ABSTRACTS (MASTER THESIS)

A study on an ultraviolet rotational Raman lidar for temperature profiling with a multispectral detector

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Temperature profiling in the atmosphere is essential in meteorological studies for understanding atmospheric processes. Rotational Raman (RR) lidar can be used to observe temperature based on the intensities of the lines within the RR band that exhibit different dependencies on temperature. In this study, we constructed a temperature lidar with a multispectral detector (MSD) using an ultraviolet (UV) laser. We validated the calibration methods of the lidar system and estimated the errors caused by the analytical methods and atmospheric conditions.

Two methods were investigated to correct the MSD efficiency of each channel: 1) comparison of lidar signals with temperature profiles of radiosonde to determine the calibration factors; 2) calibration of the MSD efficiency by standard calibration lamp technique. Our findings show that, although the calibration values of the radiosonde method were strongly affected by the detector wavelength resolution and laser wavelength, the values of the calibration lamp method could be determined independently of the lidar system. The maximum difference in the calibration values between the two methods was 1.3% for the four channels, except for when leakage effect caused by strong elastic scattering in the detector.

Atmospheric temperature can be estimated by fitting the corrected lidar signals to the theoretical Raman spectrum. We have evaluated the suitable fitting methods for temperature estimation of the UV Raman lidar, and calculated the temperature from the lidar signals at a laser wavelength of 355 nm with the applied correction of the two calibration methods. The derived temperature displayed similar trends for the two methods and the differences of the temperature by comparison with radiosonde at the heights of 1850-2150 m and 2150-2450 m were 0.05-0.6 K and 3.1-7.0 K, respectively.

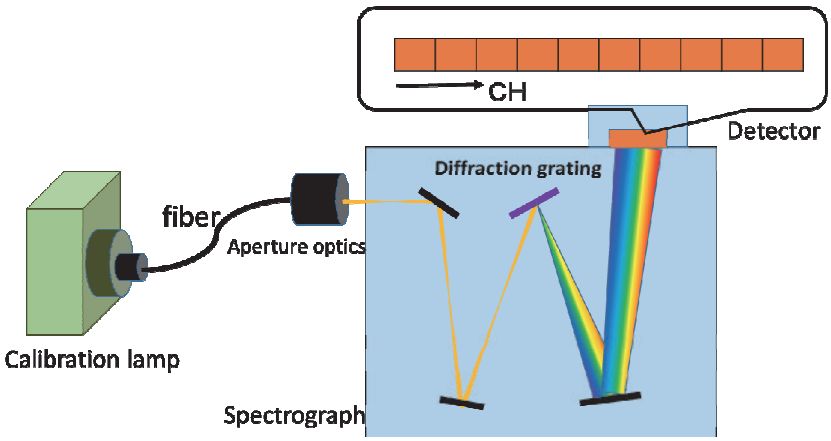

Figure 1. Schematics of the calibration setting of a temperature lidar with a multispectral detector by standard calibration lamp technique.