Evaluation of Multiple Scattering in a Polarization Scheimpflug Lidar System

Satoru Takakura[1], **Yoshitaka Jin**[2], **Tomoaki Nishizawa**[2]

[1] *CASA/APS, University of Colorado, Boulder, CO 80309 (USA),*
E-mail: satoru.takakura-1@colorado.edu

[2] *ESD, NIES, Tsukuba, Ibaraki 305-8506 (Japan)*

The Scheimpflug lidar (SLidar) is a recently developed remote sensing technique. It consists of a continuous wave (CW) laser source and a separate receiver telescope with a slant viewing angle. An imaging camera on the receiver captures the trajectory of the near backscattering signal. Then, the attenuated backscattering profile is extracted from the image using the geometrical relation. Thanks to its simple components, SLidar can be built with a lower cost than a pulsed lidar system.

The SLidar is also a unique system to observe multiple-scattering signals for clouds or aerosols. If the divergence of the laser is sufficiently small and the receiver is well configured, the single scattering signals should be focused on a line in the image. On the other hand, multiple scattering signals appear around the first scattering points within the typical scattering angle dependent on the properties of the scattering particles. The multiple scattering signal is also captured in an image of the receiver camera.

We deployed a SLidar system at NIES in Tsukuba. The source is a DPSS laser with a maximum power of 1.5 W at the wavelength of 532 nm. The beam divergence is smaller than 1 mrad. The receiver is a Newtonian telescope with a focal length of 650 mm placed at 8.0 m from the source. A polarization camera with 2448 x 2048 pixels with 3.45 µm pitch is placed at the focus of the telescope with a tilt of the image plane by 4.6 degrees. With this configuration, we can observe altitudes above 620 m.

We performed several days of measurements with various sky conditions using our SLidar. We compared the SLidar measurements with another pulsed lidar system at NIES used for AD-Net and found consistent results in clear sky data in the night by setting calibration parameters appropriately. We also find some measurements with clouds show clear contribution of multiple scattering signals.

For more detailed analysis, we developed a numerical simulation for SLidar measurements including effects of multiple scattering and polarization. We set an atmospheric profile of extinction and polarized phase functions, and compute the image of the receiver camera using a Monte Carlo method. In the simulation, we find a characteristic pattern in polarization due to multiple scattering, which is also observed in actual SLidar measurements.

In the presentation, we will demonstrate our SLidar measurements and comparisons with the pulsed lidar system or the numerical simulation. We will also discuss the application of multiple scattering signals of SLidar measurements to evaluate cloud and aerosol properties.