Multi-GNSS real-time precise orbit/clock/UPD products and precise positioning service at GFZ

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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. A rigorous multi-GNSS analysis is performed to achieve the best possible consistency by processing the observations from different GNSS together in one common parameter estimation procedure. 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%. Some outliers in the GPS-only solutions vanish when multi-GNSS observations are processed simultaneous. The availability and reliability of GPS precise positioning decrease dramatically as the elevation cutoff increases. However, the accuracy of multi-GNSS precise point positioning (PPP) is hardly decreased and few centimeters are still achievable in the horizontal components even with 40° elevation cutoff.