Comparison of Geostatistical Methods for the Spatial Estimation of Soil Moisture at the Catchment Scale

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Abstract. Topographic information is useful for estimating soil moisture at the catchment scale both because topography influences physical processes that control soil moisture and because topographic information is widely available. However, accurate estimation of soil moisture values is complicated by multiple physical processes influencing soil moisture and the challenge of representing their effects with relatively simple topographic attributes. In some cases, the physical processes involved can lead to significant organization of soil moisture patterns, where wetter locations tend to be located in valley bottom and convergent areas. Such topographic dependence introduces a complicated spatial nonstationarity. Geostatistical techniques are commonly used for estimating spatial data at unobserved locations, but the assumptions underlying such methods are inconsistent with the complicated spatial nonstationarity imbedded in soil moisture patterns. For example, standard geostatistical methods ultimately assume that geographic proximity between two points is an appropriate measure of the tendency for locations to exhibit similar soil moisture values. In this presentation, two alternative methods for calculating distance are used within a geostatistical framework in an attempt to improve the soil moisture estimates that are produced when topography is an important control on the soil moisture patterns. The first alternative calculates distance in a multidimensional terrain attribute space. The main idea behind this methodology is that topographic attribute similarity better measures the tendency for similar moisture values than geographic proximity. The second method explored is based on the idea that topography influences the lateral redistribution of soil moisture in the same manner that overland flow would move on the surface and that the resulting moisture patterns reflect this influence. This method uses a directed-tree model of the domain, and distance is calculated based on this model. Both methods are compared to more widely-used estimation methods and found to provide some improvements for the cases under consideration.