Assessing the Predictability of Mesoscale Precipitation Processes in Landfalling Atmospheric Rivers using AR Recon Dropsonde Observations

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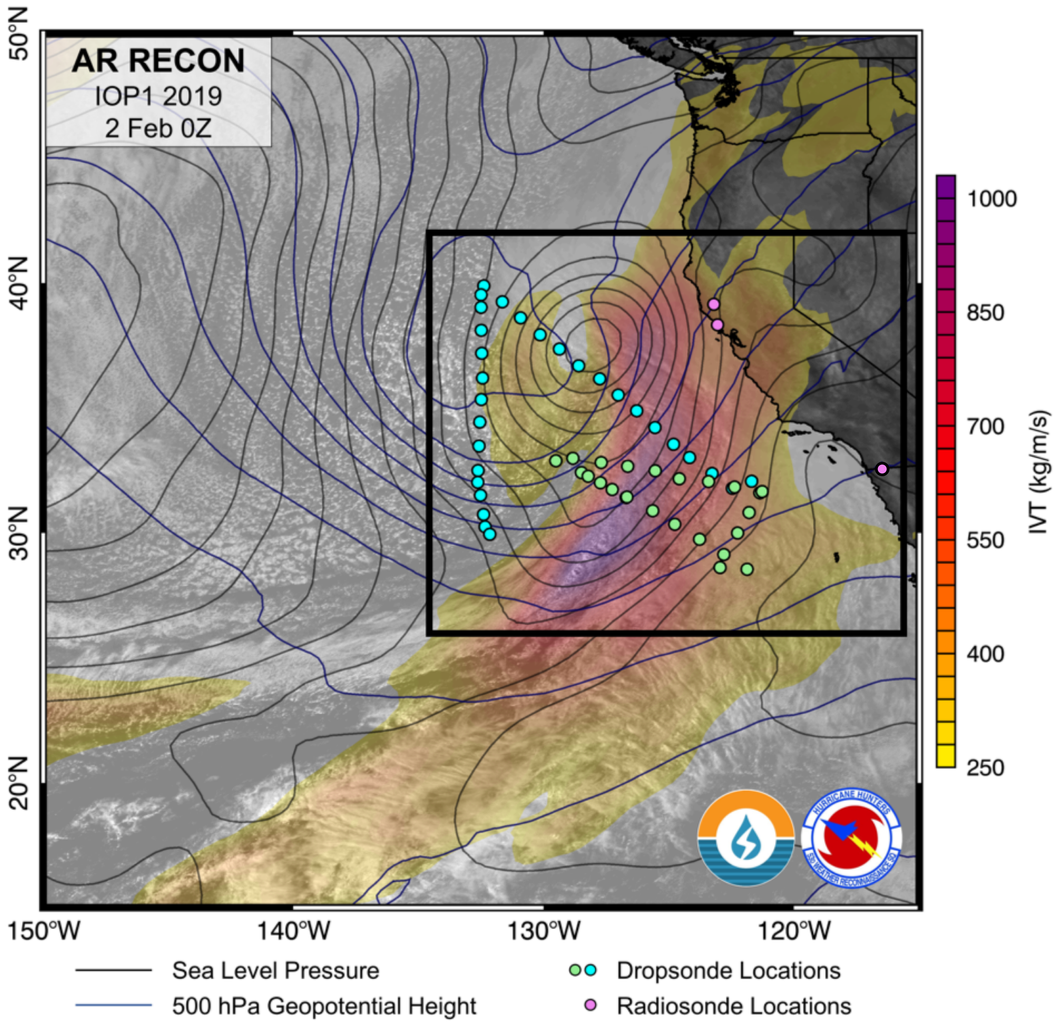
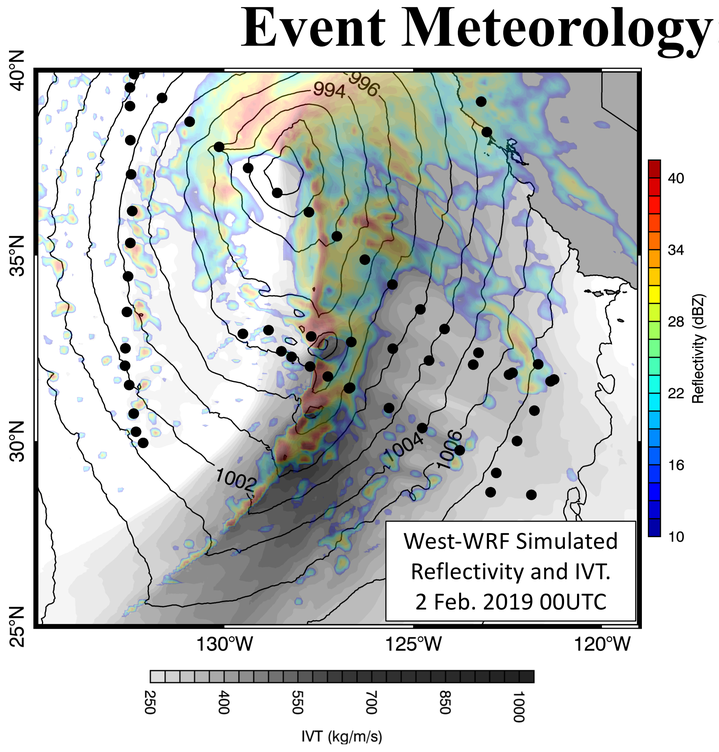
Introduction

