Comparison of a Precipitable Water Vapor with GNSS and compact Microwave Radiometer

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1. Introduction

A microwave radiometer is a equipment to passively observe a microwave (22GHz band) radiated from water vapor and directly estimate an amount of Precipitable Water Vapor (PWV) without any correction information (Fig. 1).
Our prototype microwave radiometer is smaller and lighter than conventional system (Fig. 2).
One of the prototype has been installed at Shionomisaki Wind Effect Laboratory of Kyoto University and it kept correcting data for about one year since September 2018. Accuracy verification was done by comparing with data from radiosonde and GNSS which are widely used for water vapor measurement.

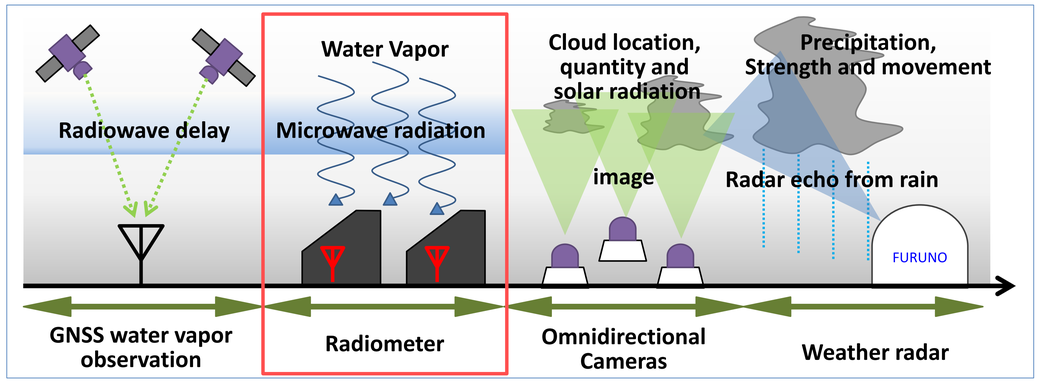

Fig. 1 Meteorological measurement instrument and target

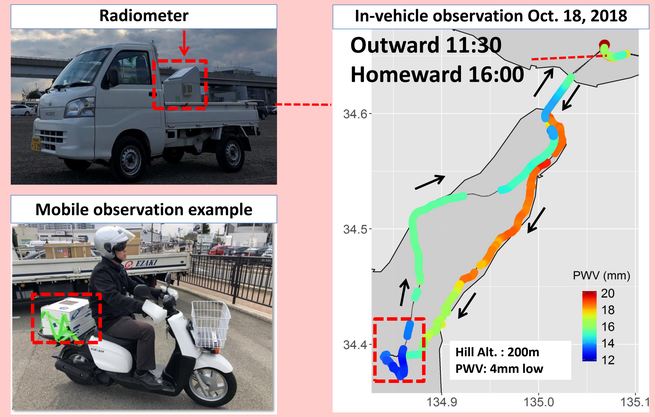

Fig. 2 Mobile measurement with proto-type Radiometer

2. Details

Observation site is Shionomisaki Wind Effect Laboratory (33.4466 N, 135.7563 E) which belongs Disaster Prevention Research Institute of Kyoto University as shown on Fig.3. The prototyped radiometer has been installed next to GNSS Water Vapor system (RTNet) on a rooftop as shown on Fig. 4.
The observation period was from Sept. 27, 2018 to Jan. 14, 2019. The estimated PWV data from the radiometer, RTNet and radiosonde are compared and evaluated. Table-1 shows the observation equipment and conditions. The data of the precipitation, temperature, and atmospheric pressure observed by the Japan Meteorological Agency were used.

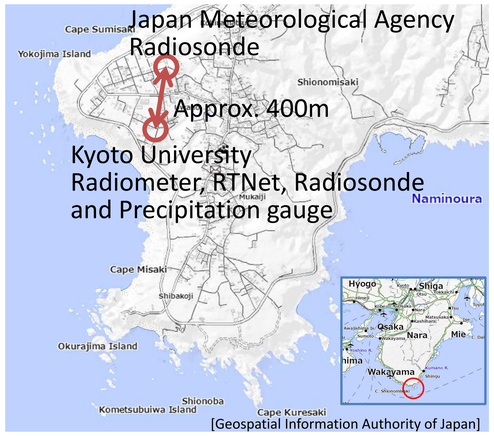

Fig. 3 Observation site

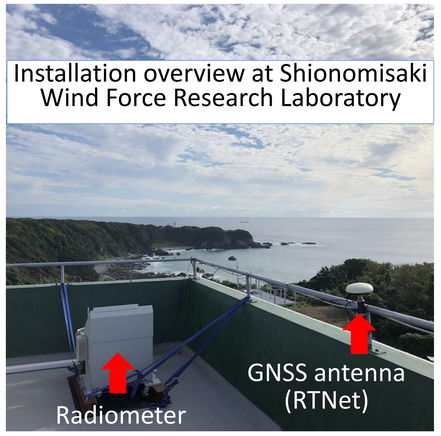

Fig. 4 Installation overview

Table-1 Observation equipment and conditions

Location	Disaster Prevention Research Institute of Kyoto University Shionomisaki Wind Effect Laboratory
Radiosonde observation station for surface pressure, temperature and precipitation	Japan Meteorological Agency Shionomisaki Observatory Located at: 33.4466 N 135.7563 E
GNSS	RTNet (Hitz, Japan)
Radiosonde	IGRA Derived data, Downloaded from IGRA. Combined radiosonde data obtained at the Wind Effect Laboratory between Oct. 11, 2018 and Oct. 20, Nov. 5 and Nov. 15
Observation Period	Sept. 27, 2018 to Jan. 14, 2019

