



## **Nonlinearities and multigrid solvers for geodynamic applications using staggered grid finite differences.**

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We report on the state of the development of the massively parallel staggered-grid finite difference version of the LaMEM code, parts of which have scaled to over 260'000 cores. In particular we present i) our matrix-free nonlinear solution strategy for visco-elasto-plasticity, ii) updated linear solver that includes a coupled velocity-pressure geometric multigrid preconditioner, and iii) an optimized treatment of the makers with approximate stress-rotation algorithm generalized from 2D to 3D formulation. The capabilities of the solver are demonstrated with a set of geodynamically-relevant benchmarks and example problems on the massively parallel computers.

### Acknowledgements.

Funding was provided by the European Research Council under the European Community's Seventh Framework Program (FP7/2007-2013) / ERC Grant agreement #258830. Numerical computations have been performed on JUQUEEN of the Jülich high-performance computing center.