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# Numerical Simulation on Retrieval of Meso-gamma Scale PWV Distribution with the Quasi-Zenith Satellite System (QZSS)

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A simulation study was conducted to investigate the retrieval of meso-gamma scale Precipitable Water Vapor (PWV) distribution with QZSS, using the output of a non-hydrostatic numerical weather prediction model. The evaluation was performed on PWV values obtained by simulating three different methods: using all GPS satellites above an elevation angle higher than 10 degree (PWVG) (conventional GPS meteorology method), using only the QZSS satellite at highest elevation (PWVQ) and using only the GPS satellite at highest elevation (PWVHG).

The RMSEs of PWVG, PWVQ and PWVHG were compared, assuming the vertically integrated water vapor amount of the model as true PWV. As a result, the RMSEs of PWVG, PWVQ and PWVHG were 2.78, 0.13 and 0.59 mm, respectively, 5 minutes before the rainfall. The PWVHG time series had a large discontinuity (~2 mm) when the GPS satellite at the highest elevation changed, whereas that of the PWVQ time series was small, because the elevation angle at which the replacement of the highest elevation QZSS satellite occurs is much higher. The standard deviation of PWVQ was smaller than those of PWVG and PWVHG, which vary largely depending on the GPS satellites geometry.

When the spatial distributions of PWVG and PWVQ were compared to the meso-gamma scale distribution of the reference PWV, PWVG smoothed out the PWV fluctuations whereas PWVQ captured them well, due to the higher spatial resolution achievable by using only high-elevation slant paths. These results suggest that meso-gamma scale water vapor fluctuations associated with a thunderstorm can be retrieved by using a dense GNSS receiver network and analyzing PWV derived from a single high elevation GNSS satellite. In this paper we focus on QZSS, as this constellation is especially promising in this context since it is going to provide nearly continuous PWV observations also as its highest satellite changes, contrary to using highest satellites from multiple GNSS constellations.

Keywords: precipitable water vapor, Quasi-Zenith Satellite System, thunderstorm, non-hydrostatic model