



Effect of grid resolution on tectonic regimes in global-scale convection models

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A key ingredient to reproduce plate-tectonics in numerical models is a viscoplastic rheology. Strongly temperature-dependent rheology generates a rigid lid at the surface, whereas plastic rheology allows for the formation of plate boundaries. The yield stress limiter controls the strength of the lithosphere.

Depending on the value used for τ_0 different tectonics regimes can be observed: (i) dripping behaviour (low τ_0), (ii) plate-like behaviour (intermediate-low τ_0), (iii) Episodic behaviour (intermediate-high τ_0) and (iv) Stagnant lid behaviour (high τ_0).

Each lid behaviour can be distinguished by comparing the evolution profile of several parameters: temperature, viscosity, surface Nusselt number and mobility (Tackley, 2000a.).

Despite the great importance of physical parameters, the outcome of geodynamical models is also affected by the grid resolution as it has been shown that the critical τ_0 that separates each lid behavior is resolution dependent (Tosi et al., 2015).

Here we use the code StagYY (Tackley, 2008) in a 2D spherical annulus geometry (Hernlund & Tackley, 2008) to determine the resolution-dependent tectonic regime in a global-scale convection setting. We tested 12 grid resolutions (ranging from 128x32 to 1024x128 nodal points) and 9 different τ_0 (ranging from 10 to 90 MPa), keeping all the remaining physical parameters unchanged.

For these simplified models we assume isothermal free slip boundaries, constant radiogenic heating, no melting, endothermic (410) and exothermic (660) phase transitions. Each simulation was run for 15 Gyrs with a Rayleigh number of $\approx 8 \cdot 10^7$ to make sure that steady-state conditions were reached.

Our resolution tests show that the observed tectonic regime is affected by grid resolution as this parameter controls how well the lithosphere is resolved. Low radial resolutions favour weak lid regimes (dripping and plate-like) as the lithosphere is defined by few thick cells, that propagate basal stress to shallower depths. On the other hand low azimuthal resolutions favour strong lid regimes (episodic and stagnant) since plate boundaries remain unresolved. In conclusion, only at high grid resolutions (512x128 and higher) the numerical influence on the observed tectonic regime is low.

