TRANSITION FROM ISOTROPIC UPPER INNER CORE TO ANISOTROPIC LOWER INNER CORE: THE IMPORTANCE OF ANISOTROPIC RAY TRACING

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Differential travel times of PKiKP - PKIKP indicate that in the western hemisphere the outermost inner core is isotropic, and slightly slower than global models such as PREM. On the other hand, observed travel-time residuals of PKP_{bc} - PKIKP and PKP_{ab} - PKIKP increase systematically from 1 to 6 s as a function of increasing ray turning depths for ray paths that are parallel to Earth’s spin axis (Figure 2). Rays perpendicular to the spin axis typically have slightly negative residuals. These observations suggest the outermost inner core is nearly isotropic and that strong anisotropy exists deeper in the inner core. We invert these times for models characterized by an outer isotropic layer and a deeper anisotropic layer separated by a transition zone with thickness varying from 0 to 150 km. Models determined by linear inversions using ray paths calculated from isotropic models can only adequately fit the observations if the isotropic layer is between 50 and 150 km thick (Figure 1). However, the strong gradients imposed by the anisotropic model force large deviations in ray paths, so a non-linear scheme with appropriate ray tracing is needed. Using anisotropic ray tracing we find that models with an isotropic layer ranging from 150 to 300 km thick all adequately fit the travel-time data. However, thick isotropic layers require correspondingly stronger anisotropy below. Finally, models with discontinuities and linear gradients up to 150 km thick cannot be distinguished by travel times alone.