3D spherical geodynamic modeling through time

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Calculations of mantle convection generally use constant rates of internal heating and time-invariant core-mantle boundary temperature. When considering calculations that span the age of the solar system, both of these assumptions must be relaxed. In this work I consider 3D spherical convection calculations that span the age of the Earth with concentrations of heat producing elements that decrease with time, a cooling core boundary condition, and a mobile lid. I begin from a hot initial temperature, consistent with a relatively short accretion time for the formation of the planet. I find that the choice of a mobile or stagnant lid has the most significant effect on the average temperature as a function of time. However the choice of mobile versus stagnant lid has less of an effect on the distribution of hot and cold anomalies within the mantle. I find the same pattern of broad upwelling temperature structures in these new mobile lid calculations that has previously been described in stagnant-lid calculations relevant to Mars [1] [2]. The viscosity of the asthenosphere has a profound effect on the pattern of temperature anomalies, even in the deep mantle [3]. If the asthenosphere is weaker than the upper mantle by more than an order of magnitude, then the a pattern of temperature anomalies with one or two large plumes results. If the asthenosphere is less than an order of magnitude weaker than the upper mantle, then the pattern of temperature anomalies takes the form of narrow cylindrical upwellings and cold down going sheets.

[1] Zhong & Zuber (2001) *EPSL* **189**, 75–84. [2] Roberts & Zhong (2006) *JGR* **111**, E06013. [3] Anderson & King (2014) *Science*, **346**, 1184-1185.