Geophysical Research Abstracts
Vol. 14, EGU2012-12121, 2012
EGU General Assembly 2012
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Scaling laws of dynamic topography and uplift-rate in 3D spherical geometry

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Thermo-chemical convection in the Earth's mantle is thought to significantly affect the topography of the lithosphere. However, the comparison of such dynamic topography as obtained from convection models with the observed, non-isostatic topography remains complicated, both because of uncertainties about crustal structure and mantle flow estimates. Here, we focus on the latter and evaluate the role of lateral and radial viscosity variations for topography estimates. We report the magnitude of dynamic topography and uplift rates from a set of numerical computations of mantle convection in regional sections of a spherical annulus using the finite element software CitcomS. We strive to establish scaling laws of dynamic topography and uplift rate as a function of the rheology and Rayleigh number. We test both Newtonian and non-Newtonian rheologies with temperature-dependent viscosities. The dimensions of the Stokes equation suggest that both the uplift rate and the dynamic topography can be described by the Frank-Kamenetskii parameter for temperature dependent viscosity, the average viscosity, and the Rayleigh number, but with different exponents. We test the validity of this approach.