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Three-dimensional numerical simulations of crustal systems subjected to convergence and to surface processes

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As indicated by several modeling studies, the structural expression and dynamic behavior of orogenic mountain belts is dictated not only by its rheological properties but also by the efficiency of erosion and sedimentation acting on its surface. Until recently, numerical investigations have been mainly limited to 2D studies, because of the high computational cost required by 3D models. Here, we have efficiently coupled the landscape evolution model CASCADE with the 3D thermo-mechanically coupled tectonics code FANTOM. Details of the coupling algorithms between both codes are given. We present results of numerical experiments designed to study the response of viscous-plastic crustal materials subjected to convergence and to surface processes including both erosion and sedimentation. In particular, we focus on the time evolution of both the tectonic structures and on the surface morphology of the orogen. We show that increasing the efficiency of fluvial erosion decreases the thrust angle, which in turn decreases the width of the orogen. In addition, the maximum elevation of the orogen is robustly higher in the models with than without surface processes. This illustrates the strong coupling between tectonic and surface processes. Overall, our results suggest that surface processes, by enhancing localization of deformation, act as a positive forcing to topographic building.