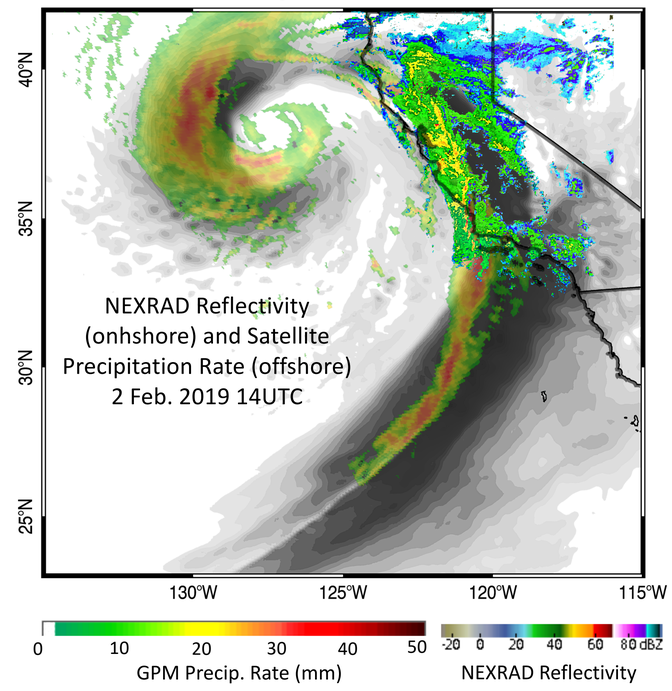
Hazard precipitation rates in atmospheric rivers (AR) have not received substantial attention from the scientific community, yet are an important consideration for emergency management in Southern California. Here, we investigate the predictability of a band of intense precipitation that developed along a cold front (narrow cold-frontal rainband; NCFR) in an AR using multiple observing platforms and models. The 2 February case study is IOP1 from the 2019 AR Recon campaign (PI - F.M. Ralph).



AR Recon dropsondes ahead of landfall provide a unique data source for studying the event's meteorology and evaluating the ability of CW3E's West-WRF model in simulating the AR and NCFR's physical processes.

Event Meteorology: 2 February 2019





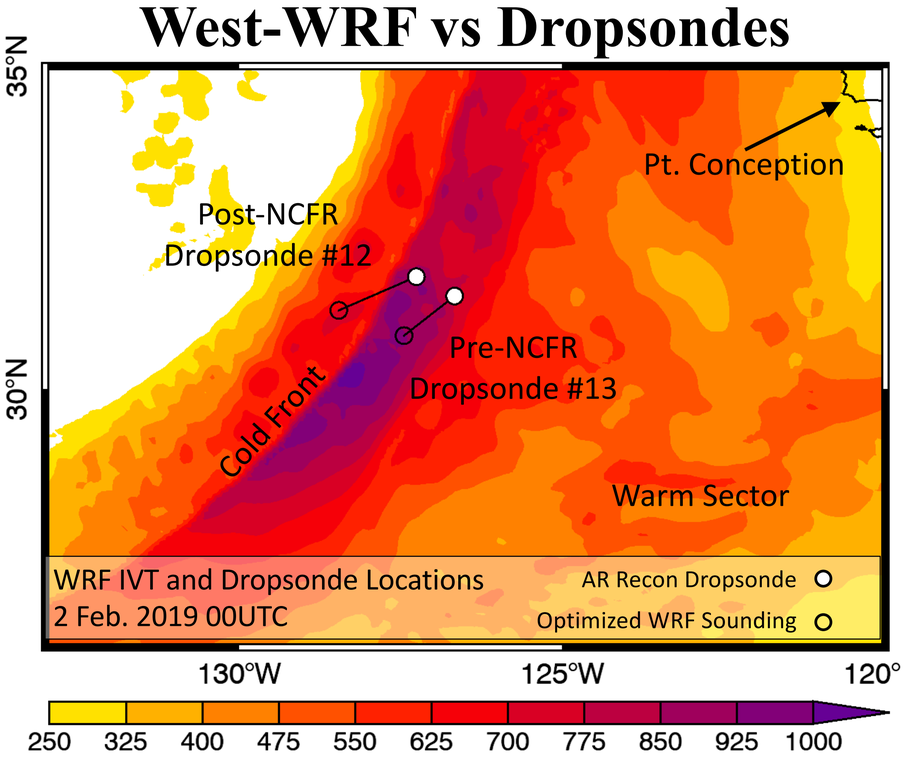
A rapidly deepening cyclone and intensifying AR with IVT > 1000 kg m^{-1} s^{-1} impacted southern CA over an 18-hour period. An NCFR developed over the cold front, fed by moisture convergence within the AR, as indicated by both West-WRF simulated reflectivity and multi-platform radar observations at the time of landfall.

