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Contribution of LARES-2 to the realization of reference frames, deriving Earth rotation and gravity field parameters

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LAser RElativity Satellite 2 (LARES-2) successfully joined the constellation of geodetic satellites tracked by Satellite Laser Ranging (SLR) stations on July 13, 2022. LARES-2 has a spherical shape and a very favorable area-to-mass ratio that minimizes the non-gravitational orbit perturbations. Due to very small retroreflectors, the spread of center-of-mass corrections for different detectors installed at SLR sites is much smaller than for LAGEOS satellites. LARES-2 orbits at a similar height as LAGEOS-1, however, with a complementary inclination angle of 70° forming a butterfly configuration together with LAGEOS-1.

Although the primary objective of LARES-2 is verification of the Lense-Thirring effect emerging from general relativity, the satellite also has a substantial impact on the geodetic parameters derived from SLR observations. We process 18 months of LARES-2 data and compare the LAGEOS-1/2 solutions with the combined LAGEOS-1/2+LARES-2 solutions. We show the impact of LARES-2 on the (1) SLR station coordinates, (2) pole coordinates, (3) length-of-day excess, (4) low-degree gravity field parameters focusing on C_{20} and C_{30} coefficients, (5) scale of the reference frame, (6) geocenter motion. We show that LARES-2 can especially improve the Z component of the geocenter coordinates and de-correlate C_{20} from the length-of-day parameter. The secular drifts of the ascending nodes for LARES-1 and LAGEOS-1 caused by C_{20} are the same in terms of absolute values but with opposite signs. This allows us to successfully separate the measurements of length-of-day excess (or the UT rate) from the C_{20}-induced changes. We also analyze the empirical accelerations acting on LARES-2 which result from unmodeled non-gravitational orbit perturbations, such as thermal effects, and compare them to those observed for LAGEOS satellites. The observation geometry of LARES-2 is especially beneficial for stations located at high and medium latitudes, which allows it to improve the estimation of station coordinates provided by LAGEOS-1/2. Therefore, LARES-2 substantially contributes not only to general relativity and fundamental physics but also to space geodesy improving the future realizations of the international terrestrial reference frames.