The Centre of Mass Correction of LARES and LAGEOS

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Abstract

A preliminary estimate of the center of mass correction (CoM) for the new LARES satellite has been given prior to launch assuming that the cube corners behave like LAGEOS and the SLR system response function is symmetric (*). In this study we update the CoM estimate for LARES and LAGEOS using real data from the stations Potsdam and Herstmonceux. Both systems work at single photoelectron level and 2 kHz repetition rate.

Method

The principle of CoM estimate has been described elsewhere [1],[2]. The main idea is to fit a model distribution (satellite response function) to the observed distribution of range residuals. The model distribution is related to the center of the spherical satellite and its first moment is equal to the desired CoM in case of a symmetrical system response and no data clipping. The model uses the following simple relation to describe the relative intensity of individual cube corners: intensity= (active area)^p x (reflectivity), where the exponent p is the only free parameter. This simple relation successfully absorbs all the effects of diffraction and aberration as well as thermal deformation of the cubes and manufacturing errors. The satellite response function has been constructed by two independent methods:

a) fully analytically [1].
b) simulation [2]

Both methods are leading to the same satellite response function despite small numerical effects in the simulation. The satellite response function is then convoluted with the system response and the result compared with the distribution of range residuals. This is done with different parameters p in the range 1…2 in steps of 0.1. This way the optimum parameter p for best fit is determined.

As system response the distribution of range residuals of a GRACE pass has been used in case of Potsdam, and the distribution of calibration data in case of Herstmonceux. The unclipped system response has been used for the convolution. Then iterative clipping has been applied for both the (convoluted) model as well as the system response using the edit criteria typical for the stations. Clipping the system response results in a shift of the mean. This shift is subtracted from the first moment of the model distribution to get the CoM value.

Table of Results

Satellite	Potsdam			Herstmonceux		
	CoM/mm	Det./edit	ILRS	CoM/mm	Det./edit	ILRS
LARES	130	PMT/2.5σ	133*)			
	132	SPAD/2.2σ		130	cSPAD/3s	133*)
LAGEOS	244	PMT/2.5σ	251**)			
	246	SPAD/2.2σ		TBD	cSPAD/3s	245**)

*) http://ilrs.gsfc.nasa.gov/missions/satellite_missions/current_missions/lars_com.html
**) http://ilrs.gsfc.nasa.gov/network/site_information/nsgf_iCoM_LAGEOScorrections.html

Conclusion

The results for LARES are very close to the preliminary estimate. The LAGEOS CoM for Potsdam is significantly lower than the ILRS value. Stations should publish the edit criteria in the configuration file (and data header).

References:

[1] R.Neubert, The Centre of Mass Corrections of Spherical Satellites
http://cddis.gsfc.nasa.gov/lw12/docs/neubert_COM.pdf
[2] Otsubo, T., Appleby, G. M., System-dependent center-of-mass correction for spherical geodetic satellites, Journal of Geophysical Research (Solid Earth) 108, 9-1, 2003.