**Modulation of Atmospheric Rivers by Mesoscale Frontal Waves and Latent Heating: Comparison of Two U.S. West Coast Events**

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A complex and underexplored relationship exists between atmospheric rivers (ARs) and mesoscale frontal waves (MFWs). The present study further explores and quantifies the importance of diabatic processes to MFW development and the AR-MFW interaction by simulating two ARs impacting Northern California’s flood-vulnerable Russian River watershed (RRW) using the Model for Prediction Across Scales-Atmosphere (MPAS-A) with and without the effects of latent heating. Despite the storms’ contrasting characteristics, diabatic processes within the system were critical to the development of MFWs, the timing and magnitude of integrated vapor transport (IVT), and precipitation impacts over the RRW in both cases. Low-altitude circulations and lower-

tropospheric moisture content in and around the MFWs are considerably reduced without latent heating, contributing to a decrease in moisture transport, moisture convergence, and IVT. Differences in IVT are not consistently dynamic (i.e., wind-driven) or thermodynamic (i.e., moisture-driven), but instead vary by case and by time throughout each event. For one event, AR conditions over the RRW persisted for 6 h less and the peak IVT occurred 6 h earlier and was reduced by ~17%; weaker orographic and dynamic precipitation forcings reduced precipitation totals by ~64%. Similarly, turning off latent heating shortened the second event by 24 h and reduced precipitation totals by ~49%; the maximum IVT over the RRW was weakened by ~42%

and delayed by 18 h. Thus, sufficient representation of diabatic processes, and by inference, water vapor initial conditions, is critical for resolving MFWs, their feedbacks on AR evolution, and associated precipitation forecasts on watershed scales.