Imaging the Crust-Mantle Boundary with Post-critical *SsPmp* in the Presence of Lateral Heterogeneity

Virtual Deep Seismic Sounding (VDSS) has recently emerged as a novel method to image the crust-mantle boundary and potentially other lithospheric boundaries. However, previous works using VDSS commonly assumed 1D velocity structures between stations and virtual sources, which are typically ~120 km apart due to post-critical reflection at the crust-mantle boundary. Here, we present synthetic *SsPmp* waveforms computed with various 2D models, which show distinct features from 1D cases. We show that in the presence of lateral heterogeneity, the differential travel time between *SsPmp* and *Ss* is no longer directly related to the crustal thickness at the reflection point as in the 1D case and is significantly affected by the lateral variation of arrival time and ray parameter of the incident S wave. The amplitude of *SsPmp* also varies significantly due to focusing and defocusing effect of lateral heterogeneity. Despite the complexities caused by 2D structure, we propose a simple ray-theory-based back-projection method that can image smoothly varying crust-mantle boundary geometry reasonably well given array observations of *Ss* and *SsPmp*. Although ray-theory approximation is capable of predicting *SsPmp* travel time well in 2D models, significant discrepancies still exist between the observed phase shift of *SsPmp* and the ray-theory predictions, which indicates a more complicated origin of *SsPmp* phase shift.