

Improving multiple LEO combination for SLR-based geodetic parameters determination using variance component estimation

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The combination of Satellite Laser Ranging (SLR) observations to various Low Earth Orbit (LEO) satellites can enhance the accuracy and robustness of SLR-derived geodetic parameters, benefiting the realization of the International Terrestrial Reference Frames (ITRF). Observation stochastic models play a critical role in the integrated processing of SLR observations to multiple LEO satellites. The consideration of precision in heterogeneous SLR observations from various satellites is essential. In this study, we aim to improve the combination of multi-LEO SLR observations for geodetic parameters determination by optimizing the stochastic model using variance component estimation (VCE). We perform weekly estimates of the geodetic parameters, including station coordinates, Earth rotation parameters (ERP), and geocenter coordinates (GCC), using three years of SLR observations to seven LEO satellites at different orbits. The satellite-dependent, station-dependent, and satellite-station-dependent variance components are separately estimated through VCE processing to refine the stochastic models. Given the fact that the precision of SLR observations significantly differs in satellites and stations, the multiple LEO combination can be significantly improved with the implementation of VCE. Satellite-station-pair dependent variance components are more suitable to the SLR VCE and the accuracy of station coordinates, pole coordinates, and length of day can be averagely improved by 8.4%, 22.6%, and 21.9% respectively, compared to the equal-weight solution. Our result also indicates that the observation insufficiency for some stations may result in an unreliable VCE estimation, and eventually leads to an accuracy degradation for station coordinates. To overcome this deficiency, we adopt the variance components derived from the monthly solutions to build the stochastic model in the weekly solutions. The application of monthly weights can effectively mitigate the accuracy deterioration of station coordinates, improving the repeatability of the station coordinates by 15.9%, 14.6%, and 9.2% with respect to the equal-weight solution in E, N, and U components. The global geodetic parameters also benefit from this processing. The import of monthly weight decreases the outliers in the GCC series, especially in the X and Y components.