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Numerical Modelling of the Dynamics of the Tibetan Plateau uplift

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The Tibetan plateau is the product of crustal thickening caused by collision between India and Asia. Geological records show continuing northward movement of the Indian plate relative to stable Eurasia at rate near 50 mm/yr for the last 50 My. Observations show a plateau at 5 km elevation with steep topographic gradients across the southern and northern margins. Fault-plane solutions of earthquakes and field observations indicate that for at least the past 10 My the Tibetan plateau has experienced significant E-W extension and minor thinning. Numerous causes of the Tibetan extension have been proposed including gravitational collapse, vertical variations of lithospheric rheology and stress states, tectonic boundary conditions and basal shear associated with subduction of the Indian plateau. Uplift late in the tectonic evolution of the plateau, the widespread extension, and the associated magmatism have been attributed to convective removal of the lower part of lithospheric mantle and its replacement by hotter and lighter asthenosphere. In this work, we study numerically some of these processes and in particular the effect of the convective removal of the lithosphere on the evolution of the Tibetan plateau. We use the thin sheet approach to model the deformation of a rheologically stratified lithosphere, where the coupled system of equations for momentum and energy conservation is numerically solved. Thickening of the whole lithosphere produces a relatively low plateau, with a smooth inverse exponential decay of elevation away from the plate boundary on a length scale of about 2000 km. This geometry does not resemble the present-day plateau. Removal of the lithosphere root at 10 Ma provokes a rapid increase in surface elevation, creating a more level plateau with high topographic gradients on the plateau margins. It also results in a significant increase in gravitational potential energy, which may explain

the present-day pattern of extension.