RECENT RESEARCH ACTIVITIES

Mie–Raman lidar techniques using the UV laser for profiling atmospheric constituents in the atmospheric boundary layer

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Atmospheric constituents in the atmospheric boundary layer (ABL), which present in the lowest part of the Earth's atmosphere, play a key role in air pollution, local weather, and climate change. Their spatial and temporal distributions near the surface are highly variable, because of the complex turbulent flow over the surface and the rapid interactions of each species. Therefore, innovative techniques for observing the distributions of atmospheric constituents with good spatio-temporal resolution are required. The Mie–Raman lidar is a laser-based remote sensing instrument that is used for profiling aerosols, ozone, water vapor, and temperature. Although the operation of the lidar system using ultraviolet (UV) optical components including the deep UV (DUV) wavelength range of 200–300 nm is not easy in comparison with systems using the visible wavelengths, the unique characteristics of the UV light have led to the development of new lidar observation methods.

Here, we introduce our four recently developed lidar systems: (1) In terms of the light scattering by particles, shorter wavelengths can be used to obtain information on small particles. A lidar with a multiple field-of-view receiver employing lasers of 266 nm and 355 nm wavelengths was developed for detecting multiple scattering effects to acquire quantitative information concerning the aerosol size distribution within the sub-micrometer and smaller size range. (2) Characteristics of the strong UV light absorption by ozone molecules in the troposphere can be used to obtain information on the ozone profile. Figure 1 shows a time–height cross section of ozone concentration observed by our Raman differential absorption lidar with a 266 nm laser. (3) The use of the deep UV wavelengths is convenient for lidar observation because of the low background noise during daytime, as most of the solar radiation in the wavelength range below 300 nm is absorbed by the ozone layer in the stratosphere. By use of this feature, we constructed a UV Raman lidar for long-term monitoring of water vapor mixing ratio profiles in the ABL for 24 hours. (4) With regard to eye safety, the UV laser has an advantage over instruments using wavelengths in the visible range because the maximum permitted exposure in the UV region is larger than that in the visible region. Highly eye-safe UV laser can be applied to the scanning lidar. We constructed a scanning Raman lidar to observe the cross-sectional distribution of water vapor mixing ratio and aerosols near the Earth's surface, which are difficult to observe when a conventional Raman lidar system is used [1].

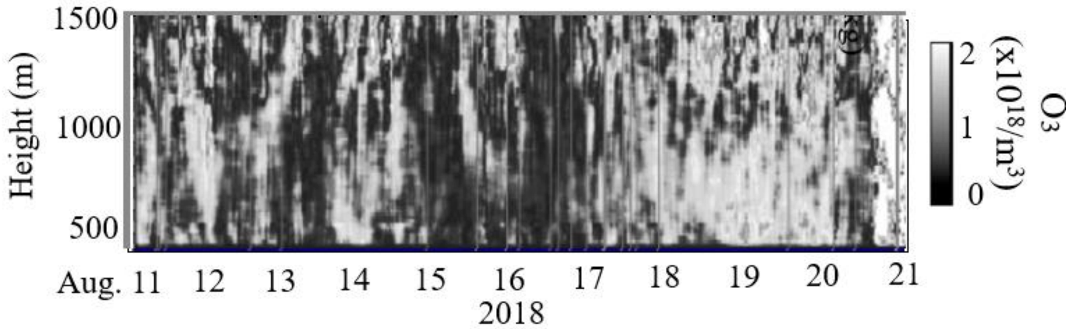

Figure 1. Time–height cross sections of the ozone profiles observed by the Raman lidar at Shigaraki, Japan, from August 11 to 21, 2018.

Reference

[1] Yabuki, M., Matsuda M., Nakamura T., Hayashi T., and Tsuda T, A scanning Raman lidar for observing the spatio-temporal distribution of water vapor, *J. Atmos. Sol. Terr. Phys.*. 59, 150-151, pp. 21-30, 2016. doi.10.1016/j.jastp.2016.10.013