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Toward attenuation tomography of the uppermost inner core from PKP waves

Tanja Pejić and Hrvoje Tkalčić
Australian National University, Research School of Earth Sciences, Canberra, Australia (tanja.pejic@anu.edu.au)

It is well accepted that the inner core solidifies from the outer core but the details of this process are still largely unclear. The solidification however shapes the texture of the core and determines the type and nature of seismic wave interaction and attenuation. Various seismic studies point to a hemispherical heterogeneity in attenuation within the inner core and correlation with isotropic velocity pattern, but several recent studies have pointed out that the lateral pattern of attenuation might be more complex than purely hemispherical. In terms of radial dependence, the details of attenuation profiles vary significantly across these studies. Some earlier results suggest that the attenuation decreases from the inner core boundary towards the centre of the core, however the depth dependency is not well resolved. Other studies point to a slight increase in attenuation in the eastern hemisphere just below the inner core boundary, a phenomenon not observed in the western hemisphere. Most studies however agree that attenuation decreases with depth even though the thickness of hemispherical layers for attenuation structure varies between these studies.

There are many interpretations to hemispherical heterogeneity within the inner core consistent with both melting, melt inclusions and various rates of solidification in either hemisphere, especially so when addressing the positive correlation between seismic velocities and attenuation. With our attenuation tomography we aim to contribute resolving some of these ongoing debates and explain the results in the context of recently proposed dynamical models of the inner core. We collected over 400 high-quality PKIKP waveform measurements from globally distributed seismic events. These measurements are directly proportional to attenuation. We invert for the logarithm of attenuation assuming that the parameters of the model are randomly distributed. This allows us to pose the problem in a Bayesian framework. The results are hence intrinsically non-negative and their posterior distribution is log-normal. The inversion does become non-linear and the most probable solution can be found using iterative methods. We study this approach on synthetic and real data approximating the uppermost inner core as one or two layers. In the latter, we divide the uppermost inner core into two layers: one between 150 and 230 km below the inner core boundary and the other between 200 and 400 km below the inner core boundary. Preliminary results so far point to a larger attenuation below the Pacific region and in the deeper layer, which may be pointing to more complex solidification processes.