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A method for the fast evaluation of the coda energy density time integral for multiple isotropic scattering

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Total seismic wave attenuation in the Earth is caused by two major factors: scattering by the redistribution of energy that occurs when seismic waves interact with the heterogeneities of the medium and intrinsic absorption due to anelasticity. Multiple scattering models have been proposed to relate scattering with coda wave amplitudes and to separately estimate intrinsic absorption (which reduces the direct and coda waves' amplitudes with propagation distance) and scattering (which reduces and enlarges the direct and coda waves' amplitudes, respectively). Higher order solutions of the multiple scattering model under the assumptions of multiple isotropic scattering and uniform distribution of scatterers have been estimated both numerically and analytically. The Multiple Lapse Time Window Analysis is an effective method to separately estimate the intrinsic absorption and scattering loss. In this method, the integrated energy density over three consecutive time windows from the S-wave arrival time is evaluated as a function of source-receiver distance. Therefore, the observed energy density is compared with the predicted to obtain the estimated scattering and absorption coefficients.

The computation of the energy density from theoretical models based on multiple isotropic scattering involves the evaluation of time-consuming two-dimensional integrals or else to compute simulations based on the Monte Carlo method, which is also time-consuming. The computation of the time integral implies to carry out a three-dimensional integral, which is an extremely slow process. The aim of this study is to develop a simple procedure for the computation of those time integrals, reducing a slow three-dimensional integration process into a fast and accurate one-dimensional integral. To achieve this reduction in the dimensionality of the integrals we use a simple and accurate approximation previously developed to evaluate the solution of the time-dependent Boltzmann equation. This approximation only involves the computa-

tion of an algebraic expression, which implies a computation time orders of magnitude smaller than the evaluation of a two-dimensional integral.