HEMISPHERICITY AND REGIONAL SEISMIC ANISOTROPY IN THE TOP 80 KM OF THE EARTH’S INNER CORE

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The IRIS Consortium has been providing freely available, high-quality broadband seismic data to the scientific community. The IRIS high-quality broadband data have led to many discoveries of unique features of the Earth’s inner core. The global coverage of the Global Seismographic Network (GSN) and dense coverage of many regional seismic networks have revealed the hemispherical variations in seismic velocity and attenuation and regional seismic anisotropy in velocity in the top 80 km of the Earth’s inner core (Niu and Wen, 2001; Wen and Niu, 2002; and Figure). Information from seismograms, such as the arrival time and the wave shape of the seismic waves transmitted through the inner core (PKIKP), allows seismologists to study velocity and attenuation structures of the inner core. The observed PKiKP-PKIKP differential travel times exhibit a distinct east-west hemispherical pattern with the PKIKP waves sampling the eastern hemisphere being about 0.7 s larger than the western hemisphere (Niu and Wen, 2001; Wen and Niu, 2002; and Figure). The above observations indicate that the east-west hemispherical variations in velocity with the eastern hemisphere being about 0.8%-1.3% higher than that in the western hemisphere. The observed amplitude ratios of the PKIKP/PKiKP show a similar pattern, but with those sampling the high-velocity eastern hemisphere having smaller amplitude ratios. The observed amplitude ratios indicate that the eastern hemisphere has higher attenuation. Recently, we also examine the PKiKP-PKIKP phases sampling the inner core globally and along various directions recorded in the GSN and many regional seismic networks (Yu and Wen, 2005). The PKiKP-PKIKP differential travel times do not show polar-equatorial anisotropy in most regions in the top 80 km of the inner core (Figure). However, in a localized region beneath Africa, the PKiKP-PKIKP differential travel times exhibit anisotropy in velocity with the velocity along the polar direction being about 1.3%-1.8% higher than that along the equatorial direction (Figure). The hemispherical variations in seismic velocity and attenuation and the presence of anisotropy in velocity in a localized region in the top 80 km of the inner core may shed light on the dynamics of the inner core and possible mechanisms on the inner core formation.

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Map view of the PKiKP-PKIKP differential travel time residuals relative to PREM displayed as PKIKP ray segments in the inner core and symbols at their turning points. Circles and triangles indicate negative and positive differential travel time residuals. The differential travel time residuals along the polar (equatorial) paths are indicated by color (black) symbols. The size of the symbols is proportional to the magnitude of the differential travel time residuals. It is evident that the differential travel time residuals show a distinct east-west hemispherical variation in velocity and a localized anisotropy in velocity beneath Africa. Ray paths of the PKiKP and PKIKP are shown in the inset.