Evaluation of a Method to Downscale Intermediate-Resolution Soil Moisture to a Fine-Resolution using Topographic, Vegetation, and Soil Data

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Abstract. Knowledge of soil moisture patterns and dynamics is important for many land and watershed management applications. Remote sensing methods can estimate soil moisture over large regions, but the spatial resolution of these estimates is very coarse (~ 1 km grid cells or larger). In order to be applicable to land and watershed management applications, finer resolutions (10-30 m grid cells) are usually required. To reach such resolutions, soil moisture must be downscaled using supplemental data. Several downscaling methods have been developed using topographic data, but studies have shown that vegetation and soil characteristics also affect fine-scale soil moisture variations. In this presentation, we propose a new downscaling model that utilizes topographic, vegetation, and soil data. It is called the *Equilibrium Moisture from Topography, Vegetation, and Soil* (EMT+VS) model. The model assumes a steady-state water balance involving four processes: infiltration, deep drainage, lateral flow, and evapotranspiration. The magnitude of each process at each location is inferred from topographic, vegetation, and soil characteristics. Inputs to the model include: intermediate-resolution (~ 1 km grid cells or larger) soil moisture data; fine-resolution (10-30 m grid cells) topography, vegetation, and soil data; and parameters related to climate, soil, and vegetation. The new model was tested at the Cache la Poudre catchment in the Colorado Front Range. This catchment was chosen due to its variable vegetation cover, which includes forests on the north-facing slopes and shrublands on the south-facing slopes. The topographic and vegetation data were measured on 15 m grid, while the soil data were measured on a 30 m grid. Topographic data are available from a field survey. Vegetation cover was calculated from available measurements of litter depth and photos of the canopy taken from the ground surface looking upward. Soil hydraulic characteristics were determined from a pedotransfer function using available percent sand, silt, and clay (which were determined from sieving and hydrometer analysis). The results show that the estimated soil moisture patterns improve greatly with the input of soil and vegetation data, almost doubling the Nash-Sutcliff Coefficient of Efficiency values from 0.09 to 0.18. The improvement in performance can be traced to the role that vegetation plays in shading the ground surface and reducing soil evaporation. The EMT+VS model was also compared to a strictly empirical approach based on *Empirical Orthogonal Function* (EOF) analysis and found to achieve similar performance.