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Initial non-uniform soil water redistribution as inherent hydrological process – from field experiments to model insights

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Proper parameterisation and conceptualisation of the commonplace process of infiltration into the soil is still a topic of debate. Measuring soil water distribution in a spatio-temporally continuous manner can advance our understanding of infiltration in non-uniform flow networks and the soil matrix. At the same time, we find different measurement techniques bound to different concepts and scales, which make a general interpretation and quantification of the data still a challenging task.

We present results from several irrigation experiments at the plot and hillslope scale, in which we combined hydrological, geophysical and remote sensing techniques. On this basis, we will point out how different techniques have advantages and pitfalls for their interpretation. E.g. despite the different scales, we found hydraulic conductivity measured in soil cores in good coherence with plot scale experiments, while in-situ measurements with a constant head permeameter deviated substantially. Another example are multispectral data of the changing surface conditions during irrigation which cannot discern different subsurface infiltration patterns, once the surface becomes sufficiently wet.

Since any parameterisation links back to the conceptual and numerical models, we have developed an alternative concept to simulate soil water infiltration and redistribution based on a Langangian approach using film flow in representative macropores and a 2D random walk for the soil matrix. Simulations highlight the inherently combined effect of antecedent state and connected preferential flow networks on the respective generation of non-uniform infiltration patterns.