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Precise Orbit Determination of BeiDou Navigation Satellite System

Lina He (1,2), Maorong Ge (2), Jiexian Wang (1), Jens Wickert (2), and Harald Schuh (2)

(1) School of Surveying and Geo-informatics, Tongji University, Shanghai 200092, China(hlnyh@foxmail.com), (2) Department of Geodesy and Remote Sensing, German Research Center for Geosciences(GFZ), Potsdam 14473, Germany(maor@gfz-potsdam.de)

China has been developing its own independent satellite navigation system since decades. Now the COMPASS system, also known as BeiDou, is emerging and gaining more and more interest and attention in the worldwide GNSS communities. The current regional BeiDou system is ready for its operational service around the end of 2012 with a constellation including five Geostationary Earth Orbit satellites (GEO), five Inclined Geosynchronous Orbit satellites (IGSO) and four Medium Earth orbit (MEO) satellites in operation. Besides the open service with positioning accuracy of around 10m which is free to civilian users, both precise relative positioning, and precise point positioning are demonstrated as well. In order to enhance the BeiDou precise positioning service, Precise Orbit Determination (POD) which is essential of any satellite navigation system has been investigated and studied thoroughly. To further improving the orbits of different types of satellites, we study the impact of network coverage on POD data products by comparing results from tracking networks over the Chinese territory, Asian-Pacific, Asian and of global scale. Furthermore, we concentrate on the improvement of involving MEOs on the orbit quality of GEOs and IGSOs. POD with and without MEOs are undertaken and results are analyzed. Finally, integer ambiguity resolution which brings highly improvement on orbits and positions with GPS data is also carried out and its effect on POD data products is assessed and discussed in detail.

Seven weeks of BeiDou data from a ground tracking network, deployed by Wuhan University is employed in this study. The test constellation includes four GEO, five IGSO and two MEO satellites in operation. The three-day solution approach is employed to enhance its strength due to the limited coverage of the tracking network and the small movement of most of the satellites. A number of tracking scenarios and processing schemas are identified and processed and overlapping orbit differences are utilized to qualify the estimated orbits and clocks.

The results show that GEO orbits, especially the along-track component, can be significantly improved by extending the tracking network in China along longitude direction, whereas IGSOs gain more improvement if the tracking network extends in latitude. For the current tracking network, deploying tracking stations on the eastern side, for example in New Zealand and/or in Hawaii, will significantly reduce along-track biases of GEOs on the same side. The involvement of MEOs and ambiguity-fixing also make the orbits better but rather moderate.

Key words: BeiDou, precise orbit determination (POD), tracking network, ambiguity-fixing