Plate formation in a mantle convection model: The effect on the dynamic topography

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With increasing computer power the numerical simulation of mantle convection becomes easier, allowing more complex models of mantle convection. In such a way characteristics of rheological aspects like variable viscosity can be investigated. A result of temperature- and stress-dependent viscosity is the occurence of serveral flow regimes like the stagnant-lid, the episodic and the mobile-lid regime (*Stein et al.(2004), Phys. Earth Planet. Int 142, 225*).
In this study we examine the surface signal different flow regimes induce, in particular we consider the dynamic topography Δh. It can be computed by assuming the boundary condition that normal stress on the surface is zero. This leads to

$$\Delta h = \frac{1}{\rho g} \left(P_D - \sigma_{zz} \right),$$

where ρ is the density of the mantle material, g the gravitational acceleration, σ_{zz} the normal part of the stress tensor and P_D the dynamic pressure. Our model uses primitive variables, so that the dynamic pressure is directly available to calculate the topography.
We present a selection of two- and three-dimensional simulations in several flow regimes and their relating flow structure. We show different styles of plate formation on the surface and their effect on the topography.

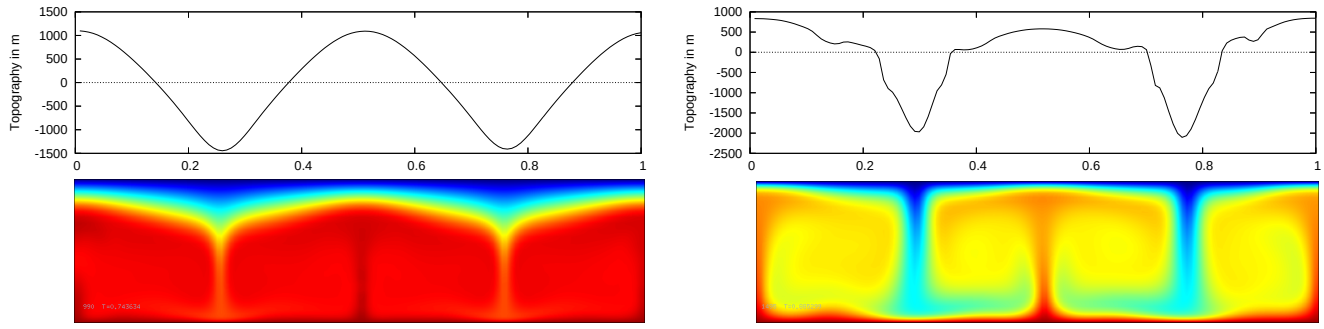

Figure 1: Two examples of mantle convection in different flow regimes. A snapshot of the temperature field and the relating topography at the surface are shown. On the left hand side the flow forms a stagnant lid and on the right hand side a mobile lid is established. This two examples show differences in the roughness of the topography.