Global-, teleseismic- and regional-scale Green's function retrieval: on the sampling of the surface integral

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Seismic Green's function retrieval or seismic interferometry (SI) refers to the principle of generating new seismic responses by crosscorrelating seismic observations at different receiver locations. SI can be applied independently of the scale and wavetype under consideration. We consider the application of SI with natural transient seismic sources. In this case, 3D SI consists of a surface integration of correlations over source positions. The quality of the retrieved Green's function between two receiver locations depends largely on how well this surface integral is sampled.

For an arbitrary inhomogeneous medium, the source sampling needs to satisfy the Nyquist criterion. In many situations, the natural distribution of primary sources, e.g., earthquakes, is not such that this sampling criterion is reached. Fortunately, it does not matter whether this sampling criterion is reached by actual or secondary (Huygens) sources. As has been stated in many papers, the more inhomogeneous the medium, which means more scattering, the better the SI retrieval of the Green's function. In the optimal case when an equipartitioned state is reached, only one source suffices. That is, the medium is so heterogeneous that -with one source only- the medium surrounding the receivers is already indirectly illuminated from all directions.

For a natural source distribution, the sampling of the integration surface will never be regular. The problem of integrating over an irregularly sampled surface has long been studied for the application of migration algorithms in exploration geophysics. Solutions found for migration, e.g., binning and triangulation weighing, can also be used for SI.

We show formulations for global-, teleseismic- and regional-scale SI. We determine the source sampling required for the different scales and media and evaluate how this source sampling can be reached in practice. Also, we evaluate the effects of an irregular sampling and show how its negative effects can be minimized.