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Global-scale full-waveform ambient noise inversion applied to Earth's Hum

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We develop and apply a novel full-waveform ambient noise inversion that jointly constrains 3D Earth structure and heterogeneous noise sources. The fundamental idea is to drop the principle of Green's function retrieval, which is the basis for current noise tomographic studies, and to establish correlation functions as self-consistent observables in seismology. Our method is valid for arbitrary noise source distributions in both space and frequency, and it accounts for the complete seismic wave propagation physics in 3D heterogeneous and attenuating media. Extracting waveform information from correlation functions allows us to improve the resolution of ambient noise tomography and to refine noise source location, which is essential for a better understanding of noise generation.

The forward problem of modeling correlation functions and the computation of sensitivity kernels for noise sources and Earth structure are implemented based on the spectral-element solver Salvus. As a first application, we consider a global dataset focusing on the Earth's hum period band and invert for both the distribution of noise sources and Earth structure. In order to validate our approach, we assess the quality of the obtained tomographic model with an independent dataset comprised of earthquake recordings.

The successful application of full waveform ambient noise inversion opens new possibilities in tomographic imaging due to the continuous and ubiquitous nature of ambient noise sources.