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EVALUATION OF THE ONSET OF DEPENDENT SCATTERING IN SPHERICAL PARTICULATE MEDIUM USING SUPERPOSITION T-MATRIX METHOD

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ABSTRACT. Estimating the radiant energy transfer through a particulate medium requires considering absorption, emission, and scattering by the medium through the solution of the radiative transfer equation. The independent scattering assumption is commonly used to predict the scattering and absorption coefficients of the particulate medium. This assumption relies on the superposition of the corresponding cross-sections of independent particles, which is applicable at low particle concentrations where randomly distributed particles are well-separated from each other with respect to the incident wavelength. A well-established scattering regime map is used to identify if independent scattering is applicable or not. However, recent studies have shown that the validity of this regime map in certain regions might be erroneous. Here, we revisit the scattering regime map by considering the full electromagnetic solution of light scattering by particle clouds that represent ergodic media. The existence of boundary enclosing the dense medium and free-space leads to an overestimation of the scattering coefficient, which is further enhanced when particles with smaller size parameters and a denser medium are considered. It is possible to deduce the scattering contribution of the boundary from the total scattered field using the recently developed Incoherent Volume Element Generation method. The scattering regime map is revisited using a greater number of particles than previous studies, leading to a more accurate representation of the medium. Moreover, the scattering regime map does not consider the effect of particle refractive index on the onset of independent scattering. We consider particles with low to high refractive indices to identify the effect of the refractive index on the onset of dependent scattering.

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