# Study of a ground-based calibration technique for Raman lidar to apply for multipoint observation of temperature profiles

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Information on atmospheric temperature and water vapor is vital for understanding urban climates, such as localized heavy rains causing water-related disasters and urban heat islands. Multipoint observation by the Raman lidar is useful for obtaining temperature and water-vapor data with high spatiotemporal resolutions. However, the calibration factor must be determined before observation, by comparing lidar signals with those of independent measurement techniques (e.g., radiosonde). Therefore, it is difficult to apply this calibration technique to lidar sites where radiosonde observation cannot be carried out. In this study, we aim to establish a versatile calibration method for Raman lidar with in-situ observations. For temperature and water vapor measurements, the Raman lidar detects vibrational Raman scattering and rotational Raman (RR) scattering with wavelength ranges of 30-50 nm and 2-3 nm, respectively. As it is difficult to apply the same calibration method for both temperature and water vapor observations due to the difference in spectral ranges, we showcase a temperature calibration method here.

Conventional temperature lidar methods detect the ratio of two RR lidar signals of contrasting temperature dependence for the wavelengths in combination with many edge and interference filters. On the other hand, the lidar with a multispectral detector developed by our group is based on the understanding of the shape of the rotational Raman spectrum to reduce uncertainties in the optical alignment of the polychromator and in the stability of laser wavelength. Considering these characteristics of our system, we propose a method to obtain the RR spectrum in the laser irradiation area before emitting into the atmosphere and estimate the calibration value from the dependence of the RR spectrum shape on time and temperature.First, we estimated the effect of both spectral resolution and the laser wavelength stability on the variation of the RR spectrum by theoretical simulations. Subsequently, the ground-based compact calibration system was constructed by controlling the temperature in a small detection area installed in the neighborhood of the laser beam path to obtain the actual RR spectrum at each temperature using the lidar detector. The ground-based calibration can be performed simultaneously with atmospheric measurement for obtaining the vertical temperature distribution. Therefore, it can be applied for real-time continuous calibration, providing a more accurate temperature estimation than conventional methods that calibrate based on comparison with intermittent radiosonde observations. This presentation will show the preliminary results of the RR spectrum using the proposed ground-based calibration system.

Keywords: Raman lidar, Temperature profile, Calibration technique, Urban climate

 