Extended Abstract

We study the Stokes equation with high-contrast viscosity coefficient and this regime corresponds to a small Reynolds number regime because viscosity is inversely proportional to the Reynolds number. Numerical solution to the Stokes flow problems especially with high-contrast variations in viscosity is critically needed in the computational geodynamics community. One of the main applications of the high-contrast Stokes equation is the study of earth’s mantle dynamics; see recent studies [4, 5, 6].

The high-contrast coefficient creates small eigenvalues which prohibits the utilization of traditional iterative solvers. In order to overcome solver difficulties, we construct a preconditioner that is robust with respect to contrast size and mesh size simultaneously based on the preconditioner proposed by Aksoylu et al. [1]. One of the strengths of our proposed preconditioner is rigorous justification. The proposed preconditioner was originally designed for the high-contrast diffusion equation under finite element discretization [1]. Rigorous justification has been obtained through the usage of singular perturbation analysis. Aksoylu and Yeter [2] extended the proposed preconditioner from finite element discretization to cell-centered finite volume discretization. Hence, we have shown that the same preconditioner could be used for different discretizations with minimal modification. Furthermore, Aksoylu and Yeter [3] applied the same family of preconditioners to high-contrast biharmonic plate equation. Such dramatic extensions rely on the generality of the employed singular perturbation analysis. Therefore, we have accomplished a desirable preconditioning design goal by using the same family of preconditioners to solve the elliptic family of PDEs with varying discretizations. In this article, we aim to bring the same rigorous preconditioning technology to vector valued problems such as the Stokes equation.
References


