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A new axis-symmetric, multigrid based Stokes solver for compressible flow

J. Weismüller, M. Mohr, and H.-P. Bunge
Ludwig-Maximilians University Munich, Germany (weismueller@geophysik.uni-muenchen.de)

Mantle convection is governed by the conservation of momentum and mass, yielding the Stokes equations, and the conservation of energy. We solve these equations for a compressible Newtonian fluid with infinite Prandtl number, using finite elements on a 2d annulus. A Conjugate Gradient method together with a Multigrid solver is used to solve the resulting linear system of equations. Parallelization for symmetric multiprocessing architectures enables fast calculations at the resolutions necessary to resolve convection patterns at earth-like Rayleigh numbers. Mathematical formulations that are similar to those of the 3d mantle convection code TERRA together with a modular design enable us to use the code as a framework to test various discretization approaches. Also, different Multigrid designs can be selected, yielding distinctive cycling patterns and smoothers. These can be applied to several levels of complexity in the original problem, currently ranging from the Poisson equation to compressible Stokes flow.