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A convective forecast experiment of global tectonics

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Modeling jointly the deep convective motions in the mantle and the deformation of the lithosphere in a self-consistent way is a long-standing quest, for which significant advances have been made in the late 1990's. The complexities used in lithospheric models are making their way into the models of mantle convection (density variations, pseudo-plasticity, elasticity, free surface), hence global models of mantle motions can now display tectonics at their surface, evolving self-consistantly and showing some of the most important properties of plate tectonics on Earth (boundaries, types of boundaries, plate sizes, seafloor spreading properties, continental drift).

The goal of this work is to experiment the forecasting power of such convection models with plate-like behavior, being here StagYY (Tackley, 2008). We generate initial conditions for a 3D spherical model in the past (50Ma and younger), using models with imposed plate velocities from 200Ma. By doing this, we introduce errors in the initial conditions that propagate afterwards. From these initial conditions, we run the convection models free, without imposing any sort of motion, letting the self-organization take place. We compare the forecast to the present-day plate velocities and plate boundaries.

To investigate the optimal parameterization, and also have a flavor of the sensitivity of the results to rheological parameters, we compute the derivatives of the misfit of the surface velocities relative to the yield stress, the magnitude of the viscosity jump at 660km and the properties of a weak crust. These derivates are computed thanks to the tangent linear model of StagYY, that is built through the automatic differentiation software TAF (Giering and Kaminski, 2003).

References

Tackley, P. J., Modeling compressible mantle convection with large viscosity contrasts in a three-dimensional spherical shell using the yin-yang grid, Phys. Earth Planet. Inter. 171, 7-18 (2008).

Giering, R., Kaminski, T., Applying TAF to generate efficient derivative code of Fortran 77-95 programs, PAMM 2, 54-57 (2003).