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Comparative analysis of positioning and zenith total delay retrieval using GPS-, GLONASS-only, and GPS/GLONASS combined precise point positioning

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Since October 2011, the Russian GLONASS has been revitalized and is now fully operational with 24 satellites in orbit. It is critical to assess the benefits and problems of using GLONASS observations (i.e. GLONASS-only or combined GPS/GLONASS) for precise positioning and zenith total delay (ZTD) retrieval on a global scale using the precise point positioning (PPP) technique.
In this contribution, extensive evaluations are conducted with GNSS data sets collected from 251 globally distributed stations of the International GNSS Service (IGS) network in July 2016. The stations are divided into 30 groups by antenna/radome types to investigate whether there are antenna/radome-dependent biases in position and ZTD results derived from GLONASS-only PPP. The positioning results do not show obvious antenna/radome-dependent biases except the stations with JAV_RINGANT_G3T/NONE. The averaged biases of the stations with JAV_RINGANT_G3T/NONE in horizontal component especially in north component can even achieve –9.0 mm. The standard deviation (STD) and root mean square (RMS) are used as indicators of positioning repeatability and accuracy, respectively. Compared with GPS-only PPP, smaller averaged STD and RMS values of GLONASS-only PPP are achieved in horizontal component, while larger ones in vertical component. Furthermore, the STD and RMS values of GPS/GLONASS combined PPP solutions are the smallest in horizontal and vertical components, indicating that adding GLONASS observations can achieve better positioning performance than GPS-only PPP. Meanwhile, better positioning repeatability and accuracy are found in north component than that in east component, which may be caused by the configuration of GNSS satellite orbit.
With respect to GPS-only PPP-derived ZTD, the ZTD biases, accuracy, and correlation derived from GLONASS-only and GPS/GLONASS PPP solutions are antenna/radome-independent, while the biases and accuracy are slightly latitude- or Geometric Dilution of Precisions (GDOP)-dependent, as well as the ZTD correlation are highly latitude- or GDOP-dependent. We also studied the impact of the chosen elevation cutoff angles on the positioning and ZTD retrieval. GLONASS-only PPP is found more sensitive with the elevation cutoff angles than GPS-only PPP.