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Aspects of Multigrid for Mantle Convection

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Convection in the Earth's mantle can be described by a Stokes-type equation with strongly varying viscosity values coupled to an energy equation. The dynamics of the mantle depend essentially on the underlying viscosity structure. Computing the quasi-stationary flow field in each time step dominates the computational cost of Earth mantle simulators. Therefore constructing efficient solvers is crucial for simulating Earth mantle dynamics. In this article we consider a geometric multigrid method for the viscous operator of the Stokes-type system and study the convergence behaviour for different smoothers and transfer operators. We focus on two aspects, the influence of operator complexity, starting with a simplified form and ending with its most general formulation, and the effects of highly discontinuous viscosity parameters. Systematic numerical tests help to identify the most efficient multigrid components.