Aerosol Effective Radius Retrieval Based on Dual-wavelength Mie Scattering Lidar Measurement

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The effective radius, as an important parament of aerosols, is usually obtained directly by optical particle counter on the ground. The vertical profile of aerosol effective radius is rarely measured except using the balloon or aircraft platform. Multiwavelength Raman lidar provides a remote sensing method to retrieve the vertical distribution of aerosol microphysical parameters including the effective radius. However, the multiwavelength Raman lidar system is always complex and costs much. In this paper, the scheme of using two wavelengths with the assumption of Gamma size distribution of aerosol is proposed to retrieve the effective radius.

The ratios of two-wavelength aerosol optical parameters such as extinction coefficients, backscattering coefficients, and lidar ratio (extinction to backscattering ratio) are elaborately simulated using the Mie scattering theory and OPAC (Optical Properties of Aerosols and Clouds) packages. A linear relationship versus effective radius at its certain scope is found which means once the ratio of two-wavelength aerosol optical parameters is obtained, the aerosol effective radius can also be obtained straightforward using this linear relationship.

The Gamma size distribution of aerosol is selected for this study due to its mathematical advantage of integration form. The effective radius can be expressed in terms of its integral combination and is related to only two of the three parameters of Gamma distribution, while the remaining one does not affect neither the extinction nor the backscattering coefficients ratio calculations. Therefore, once Gamma distribution is assumed, the aerosol size distribution corresponding to the effective radius can be obtained.

The wavelengths of 355nm and 532nm and ten types of aerosols from OPAC package are selected to simulate the linear relationship of the ratios of two-wavelength aerosol optical parameters and the look-up tables are constructed. The urban-type aerosol is assumed to retrieve the effective radius vertical profile using the real dual-wavelength Mie scattering lidar measurement data. A lidar ratio iteration scheme is also applied to constrained the retrieval procedure. The results show the good feasibility of our above-proposed scheme which can be further used to study the aerosol vertical microphysical properties using a dual-wavelength Mie scattering lidar.