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Modelling multiphase dynamics during infiltration using a pore network model

Jannis Tzavaras, Ji-Youns Arns, Koehne Max, and Vogel Hans-Joerg
Department of Soil Physics, Helmholtz Centre for Environmental Research UFZ, Halle, Germany

We present an implementation of water infiltration into a pore network model where the local water pressures is continuously updated during the transient process.
The network geometry is designed to represent structured soil which is different from simple granular porous media in some respect: Pores are more elongated and less isometric and the pore size distribution is much wider and structured hierarchically. To reproduce these properties, the classical concept of pore-bodies and throats is replaced by direct measurements of pore topology and the pores below the minimal pore size of the network model are represented by a continuous network of water saturated micro pores. The latter ensures that the water phase is always continuous which affects the propagation of the water potential during infiltration.

The network model is based on cylindrical pores and considers capillary and gravitational forces. The propagation of interfaces is calculated for each time step by repeatedly solving the complete set of linear equation arising from Kirchhoff's law based on mass balance at each node of the network. This is done using the public domain package ITPack. The successive overrelaxation (SOR) and the Jacobi conjugate gradient (JCG) method proved to be more robust and faster than other solvers tested for the complex topology. The model accounts for entrapped air which is assumed to be incompressible.

We present first results demonstrating the impact of external forcing (i.e infiltration rate) and pore topology on the dynamics of water-gas interfaces, the volume of entrapped air and hysteresis.