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Gaining insight into the spatial distribution of soil hydraulic properties on the soil profile scale by high resolution TDR and tensiometer measurements

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Measurement of the spatial distribution of hydraulic properties in a field with high resolution and good precision is still depending on the laborious and time consuming measurement with invasive equipment, such as TDR probes and tensiometers. If measurements are available, their spatial resolution is often rather coarse. When sensors are applied to monitor soil water dynamics under natural or artificial boundary conditions, the typical distance between probes is in the range of several decimetres. Finer resolutions are usually not realized because they are likely to influence the flow field in an unwanted manner. On the other hand, spatial correlation length especially of the water content in soils is often smaller leaving a question mark on how to interpolate gaps and get the hydraulic structure right. An alternative approach is the destructive measurement of these properties once an experiment has ended. The measurement of soil hydraulic functions on soil cores is very time consuming and if taken on a grid, a spacing of about 15 cm between individual cores is the resolution limit. In this study, we approach the problem by cutting several soil profiles through the experimental plot at the end of an infiltration experiment from a site north of Hannover, Germany. Using TDR and microtensiometer, data pairs of water content and tension are measured on a grid with a resolution of 5 x 5 cm. The measurement is relatively quick once a soil profile is prepared. However, only a single pair of water content and water tension is acquired per measuring location. For a soil profile of approx. 1 by 2 m this adds up to about 700 data pairs. By a visual inspection of the data measured on the profile, bordering structures having similar tensions but different water contents are identified. Some of these structures are much smaller than the usually encountered measuring resolution of several decimetres. In a second step, data pairs are grouped according to their location within the different structures visible in the soil profile. For these groups, water characteristic reference functions are calculated and heterogeneity is formulated using different scaling approaches. The resulting heterogeneous distributions are compared and evaluated with regard to their ability to capture the characteristics of the true heterogeneity in the profile. Results of this investigation will eventually be fed into a soil water transport model that will be used for a hindcast model exercise aiming at remodelling the infiltration experiment. Model results will be compared to electrical resistivity tomography measurements carried out parallel to the infiltration experiment.