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Global distribution of azimuthal anisotropy within the lithosphere, asthenosphere, and transition zone

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We present our new global, azimuthally anisotropic model of the upper mantle, crust, and transition zone. We compare two versions of this new model, the rough SL2013svAr and smooth SL2013svA, which are constrained by a larger, updated waveform fit dataset (>900, 000 vertical component seismogram fits) than that used in the construction of the isotropic model SL2013sv (Schaeffer and Lebedev, 2013). These two anisotropy models are computed using a more precise regularization of anisotropy, which is tuned to honour the both the amplitude and orientation of the anisotropic terms uniformly, including near the poles. Automated, multimode waveform inversion was used to extract structural information from surface and S wave forms, yielding resolving power from the crust down to the transition zone. Our unprecedentedly large waveform dataset, with complementary high-resolution regional array subsets within larger global networks, produces improved resolution of global azimuthal anisotropy patterns. The model also reveals smaller scale patterns of 3D anisotropy variations related to regional lithospheric deformation and mantle flow, in particular in densely sampled regions.

In oceanic regions, we examine the strength of azimuthal anisotropy, as a function of depth, spatial position with respect to the spreading ridge, and deviation in fast axis orientation from the current and fossil spreading directions. Furthermore, we explore correlations between anisotropic tomography models and a new reference frame developed such that the net rotation of spreading ridges is minimized (RNR; Becker et al, 2014). In continental regions, azimuthal anisotropy is more complex. Reconciling complementary observations given by shear wave splitting, surface-wave array analysis, and large-scale, global 3D models offers new insights into the mechanisms of continental deformation and the architecture and evolution of the lithosphere.

Finally, quantitative comparisons with other recently published models demonstrate which features are consistently resolved across the different models, and therefore provide a means to estimate the robustness of anisotropic patterns and amplitudes spanning the from the crust down to the transition zone.

References:

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