Observation of Water Vapor Profiles by Raman Lidar with 266 nm laser in Tokyo

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Water vapor is a key parameter in understanding the localized extreme weather events such as torrential rains and floods. Information on the distribution of water vapor at high spatiotemporal resolution is beneficial for improving the accuracy of weather forecasts and a Raman lidar is a useful technique to obtain such information. Although the most of Raman lidars have been studied with a 355-nm laser, a Raman lidar with a laser light of wavelength 266 nm has been reported from several groups [1-2]. Since the solar radiation in the wavelength range below 300 nm reduces to much lower level due to the absorption by the ozone layer in the stratosphere, one can measure water vapor with low background noise even in daytime. We developed a Raman lidar by employing a 266-nm laser and an interference-filter-based polychromator. In 2018, our system demonstrated the ability to acquire continuous water vapor profiles at an observatory surrounded by forest throughout a year [3]. In this study, we conducted an observation of water vapor in an urban city area, Tokyo, during the summer 2020 to evaluate the impact of the surface ozone on the measurement performance since the surface ozone tended to increase in summer.

Water vapor mixing ratio was obtained from three Raman backscatter signals: oxygen, nitrogen and water vapor; and a calibration constant which was evaluated by comparing the results with radiosondes. The Raman scattering light from oxygen was used to correct the effect of ozone absorption. An Nd:YAG laser, which had the pulse energy of ~50 mJ at 266 nm and the repetition rate of 10 Hz was used as excitation source. Raman scattering light was collected by a 20-cm diameter Cassegrain telescope and the Raman scattering light was separated into three wavelengths with dichroic mirrors and interference filters, and detected with photomultiplier tubes in analog and photon counting modes. The signals were accumulated over 15 min and the height resolution was ~150 m. Water vapor profiles obtained with the lidar and the radiosondes were compared several times and the results showed good agreement about up to 1,500 m day and night. Despite presence of the surface ozone in several tens of ppb, water vapor was obtained more than 1,000 m in daytime. Moreover, the continuous measurement results of water vapor will be shown in this presentation.

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