Sharpness of the hemispherical boundary in the inner core beneath the northern Pacific

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The hemispherical heterogeneity in the topmost of the Earth’s inner core, faster velocity and higher attenuation in the eastern hemisphere and slower velocity and weaker attenuation in the western hemisphere, has been revealed by seismological studies. However, how the transition structure between two hemispheres looks like has not been known because of the difficulty to analyze complex core-sensitive data and the limitation of earthquake and seismic array distribution. In this study, we apply the array-based waveform inversion (Iritani et al., 2014) to core phase data that propagate beneath the northern Pacific, and investigate the nature of the transition structure in this region.Dataset used in this study consists of two directional event-station pairs, seismograms observed by the permanent European stations for events at Fiji-Tonga region, and USArray for events near Indonesia. We analyze the broadband vertical component of core phase data containing PKIKP and PKP phases (i.e. the epicentral distance between 145 –155 degree). Resultant analyzed waveforms for EU stations and USArray are 2,108 and 1,172 traces respectively.
In the analysis, waveform inversion approach is employed for each event data to measure traveltime and attenuation in the inner core. As a result, traveltime anomalies observed by EU stations show obvious positive anomaly suggesting mainly propagating the eastern hemisphere, while traveltimes observed by USAray show relatively smaller (or no) anomalies suggesting effects from both of hemispheres. On the other hand, attenuation parameters for both arrays show similar trend that suggests high attenuation corresponding to the eastern hemisphere. To investigate a hemispherical transition boundary in the sampled region, we conduct a ray theory based forward modeling of traveltimes by changing a shape of boundary from meridian boundary to eyeball shaped boundary, and its position. We compute root-mean-square (RMS) of residual between observations and theoretical traveltimes computed with each boundary model. Then, an eyeball shaped boundary, that is located at longitude of 158°W on the equatorial line and latitude of 80°N at the northernmost point, obtained as the preferred boundary model. Finally, we investigate a sharpness of the boundary by varying a width of hemispherical transition. We assume linear variation from the eastern and western hemisphere in a given width and compute RMS. As a result, a width of 600 km at the surface of the inner core shows smaller RMS than sharp boundary. Geophysical significance of this finding will be further discussed.

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