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Precise orbit determination for FY-3C satellite using the onboard BDS GPS observations during 2013∼2017

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FengYun-3C (FY-3C) satellite was launched in 2013 by Meteorological Administration/National Satellite Meteorological Center (CMA/NSMC) of China as the new generation of weather satellite to monitor the Earth's neutral atmosphere, climatic prediction and forecast. The satellite carries a GNSS Occultation Sounder (GNOS) instrument which has the capability to collect both BDS and GPS code and phase observations simultaneously. Based on FY-3C onboard BDS+GPS data from 2013 to 2017, the performance and contribution of BDS to precise orbit determination (POD) for the low earth orbit (LEO) are investigated in this study. The availability of onboard data collected by FY-3C receiver is firstly analyzed and BDS onboard data show a decreasing trend from 2013 to 2017 due to the loss of data. The FY-3C onboard BDS data also provide the possibility to study the BDS satellite-induced code bias. The results show that BDS GEO has a similar satellite-induced code bias like BDS IGSO and MEO. Overlap comparison result indicates that code bias correction of BDS can improve the POD accuracy of 12.4%.

The accuracy of GPS-only POD for FY-3C is comparable to the POD accuracy of GRACE satellite. The orbit accuracy of BDS-only solution is worse than that of GPS-only solution due to the regional system of BDS and the few channels of FY-3C receiver allocated for BDS. For BDS+GPS combined solution, the averaged 1D RMS are (8.00, 2.55, 1.84) cm respectively in 2013, 2015 and 2017 when BDS GEO satellites are included, while the results become (2.33, 1.34, 1.18) cm after the exclusion of GEO satellites, which presents a significant improvement of BDS+GPS POD without GEO satellites. The main reason is the limited geometry and orbit accuracy for GEO satellites. Meanwhile, the accuracy for BDS-only, and BDS+GPS combined solutions are gradually improved from 2013 to 2017 thanks to the accuracy improvement of IGS orbit and clock products recent years, especially the availability of high-frequency satellite clock product since 2015. Moreover, the BDS+GPS POD (without GEO) can achieve better accuracy than GPS-only POD in 2017, which means that the fusion of BDS and GPS observations can further improve the accuracy of LEO POD.

We also perform integrated POD to evaluate the contribution of LEO to GNSS POD. The overlap comparison results show that the 1D RMS of GPS-only POD can improve by 36.8% with FY-3C onboard data. The integrated POD can improve the orbit accuracy for BDS-only solution by 26.4%, 18.7% and 15.6% for GEO, IGSO and MEO respectively, which indicated that the inclusion of LEO can greatly strengthen the geometry for BDS and improve the BDS orbit accuracy. Meanwhile, BDS+GPS combined solution also get a better orbit accuracy after LEO is involved. Moreover, a significant improvement can also be observed in the FY-3C orbit accuracy with the integrated POD processing.