Assessing superspheroidal dust models in particle scattering and polarized radiative transfer simulations

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As one of the major atmospheric aerosols, dust has important effect on the Earth's radiative energy budget and profoundly affects regional and global climate. Although tremendous efforts have been devoted to parameterizing dust optical properties, there has not been a standard and consistent approach to remote sensing and radiative transfer studies. In this presentation, we report on our recent progress made to improve dust optical modeling in a superspheroidal shape space. Superspheroids have one more freedom than spheroids. However, the additional freedom can be constrained by comparing theoretical simulations with laboratory measurements. In this study, the scattering matrices of 25 dust aerosol samples from the Amsterdam–Granada Light Scattering Database [1] were used. We found that 1) extreme aspect ratios for spheroids in reproducing the measurements were unnecessary if superspheroids were employed [2]; 2) even with equi-probable aspect ratio distribution, concave superspheroids with large roundness parameters (e.g., from 2.4 to 3.0) could concurrently match six nonzero scattering matrix elements from the laboratory measurements [2]; 3) superspheroidal models with constrained roundness parameter also exhibit better performances than spheroids in reproducing backscattering ratios that are critical in active Lidar remote sensing [3]. Additionally, to understand the impact of models in atmospheric radiative transfer, we carried out sensitivity studies on how the shape parameters (i.e., aspect ratio and roundness parameter) affect the TOA radiance and polarization simulations. By analyzing modeling results, the implications of applying superspheroidal dust models in polarized remote sensing will be discussed.

References

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