A Multi-Scale Approach for Infiltration Processes in Porous Media

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ABSTRACT: We consider the infiltration into a homogeneous porous medium. We are interested in different formations of preferential flow paths with saturation overshoots, which are caused by a dynamic capillary pressure. For the dynamic capillary pressure we use the extended model of Hassanizadeh&Gray (1993).
The equations for this two-phase flow problem are given by the Darcy-law and the mass balance law for each phase. Neglecting capillary pressure effects conventional schemes cannot resolve saturation overshoots. Including a dynamic capillary pressure saturation overshoots can be resolved. But for direct numerics it is computationally too expensive to solve this equation on the whole domain, because a very fine grid and a very small time step is necessary to resolve the saturation overshoot. The extended model is only of importance close to a saturation overshoot. Away from the saturation overshoot the capillary pressure can be neglected and a coarser grid can be used. To overcome this problem we will couple both models by a new multidimensional mass-conserving numerical method which belongs to the class of Heterogeneous Multiscale Methods originally introduced by E&Engquist (2003). The additional information which we gain by the extended model serves as update with the help of a novel flux function, which is a key part of the approximation for the multidimensional setting. We will demonstrate the efficiency of the new method on the basis of numerical examples in 2D including saturation overshoots. Furthermore we will present first results for parameters and conditions based on experimental measurements.