The Evolution of a Northward Propagating Buoyant Coastal Plume After a Wind Relaxation Event

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After a relaxation of the regional upwelling-favorable winds along the south central Californian coast, warm water from the Santa Barbara Channel propagates northward as a buoyant plume. As the plume transits up the coast, it causes abrupt temperature changes and modifies shelf stratification. Compared to other buoyant coastal plumes, such as freshwater plumes originating from estuaries, the density contrast associated with the front (g') is relatively small and our system represents a geophysical parameter space that is less-frequently explored. However, our analysis demonstrates that the plume dynamics are consistent with existing buoyant plume theory. We investigate the evolution of a coastal plume after a regional wind relaxation in the context of cross-shore propagating internal waves that both modulate the shelf stratification on similar spatiotemporal scales and likely contribute to the plume's destruction.

Our analysis utilizes temperature and current velocity data from 42 moorings which were deployed September – October 2017 and span a ~30 km stretch of coastline in south central California, including 9 cross-shelf transects. The high spatial resolution of the dataset enables us to track the plume's evolution, including frontal shape and speed. We observe both 1) a rapidly propagating, alongshore velocity signal that takes ~10 hours to propagate ~30 km alongshore and 2) a slower-moving temperature signal that takes ~2 days to propagate the same distance. The plume nose cools as it transits northward, leading to a decrease in the temperature gradient across the front and a deceleration of the plume. In the northern region, the temperature and stratification variability caused by the plume becomes difficult to distinguish from that driven by internal waves.