Geophysical Research Abstracts
Vol. 13, EGU2011-3676, 2011
EGU General Assembly 2011

Identifying the origin of seismic anomalies using 300Myr plate motion history in mantle circulation models

Peter Webb (1), Huw Davies (1), and Rhodri Davies (2)

(1) Cardiff University, Earth and Ocean Science, Cardiff, United Kingdom (webbpj@cf.ac.uk), (2) Department of Earth Science and Engineering, Imperial College, London

Mantle circulation models (MCMs) are mantle convection models conditioned with recent plate motion history as a surface velocity boundary condition. MCMs are used to investigate the coupling of Earth's surface with its interior. Traditionally MCMs have used around 120Myr of plate motion history to condition the model, here we use up to 300Myr of history in combination with the sophisticated mantle convection code TERRA to better understand the interaction between Earth's surface and interior. Seismic tomography is used as a snapshot of the present day state of Earth's mantle to validate model predictions.

Assuming a mantle driven primarily by thermal convection we can relate regions of colder than average mantle with regions of faster than average seismic velocity, frequently interpreted as dense mantle associated with subducted slabs. Comparing the predictions of a MCM forward modelled to present day with seismic tomography provides information on mantle parameters, plate motion history and the behaviour of subducted material. However, comparing temperature predictions to seismic velocities may not show the entire picture. This work presents the results of some cutting edge MCMs analysed using a variety of techniques in addition to a simple direct comparison of the model predictions with tomography.

A wide range of MCMs with surface resolution of approximately 50 km are analysed to find a set of mantle parameters producing an Earth like series of downwellings, associated with subducted slabs. Parameters investigated included the effects of varying magnitudes of viscosity increase into the lower mantle as well as the differences between compressible and incompressible convection and the effect of adding temperature dependance to the viscosity field. This study also presents the result of higher resolution models (26 km grid spacing at the surface) analysed using a number of techniques to further understand the nature and origin of temperature anomalies associated with subducted crust. These techniques include:
(a) converting the modelled temperature field to a seismic velocity field using experimental mineral physics data,
(b) using passive particles attached to specific surface plates to track the motion of the slab once it enters the mantle and
(c) comparing the model predictions to seismic tomography data in three dimensional, spherical visualisation software.

Current models suggest that the simplest cases accurately predict larger regional anomalies such as the subduction of the Farallon ocean below North America and the Tethys ocean below South Asia. Whilst more complex models including a compressible equation of state and temperature dependent viscosity recover greater detail in these regions including more localised anomalies.