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# Estimation of Local-scale PWV Distribution Around Each GNSS Station Using Slant Path Delay -Method and Evaluation-

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A procedure for estimating the precipitable water vapor (PWV) distribution around ground-based stations of the global navigation satellite system (GNSS) on a scale of several kilometers is presented. This procedure utilizes the difference between the zenith total delay above a GNSS station and the zenith mapped slant path delay (SPD). This difference can be used to estimate the PWV gradient in each SPD direction by assuming an exponential distribution for the horizontal water vapor gradient.

The procedure was tested using an estimation of the PWV variation associated with the parent storm of an F3 Fujita scale tornado that occurred in Ibaraki prefecture on May 6, 2012. Differential reflectivity observed by a dual-polarimetric radar indicated the existence of a developed parent cloud approximately 1h before the tornado occurred. A high-resolution numerical weather model simulation suggested the existence of a strong PWV gradient around the parent cloud, made evident by the co-existence of a strong updraft and downdraft within an approximately 5-km radius. The PWV gradient, calculated using the GNSS observation network with an average spacing of approximately 17km, could not detect such a small-scale, strong PWV gradient. The PWV gradient estimated using the proposed procedure revealed a strong PWV gradient and its enhancement. In this case, a higher-order inhomogeneity component of each SPD played a critical role.

To evaluate this new method, we simulated GNSS SPDs using a high-resolution numerical weather prediction model result, emulated GNSS analysis, retrieved PWVs and compared their accuracy against conventional method for a severe tornado case occurred in Japan on May 6 2012.

The comparison results demonstrate the validity of the new method for this case. The conventional procedure introduces a 0.3-0.7 mm root?mean?square-error (RMSE) at the GNSS site location, errors made by simple extrapolation increased with distance and reached 1.5 mm at about 1-3 km. The distance dependency of PWV errors in the new procedure varied with the SPD elevation angle. Using an SPD with an elevation angle of higher than 15 degree, we were able to estimate PWV with about 1.5 mm or better RMSE within a 6-km distance from a GNSS station.

Keywords: GPS/GNSS Meteorology, Mesoscale Meteorology, Satellite Geodesy, Precipitable Water vapor, Slant path delay, Cumulus convection