Geophysical Research Abstracts
Vol. 15, EGU2013-12368, 2013
EGU General Assembly 2013

Comparison of iterative methods and preconditioners for two-phase flow in porous media using exact and approximate Jacobians

Henrik Büsing

Institute for Applied Geophysics and Geothermal Energy, E.ON Energy Research Center, RWTH Aachen University, Germany, hbuesing@eonerc.rwth-aachen.de

Two-phase flow in porous media occurs in various settings, such as the sequestration of CO_2 in the subsurface, radioactive waste management, the flow of oil or gas in hydrocarbon reservoirs, or groundwater remediation. To model the sequestration of CO_2, we consider a fully coupled formulation of the system of nonlinear, partial differential equations. For the solution of this system, we employ the Box method after Huber & Helmig (2000) for the space discretization and the fully implicit Euler method for the time discretization. After linearization with Newton's method, it remains to solve a linear system in every Newton step.

We compare different iterative methods (BiCGStab, GMRES, AGMG, c.f., [Notay (2012)]) combined with different preconditioners (ILU0, ASM, Jacobi, and AMG as preconditioner) for the solution of these systems.

The required Jacobians can be obtained elegantly with automatic differentiation (AD) [Griewank & Walther (2008)], a source code transformation providing exact derivatives. We compare the performance of the different iterative methods with their respective preconditioners for these linear systems. Furthermore, we analyze linear systems obtained by approximating the Jacobian with finite differences in terms of Newton steps per time step, steps of the iterative solvers and the overall solution time.

Finally, we study the influence of heterogeneities in permeability and porosity on the performance of the iterative solvers and their robustness in this respect.

References

[Griewank & Walther(2008)] Griewank, A. & Walther, A., 2008. *Evaluating Derivatives: Principles and Techniques of Algorithmic Differentiation*, SIAM, Philadelphia, PA, 2nd edn.

[Huber & Helmig(2000)] Huber, R. & Helmig, R., 2000. Node-centered finite volume discretizations for the numerical simulation of multiphase flow in heterogeneous porous media, *Computational Geosciences*, 4, 141–164.

[Notay(2012)] Notay, Y., 2012. Aggregation-based algebraic multigrid for convection-diffusion equations, *SIAM Journal on Scientific Computing*, 34, A2288–A2316.