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Recent Precise Point Positining Performance of Galileo

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Precise Point Positioning (PPP), which enables centimeter- or millimeter-level positioning accuracy with a single receiver only on the global scale, has taken increasing attention within the GNSS community in recent years. For a long time, GPS has been the dominant constellation for PPP processing. However, the completion of GLONASS constellation and the emergence of new satellite systems, such as European Galileo and Chinese BeiDou, presents significant opportunities to improve the PPP performance. As of October 2018, Galileo constellation consists of 18 full operational capability (FOC) satellites in addition to 2 further satellites whose test process are ongoing. Therefore, Galileo constellation provides considerable satellite resource for PPP, like the other GNSS applications. In this context, the principal objective of this study is to investigate the very recent capability of Galileo-only PPP and to evaluate its contribution to the multi-GNSS PPP performance. For this purpose, 24-hour observation dataset collected at twelve IGS MGEX (International GNSS Service Multi-GNSS Experiment) stations, which are selected taking their geographical distributions into account, during the ten-day period of 22-31 October was processed with different PPP modes including Galileo-only, GPS-only, and GPS/Galileo. Additionally, the same dataset was processed by restarting the filter estimator every 3 hours to evaluate the PPP performance more comprehensively. In the study, PPPH, which is an open-source software for multi-GNSS precise point positioning analysis developed by the authors, was utilized to perform PPP processes. The results indicate that the number of visible Galileo satellites varies depending on the location of stations due to irregularity in satellite distribution caused by that Galileo has not reached full constellation yet. The average number of visible Galileo satellites per epoch ranges between 3.6 and 7.7 for the stations utilized in the study. Moreover, one of the stations used in the test has five or greater visible satellites in every epoch during the 10-day period, while the number of the visible satellites does not exceed four in any epoch for another station. The average percentage of epochs in which the number of visible Galileo satellites are 5 or more equals 82% considering the whole epochs for all stations. The results also show that although its positioning performance alters depending on the number of visible satellites, therefore on the station's location, Galileo-only PPP has averagely provided 4.2 cm 3D positioning accuracy and 91.4-minute convergence time, which are almost two times worse than GPS-only performance. On the other hand, for the 24-hour observation dataset, the addition of Galileo improves GPS-only PPP performance by 6% and 35% on average in terms of positioning accuracy and convergence time, respectively. Consequently, considering that Galileo is going to complete its constellation consisting of 30 satellites in the near future, we can say that Galileo offers the important possibility for better PPP performance.