Multi-GNSS real-time orbit and clock quality changes over time

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Navigation systems have substantially evolved in the last decade. The multi-GNSS constellation including GPS, GLONASS, Galileo, and BeiDou consists of more than a hundred active satellites. To fully exploit their potential, users should be able to take advantage of those systems not only in postprocessing mode employing final solutions but also in real-time. It is also important to make satellite signals highly useful in a real-time regime not only in standard positioning mode but also with the precise positioning technique. That is why real-time products are highly desirable. One of the IGS Analysis Centers that support multi-GNSS real-time solution is CNES which provides not only orbits and clocks but also code and phase biases and VTEC global maps. Over the last few years, real-time products have been changing similarly to navigation systems, which come along with observation availability and calculation strategy changes.

We utilize the signal-in-space ranging error (SISRE) as the main orbit and clock quality indicator. Additionally, SLR observations are used as an independent source of information about orbit quality. Three years of data, between 2017 and 2020, are used to check the progress in the quality of the delivered products to the users through the internet streams provided by CNES.

The progress in the product quality in the test period is obvious and it depends on the satellite system, block or satellite type, time, and the height of the Sun above the orbital plane. The most accurate orbits are available for GPS, however, the very stable atomic clocks of Galileo compensate for systematic errors in Galileo orbits. Consequently, the SISRE for Galileo is lower than that for GPS, equaling 1.6 and 2.3 cm for Galileo and GPS, respectively. The SISRE value for GLONASS, despite the good quality of the orbits, is disturbed by the lower quality of the onboard clocks and is equal to 4-6 cm. The same quality level is for BeiDou-2 MEO and IGSO satellites. Products for BeiDou-2 GEO satellites are less accurate and with poor availability due to a large number of satellite maneuvers, thus they are not very useful for real-time positioning.

For positioning purposes, the presented results may be interesting especially in the context of the proper observation weighting in the multi-GNSS combinations. It is worth mentioning that the quality of the real-time products is not constant and neglecting this fact may bring undesirable positioning errors, especially for long processing campaigns.