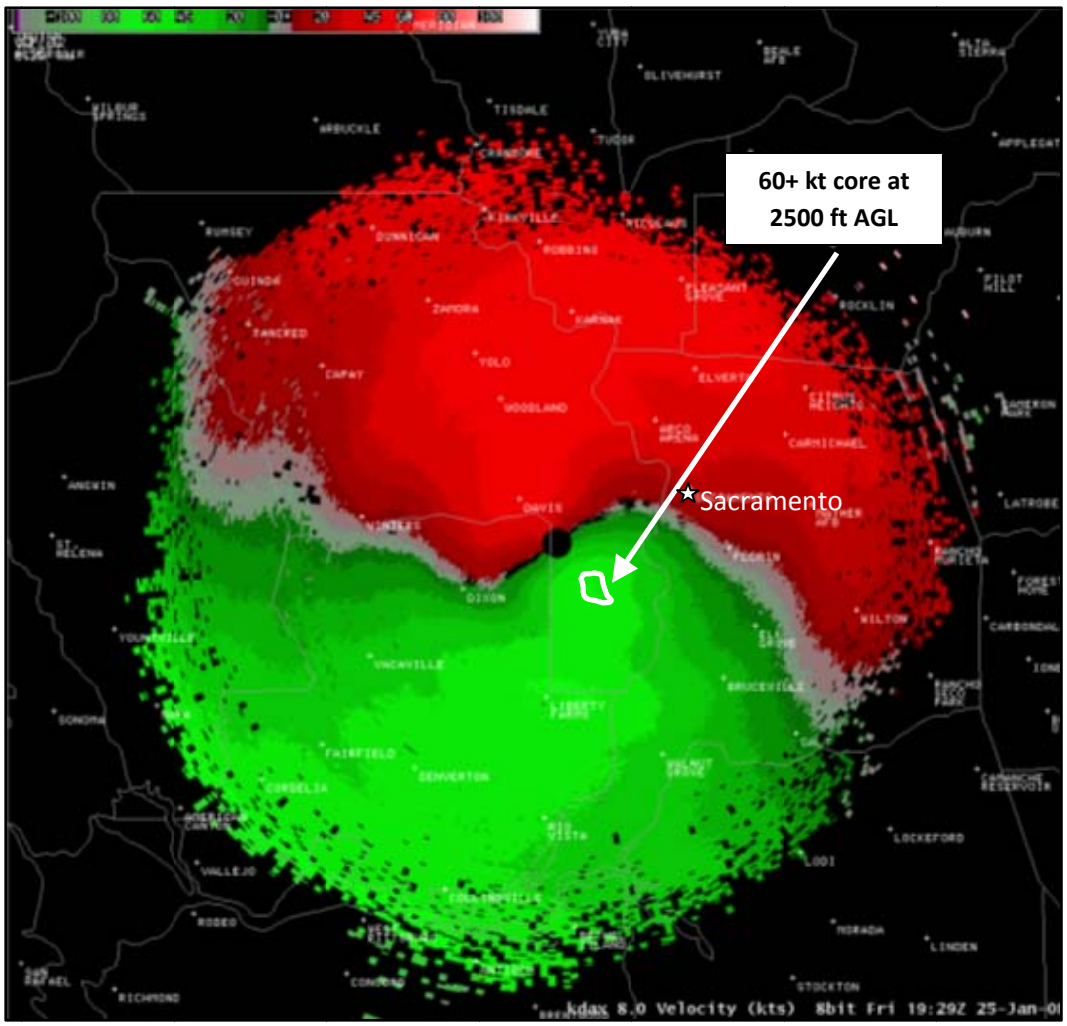

Figure 2. KDAX 8.0 Degree Velocity Product from 1929Z

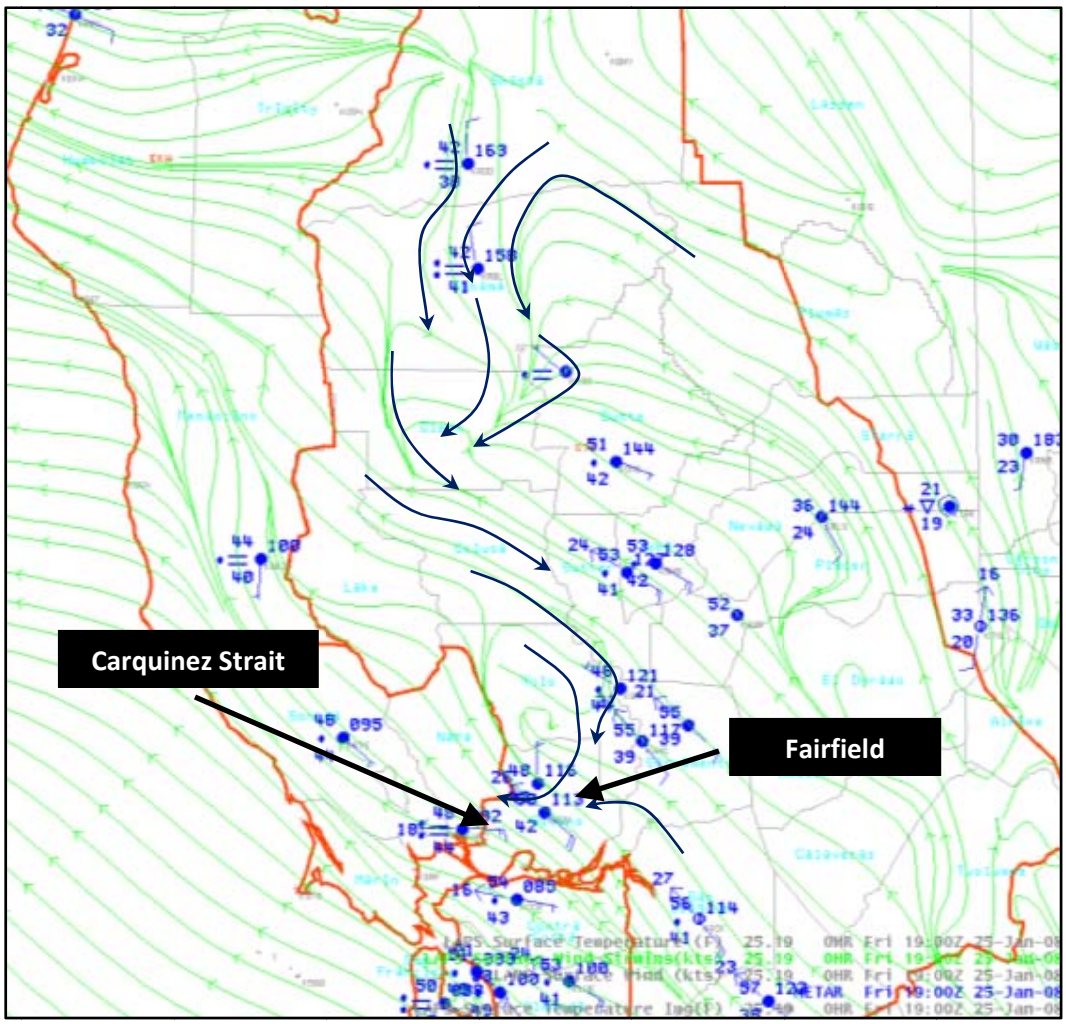

Figure 3. LAPS Streamlines (green) and METARs from 18Z

