MAY WE IDENTIFY THE SPATIAL VARIABILITY OF SOIL HYDRAULIC PROPERTIES BASED ON MEASUREMENTS WITH "SPATIAL TDR"? A) MODEL STUDY

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A dynamic system left without external disturbances, will always tend to a stable equilibrium state that is consistent with the internal physics. For natural soils such an equilibrium state is reached when the gradients of the total hydraulic potential tend to zero. This statement is still valid for heterogeneous soils, because the hydraulic potential is an intensive state variable and therefore continuous at discontinuities of the pore space. In contrary the soil water content is as an extensive property discontinuous at discontinuities of the pore space. Hence, a small scale soil moisture pattern that persists if the soil state tends to hydraulic equilibrium, reflects the lateral small scale variability of the pore space. The objectives of our study are to show a) whether and how we could use TDR observations to identify the small scale variability of the pore space. For that purpose we analyse artificial TDR measurements, taken from physically based simulations of soil water dynamics in heterogeneous media. b) We want to introduce a new TDR technology which we call "Spatial TDR", that is suitable for that purposes. To produce the artificial TDR-datasets we generate random fields of soil porosity and saturated hydraulic conductivity with different statistical properties based on field data in a Luvisol and simulate artificial water dynamics in this model soil based on Richards-equation. Within this model soil we define several hypothetical "Spatial TDR" clusters, that differ in the lateral spacing and the number of the probes, in the temporal resolution of the hypothetical measurements and in the assumed measurement accuracy. If the model soil approaches hydraulic equilibrium, the remaining soil moisture pattern will be dominated by the statistical properties of the porosity. In contrary the variability of the hydraulic conductivity will dominate the soil moisture patterns during infiltration events. The hypothetical Spatial TDR measurements within the clusters give a more or less appropriate picture of these soil moisture patterns, depending on the configuration of the cluster, the sampling density and the assumed measurement accuracy. The crucial question within this approach is to establish a relation between the statistics of the observed soil moisture patterns within the cluster and the known underlying statistics of the porosity and the saturated hydraulic conductivity for the equilibrium and the infiltration case.