Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

SIT036-P02 Room: Convention Hall Time: May 24 17:15-18:45

Antipodal Observations of Earth's Core

Rhett Butler[1], Seiji Tsuboi[2*]

[1]The IRIS Consortium, [2]JAMSTEC

At the antipode of an earthquake, Earth acts like a nearly spherical lens focusing seismic energy through an axis-symmetric region about the diameter between the earthquake and its antipode. Antipodal data are rare, and the successes of the international community in openly sharing data have greatly benefited this study. Antipodal seismic observations are reviewed for three diametral axes through the Core, where the seismic energy between PKIKP and PKP-AB broadly samples the Inner Core and lowermost Outer Core. The data set contains several station-event pairs (delta >179 degree), including Algeria- Tonga (A-axis), Brazil-Indonesia (B-axis), and China-Chile (C-axis). The antipodal waveform data for the C-axis differ substantially from data for the A- and B-axes. Waveforms accurate to periods as short as 3.5 sec have been modeled by the 3D spectral element method using a PREM Core, the GAP-P1 3D P-wave model for the Mantle, and BASIN2.0 Crust. The C-axis antipodal observations may be approximately fit using the relatively simple PREM Core. However, the A-axis antipodal observations include large amplitude arrivals (some larger than PKIKP) that do not match the synthetic waveforms: precursory to PKIIKP, at PKIIKP (+PKIIIKP...) and PKP-Cdiff, and following PKP-Cdiff. Two pairs of earthquake doublets - each pair with good signal-to-noise characteristics and highly correlated waveforms - corroborate the observations for the A-axis. The B-axis observation is more akin to the A-axis than C-axis data. The observed variability of the waveforms indicates global variations in the structure above and below the Inner Core boundary region. Antipodal seismic phases observed between PKP- Cdiff and PKP-AB may indicate systematic scattering from the base of the Mantle due to heretofore unknown, high-velocity structures, or from a low-velocity zone at the base of the Outer Core. The correspondence of features of wave propagation both within and outside the Inner Core evince a connection between processes in the respective regions. For the A-axis, antipodal earthquake doublets that occur nearly 9 years apart at nearly 180 degree are observed with remarkably similar waveforms, except for the phase arriving near the time of PKIIKP. The focused antipodal broadband phase near the time of PKIIKP arrives about 0.5 sec later for the second event 9 years later. Measuring P-wave timing between the events at other stations, it is difficult to ascribe the temporal change of "PKIIKP" to relative earthquake location. As the A-axis lies within 25 degree of the equator, anisotropy associated with paths near the polar axis of the Inner Core may not contribute. Since antipodal PKIIKP averages over a substantial surface (about 60%) of the top of the Inner Core, it is not clear if or how Inner Core rotation could contribute to this temporal change. Given the Fresnel zone for a wavelength of over 50 km, a small velocity decrease over the nine-year interval in the uppermost Inner Core could explain the temporal shift, but it is not clear what would be the mechanism for such a change.

Keywords: Earth's core, Antipodal observation, Inner core, Earth Simulator