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Development of new modeling capabilities to simulate the optical properties of atmospheric particles

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Many atmospheric particles (e.g., dust aerosols, soot particles, and ice crystals within cirrus clouds) have nonspherical shapes that pose a significant challenge for accurately computing the optical properties of these particles. In this talk, we present a new physical-geometrical optics hybrid method to compute the single-scattering properties of convex dielectric particles in the case of moderate and large size parameters. The new model is readily applicable to the electromagnetic scattering by dielectric particles with specific orientations. We will also present some improvements on the application of the T-matrix method. For practical applications to remote sensing and radiative transfer simulations involving ice crystals, we will present a spectrally consistent database of the optical properties of ice crystals in the spectral range from 0.2 to 100 μm based on a combination of discrete-dipole-approximation method, T-matrix method and the improved geometric-optics method (IGOM). Electromagnetic tunneling effect is incorporated into the extinction and the absorption efficiencies computed from the IGOM. 11 ice habits (droxtal, prolate spheroid, oblate spheroid, column, hollow column, aggregate of 8 columns, plate, aggregate of 5 plates, aggregate of 10 plates, solid bullet rosette, and hollow bullet rosette) with the maximum dimension ranging from 2 to 10,000 μm are defined to model ice particles in ice clouds. For each ice habit, three roughness conditions (i.e. smooth surface, moderate surface roughness, and severe surface roughness) are considered to take into account the surface texture of large particles. The database contains ice crystal's extinction cross section, single-scattering albedo, six independent non-zero elements of the phase matrix, projected area, and volume. The datasets may be useful for remote sensing applications and radiative transfer simulations involving ice clouds. Furthermore, we will demonstrate some downstream applications of the newly developed modeling capabilities and datasets.