EGU2020-486
https://doi.org/10.5194/egusphere-egu2020-486
EGU General Assembly 2020

Determination of global geodetic parameters based on integrated SLR measurements to LEO, geodetic, and Galileo satellites

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Numerous active low Earth orbiters (LEOs) and Global Navigation Satellite System (GNSS) satellites, including the Galileo constellation, are equipped with laser retroreflectors used for Satellite Laser Ranging (SLR). Moreover, most of LEOs are equipped with GNSS receivers for precise orbit determination. SLR measurements to LEOs, GNSS, and geodetic satellites vary in terms of the number of registered normal points (NPs) or registered satellite passes. In 2016-2018, SLR measurements to LEOs constituted 81% of all NPs and 59% of all registered satellite passes, whereas 10% of NPs and 30% of satellite passes, respectively, were assigned to GNSS. The remaining SLR measurements were completed by geodetic satellites, including LAGEOS-1/2, and LARES-1.

In this study, we show that the SLR observations to Galileo, passive geodetic and active LEO satellites together with precise GNSS-based orbits of LEOs and Galileo, can be used for the determination of global geodetic parameters, such as geocenter coordinates (GCC) and Earth rotation parameters (ERPs), i.e. pole coordinates, and length-of-day parameter.

GCC are typically determined using SLR observations to passive geodetic satellites, such as LAGEOS-1/2. Also, the SLR observations to LAGEOS-1/2 together with GNSS and Very Long Baseline Interferometry data are used for the determination of ERPs. Here, we use SLR observations to Galileo, LAGEOS-1/2, LARES-1, Sentinel-3A, SWARM-A/B/C, TerraSAR-X, Jason-2, GRACE-A/B satellites to investigate whether they can be applied for the reference frame realization and for deriving high-quality global geodetic parameters.

We present various types of solutions to investigate the best solution set-up. The studied solutions differ in terms of solution lengths, the combination of different sets of satellites and the relative weights for the variance scaling factors of technique and satellite-specific normal equations. We compare our results with the standard LAGEOS-based solutions, the combined EOP-14-C04 products and show the consistency of the results.