Advances in single- and multiple-scattering simulation capabilities in support of polarimetric remote sensing of the atmosphere and oceans

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We present recent advances in simulating single and multiple scattering occurring in the atmosphere and oceans. The accurate and efficient modeling capabilities may find applications to polarimetric remote sensing of atmospheric and oceanic constituents, particularly ice cloud particles, dust aerosols, and aquatic particles. A synergistic combination of the invariant imbedding T-matrix (IITM) method and the physical-geometric optics method (PGOM) is used to compute the single-scattering properties, namely the extinction efficiency, single-scattering albedo, and scattering phase matrix, of the aforesaid nonspherical particles in the entire practical size parameter range. A two-component vector radiative transfer model (TAMU-VRTM) is developed to simulate the Stokes parameters observed at the top of the atmosphere, the surface, or just above/below the sea surface. The TAMU-VRTM combines the small-angle approximation and adding-doubling techniques, which significantly improves the computation efficiency while computational accuracy is not degraded. The gaseous absorption in the atmosphere is accounted for through a regression method that is more accurate and computationally efficient than the correlated-k distribution method. The aforesaid modeling capabilities are validated by simulating Polarization and Directionality of the Earth's Reflectances (POLDER) data using Moderate Resolution Imaging Spectroradiometer (MODIS) and Modern-Era Retrospective Analysis for Research and Application Version 2 (MERRA-2) data.

Furthermore, the polarimetric backscattering signals associated with a single dust layer at wavelengths 532 and 1064 nm are simulated with a Monte Carlo lidar simulator, in conjunction with various bulk optical properties of dust aerosols based on the single-scattering property database, to demonstrate the sensitivity of polarimetric backscattering signals to dust optical properties. We also show the preliminary results of dust property retrievals based on spaceborne observations made by POLDER and Cloud-Aerosol Lidar with Orthogonal Polarization/Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIOP/CALIPSO) instruments.

Mode of presentation: Invited