EGU General Assembly 2024

EGU24-334, updated on 08 Aug 2024
https://doi.org/10.5194/egusphere-egu24-334
EGU General Assembly 2024

Impact of stochastic modeling applied to the receiver clock parameter for Galileo-only and multi-GNSS solutions

Marcin Mikoś, Krzysztof Sośnica, Kamil Kazmierski, and Tomasz Hadas
Wrocław University of Environmental and Life Sciences, Institute of Geodesy and Geoinformatics, Grunwaldzka 53, 50-375 Wrocław, Poland

In Precise Point Positioning (PPP), independently estimating the receiver clock parameters at each observation epoch introduces heightened noise in the estimated station coordinates and troposphere parameters due to correlations. To address this issue, stochastic modeling is applied to the receiver clock parameter, thereby enhancing the stability of PPP solutions and minimizing clock noise for precise time transfer. Importantly, the feasibility of receiver clock modeling relies on GNSS receivers being connected to exceptionally stable atomic clocks, such as hydrogen maser clocks (HM), which exhibit significantly lower noise compared to other clock types.

The strategy proposed by our team involves introducing Markov stochastic process modeling for the receiver clock parameters through a random walk. We opted for this stochastic process because of its simplicity in both comprehension and implementation. We conducted tests with different levels of random walk constraints for GNSS stations equipped with various clock types, exploring both Galileo-only and multi-GNSS solutions in kinematic and static PPP modes. We compare the results against a reference solution without any additional constraints. In multi-GNSS solutions, a common clock parameter is determined alongside inter-system biases (ISBs), with the common clock parameter identified as the GPS clock.

Research outcomes demonstrate that comparable results can be achieved by imposing constraints solely on the common clock parameter while treating ISBs as constant parameters. Similarly, constraints on both the common clock parameter and ISBs, with a ratio of 1:100, yield the most favorable results. However, adopting other clock-to-ISB constraint ratios, such as 1:1 and 1:10, leads to suboptimal performance. In the static PPP, the introduced clock modeling significantly enhances the precision of time transfer by effectively reducing clock noise. In the kinematic PPP, stochastic clock modeling has a marginal impact on the North and East coordinate components, whereas the Up component exhibits substantial improvement, mainly for GNSS receivers equipped with HM. An examination of Zenith Total Delay (ZTD) in both Galileo-only kinematic and static PPP modes reveals the discernible impact of clock constraints, as evidenced by observed offsets in the respective outcomes. In the case of multi-GNSS solutions, this influence is less prominent, attributed to weaker correlations between ZTD and clock parameters in multi-GNSS solutions compared to Galileo-only.