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An Enhanced Box-Wing Solar Radiation pressure model for BDS and initial results

Qunhe Zhao (1), Xiaoya Wang (1), Xiaogong Hu (1), Rui Guo (2), Lin Shang (3), Chengpan Tang (1), and Fan Shao (1)

(1) Shanghai Astronomical Observatory, Chinese Academy of Sciences, Shanghai, China (zhaoqunhe@163.com), (2) Beijing satellite navigation center, Beijing, China, (3) Shanghai Engineering Center for Microsatellites, Shanghai, China

Solar radiation pressure forces are the largest non-gravitational perturbations acting on GNSS satellites, which is difficult to be accurately modeled due to the complicated and changing satellite attitude and unknown surface material characteristics. By the end of 2015, there are more than 50 stations of the Multi-GNSS Experiment(MGEX) set-up by the IGS. The simple box-plate model relies on coarse assumptions about the dimensions and optical properties of the satellite due to lack of more detailed information. So, a physical model based on BOX-WING model is developed, which is more sophisticated and more detailed physical structure has been taken into account, then calculating pressure forces according to the geometric relations between light rays and surfaces. All the MGEX stations and IGS core stations had been processed for precise orbit determination tests with GPS and BDS observations. Calculation range covers all the two kinds of Eclipsing and non-eclipsing periods in 2015, and we adopted the un-differential observation mode and more accurate values of satellite phase centers. At first, we tried nine parameters model, and then eliminated the parameters with strong correlation between them, came into being five parameters of the model. Five parameters were estimated, such as solar scale, y-bias, three material coefficients of solar panel, x-axis and z-axis panels. Initial results showed that, in the period of yaw-steering mode, use of Enhanced ADBOXW model results in small improvement for IGSO and MEO satellites, and the Root-Mean-Square(RMS) error value of one-day arc orbit decreased by about 10%∼30% except for C08 and C14. The new model mainly improved the along track acceleration, up to 30% while in the radial track was not obvious. The Satellite Laser Ranging(SLR) validation showed, however, that this model had higher prediction accuracy in the period of orbit-normal mode, compared to GFZ multi-GNSS orbit products, as well with relative post-processing results. Because of the system bias and unknown reasons, GEO satellites had bad results, when after adding some Chinese regional stations, there had an obviously improvement of the orbit precision. This model can be used as a priori model to help build experience models for the later works.