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Seismic structures of the lowermost mantle from core-diffracted waves

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The long-period nature of core-diffracted Pdiff and SHdiff waves is presumably sensitive to the average velocity perturbations of the lowermost mantle, and the upper mantle to some extent. We analyze the Pdiff waves at four dominant period 10 s, 15 s, 21 s, and 30 s, and SHdiff waves at five dominant period 10 s, 15 s, 21 s, 30 s, and 42 s, with each dominant period increment of $\sqrt{2}$. Our data include ~3400 earthquakes recorded by more than 8,000 seismic stations in total in the epicentral distance range of 92–145°. An automated data-processing method is carried out to obtain the measurements. Those earthquakes are selected from the SCARDEC earthquake database which include well-resolved source time function S(t). The Green's function G(t) for each source–station path is derived from the method of the AxiSEM and Instaseis based on 2 s precision transversely isotropic PREM model, given the source coordinate, gCMT, and station coordinate. The convolution of G(t) and S(t), denoted as U(t), indicates the synthetics that take into account the effect of source rupture. The cross-correlation between U(t) and the observed data D(t) provides the absolute travel time residual dt relative to the PREM. This automated processing yields ~1.09 million dt for Pdiff and ~1.11 million dt measurements for SHdiff waves that satisfy the threshold of cross-correlation coefficient > 0.8 and signal-to-noise ratio > 7. The peak-to-peak dt values are ± 16 s for Pdiff, and ±25 s for SHdiff waves, respectively. Compared to Pdiff, the distribution of dt of SHdiff waves exhibit a degree 2 pattern, with a strong, positive dt > 10 s concentrated in the LLSVP (Large Low Shear-Velocity Provinces) beneath Africa, the south Indian Ocean, and the central Pacific.

Keywords: lowermost mantle, core-diffracted waves