



Thickness of Asthenosphere Channel at extreme spatial resolutions and its implications on dynamic topography

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The asthenosphere is a mechanically weak layer beneath the lithosphere that was advocated early on as a means to promote isostatic movement. The amount of viscosity reduction in the asthenosphere relative to the deeper mantle, however, is not well known. In this study, we study the effect of several asthenosphere channel thicknesses on the mantle-induced surface deformation. We start from a thickness of 1000 km up to an extremely narrow channel of 100 km. Above the asthenosphere we place a very thin lithosphere layer of 100 km. This leads to high jumps in the viscosity between the different layers of up to three orders of magnitude. Additionally we include temperature dependence in our viscosity model using a published tomography model. That yields strong lateral viscosity variation on top of the radial jumps.

Such a setup requires an extremely fine spatial resolution and poses a high challenge for the numerical solver. We employ the hierarchical hybrid grids framework, a matrix-free finite element implementation, with our recently proposed highly efficient on-the-fly stencil assembly routines. We show simulation results with an unprecedented global resolution close to 1 km using 61 440 compute cores on a current peta-scale architecture.