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Two-dimensional numerical modeling on crustal shortening partitioning during continental collision

Jie Liao and Taras Gerya
Institute of Geophysics, ETH Zurich, Zurich, Switzerland (jie.liao@erdw.ethz.ch)

Crustal shortening during continental collision may largely localize on the lower plate or distribute on both the lower and upper plates. A natural example showing variation of crustal shortening partitioning along strike is on the central Alps, where crustal shortening is gradually changed from lower-plate-localized in the western part to upper-plate-concentrated in the eastern part. Alpine collision has a very complex history (and it has been largely influenced by the previous European oceanic subduction), and the crustal shortening partitioning may controlled by pre-existing structures. However, to the first order, it is poorly understood that crustal shortening partitioning during continental collision is dominated by geological structures or by rock properties (in particular rheological properties).

In this work we present 2D thermal-mechanical coupled numerical simulations to investigate the influence of rock/rheological properties on crustal shortening. Three parameters (i.e. mechanical strength of upper crust, Moho temperature, and convergence rate) are investigated, and all influence the crustal shortening transformation from lower-plate-localized to upper-plate-concentrated. Strong upper crust of the lower plate and high Moho temperature largely promote crustal shortening transformation, and a threshold is present in both parameters. Convergence rate also influences crustal shortening, although the threshold is not significant.

Besides, validity of internal constant velocity boundary condition employed in numerical models is tested through horizontal force balance. Boundary force is computed and analyzed, which correlates highly with model deformation. Furthermore, we present numerical simulations with constant force boundary condition, which is rarely employed in the previous numerical studies. Boundary velocity variation as a response to constant boundary force is discussed. This constant force boundary condition may provide an alternative way to set velocity boundary conditions in collisional models.