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A Multi-Scale, Integrated Approach to Representing Watershed Systems

Valeriy Ivanov (1), Jongho Kim (1), Simone Fatichi (2), and Nikolaos Katopodes (1)

(1) University of Michigan, Civil and Environmental Engineering, Ann Arbor, United States (ivanov@umich.edu), (2) Institute of Environmental Engineering, ETH Zürich, Zürich, Switzerland

Understanding and predicting process dynamics across a range of scales are fundamental challenges for basic hydrologic research and practical applications. This is particularly true when larger-spatial-scale processes, such as surface-subsurface flow and precipitation, need to be translated to fine space-time scale dynamics of processes, such as channel hydraulics and sediment transport, that are often of primary interest. Inferring characteristics of fine-scale processes from uncertain coarse-scale climate projection information poses additional challenges. We have developed an integrated model simulating hydrological processes, flow dynamics, erosion, and sediment transport, tRIBS+VEGGIE-FEaST. The model targets to take the advantage of the current generation of wealth of data representing watershed topography, vegetation, soil, and landuse, as well as to explore the hydrological effects of physical factors and their feedback mechanisms over a range of scales. We illustrate how the modeling system connects precipitation-hydrologic runoff partition process to the dynamics of flow, erosion, and sedimentation, and how the soil's substrate condition can impact the latter processes, resulting in a non-unique response. We further illustrate an approach to using downscaled climate change information with a process-based model to infer the moments of hydrologic variables in future climate conditions and explore the impact of climate information uncertainty.