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Near real-time and real-time GNSS Precise Point Positioning with external a priori troposphere models

Tomasz Hadas (1), Marcelo Santos (2), Alex Garcia (2), Jaroslaw Bosy (1), and Jan Kaplon (1)

(1) Wroclaw University of Environmental and Live Sciences, Institute of Geodesy and Geoinformatics, Wroclaw, Poland (jaroslaw.bosy@up.wroc.pl, +48713205617), (2) University of New Brunswick, Geodesy and Geomatics Engineering, NB, Canada

Precise Point Positioning (PPP) is a positioning technique that uses a single GNSS (Global Navigation Satellite System) receiver that requires external information from analysis of global GNSS permanent network, in particular precise orbits and satellite clocks. This technique is commonly used in post-processing mode and gives results comparable to relative positioning. A shortcoming of this technique is the time required for the solution to converge, which is a main limitation for near real-time and real-time applications.
The convergence time depends on the quality of GNSS data, on the accuracy of the a priori parameters and on fast ambiguity resolution. Until recently, near real-time and real-time users were limited in the sources of precise products, since only the predicted part of the ultra-rapid products were available. In 2012, the International GNSS Service (IGS) launched the Real-Time Service (RTS), making available a dedicated set of real-time products, known as IGS-RTS. Nevertheless, there is still no standard procedure for handling the troposphere delay. The a priori troposphere delay, as well as mapping functions, has to be derived from an external source and the adjustment model should account for the correction to an apriori value of the delay. Currently, a number of empirical troposphere state models and mapping functions are available for users in real-time. Near-real time model of troposphere delay can also be determined from the analysis of regional GNSS permanent network.
In this paper, we make use of the IGS-RTS along with a number of a priori tropospheric models in order the assess how they influence convergence time and estimated position. For this purpose, we use GPS Analysis and Positioning Software (GAPS) for near-real time processing and GNSS-Wroclaw Algorithms for Real-time Positioning (GNSS-WARP) software for real-time processing of GPS only data together with IGS-RTS precise orbits and satellite clocks. As a priori troposphere model we used GPT together with the Saastamoinen formula, UNB3 model and regional near-real time troposphere model from the analysis of a network of permanent GNSS stations. We combine these models with Niell and VMF mapping functions to compute slant troposphere delays, including those of low-elevation satellites.