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Impact of advanced ZTD estimate method - Separation from site coordinates estimation -

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In this paper we introduce the new procedure to estimate ZTD to obtain GPS PWV for numerical weather models. In general the major systematic error source of the ZTD estimation is the trade-off between the ZTD and the coordinate solutions usually simultaneously estimated in the GNSS analysis. In the analysis of the ZTD estimation, we fix the accurate site coordinates and exclude the trade-off systematic errors.

In the first step of the procedure, we estimate site coordinates as well as hourly ZTD, every four-hourly atmospheric gradient, and ambiguities of all of the GEONET network sites as well as the IGS fiducial sites applying the GAMIT program. In the second step, we estimate the accurate present-day site coordinates of the GEONET sites, estimating from the recent 30-days site coordinates solutions time series applying the Kalman filtering of the GLOBK program, constraining the IGS fiducial site coordinates. Then in the final step of the procedure, we estimate every hourly ZTD and every four-hourly gradients of the GEONET sites fixing the site coordinates obtained in the second step.

To evaluate the advanced ZTD estimation, we compare the PWV values calculated from the three kind of ZTDs obtained by three different analysis procedures. We assimilate the PWVs to the CReSS numerical weather model, and examine the impact of the PWVs in the heavy rain in the Southern Gifu Prefecture, Central Japan, on July 15 2010. The ZTDs are estimated by the following three procedures; (a) in the near real-time analysis applying the GAMIT program and estimating site coordinates, hourly ZTDs, four-hourly atmospheric gradient, and ambiguities simultaneously using IGS ultra-rapid orbit, (b) in the post-processing analysis applying the Bernese software and estimating site coordinates, three-hourly ZTDs, atmospheric gradient, and ambiguities simultaneously using IGS final orbit calculated by GSI (F3 solution), (c) in the post-processing analysis and applying the procedure mentioned above in this study (advanced ZTDs) using IGS final orbit. Examining the wide area distribution of water vapor in the objective analysis, (a) and (b) indicate the almost same distribution and (c) only shows the sharp contrast of the mixing ratio, dry in the north-western area in contrast with wet in the south-western area, in Central and Western Japan. The heavy rain phenomena calculated using (c) only significantly coincides with the observation.

We also introduce the impact of the heavy rains applying PWVs obtained by the advanced ZTDs in the cases of the heavy rain in the Niigata Prefecture, Central Japan, in July 2011, and the thunderstorm in the Tokyo metropolis on July 15 2006.

Keywords: Zenith Total Delay, GNSS precipitable water, GEONET, Numerical weather model, CReSS model