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Deep and near-surface consequences of root removal by asymmetric continental delamination: comparison from different initial scenarios

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Removal of continental lithospheric mantle has been inferred from a wide range of observations such as anomalously high heat flow, regional uplift, change of stress field toward extension, and the presence of cold slabs in the upper mantle and igneous activity in continental areas far from present subduction zones. Delamination mechanism is commonly invoked to explain this lithospheric mantle removal in many continental areas characterized by highly variable geodynamic settings. In this study we present results of numerical simulations considering different initial setups, representative for geodynamic scenarios where delamination could potentially develop. We focus on predicted evolution of surface and near-surface observables, namely the crustal structure, surface heat flow and isostatic and dynamic topography evolution. Our results show that the predicted geometry of delaminated lithospheric slabs resembles the well-studied geometry of subducted slabs. The pattern of local isostatic elevation is characterized by laterally migrating surface uplift/subsidence. This pattern is shown to be little sensitive to lower crust density variations. In contrast, predicted dynamic topography is more sensitive to these changes, and shows surface subsidence adjacent to the delaminating lithospheric mantle for the model with a high density lower crust, and surface uplift above the slab for a model with a less dense lower crust. The positive buoyancy of the thickened crust is able to overwhelm in some cases the effect of negative buoyancy of the slowly sinking lithospheric mantle. We infer from our modeling that there is not a specific characteristic pattern of topography changes associated with delamination, but it depends on the interplay between highly variable factors, as slab sinking velocity, asthenospheric upwelling and changes in crustal thickness.