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Hysteresis of Soil Moisture Spatial Heterogeneity in Complex Topography of Semi-Arid Climate

Valeriy Y. Ivanov (1), Simone Fatichi (2,1), G. Darrel Jenerette (3), Javier F. Espeleta (4), Peter A. Troch (5), and Travis E. Huxman (6)

(1) Department of Civil and Environmental Engineering, University of Michigan, Ann Arbor, MI, USA (ivanov@umich.edu), (2) Department of Civil and Environmental Engineering, University of Florence, Florence, Italy (simone.fatichi@dicea.unifi.it), (3) Department of Botany and Plant Sciences, University of California, Riverside, CA, USA (darrel.jenerette@ucr.edu), (4) Biosphere 2, University of Arizona, Tucson, AZ, USA (espeleta@email.arizona.edu), (5) Department of Hydrology and Water Resources, University of Arizona, Tucson, AZ, USA (patroch@hwr.arizona.edu) , (6) Department of Ecology and Evolutionary Biology, University of Arizona, Tucson, AZ, USA (huxman@email.arizona.edu)

By affecting the partition of mass and energy fluxes, soil moisture exerts a fundamental control on basin hydrological response. This study investigates aspects of soil moisture spatial and temporal variability in zero- and first-order catchments located in a semiarid climate. A recent study has illustrated that the hydrological response of a basin may exhibit a particular structure, which depends on whether the topography-induced subsurface stormflow is triggered. The occurrence of stormflow is conditioned by topography, soil depth, and pre-event spatial distribution of moisture. As a result, soil moisture spatial heterogeneity may exhibit a non-unique behavior, manifested through a hysteretic dependence of metrics of spatial variability on mean water content and the concurrent emergence of an "attractor" of catchment states. Further, it is argued that vegetation dynamics impose a long-term "homogenizing" effect on pre-storm states, decreasing the likelihood that any given rainfall event will result in efficient topographic redistribution of soil water. This study addresses the sensitivity of the identified hysteresis properties with respect to the temporal variability of rainfall and spatial non-uniformity of soil properties.