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Multi-GNSS real-time precise positioning service and Initial assessment of BDS-3 (G Division Outstanding ECS Award Lecture)

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The rapid development of multi-constellation GNSSs (Global Navigation Satellite Systems, e.g., BeiDou, Galileo, GLONASS, GPS) and the IGS (International GNSS Service) Multi-GNSS Experiment (MGEX) bring great opportunities and challenges for real-time precise positioning service. In this contribution, we present a GPS+GLONASS+BeiDou+Galileo four-system model to fully exploit the observations of all these four navigation satellite systems for real-time precise orbit determination, clock estimation and positioning. Meanwhile, an efficient multi-GNSS real-time precise positioning service system is designed and demonstrated by using the Multi-GNSS Experiment (MGEX) and International GNSS Service (IGS) data streams including stations all over the world. The addition of the BeiDou, Galileo and GLONASS systems to the standard GPS-only processing, reduces the convergence time almost by 70%, while the positioning accuracy is improved by about 25%.

The successful launch of five new-generation satellites of the Chinese BeiDou Navigation Satellite System (BDS-3) marks a significant step in expanding BeiDou into a navigation system with global coverage. We present an initial characterization and performance assessment for these new-generation BeiDou-3 satellites and their signals. The characteristics of the B1C, B1I, B2a, B2b and B3I signals are evaluated in terms of observed carrier-to-noise density ratio, pseudorange multipath and noise, triple-frequency carrier phase ionosphere-free and geometry-free combination, and double-differenced carrier phase and code residuals. With respect to BeiDou-2 satellites, the analysis of code multipath shows that the elevation-dependent code biases, which have been previously identified to exist in the code observations of BeiDou-2 satellites, seem to be not obvious for all the available signals of new-generation BeiDou-3 satellites. This will significantly benefit precise applications that resolve wide-lane ambiguity based on Melbourne-Wübbena (MW) linear combinations and other applications such as single-frequency Precise Point Positioning (PPP) based on the ionosphere free code-carrier combinations. With regard to the triple-frequency carrier phase ionosphere-free and geometry-free combinations, it is found that different from BeiDou-2 and GPS Block IIF satellites, no apparent bias variations could be observed in all the new-generation BeiDou-3 satellites, which show a good consistency of the new-generation BeiDou-3 signals. The absence of such triple-frequency biases will make it convenient for the future processing of multi-frequency PPP using observations from new-generation BeiDou-3 satellites.