Simulating River Processes in a Coupled Earth System

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The lack of interfaces between land, river, and ocean components is one of the major challenges in modern Earth Systems Models (ESMs). Similar to other ESMs, the Energy Exascale Earth System Model (E3SM) uses conventional latitude-longitude based grids and eight-direction flow network to represent river systems, while its ocean component routinely uses a variable-resolution Voronoi grid. Differences in mesh grids lead to significant challenges in modeling the exchange of water between the rivers and estuaries and the open ocean. In this study, we extend Model for Scale Adaptive River Transport (MOSART), the river component of E3SM to use a hexagonal mesh grid which allows the model to seamlessly connect modeling domains across the land and ocean components. We evaluate MOSART simulations by comparing results from hexagonal and latitude-longitude grids. We also demonstrate the capability of using this framework to couple MOSART with Advanced Terrestrial Simulator (ATS), which is based on unstructured mesh grids. This study improves our understanding of the impacts of spatial discretization on river process modeling. Furthermore, it paves the way to better couple river, land and ocean components in ESMs.