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Exploring detailed feature of transition zone seismic discontinuities beneath US continent with receiver function amplitudes

Kai Deng and Teh-Ru Song
University of College London, Earth Sciences, London, United Kingdom (kai.deng@ucl.ac.uk)

Transition zone seismic discontinuities (TZSDs) at depths of about 410 and 660 km are associated with mineral phase transformations. A comprehensive understanding of the discontinuity properties, such as topography, shear velocity jump and density jump, and the transition width, is essential for exploring the nature of the transition zone. While numerous studies have investigated TZSDs with diverse datasets, none has simultaneously obtained robust observations of these properties.

Joint analysis of forward scattering waves (or converted waves, Pds) and backward scattering waves (or top-side reflections, PpPds) recorded by dense seismic arrays allows us to independently constrain shear velocity and density jump across the discontinuities and explore the detailed feature of TZSDs. We collect USArray seismic data for M$\geq$6.0 earthquakes in the distance range of 60-95 degrees, and calculate receiver functions up to 350 s after P arrival. Stack of receiver functions in different distance bins shows robust detection of forward and backward scattering waves in various frequency bands. Timing of the forward/backward scattering waves are migrated to obtain the topography of the 410 and 660. Frequency-dependent (0.1 Hz – 0.5 Hz) amplitudes of Pds conversions and PpPds top-side reflections from transition zone discontinuities are analyzed to estimate the shear velocity and density jump, as well as the transition width and velocity/density gradient near the 410 and 660 beneath the US continent.

In general, as expected theoretically, the amplitude of Pds conversions decreases with increasing epicentral distance, while the amplitude of PpPds reflection increases with increasing epicentral distance. However, the amplitude oscillates with varying distance possibly due to effect of topography and interferences from other mantle waves. At high frequency (0.5 Hz), the amplitudes of forward and backward scattering waves from the 410 are about 1% and 0.5%, respectively, while at longer period (10 s), the amplitudes increase to about 2% and 1.5%. In the frequency band of 0.1-0.5 Hz, the amplitude ratio A410/A660 for forward and backward scattering waves is in the range of 0.6-0.8 for the whole US, slightly higher than the predicted value of 0.5-0.7 from reference IASP91 model. To examine the impact of long-term subduction on the thermochemical state of the transition zone, we will compare features of TZSDs in the tectonically active western US and stable eastern US, while contrasting them against the result previously obtained in the Chinese continent and Korea.