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Hydrologic prediction challenges in contrasting systems: humid mountain peaks to dessert landscapes

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We investigate challenges of predicting hydrologic fluxes and states in two end-member systems: rivers draining cloud-covered humid alpine headwaters in the Pacific Northwest US, and semiarid deserted ecosystems of the Southwest US. In the former case, the sensitivity and importance of temporally and spatially distributed mountain microclimatology and atmospheric mechanisms that control temperature and precipitation lapse rates for capturing atmospheric rivers, rain-on-snow, and snowmelt driven flood events is not well understood. There is a need to understand the tradeoffs between capturing long-term watershed behavior (monthly, seasonal, and annual) and short-term flood peaks dependent on high elevation atmospheric interactions with limited observations. Combining a gridded daily observational hydrometeorology data set, local measurements, and theoretical and empirical lapse rate relationships we produce daily and sub-daily climate forcing data consistent with spatial and temporal structure of weather predictions from the Weather Research Forecast (WRF) model. Hydrologic implications of added complexity in data preparation are investigated in a nested distributed hydrology model. In the latter case, we illustrate the role of hypothesized representations of plant competition, establishment, and disturbances, such as fires and grazing, on the prediction of spatial vegetation patters and watershed hydrologic fluxes in a tree-grass savanna ecosystem using the Landlab component-based modeling framework. While such spatial ecosystem processes are not included in complex distributed hydrology models and most ecosystem models, we argue that their role would be critical for hydrologic predictions under global change.