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What is the effect of local controls on the temporal stability of soil water contents?

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Temporal stability of soil water content (TS SWC) reflects the spatio-temporal organization of SWC. Factors and their interactions that control this organization, are not completely understood and have not been quantified yet. It is understood that these factors should be classified into groups of local and non-local controls. This work is a first attempt to evaluate the effects of soil properties at a certain location as local controls Time series of SWC were generated by running water flow simulations with the HYDRUS6 code. Bare and grassed sandy loam, loam and clay soils were represented by sets of 100 independent soil columns. Within each set, values of saturated hydraulic conductivity (K_s) were generated randomly assuming for the standard deviation of the scaling factor of ln K_s a value ranging from 0.1 to 1.0. Weather conditions were the same for all of the soil columns. SWC at depths of 0.05 and 0.60 m, and the average water content of the top 1 m were analyzed. The temporal stability was characterized by calculating the mean relative differences (MRD) of soil water content.

MRD distributions from simulations, developed from the log-normal distribution of K_s, agreed well with the experimental studies found in the literature. Generally, K_s was the leading variable to define the MRD rank for a specific location. Higher MRD corresponded to the lowest values of K_s when a single textural class was considered. Higher MRD were found in the finer texture when mixtures of textural classes were considered and similar values of K_s were compared. The relationships between the spread of the MRD distributions and the scaling factor of ln K_s were nonlinear. Variation in MRD was higher in coarser textures than in finer ones and more variability was seen in the topsoil than in the subsoil. Established vegetation decreased variability of MRD in the root zone and increased variability below. The dependence of MRD on K_s opens the possibility of using SWC sensor networks to relate variations of MRD of measured SWC time series to spatial variations of K_s. TS of SWC can provide information on K_s variability at ungauged watersheds if the effect of non-local controls of SWC on TS is not significant. Using the spatiotemporal statistics to convert the information about the temporal variability of soil moisture into information about the spatial variability of soil hydraulic properties presents an interesting avenue for further exploration.