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Macroscale Structures and Preferential Flow Networks at the Hillslope Scale

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Many hillslopes have macroscale structures like root channels or pipes that control their hydrological behaviour. Describing this macroscale structure, its physical properties and how it is generated is important in the advancement of the field of soil hydrology. While progress has been made both experimentally and in modeling network-like behavior at the hillslope scale, the fundamental question remains: Why do lateral preferential flow networks develop? It is hypothesized that emergence of these flow networks at the hillslope scale reflects a self-organized, macroscale flow behaviour.
Virtual experiments using the hillslope model Hill-vi will be presented to quantify the linkage between initially unconnected soil pipes and formation of dynamical network structures in time and space. Virtual experiments use the combined knowledge of observed structure (e.g. tree roots) and hydrological dynamics from different places and merge this into a process-based model. The following questions are investigated: 1) What are the underlying mechanisms governing architecture and emergence of soil pipe networks? (2) Are patterns of preferential flow within hillslopes a result of flow optimization? (3) How could preferential flow networks evolve in both space and time?
The presented results illustrate some first steps towards a better conceptualization of such complex system in order to be able to predict the hydrological behaviour of preferential flow of lateral subsurface flow at the hillslope scale.