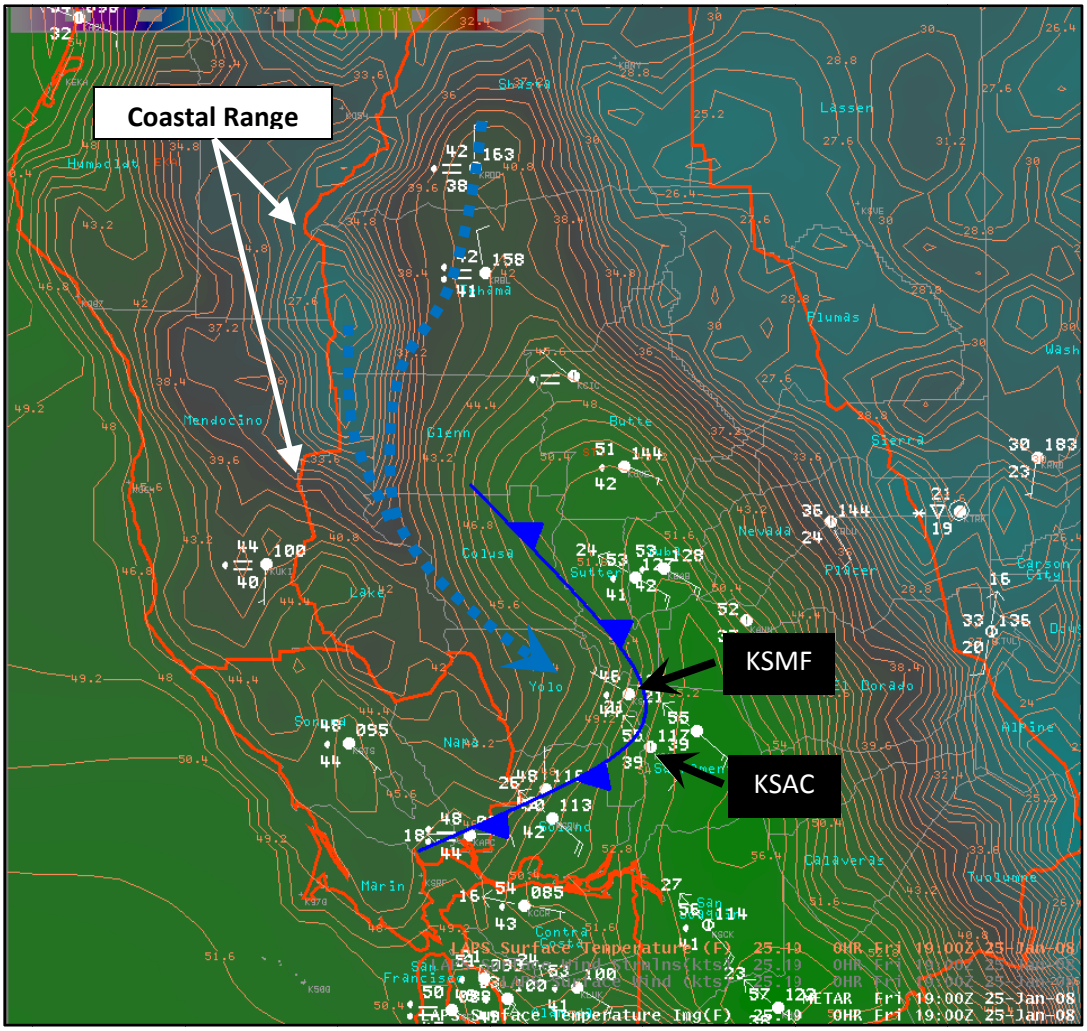

Figure 4. LAPS Surface Temperatures and METARs from 18Z. Dashed blue line indicates cold air trajectory.