



## The Earth's Correlation Wavefield: Proof of Concept, Origin and Applications

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We have recently shown that all features in the earthquake-coda correlogram can be explained by the similarity of seismic phases that have a common slowness for the analysed receiver pair. This includes both the features that have their equivalents in the conventional travelttime stacks, but also those that were previously unexplained. Consequently, the information contained in the correlograms – cross-correlated ground-motion time-series in a two-dimensional representation – can be used to constrain Earth's internal structure, however, that requires a proof of concept and further investigation into the origin of the correlation wavefield. We thus first decompose relevant correlogram features into discrete constituents with respect to their arrival times and we uniquely identify contributing seismic phases to each constituent. This confirms that the correlation wavefield does not arise due to the reconstruction of body waves between the two receivers (a.k.a. Green's function) – instead, it is dominated by the interaction of various body waves, and its features are characterised by complex sensitivity kernels.

We demonstrate that the event locations relative to the receivers alter the similarities between the body waves, and may result in significant waveform distortions and inaccuracies in arrival-time predictions. We further show that the nature of source-mechanism and energy-release dynamics are the key influencers responsible for individual correlograms equal in quality to a stack of hundreds of correlograms. In other words, a single seismic event that meets a set of criteria in the presence of multiple receivers can completely 'illuminate' the Earth's interior. Quantitative kernel-decomposition and identification of body-wave pairs that contribute to a given feature in the correlogram, along with informed choices of seismic events, thus makes the correlation-wavefield tomography and other applications fully feasible. This has the potential to change the course of global seismology in the coming decades.