Consistent estimation of station coordinates, Earth orientation parameters and selected low degree Earth’s gravity field coefficients from SLR measurements

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Abstract:

Precise knowledge on the fundamental geodetic parameters, such as positions of tracking stations, Earth Orientation Parameters (EOP) and coefficients of the Earth’s gravity field is, among others, necessary for precise orbit determination of Earth’s artificial satellites, including altimetry satellites. Satellite Laser Ranging (SLR) to geodetic cannon-ball satellites allows determining station coordinates and their velocities, EOP and low degree coefficients of the Earth gravity field. In an actual realization of a global Terrestrial Reference Frame (TRF), only EOP values are consistently estimated with station coordinates and velocities, while the coefficients of the Earth gravity field are determined separately using fixed TRF and EOP. In this presentation, we show the results of a consistent estimation of weekly 3-D station coordinates, EOP including daily x- and y-pole coordinates and the excess length-of-day (LOD), and selected weekly Earth’s gravitational field (Stokes) coefficients up to degree and order 6. We use for this purpose SLR measurements to up to 11 geodetic satellites
LAGEOS-1/2, Etalon-1/2, Stella, Starlette, Ajsai, Larets, LARES, BLITS and WESTPAC covering totally a 38-year time span from February 16, 1979 to April 30, 2017. We show that the correlations between the estimated parameters are significantly reduced when multiple satellites with various altitudes and orbit inclinations are combined. This allows us to estimate reliable parameters with better precision compared to the standard four-satellite constellation (LAGEOS-1/2, Etalon-1/2) which is currently used by the International Laser Ranging Service (ILRS) for the determination of the TRF and EOP products. In particular, the Stokes coefficients, EOP and TRF datum parameters (3 translations, 3 rotations, 1 scale factor), which are highly correlated with satellite specific orbit parameters, are improved. A special attention is given in to the improved determination of low degree gravitational field coefficients, in particular, degree 1 coefficients representing the geocentre motion, a proper modelling of which is important for precise orbit determination of altimetry satellites.

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