Global near real-time GNSS troposphere product

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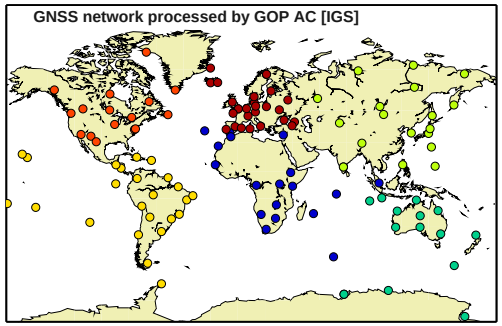
Abstract

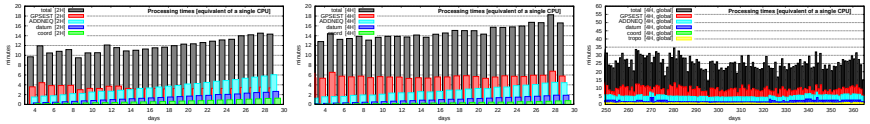
During last years, the EUMETNET EIG GNSS Water Vapour Programme (EGVAP) is responsible for the coordination of near real-time GNSS zenith total delay (ZTD) production in Europe and for the development of ZTD assimilation into numerical weather models. The analytic centre of the Geodetic observatory Pecny (GOP) is active in the field of GNSS-meteorology since 2001. In 2010, the GOP original routine processing was revised towards new demands, namely to support the global numerical models operated at some meteorological institutions with adequate GNSS ZTD products. In order to provide near real-time troposphere zenith path delays in a global scale we made use of our specific processing features and a long-term experience of near real-time orbit determination for IGS. Since July 2010, a new GOP operational system for the global tropospheric product has been deployed and it has routinely contributed to the EGVAP-II database. This poster gives a brief description of the processing strategy, some specific developments and strategy optimization and finally the evaluation of products based on testing campaign as well as on a half-year operational run.



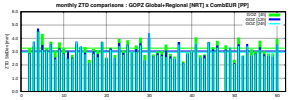
Processing strategy (near real-time, hourly)

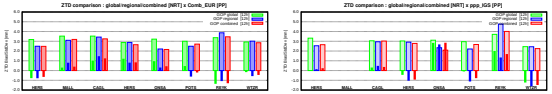
- Bernese GPS software (V50) supported by a flexible GOP processing system
- 4-hour batch data window for the standard processing and products based on stacking normal equations
- parallel processing using optimally allocated processing clusters
- independent baselines defined firstly in each cluster completed by inter-cluster multiple baselines in a global mode
- cummulative coordinate solutions (28 days) based on NEQs (hourly update)
- ionospheric product used for the ambiguity resolution (70-80% based on Melbourne-Wuebenna linear combination)
- automated handling of problematic orbits for individual satellites or data of indivual stations
- output product filtering based on available data, coordinate stability, quality check
- input - hourly and real-time data, navigation messages, IGS ultra-rapid orbits
- ouput - hourly tropospheric parameters, ionospheric model and coordinates

Strategy optimization and product combination



We have developed a global GNSS hourly processing for the zenith total delay (ZTD) estimation, which was firstly tested in a quasi-operational phase in 2010. The original regional solution was revised and carefully optimized in order to support global solution while keeping a full consistency with other processing systems at GOP. One of the optimization task dealt with the processing data window. Original processing data batch of 1h/2h has been changed to 4h in order to stabilize the solution for very long baselines and to enable integer ambiguity resolution. Two above figures shows cpu-time comparisons of different processing steps using 2h and 4h basic data window. While the GPSEST (basic processing) is much more time-consuming in the 4h window, the ADDNEQ (product stacking) is the most time-consuming step within the 2h window mainly due to the coordinate estimation over many previous days (stacking tenths of NEQs). The last figure above shows the actual time used for the routine hourly global solution of approx. 90 stations. In total it requires about 30 min, but thanks to a powerful parallelization, only 4-5 minutes are usually needed. Additionally, we have tested different solution window for the normal equation stacking. In all the cases (figure left) applying the longer window (12-24h) shows slightly lower systematic errors in the comparisons. This is especially true for a regional solution and prolonging the window corresponds to a higher accuracy of estimated ZTD.

