Spatiotemporal patterns of hydroclimatic drivers and soil water storage: Observations and modeling across scales

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Elin Jacobs

Elin Jacobs is a PhD candidate in the Ecological Sciences and Engineering program through the Lyles School of Civil Engineering and the Agronomy Department. Her research interests include ecohydrology, the hydrologic cycle, effects of land use/land cover change on water resources, and effects of climate variability and change on water resources. More specifically, her work focuses on data driven and modeling techniques for estimating changes in surface water availability in a changing climate. Elin received B.S. and M.S. degrees in Environmental Science and Physical Geography from Stockholm University, Sweden.

Lyles School of Civil Engineering

Abstract

Soil water storage is a critical regulator of water and energy balances at the land surface-atmosphere boundary. Root zone soil water in particular provides a key link between soils, vegetation and climate with consequent impacts on water and biogeochemical cycles and on ecosystems. The overarching aim of this dissertation is to contribute to the understanding of spatial and temporal patterns and properties of hydroclimatic variables, with focus on soil water storage and its key hydroclimatic drivers in the Midwestern United States. Spatial and temporal patterns and trajectories are analyzed based on field observations and high resolution numerical land surface modeling. A simple stochastic model was also used and evaluated as an alternative to the numerical model. While the studied region has undergone a change in hydroclimatic forcing over the past three decades, this has not significantly impacted average or extreme water storage states. Spatially, the region is found to be largely homogeneous in terms of hydroclimatology despite heterogeneity in surface properties. The surface properties tend to drive spatial variability in soil water storage mainly during dry periods. Because the soil-vegetation-climate system is complex and the future is uncertain, models need to be able to account for this uncertainty. Current land surface models attempt to provide detailed parametrizations of all necessary physical processes but are still unable to do so, particularly for root zone water content. The findings from this research suggest that inclusion of stochastic elements in modeling and use of a probabilistic framework for spatiotemporal data analysis can help shed light on what can be expected in a variable and changing climate while reducing the computational effort required.