Aggressive, accelerated subdomain smoothers for Stokes flow with highly heterogeneous viscosity structure

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Scalable solvers for mantle convection and lithospheric dynamics with highly heterogeneous viscosity structure typically require the use of a multigrid method. To leverage new hybrid CPU-accelerator architectures on leadership compute clusters, multigrid hierarchies which can reduce communication and use high available arithmetic intensity are at a premium, motivating more aggressive coarsening schemes and smoothers.

We present results of a comparative study of two competitive GPU-enabled subdomain smoothers within an additive Schwarz method. Chebyshev-Jacobi smoothing has been shown to be an effective smoother, and its nature as a low-communication method built from basic linear algebra routines allows its use on a wide range of devices with current libraries. ILU smoothing is also of interest and is known to provide robust smoothing in some cases, but has traditionally been difficult to use in a fine-grained parallel environment. However, a recently-introduced variant by Chow and Patel allows for incomplete factorizations to be computed and applied in these environments, hence allowing us to study them as well. We use and extend the pTatin3D, PETSc, and ViennaCL libraries to integrate promising methods into a realistic application framework.