

ABSTRACTS (MASTER THESIS)

**A study on calibration techniques for water vapor
Raman lidar using GNSS-PWV and meso-scale model**

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The Raman lidar technique is useful for observing water-vapor profiles, which help the improvement of the accuracy of weather forecasts. In this study, we propose a new calibration technique for water-vapor Raman lidar using global navigation satellite system (GNSS)-derived precipitable water vapor (PWV) and grid point values from the Japan Meteorological Agency's meso-scale model (MSM-GPV). The analysis was accomplished by directly fitting the PWV to height-integrated water-vapor profiles combined with the MSM-GPV and the Raman lidar observation results. Because this new method can be applied to lidar signals lower than a limited height range due to weather conditions and lidar specifications, it will provide many opportunities for calibration, contributing to the long-term accuracy of measurements.

We demonstrated this method's potential by using the ultraviolet C region (UV-C) Raman lidar and GNSS observation data of the dense observation network around the Shigaraki MU Observatory (34°51' N, 136°06' E; 385 m a.s.l.) of the Research Institute for Sustainable Humanosphere (RISH), Kyoto University, Japan, in June and December 2016. The calibration factor differences between the proposed and conventional methods were within 5%.

The vertical and horizontal inhomogeneous water vapor factors were estimated by calculating the standard deviations of both the water vapor lidar profiles and the horizontal distribution of PWV from the dense GNSS network, respectively. Through a case study of the June and December data, we found differing vertical and horizontal characteristics of the water vapor inhomogeneity preceding rainfall. We investigated the statistical relationship between precipitation and PWV from June 2016 to August 2017 using a database around Shigaraki constructed in this study. The ratio of the observed PWV to the saturated PWV, estimated empirically from the MSM-GPV, was higher during rain events during May-October compared with those during November-April.

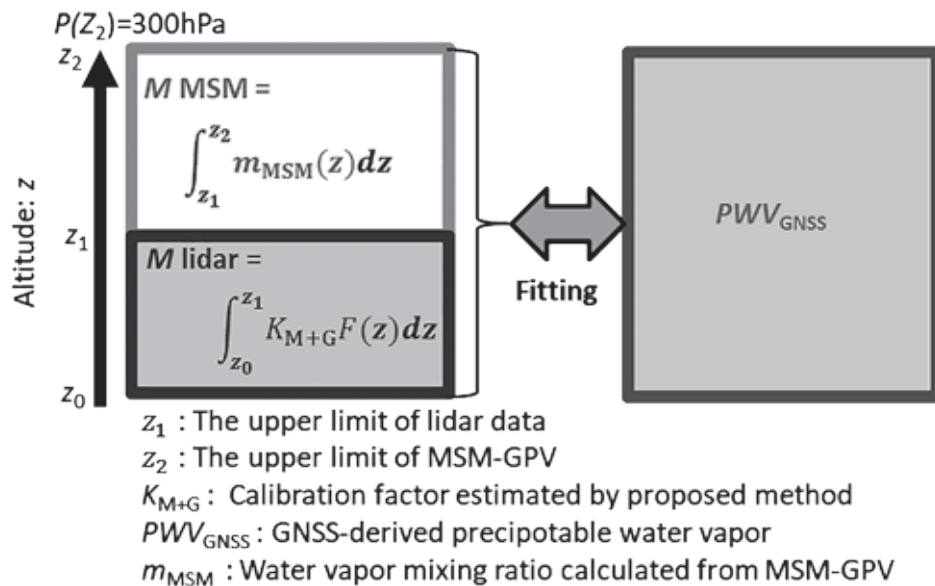


Figure 1. Schematic of new Raman lidar calibration method using GNSS-PWV and MSM. The function $F(z)$ indicates the relative water vapor profile calculated from the Raman lidar signals for each molecule. The calibration factor K_{M+G} is estimated by fitting the GNSS-PWV to integrated water vapor profiles combined with the MSM and the results of the Raman lidar observation.