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A global coupled model of the lithosphere and mantle dynamics

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Understanding the dynamics of global lithospheric motion is one of the most important problems in geodynamics today. Mantle convection is commonly accepted as the driving force for plate motion but, while the kinematics of plate movement is well known from space geodetic and paleomagnetic observations, we lack a rigorous description of the coupled mantle convection-plate motion system. Here we present first results from a combined mantle convection-global lithosphere motion model. Our plate motion code is SHELLS, a thinsheet FEM code developed by Bird which computes global plate motion and explicitly accounts for faults. The global mantle convection code is TERRA, a high-resolution 3-D FEM code developed and parallelized by Bunge and Baumgardner. We perform simple modeling experiments in which the shear tractions applied to the bottom of the lithosphere arise directly from two different mantle circulation model, in which the amount of heat coming from the core-mantle boundary is respectively 5% and 45% of the radiogenic heat. Our mantle circulation model includes a history of subduction and accounts, among others, for variations in mantle viscosity. We find that our results are sensitive to the amount of core heating, an inference that has received renewed attention lately. A quantitative comparison of our data with NUVEL-1A and GPS plate velocities shows that models with stronger core heating overall are in better agreement with observations.