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The SLR observations to GNSS satellites: Preliminary results and open questions

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Introduction

We present the initial results regarding the analysis of the SLR observations to the GNSS satellites. This is the first step of our project which deals with the optimal combination (in NEQ level) of the following data sources: (a) SLR@GNSS , (b) classical SLR (LAG+ETAL) and (c) GNSS only. Here, we show the results after the first data screening of the SLR@GNSS observations. We used observations both for GPS and GLONASS satellites from the 1st Jan. of 2000 to 6th. Jun. of 2015. We employed the utilities of SLR analysis of the Bernese GNSS Software development version.

Rationale of the Daily SLR residuals Computation (DSRC)

The DRBC is done by comparing the spatial distance differences between (1) the SLR range measurements and (2) the 3D computed distances between the stations coordinates and the GNSS satellite positions, derived from the CODE precise orbits. We used the ITRF2014 coordinates and velocities, exploiting the full Post-Seismic Deformation (PSD) information for the stations.

DSRC = SLR range – 3D distance (orbits+stations)

The initial SLR network comprised 46 stations which have tracking record of GNSS satellites. In order to proceed to a more rigorous analysis, we screened the delivered results using the well-known 3σ criterion:

DSRC – mean(DSRC) > 3σ → rejection

The application of the 3σ criterion was done using iterations, till no-blounder was identified. Finally, a set of 43 SLR stations found to fulfill the above mentioned criterion. Figures 1 and 2 show the final number (after the application of the 3σ criterion) of observations per station and satellite, respectively. Figures 3 and 4 depict the bias behavior of the Station 7358 ánd the SVN 734, respectively.

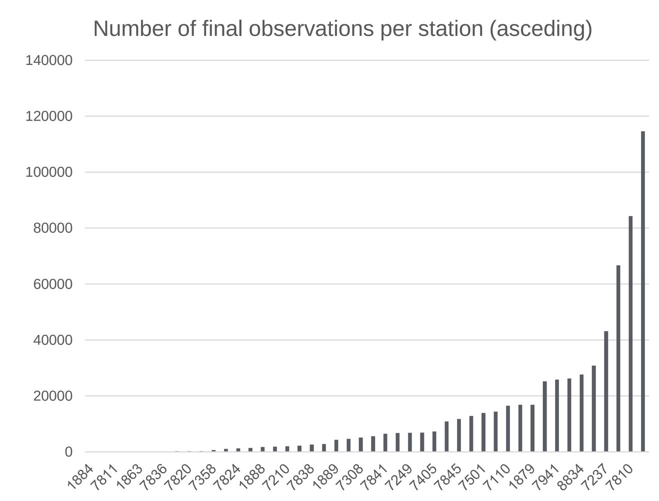

Fig.1: The final number of the used observations per station

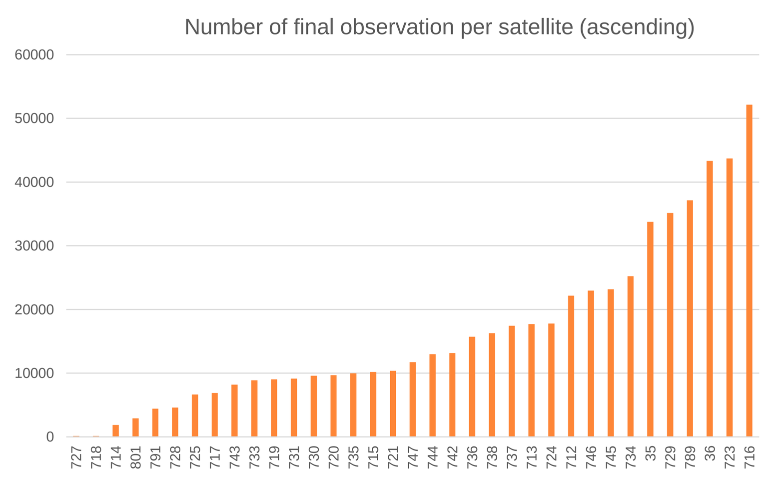

Fig.2: The final number of the used observations per satellite (svn)

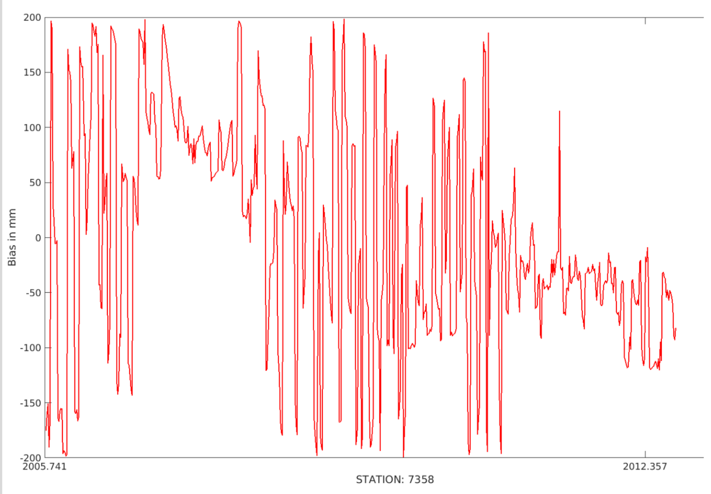

Fig.3: The bias of the station 7358 (Tanegashima, Japan)

