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Aerosol particle shape distribution observed by fluorescence microscope and its application in modeling light scattering by mixture spheroids

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Atmospheric aerosols have been recognized as one of the most uncertain factors directly affecting the radiation budget of the Earth-atmosphere system and indirectly impacting on both the regional and global climate. The uncertainty of knowledge of aerosol properties can be attributed to a number of difficulties in aerosol remote sensing. Light scattering by non-spherical particle such as mineral dust is commonly known as a major difficulty in aerosol characterization. Considering that particle morphology is of vital importance to how electromagnetic radiation is scattered by single particle and the shape distribution affects light scattering by volume particles, quantitative knowledge about various non-spherical aerosol shapes gets more and more attention in modeling the aerosol optical properties.

Natural atmospheric aerosol particles show a great variety of shapes. Thus, it is difficult to realistic model aerosol particle shape and shape distributions. Numerous studies indicate that polydisperse randomly oriented spheroids parameterized by different aspect ratios have a distinct advantage in simulating not only phase function but also other elements of the phase matrices of complex non-spherical aerosol particles. Modeling light scattering by varying the mixture spheroids' aspect ratio can cover a large range of different phase matrices, which makes it often possible to find the best-fit shape distribution of spheroids to matches the phase matrices of irregular non-spherical particles.

In this study, we also employ the model of polydisperse randomly oriented spheroids and use a fluorescence microscope to observe and measure distribution of the spheroid aspect ratios $dn/d\ln\varepsilon$. In the method, we first collect aerosol particle samples on the Teflon filter by the Total Suspended Particulate (TSP) sampler. The volume flow and time of collection are controlled according to aerosol particulate matter concentrations to make sure that the samples are not superimposed. Then, a microscope with green fluorescence is applied to obtain the image of aerosol particle samples. Next, the samples are automatically identified as different spheroids and the aspect ratio of spheroids are calculated in the image processing. Finally, we calculate the probability of different aspect ratio and obtain the shape distribution. The aerosol particle distribution based on measurements can be used in modeling light scattering to simulate more realistic optical properties of atmospheric aerosols. These efforts are expected to improve the retrievals of aerosol microphysical properties in future.