Modeling of low-stability GPS receiver clocks and its impact on pseudo-range kinematic coordinates

Wang Kan[1], Rothacher Markus[1]

[1]Institute of Geodesy and Photogrammetry, ETH Zurich, Switzerland

Email: wangk@ethz.ch

In Precise Point Positioning (PPP) with GNSS, the receiver clocks are typically estimated together with receiver coordinates (and even troposphere parameters) despite of the strong correlations between these parameter types. Deterministic[1] and stochastic[2] modelling of high-stability receiver clocks (e.g. H-Masers) instead of the usual epoch-wise estimation of the clock parameters can significantly improve the stability of, e.g., the vertical component of the kinematic phase solutions. Appropriate relative constraints on such high-performance clocks also improve the kinematic height coordinates when using pseudo-range observations[3].

However, in industrial and low-cost GNSS applications the working environment, the cost and the mobility of the receivers may prevent the usage of high-stability clocks like H-Masers. In this paper, we discuss the modelling of receiver clocks with relatively low stability and its impact on the pseudo-range kinematic coordinates. Pseudo-range observations are simulated based on the data from several real quartz clocks and from a rubidium clock thereby using different code measurement noise levels and sampling rates. The best suitable relative constraints between subsequent clock parameters and the improvement of the stability of the kinematic height coordinates are studied in detail for different clock qualities, observation noise levels and sampling intervals based on the simulated data.

In the end, also real pseudo-range observations from receivers with quartz clocks as mentioned above are analyzed to verify the conclusions drawn from the simulations. The results lead to conclusions, whether positioning and navigation applications may profit from clock modelling and clocks that are better than those used in mass applications today.

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[3] U. Weinbach and S. Schön, "Evaluation of the clock stability of geodetic GPS receivers connected to an external oscillator", Proc. ION GNSS 2009, p. 3317-3328, Savannah, GA, USA, 2009.