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Precise orbit determination of Multi-GNSS constellation including GPS GLONASS BDS and GALIEO

Xiaolei Dai
China (daixlei@126.com)

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Dai Xiaolei1, 2, Ge Maorong2, Shi Chuang1, Yidong Lou1, Harald Schuh1
1. GNSS Research Center, Wuhan University, 129 Luoyu Road, Wuhan 430079, China
2. GeoForschungZentrum, German (GFZ), Telegrafenberg, 14473 Potsdam, Germany

Abstract: In addition to the existing American global positioning system (GPS) and the Russian global navigation satellite system (GLONASS), the new generation of GNSS is emerging and developing, such as the Chinese BeiDou satellite navigation system (BDS) and the European GALILEO system. Multi-constellation is expected to contribute to more accurate and reliable positioning and navigation service. However, the application of multi-constellation challenges the traditional precise orbit determination (POD) strategy that was designed usually for single constellation. In this contribution, we exploit a more rigorous multi-constellation POD strategy for the ongoing IGS multi-GNSS experiment (MGEX) where the common parameters are identical for each system, and the frequency- and system-specified parameters are employed to account for the inter-frequency and inter-system biases. Since the authorized BDS attitude model is not yet released, different BDS attitude model are implemented and their impact on orbit accuracy are studied. The proposed POD strategy was implemented in the PANDA (Position and Navigation Data Analyst) software and can process observations from GPS, GLONASS, BDS and GALILEO together. The strategy is evaluated with the multi-constellation observations from about 90 MGEX stations and BDS observations from the BeiDou experimental tracking network (BETN) of Wuhan University (WHU). Of all the MGEX stations, 28 stations record BDS observation, and about 80 stations record GALILEO observations. All these data were processed together in our software, resulting in the multi-constellation POD solutions. We assessed the orbit accuracy for GPS and GLONASS by comparing our solutions with the IGS final orbit, and for BDS and GALILEO by overlapping our daily orbit solution. The stability of inter-frequency bias of GLONASS and inter-system biases w.r.t. GPS for GLONASS, BDS and GALILEO were investigated. At last, we carried out precise point positioning (PPP) using the multi-constellation POD orbit and clock products, and analyzed the contribution of these POD products to PPP.

Keywords: Multi-GNSS, Precise Orbit Determination, Inter-frequency bias, Inter-system bias, Precise Point Positioning