Evaluation of Sampling Techniques for Observing Topographically-Dependent Variability in Catchment-Scale Soil Moisture Patterns

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Abstract. The spatial structure of soil moisture is important in many catchment-scale hydrologic applications including flood forecasting and watershed and land management. Unfortunately, estimating these patterns at suitable resolutions (e.g., patterns with 10 – 30 m grid cells) is difficult. In many instances, coarse-resolution patterns obtained from remote sensing are downscaled using known relationships between soil moisture and observable ancillary variables like topographic attributes. These relationships are typically determined using soil moisture observations from the catchment of interest. In the past, these soil moisture observations usually have been collected on multiple dates on uniform grids that contain hundreds of locations. Thus, the number of catchments with such datasets is quite small. Sampling techniques are needed to characterize catchment-scale soil moisture variability and its relationship to ancillary variables with many fewer observations. Here, we evaluate and compare three sampling techniques: random sampling (RS), conditioned stratified random sampling (cSRS), and conditioned Latin hypercube sampling (cLHS). cSRS sampling divides the observed range of values for the ancillary variable into equal-sized bins and samples evenly from the bins. cLHS divides the range of cumulative probability for the ancillary variable into equal-sized bins and samples evenly from those bins. Thus, cLHS samples more frequently from bins with more observations in the catchment. Each sampling technique is used to select a limited number of observation locations and dates and the selected observations are then used to calibrate two available downscaling methods. The efficiency of the sampling techniques is measured by the downscaling methods' ability to reproduce the known soil moisture patterns at the catchment. The results show that all three sampling techniques can characterize the soil moisture variability at a catchment with many fewer locations than have been collected previously. In addition, the cSRS and cLHS methods exhibit much better performance than RS when relatively few observations are collected.