3. Results

The trends in PWV matched very well between the microwave radiometer (Radiometer : Blue line), RTNet (GNSS : Orange line) and radiosonde (RAOB : White circle). This result suggests that the our compact radiometer correctly observed a fluctuation of PWV. It is generally known that microwave radiometers are difficult to observe during rain (vertical blue strips on Fig. 5). The radiometer gave overwhelmed values during precipitation period. But we have concluded that the radiometer has provided adequate figures excluding the precipitation period as shown on fig. 6. The correlation coefficient between radiometer and radiosonde is 0.98 including times of rain, and RMSE is 3.1mm. On the other hand, when it is sunny, the correlation coefficient is 0.98 and RMSE is 2.6mm.

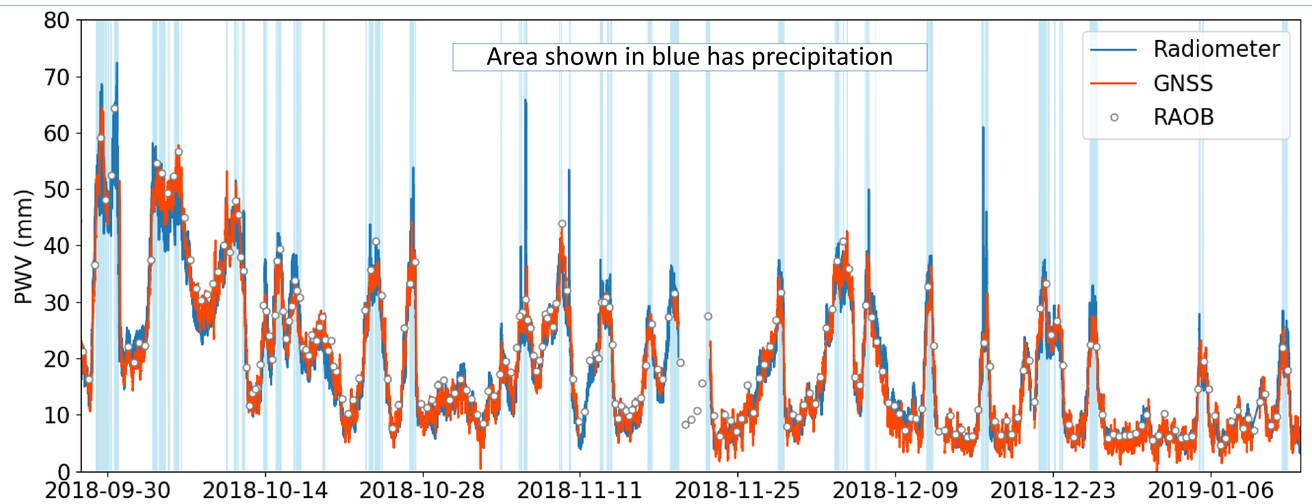

Fig. 5 Correlation between Radiometer (Radiometer), Radiosonde (RAOB) and RTNet (GNSS)

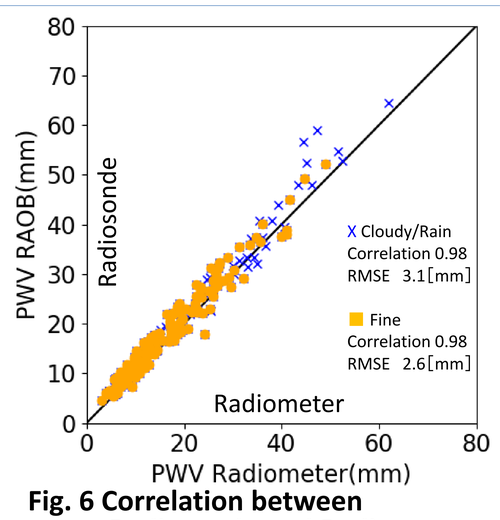

Fig. 6 Correlation between Radiosonde and Radiometer

4. Conclusions

This study shows the comparison of PWV observation from Sept. 27, 2018 to Jan. 14, 2019. Fluctuation of Precipitable Water Vapor was observed by three meteorological instruments, microwave radiometer (prototyped by FURUNO), radiosonde and GNSS. The result shows the measurement accuracy of PWV fluctuation between 10mm and 70mm at autumn and winter time was equivalent to radiosonde and RTNet. The observation using a compact and light-weight microwave radiometer indicates the possibility for understanding the atmospheric fluctuation. It helps local weather observation and prediction, and we expect the radiometer contributes to effective disaster prevention through data assimilation.