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Development and applications of a continental-scale integrated groundwater-surface water hydrologic model

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Here we present recent achievements and challenges in the development of an integrated and hypre-resolution hydrologic model that spans the entire contiguous United States (CONUS) and represents a major step towards large scale, physical representation of terrestrial water. Mechanistic and accurate macroscale representation of water and energy exchange has become increasingly important to the scientific community, in preparing policy makers for a changing global climate and resource demand, bridging gaps between point scale observations and coarse resolution remote sensing products, and informing meteorological forecasts. As such, continental-scale hydrologic modeling is a nascent challenge and opportunity to the scientific community.

Previous literature has described the first iteration of the CONUS ParFlow model, a parallel, integrated groundwater-surface water hydrologic model, which captures states and fluxes of the terrestrial water cycle and surface energy budget over a 6.3 million square kilometer area at 1-km lateral resolution. ParFlow simulates variably saturated subsurface flow, surface water routing, and has been coupled to the Common Land Model to capture fully integrated surface energy. The CONUS model has previously been used to analyze continental-scale patterns of water table depth and its mechanistic relationship with topographic indices, recharge and evapotranspiration in North America.

The current work presents major advancements in the development of our continental hydrologic model, which include modern day atmospheric forcing, collaboration and comparisons with other national-scale hydrologic modeling products such as the National Water Model, and lateral expansion of the previous box domain to the North American coastlines. The coastline CONUS model presents numerous opportunities: We discuss the model's ability to simulate and track continental-scale natural and anthropogenic disturbance events; guide and draw connections between observations at multiple scales; and quantify groundwater storage and evapotranspiration at the national level.