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# Strong, Multi-Scale Heterogeneity in Earth's Lowermost Mantle

Hrvoje Tkalčić and Mallory Young
The Australian National University, Research School of Earth Sciences, Canberra, Australia (hrvoje.tkalcic@anu.edu.au)

The ∼300 km thick layer above the Earth's core mantle boundary remains largely an enigma and has proven to be far more than a simple dividing line; rather it is a complex region with a range of proposed phenomena such as thermal and compositional heterogeneity, partial melting and anisotropy. Characterizing the heterogeneity in the lowermost mantle will prove crucial to accurately understanding key geodynamical processes within our planet.
Here we obtain compressional wave (P-wave) velocity images and uncertainty estimates for the lowermost mantle using old and newly collected travel time data sensitive to the lowermost mantle and core and collected by waveform cross-correlation. The images obtained by the inversion technique are void of explicit model parameterization and smoothing. To attest to the impressive capabilities of the transdimensional and hierarchical Bayesian inversion scheme, we design a comprehensive, all-embracing synthetic resolution test demonstrating the retrieval of velocity discontinuities, smooth velocity transitions, structures of varying scales and strengths.
Subsequent spectral analyses reveal a power of heterogeneity three times larger than previous estimates and a multi-scale wavelength content in the P-wave velocity field of the lowermost mantle. The newly obtained P-wave tomographic images of the lowermost mantle are not dominated by harmonic degree 2 structure as is the case for tomographic images derived from S-wave data. Instead, the heterogeneity size is more uniformly distributed between about 500 and 6000 km. Inter alia, the resulting heterogeneity spectrum provides a bridge between the long-wavelength features of previous global models and the very short-scale dimensions of scatterers mapped in independent studies. Because the long scale features are less dominant in our model than in S-wave velocity maps, we cannot reasonably determine a correlation between them and the position of detected ultra-low velocity zones.