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Numerical simulations for the saltpool benchmark problem using the mixed hybrid and discontinuous finite element methods with locally varying time steps

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We consider the numerical solution of the density coupled flow and transport in porous media. The flow equation is solved by means of the mixed hybrid finite element method (MHFE), while the transport equation is discretized by MHFE and Discontinuous finite element method (DFE) combined together via an appropriate time splitting technique.

This method has been shown to be effective for the numerical solution of two-dimensional density-dependent flow and transport problems in groundwater even when concentrations gradients are high and the process is dominated by density effects.

In this work, we extend this approach to three dimensions employing tetrahedral meshes and introduce a spatially variable time-stepping procedure that improves computational efficiency while preserving accuracy by adapting the time step size according to the local Courant-Friedrichs-Lewy (CFL) constraint.

The three-dimensional saltpool problem, recently introduced as a new benchmark for testing three-dimensional density models, provides assessments with respect to accuracy and reliability of the numerical approach we propose.