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Titel
Comparison of 2D and 3D modeling for deriving effective hydraulic properties of stony soils

Abstract
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Stone, gravel or rock fragments that are embedded in a matrix of fine soil have a substantial effect on effective soil hydraulic and transport properties. Understanding the role of stones in soils is important not only for soil water transport processes such as infiltration, evaporation and redistribution, but also for related solute transport processes. A variety of models has been proposed in the past to predict the systematic effect of varying amounts of stones on effective saturated conductivity and water retention of a soil-stone mixture. Respective studies for unsaturated hydraulic conductivity are still missing. To test the accuracy and validity of such predictive models, and to expand them to unsaturated conductivity, the investigation of virtual porous media, which can be obtained by numerical forward modeling of water and solute transport in soil-stone mixtures is the method of choice. Furthermore, to test the postulate that effective homogeneous properties exist and can replace the heterogeneous system, the ability of a 1D model with assumed homogeneous soil properties to match "observed" state variables and fluxes of a higher-dimensional heterogeneous model under a variety of conditions is a necessary requirement. With few exceptions, such heterogeneous modeling studies have hitherto been performed only for simplified cases, i.e., either under fully saturated conditions, or with a reduced dimensionality, i.e., 2D simulations of soil/stone mixtures. In this work, we use the simulation tool HYDRUS-2D3D to investigate the systematic differences that occur when modeling partially unsaturated transient water in stony soils, based on the Richards equation. Specifically, we compare truly 3D with 2D simulations and discuss the implications for effective 1D hydraulic properties.
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