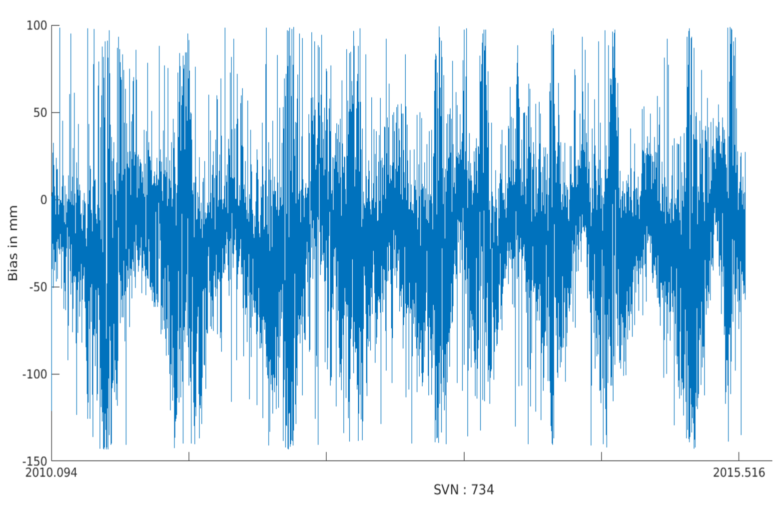

Fig.4: The bias of the SVN 734 (GLONASS)

Results

The results include two different comparisons: (1) The first comprises the range bias per SLR-station and (2) the second one refers to the range bias per satellite. Figures 5 and 6 illustrate the rms of the SLR residuals, while Figures 7 and 8 show the mean SLR residuals, respectively. Figure 9 illustrates the global SLR network we used.

