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Rapid convergence for multi-GNSS precise point positioning in the data-interrupted situation

Nan Zang, Bofeng Li, and Yunzhong Shen
Tongji University, Shanghai, China (zang6050@126.com)

Positioning performance of precise point positioning (PPP) mainly embodies at convergence time and positioning accuracy. Traditional dual-frequency PPP can implement mm to cm and cm to dm positioning accuracy in static and kinematic mode, respectively. However, the initialization is the restricted factor to be widely used, on account of the approximate thirty minutes in GPS-only case, especially in the frequent time-interrupted situation. Though the multi-GNSS PPP improves the positioning convergence to about 10 minutes to be cm level, it still cannot avoid the positioning initialization caused by the time interrupted situation. Hence an efficient algorithm is significantly proposed to solve the rapidly converged issue in multi-GNSS PPP integration in time-interrupted situation, i.e. RC-PPP. The algorithm is a generalized model, which is suitable for CDMA and FDMA constellations in multi-GNSS PPP integration. The algorithm is based on the epoch-difference geometry-based (ED-GB) model, determining the hops of phase observations in all satellites by estimation, then repairing the phase observations in time-interrupted situation for successively and rapidly converged precise point positioning. There are two crucial technologies to implement this method including: (i) prediction of the epoch-difference ionospheric constrains during the time interruption; (ii) determination of the hop for each satellite to repair the phase observations. To rationally predict the epoch-difference ionospheric variation, we adopt a sliding window to implement by polynomial fitting method in short-term time interruption. Then we utilize the epoch-difference ionospheric variation prediction as constrain to fix the hop caused by the time interruption in phase observations. Finally we can avoid the initialization of PPP after time-interruption after repairing the phase observations to implement the rapidly converged PPP. To validate the algorithm, we choose different sample interval data for sliding windows size determination. We design different time-interruption cases to illustrate applicability of the algorithm. The Results reveal that: (i) the ED ionospheric variation for each satellite embodies the preferable predictability as the slow varying; (ii) successfully fixing the hop for each satellite will significantly benefit to repair the phase observations after the signals loss; (iii) with the repaired the phase observations, RC-PPP algorithm can perform the optimal continuity and convergence in the time-interruption situation.