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Implementation of Newton-Rapshon iterations for parallel staggered-grid geodynamic models

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Staggered-grid finite differences discretization has a good potential for solving highly heterogeneous geodynamic models on parallel computers (e.g. Tackey, 2008; Gerya &Yuen, 2007). They are inherently stable, computationally inexpensive and relatively easy to implement. However, currently used staggered-grid geodynamic codes employ almost exclusively the sub-optimal Picard linearization scheme to deal with nonlinearities. It was shown that Newton-Rapshon linearization can lead to substantial improvements of the solution quality in geodynamic problems, simultaneously with reduction of computer time (e.g. Popov & Sobolev, 2008).

This work is aimed at implementation of the Newton-Rapshon linearization in the parallel geodynamic code LaMEM together with staggered-grid discretization and viso-(elasto)-plastic rock rheologies. We present the expressions for the approximate Jacobian matrix, and give detailed comparisons with the currently employed Picard linearization scheme, in terms of solution quality and number of iterations.

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