Geophysical Research Abstracts
Vol. 13, EGU2011-5442, 2011
EGU General Assembly 2011

Observational evidence for cylindrical anomaly of seismic velocity in the Earth's outer core

Dmitry Krasnoshchekov, Vladimir Ovtchinnikov, and Petr Kaazik
Institute of Dynamics of Geospheres, Russian Academy of Sciences, Moscow, Russian Federation (krasnd@idg.chph.ras.ru)

Division of the rotating liquid outer core into two domains with different dynamical regimes by an imaginary cylinder tangent to the inner core boundary and coaxial with the rotation axis has been an acceptable but hard to observe feature of the Earth's outer core. The resulting two outer core regions are assumed to have different convective motions reflecting transportation of heat and compositionally buoyant elements from the inner core boundary to mantle. The relevant numerical models and data analyses predict mostly columnar convection outside the cylinder and reveal complex helical motions insides. This pattern leads to separation of mixing domains and excess of light elements within the cylinder, which results in density and body-wave velocity variations across the cylinder boundary. On one hand, this outer core's feature is predicted by geodynamo simulations and can be invoked to account for anomalous splitting of the 3S2 normal mode still not fully explained by the inner core anisotropy. On the other hand, density variations in the bulk outer core can be subject to a number of restrictions requiring sometimes almost zero changes, for example, to support polar vortex. Furthermore, despite pretty distinct description provided by geodynamo studies, the outer core tangent cylinder has never been backed by substantial seismological observations, especially if compared to anisotropy of the inner core – another key feature of the Earth's core generally accepted in geophysics. Here we present direct measurements of tangent cylinder effects by estimating PKP differential travel times at polar paths below Africa and Australia. Our database includes more than 150 records of events from South Sandwich Islands, Novaya Zemlya and Kamchatka region recorded by NRIL, SNA, NVL and SYO stations. The relevant seismic ray angles with the Earth's rotation axis in the core is between 6 and 26 degrees. We show the PKP differential travel time residuals with respect to ak135 depend on the ray angle with the Earth's rotation axis, and in a narrow range of angles where PKP(DF) and PKP(BC) waves are differently influenced by tangent cylinder, the measured residuals produce the specific form of dependence on the ray angle predicted by the model with an outer core tangent cylinder of the radius of 1375 km. The observed specific form of dependence on the ray angle is reconciled by the models with 0.4 – 0.8% P-wave velocity anomaly in the cylindrical region of the outer core. Furthermore, introduction of the outer core tangent cylinder is capable of producing the whole dependence of PKP differential travel time residuals on ray angle commonly attributable to anisotropy in the inner core. This shows the impact of the outer core tangent cylinder in widely measured PKP differential travel time residuals can be significant or even fully replace the one generally thought to be due to anisotropy of the Earth's inner core.