



## **StagBL: A Scalable, Portable, High-Performance Discretization and Solver Layer for Geodynamic Simulation**

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StagBL is an open-source parallel solver and discretization library for geodynamic simulation, encapsulating and optimizing operations essential to staggered-grid finite volume Stokes flow solvers. It provides a parallel staggered-grid abstraction with a high-level interface in C and Fortran. On top of this abstraction, tools are available to define boundary conditions and interact with particle systems.

Tools and examples to efficiently solve Stokes systems defined on the grid are provided in small (direct solver), medium (simple preconditioners), and large (block factorization and multigrid) model regimes.

By working directly with leading application codes (StagYY, I3ELVIS, and LaMEM) and providing an API and examples to integrate with others, StagBL aims to become a community tool supplying scalable, portable, reproducible performance toward novel science in regional- and planet-scale geodynamics and planetary science.

By implementing kernels used by many research groups beneath a uniform abstraction layer, the library will enable optimization for modern hardware, thus reducing community barriers to large- or extreme-scale parallel simulation on modern architectures. In particular, the library will include CPU-, Manycore-, and GPU-optimized variants of matrix-free operators and multigrid components.

The common layer provides a framework upon which to introduce innovative new tools.

StagBL will leverage p4est to provide distributed adaptive meshes, and incorporate a multigrid convergence analysis tool.

These options, in addition to a wealth of solver options provided by an interface to PETSc, will make the most modern solution techniques available from a common interface. StagBL in turn provides a PETSc interface, DMStag, to its central staggered grid abstraction.

We present the development version of StagBL, including preliminary integration with application codes and demonstrations with its own demonstration application, StagBLDemo. Central to StagBL is the notion of an uninterrupted pipeline from toy/teaching codes to high-performance, extreme-scale solves. StagBLDemo replicates the functionality of an advanced MATLAB-style regional geodynamics code, thus providing users with a concrete procedure to exceed the performance and scalability limitations of smaller-scale tools.