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Application of NTR ZTD estimates from GBAS network to improve fast-static GNSS positioning

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In precise GNSS positioning, the correlated tropospheric effects are usually reduced by double differencing of the observations and applying mathematical atmospheric models. However, with a growing distance between the receivers, the tropospheric errors decorrelate causing large residual errors affecting positioning quality. These errors mostly concern the height component of the user position and are related to a high correlation of this component with zenith tropospheric delays (ZTD). This is why nowadays the troposphere is considered as an ultimate accuracy limiting factor in geodetic applications of GNSS. Currently, the most popular solution in the state of the art applications is to estimate ZTD together with station coordinates in the common data adjustment. This approach requires long data spans, e.g., at least 30-60 minutes. However, in fast-static positioning when short data spans (a few minutes only) are available, this method in not feasible and the troposphere is very difficult to model. Therefore, fast-static positioning requires external tropospheric information in order to improve its accuracy. This can be achieved by a network of the reference GNSS stations (GBAS), where ZTD can be obtained in the adjustment of GNSS data or directly from the ground meteorological data in near real-time (NRT) and provided as an external supporting product.

The presented research are carried out in the frame of the "ASG+" project aimed at the development of NRT supporting modules for the ASG-EUPOS system. In this paper we present the analysis of the application of several ZTD modeling techniques to fast-static GNSS positioning, namely: (1) NRT ZTD estimates obtained based on GNSS data from Polish GBAS system called ASG-EUPOS and IGS/EPN and IERS products, (2) NRT ZTD determination based on meteorological data collected in real time from ASG-EUPOS, METAR and SYNOP systems. In order to assess the accuracy of these ZTD modeling techniques, test baselines of several tens of kilometers were processed in fast-static mode using in-house developed GINPOS software. A 24-h data set was divided into 288 sessions, each of 1- or 5-minute long. Each session was processed independently and the obtained coordinate residuals were analysed. Four different approaches to the troposphere modelling were applied and tested: a) using a standard mathematical atmosphere model, b) using ZTD estimates based on GNSS data, c) using NRT ZTD estimates based on GNSS data, d) using NRT ZTD estimates based on meteorological data.

The results show that NRT ZTD products can improve both the accuracy and the reliability of the fast-static positioning, what is of special interest to field surveyors. The most noticeable effect is observed in the station height component estimation. In some extreme cases, mismodelling of the troposphere may even disrupt ambiguity resolution and, therefore, prevents user from obtaining accurate position.