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Soil water content variability in the 3D 'support-spacing-extent' space of scale metrics

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Knowledge of soil water content variability provides important insight into soil functioning, and is essential in many applications. This variability is known to be scale-dependent, and divergent statements about the change of the variability magnitude with scale can be found in literature. We undertook a systematic review to see how the definition of scale can affect conclusions about the scale-dependence in soil water content variability. Support, spacing, and extent are three metrics used to characterize scale in hydrology. Available data sets describe changes in soil moisture variability with changes in one or more of these scale metrics. We found six types of experiments with the scale change. With data obtained without a change in extent, the scale change in some cases consisted in the simultaneous change of support and spacing. This was done with remote sensing data, and the power law decrease in variance with support increase was found. Datasets that were collected with different support or sample volumes for the same extent and spacing showed the decrease of variance as the sample size increased. A variance increase was common when the scale change consisted in change in spacing without the change in supports and extents. An increase in variance with the extent of the study area was demonstrated with data an evolution of variability with increasing size of the area under investigation (extent) without modification of support. The variance generally increased with the extent when the spacing was changed so that the change in variability at areas of different sizes was studied with the same number of samples with equal support. Finally, there are remote sensing datasets that document decrease in variability with a change in extent for a given support without modification of spacing. Overall, published information on the effect of scale on soil water content variability in the 3D space of scale metrics did not contain controversies in qualitative terms. However, there were substantial differences in quantitative terms, that might reflect both the methods of changing support and site-specific differences in soil water content controls. Since both local and non-local controls of soil water contents appear to be scale-dependent, supports have to be matched for soil water contents and for controls to evaluate the effect of the controls on soil water content variability.