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Receiver Function Diffractional Tomography of Mantle Transition Zone Structure

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Teleseismic *P* waves generate secondary converted *S* waves at major seismic discontinuities. The converted S waves arrive in the P-wave coda and provide important constraints on the depths of the discontinuities. Receiver Functions are based on spectral ratios between horizontal and vertical component P-wave coda seismograms and have been widely used to study the structure of seismic discontinuities. Traditional Receiver Function studies are based on ray theory, which is a high-frequency approximation and breaks down when the length scale of discontinuity depth perturbations becomes comparable to or smaller than the size of the Fresnel zone.

To account for wave diffraction effects in Receiver Function imaging, we calculate finite-frequency sensitivity of Receiver Functions to depth perturbations of the 410-km and 660-km discontinuities. The boundary sensitivity kernels are formulated in the framework of traveling-wave mode summation to account for complete wave interactions within the measurement window. The sensitivity kernels allow us to image high-resolution topographic structure of the mantle transition zone discontinuities beneath the continental United States using Receiver Functions at USArray TA stations. The 2-D tomographic problems are solved in regularized least-square inversions.

The 410-km and 660-km discontinuities in our model show $\sim$10-20 km of downward deflection in regions associated with fast seismic (slab) anomalies, and the geometry of the discontinuity anomalies suggests a NW/SE orientation of the subducting slab. The perturbations in transition zone thickness in general agree with a thermal origin but show significant small-scale variations with thinning of the transition zone along a NE channel where the slab breaks apart. The amount of thinning ($\sim$10 km) of the transition zone is similar to that beneath the Yellowstone hotspot.