

Simulation of Coupled Transport Processes in Natural Porous Media

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Abstract: Water, gas, heat and solute transport in natural porous media can be tightly coupled. The types of coupling are shown and an equation system for the coupled transport in frozen and unfrozen porous media is presented. The discretization (vertex centered finite volume method in space, implicit Euler in time) and solution process (fully coupled, Newton method for nonlinear, imperfect multigrid for linear equations) are outlined. When freezing porous media are simulated, a variable substitution at the freezing point is necessary. An approach to incorporate the variable switching in the parallel multigrid solver is demonstrated.

The model is applied to the simulation of permanent frozen soils in arctic environments and the simulation results are compared to measured data. Furthermore multiphase (water/gas) transport near water saturation is simulated and deviations from results of a single phase flow model using Richards' equation are discussed.

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