TOWARDS A FULL WAVEFORM AMBIENT NOISE INVERSION

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Key words noise tomography, full waveform inversion, source imaging, adjoint techniques.

Noise tomography usually works under the assumption that the inter-station ambient noise correlation is equal to a scaled version of the Green function between the two receivers. This assumption, however, is only met under specific conditions, for instance, wavefield diffusivity and equipartitioning (e.g. [1], [2], [3]) or the isotropic distribution of both mono- and dipolar uncorrelated noise sources (e.g. [4], [5], [6]). These assumptions are typically not satisfied in the Earth. While attempts have been made to acknowledge heterogeneous noise source distributions (e.g. [7], [8]), the inconsistency between reality and theory inhibits the exploitation of the full waveform information contained in noise correlations regarding Earth structure and noise generation.
Realizing the need to go beyond the Green function principle and also its feasibility with current high-performance computing resources, we attempt to develop a method that consistently accounts for noise distribution, 3D heterogeneous Earth structure and the full seismic wave propagation physics. By this we intend to improve the current resolution of tomographic images of the Earth and to geographically map noise sources, thereby contributing to a better understanding of the generation of noise.

As an initial step towards a full waveform ambient noise inversion we develop a preliminary inversion scheme based on a 2D finite-difference code simulating correlation functions and on adjoint techniques. While the corresponding theory is mostly derived in the frequency domain (e.g. [9], [10]), time domain implementations of the seismic wave equation are widely used and further optimized in the seismology community. For future inversions using these codes, we present an efficient way to calculate kernels for the distribution of noise and for Earth structure in the time domain.
With respect to our final goal, a simultaneous inversion for noise distribution and Earth structure, we address the following two aspects:

1. The capabilities of different misfit functionals to image wave speed anomalies and source distribution.
2. Possible source-structure trade-offs, especially to what extent unresolvable structure could be mapped into the inverted noise source distribution and vice versa.

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