

## Abstract

Depolarization lidar (light detection and ranging) measurements were performed for the first time using a coherent white light continuum light ranging from UV to IR regions. Firstly, the polarization properties of the white light generated in a 9-m-long gas cell with krypton gas were investigated with a terawatt femtosecond laser system. The white light polarization is the same as that of the linearly polarized original laser. These results have a significant effect on the use of a white light depolarization lidar. The main characteristics of the white light depolarization lidar system are presented in chapter 2, along with a description of the depolarization measurements at 450 nm. The lidar system consisted of a depolarization channel at 450 nm and the five-wavelength Mie scattering channels at 350, 450, 550, 700, and 800 nm. This first observation provided the necessary foundation for the multi-wavelength depolarization lidar.

For further investigation in chapter 3, the white light depolarization lidar system was developed to permit simultaneous measurement of depolarization ratios at 450, 550, and 800 nm. The results presented here provided the wavelength dependence to enable the multi-wavelength depolarization ratio to be used as a method to evaluate the size of the atmospheric aerosols without using conventional inversion algorithms. Moreover, the  $T$ -matrix computation of depolarization ratio supports the idea that the particle size can contribute significantly to the depolarization ratio.

In chapter 4, an observation of Asian dust aerosols was described for the first time using the white light depolarization lidar system. Lidar depolarization ratios of 0.30-0.70 at 800 nm were obtained. These data revealed a higher depolarization ratio than usual (normally almost zero) in the lower troposphere. Thus, white light lidar can identify the Asian dust particles that pose a threat to cross-border pollution in Japan.

A method for evaluating the number density of particles in atmospheric clouds is presented, based on depolarization measurement of backscattering and multiple scattering from ice clouds. The lidar we used in the observation is a three-wavelength (450, 550, and 800 nm) depolarization lidar with a variable receiving field-of-view (FOV). The wavelength dependence of multiply scattered lidar returns has made possible the retrieval of cloud droplet size and the particle size density distribution.

White light lidar is an efficient tool for remotely measuring the multi-wavelength

backscattered signal simultaneously, but the available wavelength is limited by the white light intensity. In chapter 7, a noise reduction based on wavelet transform was proposed to detect the weak signals buried in noises. Firstly, the raw data are decomposed by means of the wavelet transform, secondly, the wavelet coefficients are shrunk, and finally, the denoised signal is reconstructed from the processed wavelet coefficients through the inverse wavelet transform. This method can improve quality of the lidar signal by reducing the noise without affecting the original signal. It also allows the detection of backscattered signals from clouds which were buried in noise. The result of this study demonstrated that wavelet signal denoising could improve the detectable range of the white light lidar system.

Last chapter summarizes the obtained results and present the future prospects of this field. This study shows that the white light lidar system can be utilized as sensor widely for meteorological and environmental measurement.