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Improved methods for reprocessing of GNSS data for climate monitoring over Poland

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The goal of this work is to determine the most accurate and homogeneous processing strategy to reprocess ground-based GNSS data for climate monitoring applications (analysis of trends and variability of Zenith Total Delay, ZTD, and Integrated Water Vapor, IWV). Namely, we investigate the impact of network design strategy and tropospheric modeling approach on the quality and homogeneity of both relative (double difference) and absolute (PPP) solutions.
A network of 138 GNSS stations (including 33 stations from the EUREF Permanent Network, EPN, and 105 stations from ASG-EUPOS in Poland) is reprocessed for year 2014 using Bernese 5.2 GNSS software with the final IGS (International GNSS Service) orbits and clocks. First a standard (the shortest) "star" baseline design strategy is used in which the EPN stations are connected together defining a reference network and every ASG-EUPOS station is connected to the nearest EPN station. The initial network is modified automatically by the Bernese software every day depending on the availability of observations at the EPN stations. We show that in case of sub-daily gaps in the measurements of the reference stations, small clusters of stations can be disconnected from the main reference network. As a result, offsets of a few centimeters in ZTD estimates and spikes in formal errors can appear. These offsets and spikes cannot always be detected. This phenomenon is quite frequent in a large network such as considered in this study. It is also responsible for significant discontinuities in the estimated ZTD series which are detrimental to climate monitoring applications.
We developed a new baseline design strategy algorithm to circumvent this event and assure that all the stations remain connected to the main reference network. It is shown that using this strategy, the reprocessed ZTD series are much more continuous and homogeneous in comparison to the standard strategy. The results are further validated against a Precise Point Positioning (PPP) solution and with respect to ERA-Interim reanalysis. Different processing variants were also tested implying different mapping functions and different time resolutions and constraints on ZTD and gradient parameters. It is shown that tropospheric modelling has much less impact than baseline design strategy in DD processing. The PPP is an interesting alternative to DD processing as it does not contains such artifacts. Hence, a long term PPP solution was also produced and used for analyzing trends and variability in IWV over Poland.

Keywords: GNSS, processing, ZTD, IWV, climate