Ray optics for absorbing particles with application to NIR scattering by ice crystals

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Light scattering by particles large compared to the wavelength of incident light is traditionally solved using ray optics which considers absorption inside the particle approximately. To study the effects rising from this simplification, we have updated the ray-optics code SIRIS [1–3] to take into account the propagation of light as inhomogeneous plane waves inside an absorbing particle following the methodology presented in [4]. We investigate the impact of this correction on traditional ray-optics computations in the example case of light scattering by ice crystals through the extended near-infrared (NIR) wavelength regime, where the refractive index of ice has a high spectral dependence.

We show that the correction for inhomogeneous waves systematically increases the single-scattering albedo throughout the NIR spectrum for both randomly-oriented, column-like hexagonal crystals and ice crystals shaped like Gaussian random spheres. We also present results for the scattering-matrix elements that show generally minor differences. We evaluate the correction for inhomogeneous waves through comparisons against the discrete exterior calculus (DEC) method [5], and our comparisons at two NIR wavelengths agree that the consideration of the inhomogeneous waves brings the ray-optics solution generally closer to the exact result.

References

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