Multiple scattering by discrete random media of Rayleigh scatterers using first-order incoherent interactions

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We consider scattering of electromagnetic waves by a finite discrete random medium composed of spherical particles. The size of the random medium can range from microscopic sizes of a few wavelengths to macroscopic sizes approaching infinity. The size of the particle is here assumed to be much smaller than the wavelength. Thus, the single scattering characteristics are those of electric-dipole or Rayleigh scatterers.

We have recently extended the numerical Monte Carlo method of radiative transfer and coherent backscattering (RT-CB) to the case of dense packing of particles using ensemble-averaged first-order incoherent interactions among volume elements (K. Muinonen et al., Radio Science, submitted, 2017; J. Markkanen et al., this meeting). We have shown that the dense-medium RT-CB results for discrete random media of wavelength-scale spherical particles compare favorably to the asymptotically exact results computed using the Superposition *T*-matrix method.

Here we adopt the first-order incoherent extinction, scattering, and absorption characteristics of a volume element of Rayleigh scatterers as input for the RT-CB. The volume element must be larger than the wavelength but smaller than the mean free path length of incoherent extinction. In the radiative transfer part, at each absorption and scattering process, we account for absorption with the help of the single-scattering albedo and peel off the Stokes parameters of radiation emerging from the medium in predefined scattering angles. We then generate a new scattering direction using the joint probability density for the local polar and azimuthal scattering angles. In the coherent backscattering part, we utilize amplitude scattering matrices along the radiative-transfer path and the reciprocal path, and utilize the reciprocity of electromagnetic waves to verify the computation. We illustrate the incoherent volume-element scattering characteristics and compare the RT-CB with incoherent interactions to the conventional RT-CB solution with individual Rayleigh scatterers as elementary scatterers.