

A comparison of precipitable water vapor retrieved with novel ground-based microwave radiometer, GPS and analysis data in Tsukuba during a cold front passage

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We have developed a state-of-the-art microwave radiometer named KUMODeS (KEK Universal Moisture and Oxygen Detection System) using the technology of millimeter-wave spectroscopy for the high-resolution and high-precision monitoring of water vapor behavior. We have carried out comparative measurements of precipitable water vapor (PWV) in order to investigate the potential of KUMODeS/PWV measurements.

KUMODeS measures spectra using two receivers with frequency bands of 20–30 GHz and 50–60 GHz. The low-noise amplifier of the first receiver and a cold calibration source are implemented in a cryostat, which is maintained at 10 K in order to improve the sensitivity in the detection of the characteristic broad peak of water vapor at around 22 GHz. The second receiver is used to measure the absorption peaks of oxygen (~60 GHz).

The GPS-based PWV is estimated reliably with 1–2 mm accuracy according to previous studies. The GPS PWV values are retrieved from zenith wet delays (ZWDs), which are computed by subtracting the zenith hydrostatic delays (ZHDs) from GPS-based zenith total delays (ZTDs). In this procedure, the ZHDs are obtained from the surface pressure and temperature.

We analyzed the PWV variation in Tsukuba, Japan, derived from three techniques, i.e., using KUMODeS, GPS and JMA operational local analysis (LA), during a cold front passage. The PWV measurements derived from GPS and KUMODeS have temporal resolutions of 30 s and about 2 min, respectively. The estimates from the LA have a temporal resolution of 1 h. A comparison of time series shows good agreement between the PWV measurements retrieved from KUMODeS, GPS and the LA between 20 and 22 December 2016. On the other hand, some differences between them appeared after the heavy rainfall of 22 December.

Although further investigation is required to evaluate the performance of KUMODeS, the preliminary result of the comparison implies the consistency and potential of KUMODeS measurements.

Keywords: microwave radiometer, precipitable water vapor, GNSS

