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Hidden Tectonic Shortening: A Numerical Model of Coupled Erosion and Deformation at Plateau Margin

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The idea that high fluvial erosion rates at the plateau rim can influence the dynamic behavior of the plateau/foreland system is directly tested with the thermo-mechanical modelling in 2D. We employ parallelized lagrangian FEM/FD explicit code LAPEX-2D, which uses material points that store history-dependent properties including stress and strain tensors. The code incorporates highly nonlinear visco-elasto-plastic rheology as well as surface processes in form of fluvial and landsliding erosion. The model setup represents a converging plateau/foreland system. At low erosion rates tectonic shortening is unevenly distributed among the plateau and the foreland, depending on their relative effective stiffness, which is a function of thermal history, lithology and height of the plateau. In contrast, when the erosion rate is high, such as in areas with Moonson climate, the overall tectonic shortening could be almost completely taken up by a single exhumational shear zone at the plateau rim. In this case estimates of tectonic shortening based on the deformation of the plateau region will underestimate the total convergence. These results might be relevant for the Himalayas at the southern rim of the Tibetian plateau which is under Monsoon-type climatic conditions as well as for the some portions of the north-eastern Altiplano plateau margin in the Central Andes.