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Progress towards Continental River Dynamics modeling

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The high-resolution National Water Model (NWM), launched by U.S. National Oceanic and Atmospheric Administration (NOAA) in August 2016, has shown it is possible to provide real-time flow prediction in rivers and streams across the entire continental United States. The next step for continental-scale modeling is moving from reduced physics (e.g. Muskingum-Cunge) to full dynamic modeling with the Saint-Venant equations. The Simulation Program for River Networks (SPRNT) provides a computational approach for the Saint-Venant equations, but obtaining sufficient channel bathymetric data and hydraulic roughness is seen as a critical challenge. However, recent work has shown the Height Above Nearest Drainage (HAND) method can be applied with the National Elevation Dataset (NED) to provide automated estimation of effective channel bathymetry suitable for large-scale hydraulic simulations. The present work examines the use of SPRNT with the National Hydrography Dataset (NHD) and HAND-derived bathymetry for automated generation of rating curves that can be compared to existing data. The approach can, in theory, be applied to every stream reach in the NHD and thus provide flood guidance where none is available. To test this idea we generated 2000+ rating curves in two catchments in Texas and Alabama (USA). Field data from the USGS and flood records from an Austin, Texas flood in May 2015 were used as validation. Large-scale implementation of this idea requires addressing several critical difficulties associated with numerical instabilities, including ill-posed boundary conditions generated in automated model linkages and inconsistencies in the river geometry. A key to future progress is identifying efficient approaches to isolate numerical instability contributors in a large time-space varying solution. This research was supported in part by the National Science Foundation under grant number CCF-1331610.