ABSTRACTS (MASTER THESIS)

Aerosol Size Distribution Determined from Multiple Filed-Of-View Lidar

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Atmospheric aerosols play a key role in climate, air quality, and public health. Knowledge of aerosol size distribution is essential for determining its optical properties, cloud condensation nucleus activity, and physical activity related to particle deposition patterns in human lungs. Optical remote sensing techniques such as lidar are effective for monitoring aerosols with high temporal and spatial variation. Aerosol instruments using light with UV, VIS, and near-IR wavelengths have been used to effectively detect particles with diameters comparable to their wavelength. However, to quantitatively estimate the particle size distribution, more information of small particles with sub-micrometer size and below is required.

Conventional lidars employ a very small field-of-view (FOV) for profiling aerosol distribution and simply detect single scattering in the direction opposite to incident light, while multiple scattered signals are also influenced by aerosols' size and distribution along the laser path. In this study, a multiple FOV lidar with laser wavelengths of 266 and 355nm was used for detecting multiple scattering effects, in order to obtain more quantitative information concerning small particle size distribution. Although shorter wavelengths can be used for obtaining information of smaller particles, they have not been used for aerosol measurement owing to the strong light absorption by atmospheric constituents such as ozone.

Numerical simulation and field experiments were performed to verify the proposed method utilizing wavelengths of 532 and 1064nm for single scattering and 266 or 355nm for multiple scattering. In the simulation and field experiments, the multiple-scattering lidar observations at both wavelengths of 266 and 355nm supported the feasibility of proposed method. However, the 266nm lidar performed better than the 355nm lidar in the particle diameter range below 100 nm. We also found that the 266nm lidar can be applied to measurements under low particle concentration due to stronger multiple scattering.

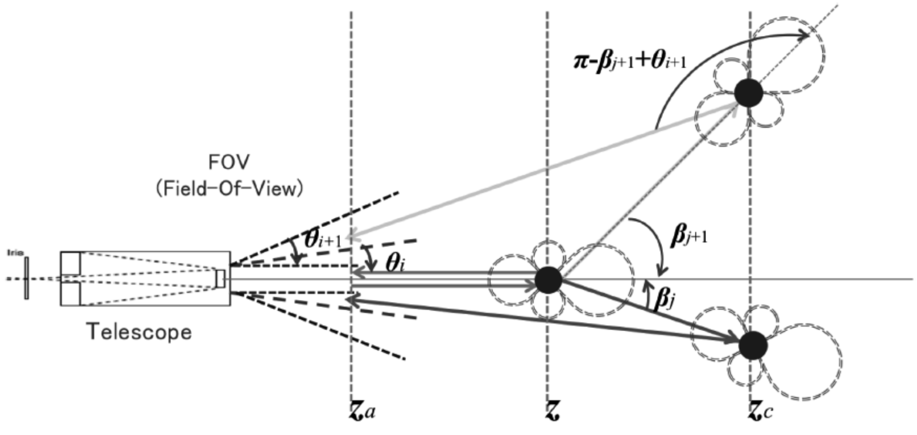

Figure 1. Schematic diagram of single scattering and multiple scattering in the lidar geometry. The straight arrows are the scattering events; the two pairs of dot lines indicate the limits of two receiver field of view that correspond to a narrow one for near-single-scattering detection and a wider one for multiple-scattering detection. Parameters of θ, z_c–z_a, and β are Field-Of-View(FOV), Aerosol layer thickness, and scattering angle, respectively.