EGU22-3339
https://doi.org/10.5194/egusphere-egu22-3339
EGU General Assembly 2022

Evidence for Anisotropy in the Innermost Inner Core from the Earthquake Coda-correlation Wavefield

Thuany Costa de Lima[1], Hrvoje Tkalčić[1], and Lauren Waszek[2,3]
[1]Research School of Earth Sciences, The Australian National University, Canberra, ACT, 2601, Australia
[2]Physical Sciences, James Cook University, Douglas, QLD, 4811, Australia
[3]Department of Physics, New Mexico State University, Las Cruces, NM, 88003, United States of America

Progress on seismic imaging of the Earth's inner core (IC) is fairly limited by the uneven distribution of sources and receivers; large earthquakes are primarily confined to plate margins, and seismic stations are unevenly deployed on the Earth's surface. Advances in data processing techniques and new methods are required to bridge new opportunities to probe the centre of our planet and provide us with valuable information on the IC seismic structure and its surrounding dynamics. In this study, we present a newly-developed method based on the global earthquake coda-correlation wavefield to investigate the anisotropic structure of the IC. Anisotropy in seismic velocity is the directional dependence of seismic waves. Under IC pressure and temperature conditions, different phases of iron – the core's main mineral constituent can stabilize and form elastic anisotropy. Thus, improved constraints on its strength and distribution are required to understand the crystallographic structure of iron in the IC, which is linked to the evolution of its solidification and deformation processes. Here, we stack the cross-correlation functions of the late-coda seismic wavefield (the correlation wavefield) that reverberates within the Earth up to 10 hours after large earthquakes. We analyse the travel times of the I2* correlation feature, a mathematical manifestation of similarity among IC seismic phases with the same slowness detected in global correlograms at small interstation distances (<10°). The I2* spatial sampling offers an unprecedented data coverage of the IC's central portion, also known as the innermost IC (IMIC), which overcomes the shortage of the traditional approach using PKIKP ray paths sampling. By comparing the time residuals of different paths of I2* propagating through the IC, we confirm the presence of a deep IC structure with anisotropy fundamentally different from the IC's outer layers. Our observations support an IMIC cylindrical anisotropy model with a slow direction oriented 55° from the Earth's spin axis. This new evidence reinforces previous inferences on the existence of the IMIC, with implications for our understanding of the core's geodynamical evolution. In the future, a similar approach could be applied to advance our understanding of anisotropy in the Earth's mantle.