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Sensitivity of coda waves to lateral variations of absorption and scattering

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We investigate the impact of lateral variations of absorption and scattering properties on the energy envelopes of coda waves. To model the spatio-temporal distribution of seismic energy, we employ a scalar version of the radiative transfer equation with spatially-dependent absorption and scattering quality factor. The scattering pattern which describes the angular distribution of energy upon scattering is assumed to be statistically isotropic, independent of position, but otherwise arbitrary. Further assuming that the lateral variations of the governing parameters are sufficiently weak, we employ perturbation theory to derive linearized relations between the absorption/scattering properties of the medium and the intensity detected in the coda. These relations take the form of weighted integrals where so-called scattering/absorption sensitivity kernels play the role of weighting function. The kernels depend on the type of perturbation (scattering or absorption) and the lapse time in the coda. As an illustration of the theory, we calculate the absorption and scattering sensitivity kernels in a 2-D isotropically scattering medium at different lapse times in the coda, and discuss their singularities in detail. The sensitivity kernels are then employed to calculate the relative intensity variations of the coda caused by a localized Gaussian absorption/scattering anomaly. We find that the dominant effect of absorption anomalies is to modify the decay rate of the coda, while scattering anomalies have a more complex signature.