Geophysical Research Abstracts
Vol. 19, EGU2017-17415, 2017
EGU General Assembly 2017

On the Impact of Multi-GNSS Observations on Real-Time Precise Point Positioning Zenith Total Delay Estimates

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Observations from multiple Global Navigation Satellite System (GNSS) can improve the performance of real-time (RT) GNSS meteorology, in particular of the Zenith Total Delay (ZTD) estimates. RT ZTD estimates in combination with derived precipitable water vapour estimates can be used for weather now-casting and the tracking of severe weather events. While a number of published literature has already highlighted this positive development, in this study we describe an operational RT system for extracting ZTD using a modified version of the PPP-wizard (with PPP denoting Precise Point Positioning). Multi-GNSS, including GPS, GLONASS and Galileo, observation streams are processed using a RT PPP strategy based on RT satellite orbit and clock products from the Centre National d'Etudes Spatiales (CNES). A continuous experiment for 30 days was conducted, in which the RT observation streams of 20 globally distributed stations were processed. The initialization time and accuracy of the RT troposphere products using single and/or multi-system observations were evaluated. The effect of RT PPP ambiguity resolution was also evaluated. The results revealed that the RT troposphere products based on single system observations can fulfill the requirements of the meteorological application in now-casting systems. We noted that the GPS-only solution is better than the GLONASS-only solution in both initialization and accuracy. While the ZTD performance can be improved by applying RT PPP ambiguity resolution, the inclusion of observations from multiple GNSS has a more profound effect. Specifically, we saw that the ambiguity resolution is more effective in improving the accuracy, whereas the initialization process can be better accelerated by multi-GNSS observations. Combining all systems, RT troposphere products with an average accuracy of about 8 mm in ZTD were achieved after an initialization process of approximately 9 minutes, which supports the application of multi-GNSS observations and ambiguity resolution for RT meteorological applications.