Comparing global mantle models: from mapping to hypotheses testing

Thorsten W. Becker and **Richard J. O'Connell**

[1]*Department of Earth and Planetary Sciences, Harvard University, 20 Oxford Street, Cambridge MA 02138, USA*

We present a comprehensive quantitative analysis of recent p- and s-wave tomography and compare seismological with geodynamical models of mantle structure. By focusing on similarities and differences between these models as a function of spatial wavelength and depth we can distinguish stable features from structures that are dependent on the data selection and the inversion technique. Our approach should help in moving from the mapping phase of global tomography to the testing of geologically relevant hypotheses since we must understand uncertainties in the input models to proceed with geodynamical interpretations.

We confirm previous results such as the presence of slab-like features in the mid-mantle in all tomography models. Radial correlation functions, furthermore, do not show strong layering at any depth, favoring whole mantle style convection. However, geodynamical models that are based on whole mantle flow, subduction and plate motion histories do not correlate well with tomography on a global level. This testifies to our incomplete understanding of what the mantle is "supposed" to look like.

Focusing on a particular geodynamics application, we proceed to explore consequences of model discrepancies when tomography is used as a proxy for density distribution in the mantle. Geodynamical models that are driven by such buoyancy anomalies are seriously affected by the choice of model. We demonstrate this finding by looking at inferred plate driving forces where we observe that a number of model combinations can explain plate motions, leading to different conclusions about the relative importance of plate tectonic forces such as ridge-push and slab-pull. Since plate velocities appear to be poorly suited to help selecting viscosity profiles or density models, we propose the use of stress and strain fields in the plates instead. Using an improved description of the faulted lithosphere, we explore how well observations such as the global stress or strain maps can be matched by geodynamical models.