High Resolution Distributed Hydrological Modeling for Extreme Flood Events

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Increasing frequency of intense extreme storm events under a changing climate has created a strong need to enhance our modeling capabilities to assess the potential flood hazard. A high resolution modeling framework will enable more accurate simulation of extreme flood events such as probable maximum flood (PMF) which is used as one of the criteria to design critical infrastructures like major dams and nuclear power plants. In this study, we perform high resolution hydrological modeling using Distributed Hydrology-Soil-Vegetation Model (DHSVM) at a spatial resolution of 90m over Alabama-Coosa-Tallapoosa (ACT) River Basin near Atlanta metropolitan area. DHSVM is capable of simulating various hydrologic processes, including soil moisture, snow cover, evapotranspiration, overland flow and river routing at sub-daily temporal scale. DHSVM requires detailed inputs at each grid cell including digital elevation, soil properties (e.g., texture, porosity, bulk density and hydraulic conductivity), vegetation and land use classes. DHSVM model is driven by Daymet meteorological forcing and calibrated against U.S. Geological Survey stream-flow observations for each of the fourteen 8-digit hydrologic units (HUC08s) that comprise ACT River Basin. The simulation is conducted by setting the model on supercomputer TITAN. After model calibration, DHSVM is driven by a series of probable maximum precipitation (PMP) events that are obtained from regional climate model for historical and future periods using various projected land use land cover and climate change scenarios. The estimated PMF can be utilized to evaluate the risk of existing energy-water infrastructures under a changing climate.