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Planforms and Time-dependence of self-consistently generated plate tectonics in 3D spherical Models of Mantle Convection

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In the past decade, several studies have documented the effectiveness of plastic yielding in causing a basic approximation of plate tectonic behavior in mantle convection models with strongly temperature-dependent viscosity- strong enough to form a rigid lid in the absence of yielding. The vast majority of such research to date has, however, been in either 2-dimensional, or 3-dimensional cartesian geometry, so there are several questions about how this behavior will manifest itself in a 3-D spherical shell. For example, in 3-D cartesian calculations of aspect ratio 8 [Tackley, G-cubed, paper number 2000GC000043], some cases formed almost steady-state two-dimensional 'cells' of wavelength 8, which it is not possible to fit in a 3-D sphere. Therefore, it seems likely that spherical cases will display less symmetry and greater time-dependence than equivalent cartesian cases, which might result in higher toroidal:poloidal ratios. Also of interest is the scaling of plate size and heat flux with convective parameters, which has implications for understanding the thermal evolution of a cooling terrestrial planet. A systematic investigation of these issues is now being performed using a new spherical version of the code Stag3D, which uses the yin-yang grid to cover the sphere with two longitude-latitude patches.