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Quality assessment of multi-GNSS real-time orbits and clocks

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A continuously increasing number of satellites of Global Navigation Satellites Systems (GNSS) and their constant modernization allow improving the positioning accuracy and enables performing the GNSS measurements in challenging environments. The constant development of GNSS, among which GPS, GLONASS, Galileo and BeiDou can be distinguished, contributes to improvements in GNSS usage in areas desired by common users or GNSS community. The Multi-GNSS experiment (MGEX) of the International GNSS Service (IGS) has been established for tracking, collating and analyzing all available GNSS signals. Provided precise orbits and clocks do not allow users to process data in real-time due to the significant latency of provided products which may reach up to even 18 days. In order to satisfy needs of real-time users IGS Real-Time Service (RTS) was launched in 2013. The service is currently insufficient for Multi-GNSS applications as it provides products for GPS and GLONASS only. One of the publicly available real-time corrections for the all GNSS, including the new systems, are those provided by the Centre National d'etudes Spatiales (CNES). Presented works evaluate clocks and orbit corrections, i.e. the availability and quality of real-time products provided by CNES (mountpoint CLK93). As a decoder of the RTCM streams the BNC software v2.12 is used. All computations are performed using the GNSS-WARP software which is developed by Institute of Geodesy and Geoinformatics (IGG) at Wroclaw University of Environmental and Life Sciences (WUELS). The final products provided by the Center of Orbit Determination in Europe (CODE) are used for the evaluation of the real-time CNES orbits and clocks. Moreover, the Satellite Laser Ranging (SLR) data are employed as an independent way of the orbit quality assessment. The availability of the real-time corrections is at the level of about 90%, when excluding BeiDou, for which the availability is at the level of about 80%. The obtained results with reference to CODE products indicate that satellites' position quality is different for different systems. The best performance is obtained for GPS (about 3 cm) and the worst for BeiDou (about 30 cm). A similar situation occurred for GPS clocks with the clock residues RMSE at the level of 15 cm. The greatest clock residues RMSE was obtained for GLONASS and reached up to 1 m. Conducted works allow us to perform a further study related to the real-time GNSS data processing, e.g., using the system-specific observation weighting.

Keywords: Multi-GNSS, real-time processing, clocks, orbits