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Constraints on small-scale heterogeneity in Earth's inner core determined from transmitted P waves

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Scattered waves composing the coda of the PKiKP wave, reflected by the boundary of Earth's inner core at pre-critical range, reveal the existence of small-scale heterogeneity in the uppermost inner core. Since the shape this coda envelope is relatively insensitive to intrinsic viscoelastic attenuation, seismograms synthesized using the Axisem code (Nissen-Meyer, 2014) are exploited to determine whether heterogeneity spectra consistent with the coda envelope of PKiKP can contribute to the attenuation observed in long range PKIKP waves transmitted through the deeper inner core. Peng et al. (2008) have shown that a range of possible parameters describing an exponential autocorrelation of small-scale heterogeneity can fit observed PKiKP coda envelopes, with the rms P velocity fluctuation trading off against the corner scale length parameter "a" of the heterogeneity spectrum. Testing the effects of a series of "a's" and velocity fluctuations that fit PKIKP coda envelopes we determined upper bounds to “a” and the rms P velocity fluctuation below 300 km depth in the inner core. Parameter combinations of “a” > 2 km and rms dVp/Vp > 2% can be eliminated from consideration because they produce too strong a coda following PKIKP. In the antipodal range (178^o to 180^o) we found that there exists a strong focusing of multiply scattered waves affecting the pulse width and coda of PKIKP. The parameter combination "a"= 2 km and rms=1.2% produces a strong PKIKP coda, which is not observed in antipodal data. This, coupled with the fact that Axisem ignores out-of-plane scattering, suggests that the attenuation of PKIKP observed beyond 160^o is dominated by viscoelastic rather than scattering attenuation and that the rms P velocity fluctuation must decrease by at least a factor of 2 below 300 km to be consistent with the coda of antipodal PKIKP waves.

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