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Morphology of large and meso-scale slow provinces in the lowermost mantle

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In this study we map the geographic extent of the Large Low Shear Velocity Provinces (LLSVPs) and faster-than-average regions in the lower mantle by applying cluster analysis to recent global tomographic models. Cluster analysis provides a quantitative method for delineating fast and slow structures in the lower mantle based on seismic tomographic models. We exploit the complementary information provided by several published shear wave tomography models and find that the results of cluster analysis are fairly consistent across models. Our approach builds upon cluster analysis previously performed on the whole lower mantle Vs profiles (Lekic et al. 2012). Here we restrict our analysis of Vs profiles to a set of depth ranges, which enables us to construct maps that potentially represent the three-dimensional morphology of LLSVPs and subducting and accumulating slab material. We provide an upper bound estimate of LLSVP volume - which is 2-3 times larger than previous estimates based on iso-surfaces and waveform studies. Additionally, we find that the African LLSVP is 50% larger than the Pacific LLSVP in nearly all models.
The cluster analysis also reveals several meso-scale structures outside of the two main LLSVPs. One such anomaly has a diameter of roughly 1000 km and is situated beneath Perm, Russia. This 'Perm' Anomaly appears to be spatially distinct from the nearby African LLSVP and waveform modeling confirms that it has a similar Vs reduction ($\sim$ 6%) and sharp lateral gradients. We detect other meso-scale anomalies appear beneath the Amazon and the Bering Sea. We present waveform evidence for the presence of these anomalies. The existence of these smaller slow structures provides further constraint to geodynamical models and the potential interaction of compositionally distinct material with subducting slabs.