Impact of the network constraining strategy on the quality of SLR-based global geodetic parameters

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The Satellite Laser Ranging (SLR) network struggles with some limitations including the inhomogeneous global distribution of stations and uneven performance of SLR sites. Only the most reliable stations can be taken into account to realize the reference frame from global SLR processing correctly. The International Laser Ranging Service (ILRS) prepares the time-variable list of the most well-performing stations denoted as ‘core sites’ and recommends using them for the reference frame realization in SLR processing. We explore how relevant the list of core sites is and whether any stations outside the list of core sites are suitable for the reference frame realization.

In the frame of this contribution we check how different approaches of the reference frame realization using minimum constraint conditions and the selection of core sites affect the estimated SLR station coordinates, the global scale, Earth rotation parameters, and geocenter coordinates. The analyses are made on the results from the processing of the SLR observations to LAGEOS-1 and -2 in 2010-2018.

The results show that all the stations, which are currently classified as core stations by the ILRS, were actually very stable in the analysed timespan. However, we show that it is essential to reject epoch-wise outlying stations from the reference frame realization to maintain a high quality of SLR-based products. We test station selection criteria based on the Helmert transformation to reject misbehaving stations from the list of datum-defining stations using different acceptability thresholds. The 25 mm threshold is considered to be optimal to both eliminate the epoch-wise temporal deviations and not to deteriorate the minimum number of datum-defining stations. According to the station selection algorithm, we found that some of the stations outside the list of core sites were accepted for the reference frame realization in more than 80% of their occurrences.

When using a robust station selection for the datum definition, we can improve the station coordinate repeatability by 8%, 4%, and 6%, for the North, East and Up components, respectively. The global distribution of datum-defining stations is also crucial for the estimation of Earth rotation parameters and geocenter motion. The distribution of selected stations can affect the amplitude of the annual signal in the geocenter coordinate estimates up to 0.5 mm, and may increase the noise of the estimated pole coordinates when excluding just two core stations from the SLR network.

Keywords: Satellite Laser Ranging, Minimum constraint conditions, Reference frame realization

