

Fine seismic velocity structure of the lowermost outer core determined using outer core sensitive phases

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The liquid outer core of the Earth is regarded as homogeneous and approximately in hydrostatic equilibrium [Stevenson, 1987]. However, a low-velocity layer appears at the base of the outer core (F-layer) [Souriau and Poupinet, 1991; Kennett et al., 1995]. This basal layer may exhibit hemispherical features, as reported by Yu et al. [2005], corresponding to the quasi-hemispherical pattern of the inner core [Tanaka and Hamaguchi, 1997; Wen and Niu, 2002]. The pattern of the inner core is suggested to reflect solidification and melting at the inner core boundary (ICB), which might cause an Fe-rich or Fe-poor layer in the F-layer [Gubbins et al., 2008; Alboussiere et al., 2010; Monnereau et al., 2010]. However, the seismic profile of the F-layer is poorly revealed because of the non-uniqueness of the profiles investigated using previous methods and the interdependence of the F-layer velocity and other seismic properties of the Earth. Thus, a better constrained F-layer velocity is required before discussing its composition.

In this study, we investigated the velocity profile of the F-layer using two new methods: frequency dispersion of the traveltimes of waves that graze or are diffracted at the ICB, and differential traveltimes between waves reflected from the boundary and those that turn above the boundary. The first approach is sensitive to velocity gradients in the layer, while the second is sensitive to velocity excesses or deficits relative to a reference model for the layer; neither approach is sensitive to inner core properties or its radius. We analyzed seismograms of South American earthquakes observed using the Hi-net array [Okada et al., 2004] and the J-array network [J-Array Group, 1993] in Japan. The area investigated in the study is beneath the eastern Pacific, which is placed on the quasi-western hemisphere of the inner core.

Our results show that V_p values in the F-layer are intermediate between those of AK135 and PREM, and that the vertical velocity gradient is larger than that of AK135. Nearly constant velocities in the F-layer are not suited to observations.

Keywords: P-wave velocity in the lowermost outer core, F-layer, Traveltime dispersion of PKPbc, differential traveltimes between PKiKP and PKPbc