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The influence of deep mantle heterogeneity on the rhythms and scales of surface topography evolution

Maëlis Arnould (1), Nicolas Coltice (2), and Nicolas Flament (3)

(1) Ecole Normale Supérieure de Lyon, Lyon, France (maelis.arnould@ens-lyon.fr), (2) Université de Lyon, Lyon, France (nicolas.coltice@univ-lyon1.fr), (3) School of Geosciences, University of Sydney, Sydney, Australia (nicolas.flament@sydney.edu.au)

Abstract:

Earth's surface, the interface between external processes and internal dynamics (lithosphere motions and mantle convection), is continuously reorganised. A large part of Earth's topography is generated by mantle motions and lithospheric stresses [1], which impacts for instance the global sea-level, the dynamics of sedimentary basins and the geoid. Studying how surface topography evolves in both space and time thus not only provides information on the rhythms and scales of evolution of those processes, but would also be a tool for the study of the mantle motions and properties from which it originates [2].

In this study, we propose to characterise the spatial and temporal scales of evolution of surface topography in 2D spherical annulus numerical models of mantle convection developing a plate-like behaviour. We use the geodynamical code StagYY [3] to first determine a mantle convection regime generating a surface topography with Earth-like amplitudes and realistic mantle dynamics at first order (e.g. high Rayleigh number, reasonable lithosphere thickness, pseudo-plastic lithosphere rheology generating plate tectonics). We then use this convection regime to investigate how the presence of stable deep-rooted thermochemical heterogeneities influence the rhythms of evolution of surface topography. We analyse our results to identify how the timescales of evolution are connected with the lengthscales of topography, in light of the tectonic histories produced by the models.

References:

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