GPU support for sparse matrix calculations in PETSc, with applications to nonlinear Stokes

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Many geophysical phenomena (matle convection, glacier dynamics) are described by nonlinear Stokesian fluids coupled to various thermodynamic quanti-ties. Linearization leads to variable coefficient linear Stokes systems, which can exhibit poor convergence in absence of effective preconditioners. The emergence of GPU-based architectures offers dramatic hardware acceleration of many scientific computation tasks. The-refore it is natural to try to take advantage of GPU acceleration for many sparse matrix calculations, inclu-ding Stokes systems. While achieving peak performance on sparse matrices is usually a challenge, we fo-cus on enabling GPU support within one of the most popular sparse linear algebra and PDE library: PETSc (Portable Extensible Toolkit for Scientific computation). In this talk we will discuss our approach to enabling GPU acceleration for sparse matrix calculations, pre-conditioning, and the implications for Stokes solvers.