Role of Latent Heating in AR Dynamics: Comparison of Two Events from February 2019

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Atmospheric rivers (ARs) play a crucial role in the Earth’s climate system by transporting large amounts of water vapor poleward in the midlatitudes. While ARs often provide necessary water resources to regions such as the western United States, these systems can also result in damaging flood events due to the production of extreme precipitation. Here, we compare and contrast two recent AR events that made landfall on the US West Coast: the “Valentine’s Day” storm from 13–14 February 2019, and the “Late-February” storm from 25–27 February 2019. The Valentine’s Day event was ranked as an AR Category 3 (Ralph et al. 2019) along most of the California coast, reaching Category 4 intensity along the southern-most region. This storm produced strong winds and heavy rain fall, with some locations experiencing rain rates exceeding ~10” in 24-h, which consequently, resulted in several road closures and evacuations throughout the state. The Late-February AR was also characterized as a Category 3, primarily due to its duration; areas along the Sonoma County Coast, in Northern California, experienced AR conditions for as long as 51 hours. Such persistent conditions resulted in many waterways throughout the region rising much above flood stage. Most notably, the Russian River in Guerneville reached 45.4 feet, which is 13.4 feet above flood stage.

While both storms were very impactful events, the dynamical players in each case were substantially different. There were several interesting aspects of the Valentine’s Day event, including a low-pressure system northeast of Hawaii associated with the primary moisture plume, a low-pressure system off the coast of British Columbia, and a frontal wave feature that formed along the intersection of the respective fronts. This frontal wave created a secondary maximum in the integrated vapor transport (IVT) field, which, as the frontal wave developed into a secondary cyclone, broadened and strengthened before impacting Northern California. In the Late-February event, as the primary AR was making landfall in Northern California, a cut-off low formed to the west, propagated eastward, and interacted with the existing IVT plume. This interaction resulted in a secondary intensification of IVT within the AR, and contributed to the prolonged duration of the event.

Both events were sampled during the 2019 AR-Reconnaissance field campaign with on-shore soundings and off-shore dropsondes, providing us with unique observations during these storms. Through analysis of observations, reanalysis data, and model experiments using the Model for Prediction Across Scales-Atmosphere (MPAS-A), we are able to quantify the different roles latent heating played in these two significant storms.