Topographic and Vegetation Controls on Spatial Patterns of Soil Moisture in a Small Semi-Arid Montane Catchment

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Abstract. Soil moisture exerts substantial control over the partitioning of latent and sensible energy fluxes, the magnitude of vertical and lateral water fluxes, and physiological and water-use characteristics of vegetation. Much progress has been made in determining how topography, vegetation, and soil properties influence soil moisture spatial patterns in humid environments at the catchment and hillslope scales. However, our understanding of the controls on spatial patterns of soil moisture in semi-arid and heterogeneous (with respect to soil and vegetation properties) environments remains limited. This study examines the relationships between the spatial patterns of near surface (upper 5 cm) soil moisture, terrain attributes, and soil and vegetation properties in a small semi-arid montane catchment. The ~7.5 ha catchment, located in the Cache La Poudre River Canyon in northern Colorado, has a total relief of 115 m and average elevation of 2193 m. It is characterized by steep slopes (mean = 17.6°) and shallow sandy soils with small, scattered rock outcroppings. Most notably, vegetation in the catchment is highly correlated with aspect as deciduous brush and coniferous forest are the dominant vegetation types on the south and north-facing hillslopes, respectively. Soil moisture point measurements were collected at more than 200 grid points (15 m resolution) in the catchment with time domain reflectometry (TDR) in the fall of 2007 at 3-4, 8-9, and 26-29 days after a snowfall event of ~4.5 cm of water equivalent. Results from soil textural analysis performed with a standard hydrometer method show that cos(aspect) is the best univariate predictor of soil texture. Additionally, the north-facing hillslope's texture is finer than that of the south-facing hillslope. Variance of soil moisture decreases and terrain attributes explain more of the variation in soil moisture as the catchment dries (contrary to previous results for humid catchments with low-relief). Preliminary results suggest that the controls on spatial patterns of soil moisture in semi-arid montane environments may be similar to those in humid environments, but additional work is needed to determine the extent of the similarities and the scales in both time and space at which similarities persist.