Spatial and temporal distribution of tropospheric water vapor observed by a Raman lidar and a GNSS receiver network over Shigaraki, Japan

*Masanori Yabuki[1], Toshitaka Tsuda[1], Yuya Kawano[2], Yusaku Tottori[2], Makoto Tsukamoto[2], Eiji Takeuchi[2]

1. Research Institute for Sustainable Humanosphere, Kyoto University, 2. EKO Instruments Co., Ltd.

Understanding the spatial and temporal distributions of water vapor in the atmosphere is critical for unveiling the fundamental mechanisms of localized extreme weather events. Besides, it is highly beneficial for improving the accuracy of weather forecasts by mesoscale numerical weather prediction models. To achieve the continuous monitoring of water vapor distributions, we performed simultaneous measurements by Raman lidar in the UV-C region and a dense Global Navigation Satellite System (GNSS) network. The former is a novel technology that can be utilized for profiling the vertical distribution of the water vapor mixing ratio for twenty-four hours, while the latter can be used for detecting the horizontal distribution of precipitable water vapor. The Raman lidar employs a laser at a wavelength of 266 nm and detects the light separated into an elastic backscatter signal and vibrational Raman signals of oxygen, nitrogen, and water vapor at wavelengths of 266, 277, 284, and 295 nm, respectively. The use of these wavelengths is convenient because of the low background noise during daytime, since most of the solar radiation in the ultraviolet range below 300 nm is absorbed by the ozone layer in the stratosphere. The lidar was encased in a temperature-controlled compact container, resistant to a variety of environmental conditions. Continuous observation of water vapor profiles by lidar has been conducted at the Shigaraki MU radar observatory (34˚51’ N, 136˚06’ E, 385 m a.s.l.) since November 2017. The dense GNSS receiver network consisted of 10 dual-frequency GNSS stations which were installed with a horizontal spacing of 3-4 km near the observatory on July 2017. In this study, we present our water vapor monitoring system as well as the preliminary results on the spatio-temporal water vapor distributions in 2018.

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