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Advances in hyper-resolution integrated modeling of the Continental US and applications for transport modeling

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Advances in hyper-resolution, integrated hydrologic modeling at large spatial scales have the potential to improve global simulation of water quantity and quality. However, as these tools progress in parallel with input datasets, a process of continuous critical assessment is needed to drive further improvement and understand the unique strengths and weaknesses of large-scale approaches. Here we present our findings in this area based on the development of a fully integrated, 1km2 resolution, model of the Continental US. Simulations with this model, which is the first of its kind for the US, provide novel insights into spatial patterns in the controls of groundwater surface water interactions and partitioning. Additionally, model validation, demonstrates strengths and weaknesses of currently available tools and datasets, highlighting the need for improved high-resolution inputs to facilitate local prediction. We also, combine our integrated hydrologic simulation with Lagrangian particle tracking to connect hydrologic patterns in watershed characteristics (i.e. geology, topography, and climate) to residence time distributions. Comparing behavior across eight major river basins in the US we demonstrate age ranges that agree well with previous observational work. Results highlight the potential for large-scale integrated models to simulate residence time distributions across physical settings and spatial scales which are not feasible with other approaches.