Sounding Observations

(above) AR Recon is an airborne meteorology field campaign designed to improve the observation of impactful weather events ahead of landfall on the U.S. West Coast.

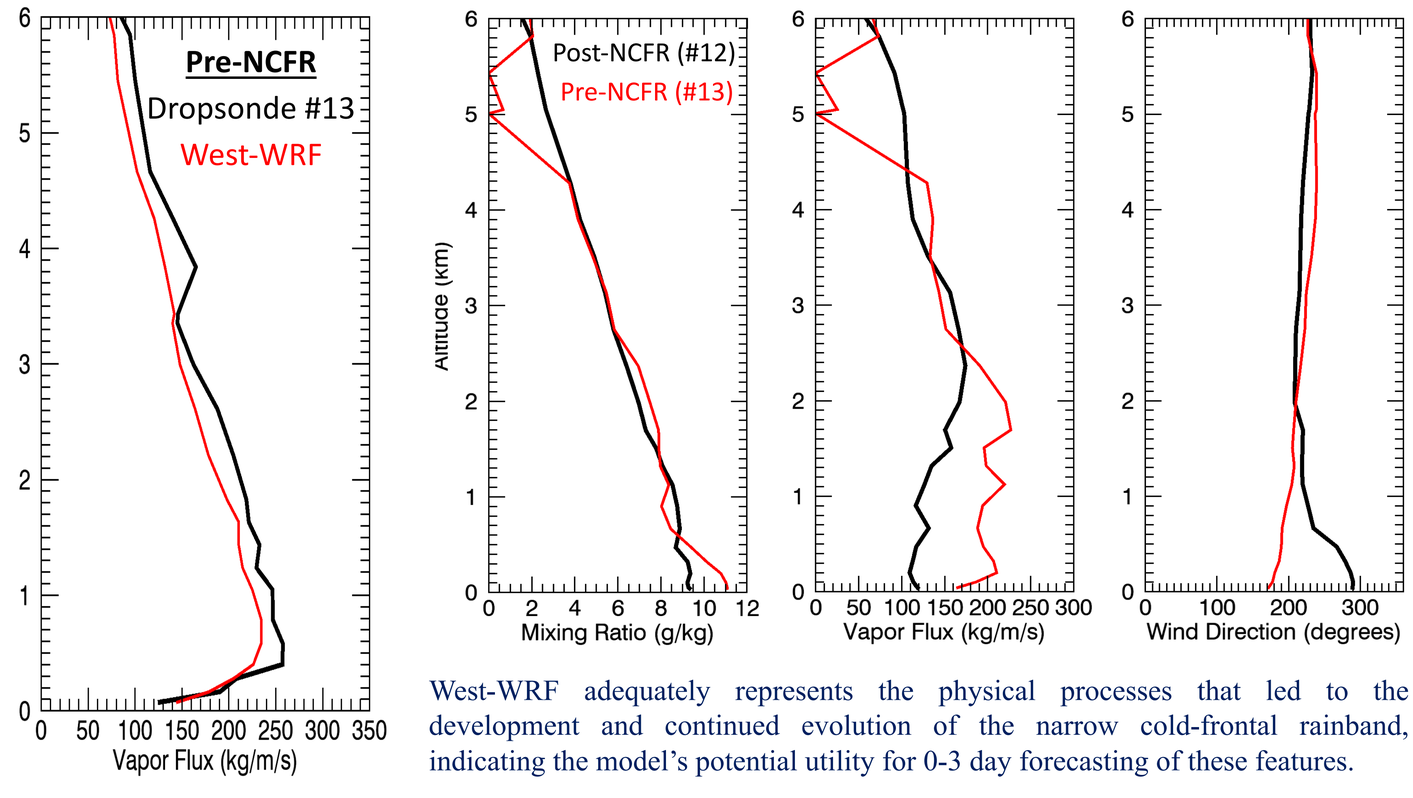
(right) CW3E operates an annual field campaign designed to observe AR events impacting California Watersheds as part of the Forecast Informed Reservoir Operations Project. Station, sounding, and remote sensing observations from the field and airborne observation campaigns are leveraged here to validate West-WRF.

