A Conceptual Model to Estimate Topographically-Dependent Soil Moisture Patterns

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Abstract. Soil moisture plays an important role in many natural processes and thus is an important consideration in various hydrologic applications including flood forecasting and watershed management. Although intermediate resolution (grid cells with an 800 – 1,000 m linear dimension) soil moisture maps are available from remote-sensing methods and weather forecasting models, many hydrologic applications require soil moisture maps at a fine resolution (10 – 40 m). Thus, methods are required to downscale the intermediate resolution maps to the desired fine resolution. It is known that topography plays an influential role in soil moisture variability at fine resolutions, and topographic data are available globally at fine resolutions. In this presentation, a conceptual model called the Equilibrium Moisture from Topography (EMT) model is presented to estimate fine-resolution soil moisture patterns. The EMT model uses fine-scale topographic attributes, calibrated parameters, and an intermediate resolution spatial-average soil moisture value to weight the importance of infiltration, lateral flow, deep drainage, and evapotranspiration in estimating soil moisture. The EMT model was calibrated and tested using the Tarrawarra, Satellite Station, and Cache la Poudre catchments, each of which has available soil moisture datasets. The performance of the EMT model was then compared to the performance of an available, purely-empirical, method based on empirical orthogonal function (EOF) analysis. The EMT model performs nearly as well as the EOF method, which suggests that the model captures much of the topographic dependence in the soil moisture patterns at these catchments. In addition, the EMT model requires calculation of fewer topographic attributes and thus is simpler to implement.