iag-comm4-2022-28
https://doi.org/10.5194/iag-comm4-2022-28
2nd Symposium of IAG Commission 4 "Positioning and Applications"

Almost-instantaneous PPP-RTK without atmospheric corrections

Andreas Brack[1], Benjamin Männel[1], and Harald Schuh[1,2]
[1]GFZ German Research Centre for Geosciences, Potsdam, Germany
[2]Technische Universität Berlin, Germany

Ambiguity resolution enabled precise point positioning (PPP-RTK) can provide fast, potentially even instantaneous, centimeter-level positioning results, given that the phase ambiguities are correctly resolved. A main problem for fast and reliable ambiguity resolution are the ionospheric delays in the user's global navigation satellite systems (GNSS) observations. Without external ionospheric corrections, a time-to-first-fix the ambiguities of around 30 min is often reported for GPS-only solutions. Faster solutions are possible when ionospheric corrections are provided, but these have to be at the level of at most a few centimeters for a clear gain in terms of the convergence time. Such a precision is currently not possible with global ionospheric models but requires corrections from nearby reference stations, which limits the field of applications.

In this contribution we investigate the capabilities of centimeter-level PPP-RTK without any a-priori ionospheric information. The key aspects are 1) the MSE-optimal best integer-equivariant estimator, which does not 'fix' the ambiguities to integers but rather weights different candidates, 2) a multi-GNSS solution using GPS, Galileo, BDS, and QZSS, and 3) a proper weighting of the satellite clock and bias corrections in order to obtain realistic observation models. Simulations are used to show that in an area with good visibility of BDS and QZSS, one can expect centimeter-level results with on average just slightly more than two observation epochs already with corrections from only a single reference station. We confirm this result with real GNSS data and show that centimeter-level horizontal positioning errors are reached within one and two epochs in 87.6% and 99.7% of the cases during an exemplary day, thereby demonstrating that almost-instantaneous PPP-RTK without atmospheric corrections is indeed possible with the current constellations.