West-WRF vs Dropsondes



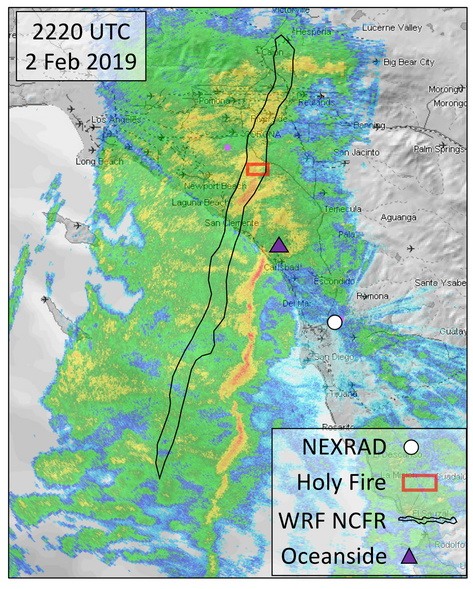
The observed transition across the front within the AR is marked by:

- A 2 g/kg decrease in specific humidity
- A 10-15 m/s decrease in wind speed through the lowest 2km
- A 50% reduction in water vapor flux at 1km (the "controlling layer")
- A shift from southerly to westerly winds at the surface



West-WRF adequately represents the physical processes that led to the development and continued evolution of the narrow cold-frontal rainband, indicating the model's potential utility for 0-3 day forecasting of these features.

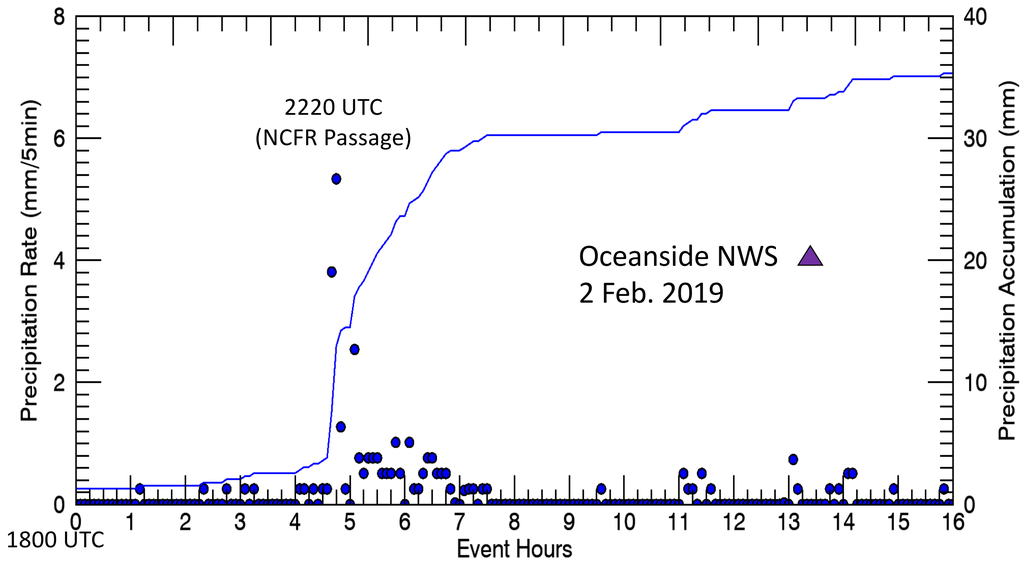
Precipitation Impacts



The passage of the NCFR at a coastal hydromet station was marked by a 20m period of high-intensity rainfall that accounted for 40% of the event total.

A primary concern was the potential impact of the NCFR over recent burn areas near population centers.

While West-WRF reproduced the NCFR's development, small-scale errors in the timing, intensity and propagation of the feature are apparent.



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