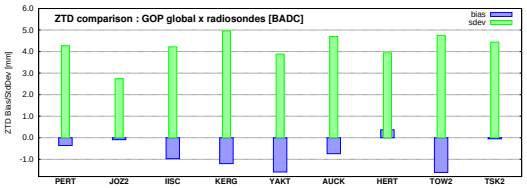


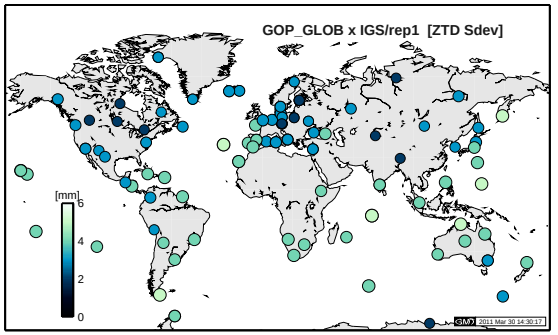


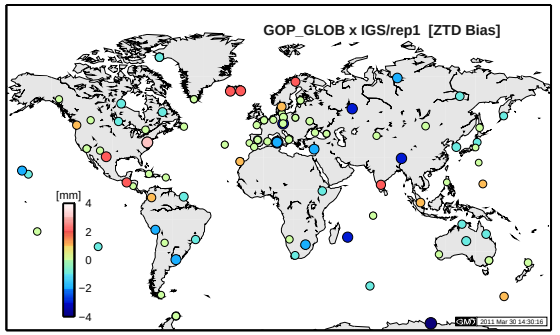
Finaly, we have developed the combination of the existing regional and new global solutions, providing about 160 stations in total. The comparison of regional, global and combined solutions with respect to the IGS and EUREF ZTD products are shown in figures right. They demonstrates very good agreement of all products and usually a bit smaller statistics for the combined product.

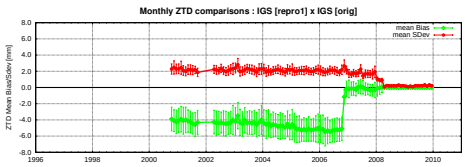
Evaluation of routine product

Since August 2010, the GOP hourly global solution is generated routinely and contributes to the EUMETNET EIG database, where it is monitored and distributed by meteorological institutions. Two figures bellow shows the comparison with official IGS ZTD product, which is consistent with the IGS repro1 ZTD product. The right figure shows the comparison with respect to radiosondes collected at the British Atmospheric Data Centre (BADC) and converted to ZTD at GOP.









ZTD products from the IGS

The GOP global ZTD products from the testing campaign (Jan-April, 2010) were compared to the IGS [old] products, while routine products were compared to the IGS repro1 ZTD products. The figure right shows the evaluation of all ZTDs for common stations based on original IGS PPP tropospheric product with respect to IGS repro1. Before GPS week 1400 (November, 2006) both products were highly inconsistent mainly due to the different PCVs and tropospheric models. A mean systematic error in ZTD over all stations was roughly 4 mm and mean standard deviation 2 mm. After applying consistent PCVs in GPS week 1400, a common character of a systematic error disappeared, but mean standard deviation (2 mm) still remained in the comparison until start of 2008 (probably due to different orbit and clock products applied for the estimation.

Conclusion and outlook

The GOP near real-time processing solution was revised in order to serve new requirement - global hourly ZTD estimation. Processing of a sparse global network provide high quality ZTD estimates, which can be characterized by mean standard deviation in ZTD bellow 5 mm. The new product is available half a year already and regularly uploaded to the EUMETNET EIG ZTD database for an exploitation in global weather forecastings. We are working on implementation of the precise point positioning solution based on GOP global products.

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