EGU2020-5408, updated on 24 Oct 2020
https://doi.org/10.5194/egusphere-egu2020-5408
EGU General Assembly 2020

Simulation of seismic wave scattering for the computation of probabilistic coda-wave sensitivity kernels

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Scattered seismic coda waves are frequently used to characterize small scale medium heterogeneities, intrinsic attenuation or temporal changes of wave velocity. Spatial variability of these properties raises questions about the spatial sensitivity of seismic coda waves. Especially the continuous monitoring of medium perturbations using ambient seismic noise led to a demand for approaches to image perturbations observed with coda waves. An efficient approach to localize the property variations in the medium is to invert the observations from different source-receiver combinations and different lapse times in the coda for the location of the perturbations. The key of such an inversion is calculating the coda-wave sensitivity kernels which describe the connection between observations and the perturbation. Most discussions of sensitivity kernels use the acoustic approximation and assume wave propagation in the diffusion regime.

We model 2-D elastic multiple nonisotropic scattering in a random medium with spatially variable heterogeneity and attenuation. The Monte Carlo method is used to numerically solve the radiative transfer equation that describes the wave scattering process here. Recording of the specific intensity of the wavefield ***I*(*r*,*n*,*t*)** which contains the complete information about the energy at position ***r*** at time *t* with the propagation direction ***n*** allows us to calculate sensitivity kernels according to rigorous theoretical derivations. We investigate sensitivity kernels that describe the relationships between changes of the model parameters P- and S-wave velocity, P- and S-wave attenuation, and the strength of fluctuation on the one hand and the observables envelope amplitude, travel time changes and decorrelation on the other hand. These sensitivity kernels reflect the effect of the spatial variations of medium properties on wavefield. Our work offers a direct approach to compute these new expressions and adapt them to spatially variable heterogeneities. The sensitivity kernels we derived are the first step in the development of an inversion approach based on coda waves.