Solvers for Coupled PDE Problems in Porous Media Science

Ruben Buijse, Niklas Conen, Arne Nägel, Patrik Schlund

G-CSC, Kettenhofweg 139, 60325 Frankfurt, Germany, naegel@gcsc.uni-frankfurt.de

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Developing efficient solvers for coupled PDE systems is often a non-trivial task, since one must to combine suitable schemes for time integration and linear solvers, which is suitable for HPC systems. In this study, we present a unified solver framework, which combines a linearly-implicit extrapolation scheme with a scalable multigrid solver.

The effectiveness of the approach is demonstrated for different applications in subsurface flow. These include (i) thermohaline flow, in which density depends on temperature and salt concentration, (ii) thermo-hydraulic flow, which features thawing and freezing in permafrost regions, and (iii) density-driven flow in domains with a free groundwater surface. We investigate robustness of the numerical methods, develop suitable error estimators and provide scaling results in an HPC environment.

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