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Effects of Horizontal Redistribution of Surface Fluxes in the Coupled WRF-Hydro Atmospheric and Hydrologic Model

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Evidence for surface and atmosphere coupling is corroborated in both modeling and observation-based field experiments. Recent advances in high-performance computing and development of convection-permitting regional-scale atmospheric models combined with high-resolution hydrologic models has made modeling of surface atmosphere interactions feasible for the scientific community. These models can account for the impacts of the overland flow and subsurface flow components of the hydrologic cycle. One such model is the Weather Research and Forecasting (WRF) regional atmospheric model that can be coupled to the WRF-Hydro hydrologic model.

In the present study, both the uncoupled WRF (advanced research WRF; WRF-ARW) and otherwise identical WRF-Hydro model are executed for the 2017 and 2018 summertime North American Monsoon (NAM) seasons in Arizona, a semi-arid environment. In this environment, diurnal convection is impacted by precipitation recycling from the land surface. Understanding of NAM convection is critical to both the research and the operational communities, as extreme weather events can give rise to flash flooding, severe straight-line winds, and blowing dust.

The current work assesses the impact of the representation of hydrologic processes at the land surface, in both modeling setups, and how these affect 1) local surface energy budgets during the NAM throughout Arizona and 2) the spectral behavior of diurnally driven NAM convection. Model results suggest that adding surface and subsurface flow from WRF-Hydro increases soil moisture and latent heat near the surface. This increases the amount of instability and moisture available for deep convection in the model simulations, and enhances the growth of convection at the peak of the diurnal cycle.