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Assessing the role of groundwater in basin productivity and surface variability from the hillslope to the continental scale

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We evaluate groundwater surface water interactions using the first high-resolution fully integrated simulation of the continental US. Dynamic interactions from the groundwater to the land surface are simulated using ParFlow-CLM for a one-year transient simulation spanning water year 1985. Model outputs have been used previously to assess complex spatial patterns in the physical controls of groundwater depth and flux. Here we expand on this steady state analysis to evaluate the connections between spatial groundwater configuration and surface water productivity and variability. Results demonstrate locations where lateral groundwater flow is critical to accurately predict surface water availability both spatially and temporally. Model outputs are also validated against more than 3,000 stream gauges with complete records for the simulation period. The simulation evaluated here is a predevelopment scenario. Therefore, comparisons to stream gauges in undeveloped basins illustrate the model's ability to accurately capture surface water behavior across many settings. While, in developed locations differences highlight the impact of development on surface water dynamics. We use the combination of high-resolution (1 km2) outputs covering a large spatial extent (~6.3 million km2) to characterize groundwater surface water exchanges across a wide range of physical settings and spatial scales. This work highlights the potential for integrated hydrologic models to improve our understanding of groundwater interactions in large heterogeneous systems.