Downscaling Soil Moisture in Regions with Large Elevation Ranges

Garret S. Cowley and Jeffrey D. Niemann
Department of Civil and Environmental Engineering, Colorado State University

Timothy R. Green
Center for Agricultural Resources Research, Agricultural Research Service, USDA, Fort Collins, CO

Mark S. Seyfried
Northwest Watershed Research Center, Agricultural Research Service, USDA, Boise, ID

Andrew S. Jones
Cooperative Institute for Research in the Atmosphere, Colorado State University

Abstract. Volumetric water content (soil moisture) influences many hydrological processes and related applications such as flood forecasting, soil protection, and crop management. Soil moisture can be estimated at coarse resolutions (1 km grid cells or larger) using remote-sensing methods, but information at that resolution is poorly suited for many applications. The Equilibrium Moisture from Topography, Vegetation, and Soil (EMT+VS) downscaling model uses coarse-resolution soil moisture data from remote sensing, along with supplemental fine-resolution topographic, vegetation, and soil data, to produce fine-resolution (10-30 m) estimates of soil moisture, which are more suitable for hydrologic applications. The EMT+VS model has been applied to smaller catchments (0.05-0.60 km^2) with low topographic relief (25-124 m) and performed well. However, the model has not been applied to larger watersheds that have larger ranges of elevation. Previous research has shown that large ranges of elevation can produce substantial ranges in the potential evapotranspiration (PET) and thus potentially affect the patterns of soil moisture. In this research, a PET downscaling method based on elevation is proposed to estimate the local PET, and the EMT+VS model is generalized to include the PET downscaling method. To test the PET downscaling method and its influence on the EMT+VS results, they are applied to the 239 km^2 Reynolds Creek Watershed in southern Idaho, which has 1200 m of relief. The downscaled PET estimates are compared with Penman-Monteith values from 17 meteorological stations within the watershed, and the soil moisture estimates are compared with observations from 30 monitoring locations. Results show that the EMT+VS model performs better with the PET-downscaling method included, returning an average Nash-Sutcliffe Coefficient of Efficiency of 0.34 instead of 0.16 with uniform PET.