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Thermo-chemical mantle convection simulations in a 3-D spherical shell incorporating improved self-consistent mineral physics databases

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Numerical mantle convection simulations with self-consistently calculated mineral physics were detailed in our previous papers [1][2]. Here we introduce some improvements to these. Firstly, the incorporation of the post-perovskite phase in the deep mantle, which was previously not precisely treated, has been improved. We have improved the databases used in such that post-perovskite phase is better included. Secondly, the treatment of harzburgite compositions has been improved so that for each MORB composition a complementary harzburgite composition is calculated using the criterion that the average composition is pyrolite. As in previous studies, pyrolite is assumed to be a mechanical mixture of MORB and harzburgite. Thermo-chemical structures and seismic structures obtained in calculations using the improved databases are not very different from those in our previous paper [2] but slightly improved for understanding the spectra of seismic anomalies compared to those of global tomography models (Figure 1 to 3). On second issue, we can incorporate mineral physics database of pyrolite and MORB compositions but not the harzburgite compositional model. The harzburgite properties are artificially generated from pyrolite properties excluded from MORB properties. We test the combinations with four compositions of MORB composition and one pyrolite composition. It is successful to generate thermo-chemical and seismic structures without harzburgite compositions from thermo-chemical mantle convection simulations with self-consistently calculated mineral physics. They are also comparable results to the global tomographic images.

References

[1] Nakagawa, T., P. J. Tackley, F. Deschamps, and J. A. D. Connolly (2009), Incorporating self-consistently calculated mineral physics into thermo-chemical mantle convection simulations in a 3-D spherical shell and its influence on seismic anomalies in Earth's mantle, Geochem. Geophys. Geosyst, 10, Q03004, doi:10.1029/2008GC002280.
[2] Nakagawa, T., P. J. Tackley, F. Deschamps, and J. A. D. Connolly (2010), The influence of MORB and harzburgite composition on thermo-chemical mantle convection in a 3-D spherical shell with self-consistently calculated mineral physics, Earth Planet. Sci. Lett., 296, 403-412, doi:10.1016/j.epsl.2010.05.026.

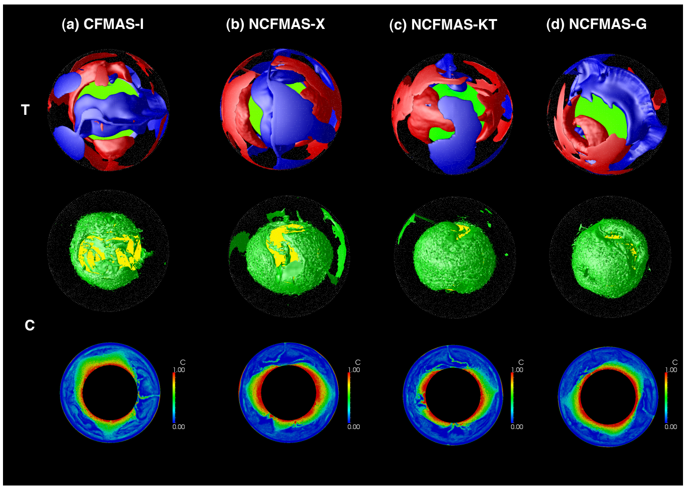

Figure 1: Thermal and chemical structures with improved databases.

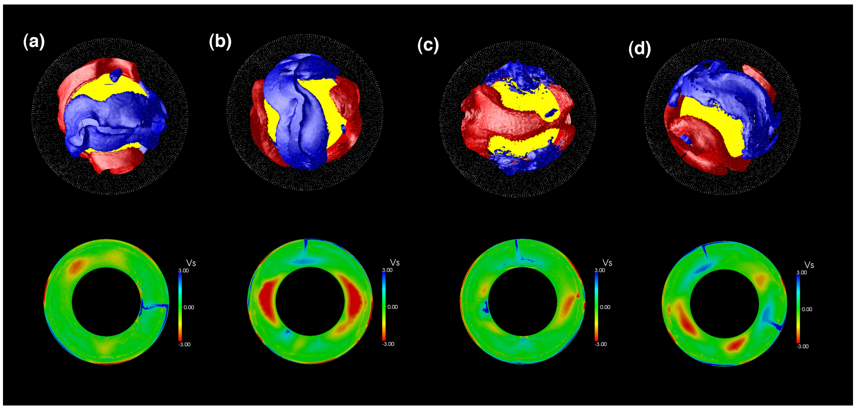

Figure 2: Shear wave anomalies corresponding to Figure 1.

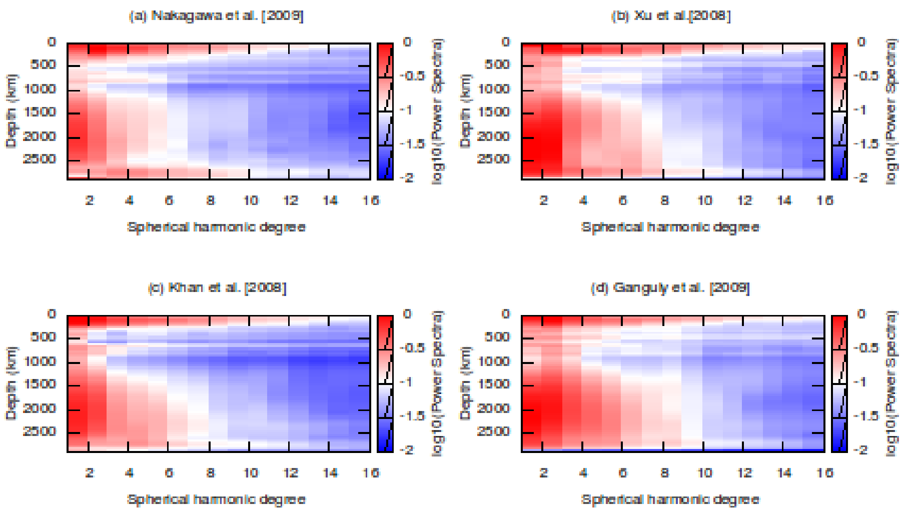

Figure 3: Spectral heterogeneity maps generated from Figure 2.