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# Improving US national water modeling: an intercomparison of two high-resolution, continental scale models, ParFlow-CONUS and National Water Model configuration of WRF-Hydro

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Development of integrated hydrology modeling systems that couple atmospheric, land surface, and subsurface flow is an increasing trend in hydrologic modeling. Using an integrated modeling framework, subsurface hydrologic processes, such as lateral flow and soil moisture redistribution, are represented in conjunction with surface processes like overland flow and evapotranspiration. There is a need for more intricate models in comprehensive hydrologic forecasting and water management over large spatial areas, specifically the Continental US (CONUS). Currently, two high-resolution, coupled hydrologic modeling applications have been developed for this domain: CONUS-ParFlow built using the integrated hydrologic model ParFlow and the US National Water Model configuration using the National Center for Atmospheric Research, Weather Research and Forecasting model hydrological extension package (WRF-Hydro). Both ParFlow and WRF-Hydro include land surface models, overland flow, and parallelization and high performance computing capabilities; however they have different approaches to overland subsurface flow and groundwater-surface water interactions. Accurately representing large domains remains a challenge considering the difficult task of representing complex hydrologic processes, computational expense, and extensive data needs; both models have accomplished this, but have differences in approach and continue to be difficult to validate. A further exploration of effective methodology to accurately represent large-scale hydrology with integrated models is needed to advance this growing field.

Here we compare the streamflow outputs of CONUS-ParFlow and the US National Water Model configuration of WRF-Hydro to each other and with observations, in order to study the performance of hyper-resolution models over large domains. Models were compared spatially over the CONUS, as well as over major watersheds within the US, with a specific focus on the Mississippi, Ohio, and Colorado River basins. We use a novel set of approaches and analysis for this comparison to better understand differences in relative flow bias and shape agreement. Results show that, generally, both models perform well compared to observed, with WRF-Hydro slightly more accurately representing shape. Both models performed nearly the same with respect to relative flow bias. This intercomparison is a step toward better understanding how much water we have and interactions between surface and subsurface, and will give insight into differences in process representation between the two models. This is a small part of a larger goal to advance understanding and simulation of the hydrologic system and ultimately improve hydrologic forecasts.