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Benchmarks and Early Applications of a Eularian Viscoelastic Code

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Rheological properties of rocks from laboratory experiments show that elastic properties of upper mantle materials influence their viscous flow. Geophysical observation as glacial rebound, fitting with elastic core in subduction and the presence of deep earthquakes down to 670 km confirm that the role of elasticity in mantle dynamics (especially for lithosphere deformation) is manifolds and requires further investigation.

We present benchmarks and first theoretical applications of a viscoelastic parallel version of Citcom, modified with the addition of lagrangian particles for tracking material, temperature and stress properties. Maxwell viscoelastic rheology is introduced in Citcom following a method introduced first by Moresi and Muhlhaus. While stress advection is calculated through particle advection, diffusion is obtained on the eulerian grid. The presence of numerical diffusion, artificial drift in displacement and rotation are verified through comparison with analytical solutions.

While in an incompressible code energy dissipation happens almost exclusively due to shear viscosity, in a general isotropic body elastic energy can be stored in bulk or shear forms. We test the role of different interpolation methods on a tensor, and of advection schemes in order to obtain energetically consistent results, both for the dissipative (viscous) and storing (elasticity) point of view. We propose constraints on the way elasticity can be introduced in viscoelastic code aimed to geophysical applications.

Finally the code is benchmarked against a lagrangian mechanical finite element commercial code (Abaqus), this last combined to an hoc remeshing routine in order to model unlimited large deformation. The codes are compared through simple two-dimensional simulations of slab deformation (e.g. bending and breaking) .