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Real-Time Tropospheric Delay Estimation using IGS Products

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The Federal Agency for Cartography and Geodesy (BKG) routinely provides zenith tropospheric delay (ZTD) parameter for the assimilation in numerical weather models since more than 10 years. Up to now the results flowing into the EUREF Permanent Network (EPN) or E-GVAP (EUMETNET EIG GNSS water vapour programme) analysis are based on batch processing of GPS+GLONASS observations in differential network mode. For the recently started COST Action ES1206 about "Advanced Global Navigation Satellite Systems tropospheric products for monitoring severe weather events and climate" (GNSS4SWEC), however, rapid updates in the analysis of the atmospheric state for nowcasting applications require changing the processing strategy towards real-time.

In the RTCM SC104 (Radio Technical Commission for Maritime Services, Special Committee 104) a format combining the advantages of Precise Point Positioning (PPP) and Real-Time Kinematic (RTK) is under development. The so-called State Space Representation approach is defining corrections, which will be transferred in real-time to the user e.g. via NTRIP (Network Transport of RTCM via Internet Protocol). Meanwhile messages for precise orbits, satellite clocks and code biases compatible to the basic PPP mode using IGS products are defined. Consequently, the IGS Real-Time Service (RTS) was launched in 2013 in order to extend the well-known precise orbit and clock products by a real-time component. Further messages e.g. with respect to ionosphere or phase biases are foreseen. Depending on the level of refinement, so different accuracies up to the RTK level shall be reachable.

In co-operation of BKG and the Technical University of Darmstadt the real-time software GEMon (GREF EUREF Monitoring) is under development. GEMon is able to process GPS and GLONASS observation and RTS product data streams in PPP mode. Furthermore, several state-of-the-art troposphere models, for example based on numerical weather prediction data, are implemented. Hence, it opens the possibility to evaluate the potential of troposphere parameter determination in real-time and its effect to Precise Point Positioning. Starting with an offline investigation of the influence of different RTS products and a priori troposphere models the configuration delivering the best results is used for a real-time processing of the GREF (German Geodetic Reference) network over a suitable period of time. The evaluation of the derived ZTD parameters and station heights is done with respect to well proven GREF, EUREF, IGS, and E-GVAP analysis results.

Keywords: GNSS, Zenith Tropospheric Delay, Real-time Precise Point Positioning