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Evaluation of high-resolution WRF-ARW model simulations of atmospheric river events during the Hydrometeorology Testbed 2006

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Numerical prediction of precipitation associated with five cool-season atmospheric river events in northern California is analyzed. The model forecasts were performed with the WRF-ARW model using four different microphysics parameterizations. This was done as a part of the 2005-2006 field phase of the Hydrometeorological Testbed project, for which special profilers, soundings, and surface observations were implemented. Using these unique datasets, the meteorology of atmospheric river events is described in terms of dynamical processes and the microphysical structure of the cloud systems that produced most of the surface precipitation. Events are categorized as "bright band" (BB) or "nonbright band" (NBB), the difference being the presence of significant amounts of ice aloft (or lack thereof) and a signature of higher reflectivity collocated with the melting layer produced by frozen precipitating particles descending through the 0°C isotherm. These structures were reasonably well represented in the model forecasts, with interesting exceptions.

The model was reasonably successful at predicting the timing of surface fronts, the development and evolution of low-level jets associated with latent heating processes and terrain interaction, and wind flow signatures consistent with deep-layer thermal advection. In terms of simulated precipitation amounts, all model versions resulted in a moderate to large overestimation. Nonetheless, there were large differences in precipitation distribution and cloud structure among model runs using the various microphysics algorithms. In sensitivity testing two out of the four schemes overestimated the production of precipitating ice, presumed to be graupel, which falls much faster

than snow and rain, and thus evaporates less as it descends. Consequently, these two schemes consistently produce more surface total precipitation than the other two. To test this hypothesis, one of the two algorithms was modified to produce graupel much more slowly, leaving more water mass in slower-falling categories, and led to lower, more accurate simulated precipitation amounts.