LARES: Analysis of the First Months of Data

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Introduction

LARES (LAser RElativity Satellite) is a new geodetic satellite in Earth's orbit since February 13, 2012. This satellite currently has the smallest area-to-mass ratio amongst all artificial satellites. We analyze the first half year of SLR measurements to LARES and compute weekly combined solutions together with the observations to LAGEOS and Etalon satellites. The solution follows the standard procedures used to generate the LAGEOS-Etalon solutions within the ILRS Analysis Working Group (AWG). The estimated range bias (RGB) parameters and the range residuals are analyzed with respect to specific characteristics. Both can be an indication whether the tentative center-of-mass (CoM) correction of 133 ± 5mm (Neubert, 2011) is appropriate or whether an improvement is needed.

Solution Setup

For the analysis at hand, 31 weekly solutions in the period from February 19 to September 22, 2012 (day of year 050-266) have been computed with the Bernese GNSS Software, including SLR extensions (Thaller et al., 2009). In this period, more than 58'000 normal points from 29 stations could be used for LARES.

For the combined weekly solutions of LARES together with LAGEOS-1, LAGEOS-2, Etalon-1 and Etalon-2 (Thaller et al., 2012), the following parameters are estimated: Station coordinates, Earth rotation parameters (piece-wise constant polar motion and length of day), geocenter coordinates, RGBs and satellite orbits. More precisely, RGBs for LAGEOS and Etalon satellites are estimated only for a few sites according to the guidelines of the AWG, whereas the station specific RGBs are setup for the observations to LARES.

The seven-day orbits for each satellite consist of six osculating orbital elements together with dynamic orbital parameters, namely a constant and a once-per-revolution acceleration in along-track direction as well as a once-per-revolution acceleration in out-of-plane direction. LARES-specific once-per-revolution pseudo-stochastic pulses in along-track direction were added. The background models are identical for all satellites, except for the air drag model: The NRLMSISE-00 (Picone et al., 2002) was considered for LARES only due to its low altitude of 1450km. No-net-rotation and -translation conditions were applied over a set of 7-12 stable fiducial stations per week for datum definition.

LARES Residual and Range Bias Analysis

After estimating RGBs the mean residual for all LARES normal points is -0.4mm with a standard deviation of 20.6mm.

The mean weekly RGBs for LARES observations (see Fig. 1) show no significant differences from zero within 2σ for all the evaluated stations. By considering only the stations with a standard deviation smaller than 20mm, the mean overall RGB is 0.4 ± 5mm (1 σ).

Further insights can be gained by comparing RGBs for different satellites at one station. For example, the SLR station Wettzell is shown (see Fig. 2). The mean RGBs for the three satellites LARES, LAGEOS-1 and LAGEOS-2 do not significantly differ. All stations with estimated RGBs also for LAGEOS show the same behavior. This leads to the conclusion that possible RBGs are due to station issues, i.e., different pulse widths, detector systems, and edit levels, rather than due to inaccurate CoM corrections.

Summary

The mean range bias for LARES over all stations is 0.4 ± 5mm (1 σ). The comparisons with the estimated range biases for LAGEOS-1 and LAGEOS-2 for a few sites do not show any systematic offsets between these three satellites. Thus, we can conclude that the tentative CoM correction of 133 ± 5mm is appropriate within the given bandwidth. In addition, the obtained results fit well to the CoM range of 131.0 to 137.1mm given by Otsubo (2011). Station-specific differences have to be further investigated, of course.

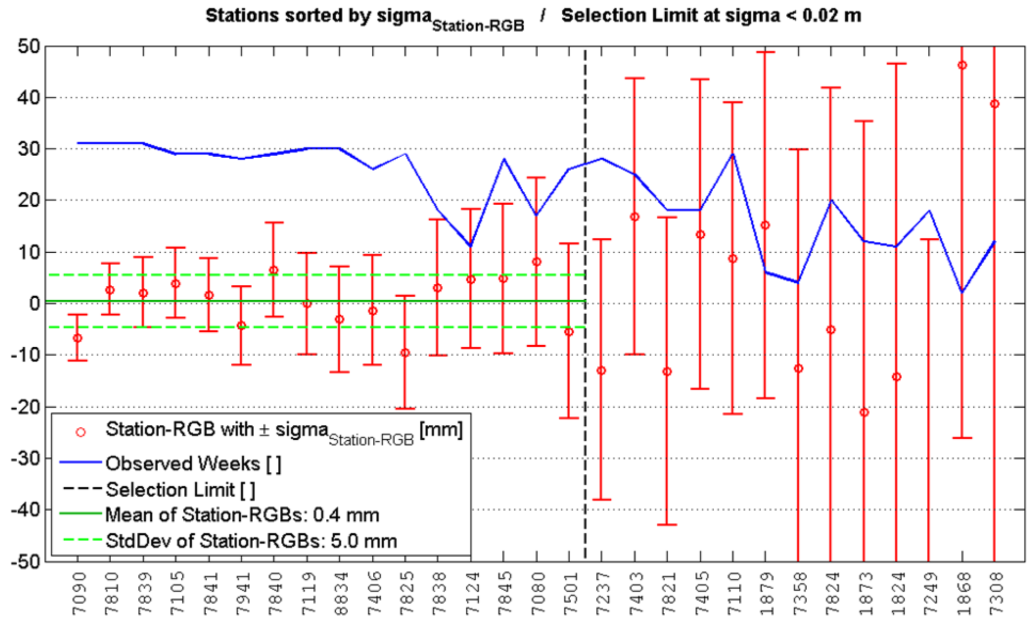

Fig. 1. LARES RGB results for SLR stations tracking LARES.

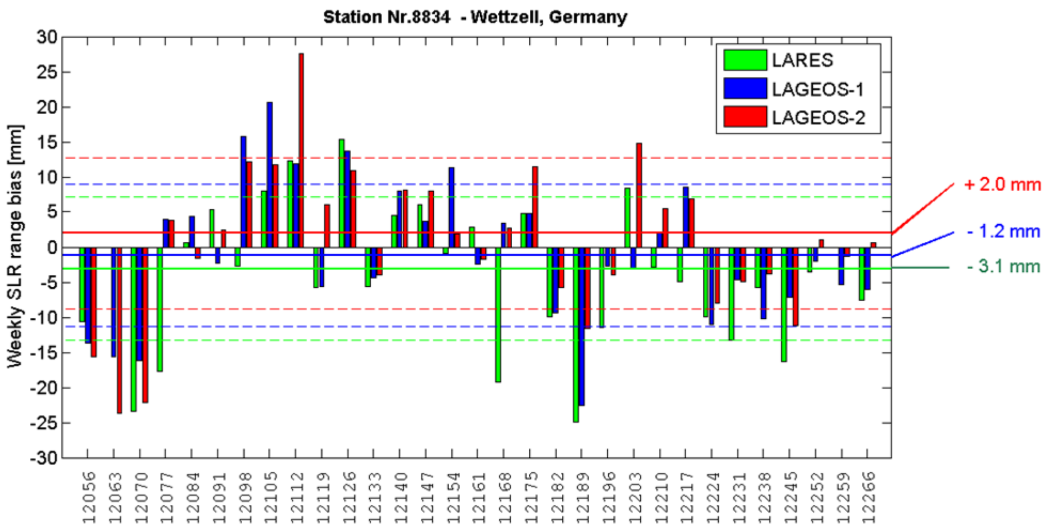

Fig. 2. Comparison of weekly range biases. On the abscissa the last DOY (Saturday) of the weekly solutions are labeled. The colored dashed lines indicate the 1σ-interval of the mean RGB (solid line).

References

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