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Improving urban streamflow forecasting using a high-resolution large scale modeling framework

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Urban flood forecasting is a critical component in effective water management, emergency response, regional planning, and disaster mitigation. As populations across the world continue to move to cities (∼1.8% growth per year), and studies indicate that significant flood damages are occurring outside the floodplain in urban areas, the ability to model and forecast flow over the urban landscape becomes critical to maintaining infrastructure and society. In this work, we use the Weather Research and Forecasting– Hydrological (WRF-Hydro) modeling framework as a platform for testing improvements to representation of urban land cover, impervious surfaces, and urban infrastructure. The three improvements we evaluate include: updating the land cover to the latest 30-meter National Land Cover Dataset, routing flow over a high-resolution 30-meter grid, and testing a methodology for integrating an urban drainage network into the routing regime. We evaluate performance of these improvements in the WRF-Hydro model for specific flood events in the Denver-Metro Colorado domain, comparing to historic gaged streamflow for retrospective forecasts. Denver-Metro provides an interesting case study as it is a rapidly growing urban/peri-urban region with an active history of flooding events that have caused significant loss of life and property. Considering that the WRF-Hydro model will soon be implemented nationally in the U.S. to provide flow forecasts on the National Hydrography Dataset Plus river reaches – increasing capability from 3,600 forecast points to 2.7 million, we anticipate that this work will support validation of this service in urban areas for operational forecasting. Broadly, this research aims to provide guidance for integrating complex urban infrastructure with a large-scale, high resolution coupled land-surface and distributed hydrologic model.