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Constraints on Inner Core anisotropy from P′P′ array-based observations

Daniel Frost and Barbara Romanowicz
United States (dafrost@berkeley.edu)

Seismic analysis of the inner core has revealed complicated physical properties. Seismic wavespeeds are observed to be anisotropic, with the fast axis oriented roughly parallel to the rotation axis. Further analysis reveals hemispherical and radial variations in seismic velocity anisotropy. Most previous studies of inner core structure have employed the wave PKIKP that samples the inner core, and referenced measurements to PKP "branches" which sample only the outer core. However, high-resolution study of the inner core with body waves is significantly limited by the paucity of appropriate "polar" ray paths that sample the inner core along the fast axis of the anisotropy. Consequently, there is disagreement over the magnitude of the anisotropy, its spatial variation, and the influence of mantle structure on inner core observations that requires further data to assess.

We present analysis of the PKIKPPKIKP wave, also written P′P′, and its branches observed at small aperture, high-latitude seismic arrays. The wave travels through the core and up to the surface as a PKIKP wave, and then reflects from the underside of the surface, back onto a second PKIKP path, thus twice samples inner core structure. We analyse paths through the core inaccessible to PKP studies. We use arrays to amplify this strongly attenuated phase relative to the noise level and distinguish it from contaminating waves. A previous study based on a limited amount of data had shown much smaller P′P′ travel time anomalies on polar paths than expected from previously derived models. We expand on past P′P′ studies with over 100 observations from two new seismic arrays sampling many new polar paths that are complementary to those sampled in previous PKP studies in an attempt to further constrain the strength of inner-core anisotropy. Here, we also evaluate possible contamination of P′P′ travel times by 3D mantle structure based on available models.