Waveform inversion for 3D shear wave velocity structure in the lowermost mantle

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We formulate the inverse problem of waveform inversion for localized 3-D seismic structure, computing partial derivatives of waveforms with respect to the elastic moduli at arbitrary points in space for anisotropic and anelastic media. In this study we minimize computational requirements by using the Born approximation with respect to a laterally homogeneous model, but this is not an inherent limitation of our approach. We solve the inverse problem using the conjugate gradient (CG) method, using Akaike's Information Criterion (AIC) to truncate the CG expansion. We apply our method to invert for 3-D shear wave structure in the lowermost mantle beneath Central America, the western Pacific, and Alaska at periods from 12.5 to 200 s for deep and intermediate-depth events. The resulting model beneath Central America shows lateral heterogeneity in the E–W direction, which may be associated with a subducted cold slab surrounded by hotter materials with slower velocities [Kawai et al. GJI 2014] and also shows another high velocity anomaly located beneath the north of South America [Borgeaud et al. AGU Fall meeting 2015]. Next, we find two low-velocity zones at the bottom of the target region, with a high-velocity zone in the middle, and a low-velocity zone above the high-velocity zone and contiguous with the two deeper low-velocity zones at a depth of 200–300 km above the core-mantle boundary (CMB) beneath the western Pacific. This supports the idea that the Pacific LLSVP may be an aggregation of small upwelling plumes rather than a single large thermochemical pile [Konishi et al. GJI 2014]. Various tests show that our model is robust.