Enhanced orbit determination for BDS-3 satellites with LEO onboard GNSS and inter-satellite link data

Hanlin Chen¹, Tao Geng¹, Xin Xie¹, Qiang Li¹, Xing Su², and Qile Zhao¹

¹Wuhan University, GNSS Research Center, Wuhan, China (hanlinchen@whu.edu.cn)
²Shandong University of Science and Technology, Qingdao, China

All BeiDou global navigation satellite system (BDS-3) satellites are equipped with Ka-band inter-satellite link (ISL) payloads to achieve the inter-satellite ranging and communication. With the rapid development of low earth orbit (LEO) satellites, the LEO onboard BDS-3 observations also become available. The LEO onboard and ISL data can be an effective supplement for precise orbit determination (POD) of the BDS-3 satellite. In this research, we processed the integrated POD of BDS-3 and LEO satellites with the real ground station, LEO onboard GNSS, and ISL observations. To analyze the contribution of different data to BDS-3 POD accuracy, four POD schemes are present: ground stations only, ground stations + 1 LEO, ground stations + ISL, and ground stations + 1 LEO + ISL. The ground tracking data are from about 40 globally distributed ground stations and 10 stations in Asia-Pacific region, respectively. The LEO onboard GNSS observations are from a dual-constellation GNSS receiver of the LUTAN-01A satellite, which is a Chinese LEO synthetic-aperture-radar (SAR) satellite for geological observation. The Ka-band observations from more than 400 ISL established between BDS-3 satellites are also used in the integrated POD. The obtained orbits are evaluated by orbit overlaps comparison, the comparison with IGS analysis center precise orbits, and SLR (satellite laser ranging) validation. Compared to the POD using the observation of only 10 ground stations, the addition of 1 LEO onboard GNSS or ISL observations can improve the orbit accuracy of BDS-3 by more than 60%. Furthermore, adding both LEO onboard GNSS and ISL observations simultaneously can lead to further improvements in BDS-3 orbit accuracy.