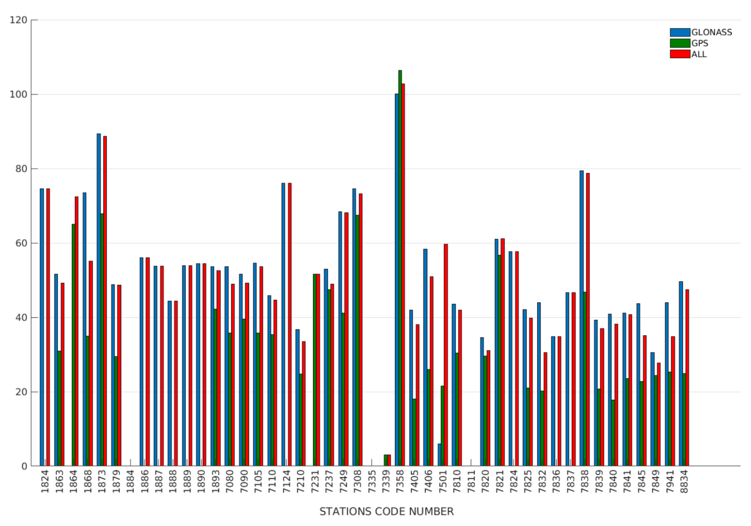

Fig.5: The rms of the SLR residuals per station

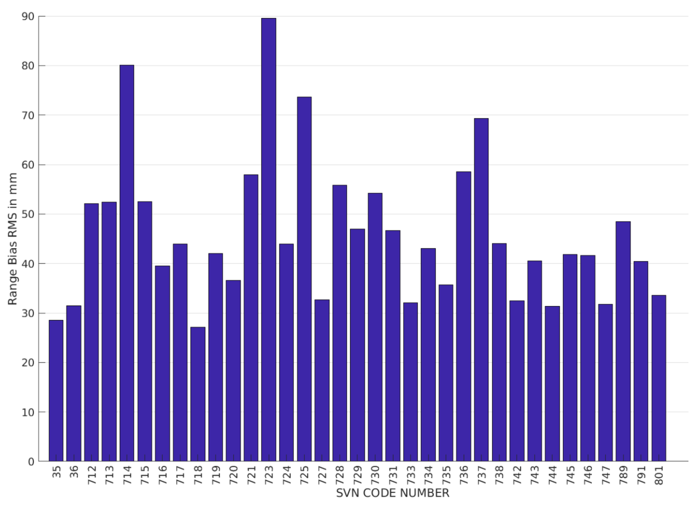

Fig.6: The rms of the SLR residuals per SVN

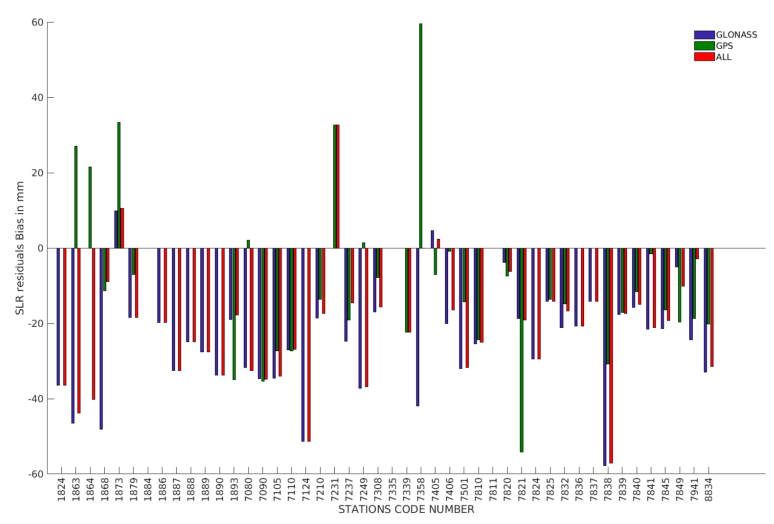

Fig.7: The mean of the SLR residuals per station

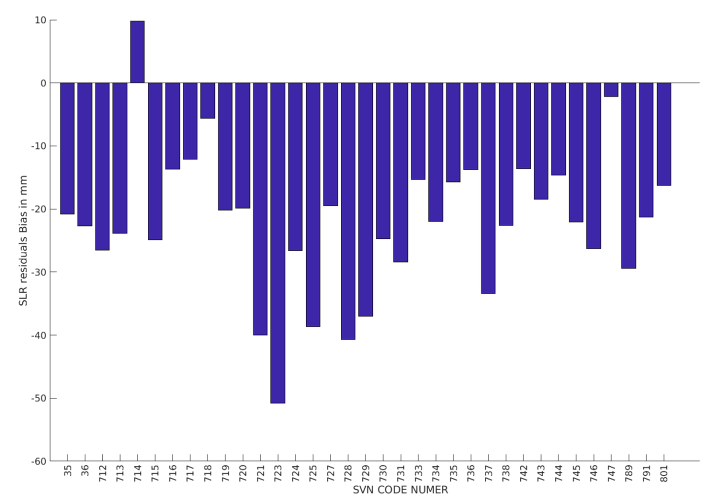

Fig.8: The mean of the SLR residuals per station

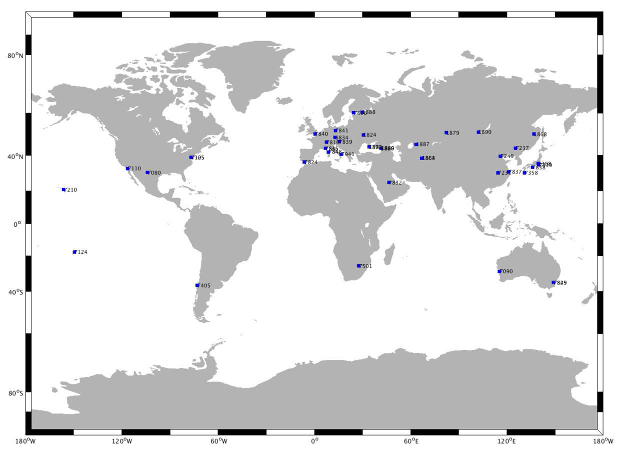

Fig.9: The global SLR network used in the present study.

I. The median of the mean SLR residuals per stations are:

a. -24.5 mm (GLONASS)
b. -13.6 mm (GPS)
c. -19.8 mm (GPS+GLONASS)

II. The median of the mean SLR residuals per satellites are:

a .-22.3 mm (GLONASS)
b. -21.8 mm (GPS)

The results indicate differences regarding the bias performance between the GPS and GLONASS satelites: The GPS satellites show smaller rms than the GLONASS satellites. There is a number of possible reasons for these bias performance like (a) SLR instrumental biases, the (b) Laser Range Array (LRA) discrepancies of the GNSS reflectors (c) the Satellite Antenna Offsets estimation the (d) the stability of the stations.

Further investigations

The DSRC reveals a mean rms of ~25 mm for the GLONASS and < 15 mm for the GPS, respectively (for the stations). This fact should be thoroughly investigated, using GNSS and classical SLR observations, respectively. We should also point out that for the rigorous SLR analysis the weekly solution is used. The next steps of the project will include all the necessary methodologies for the derivation of range biases estimation (along with other parameters such as stations coordinates, satellite orbits and ERPs).

The presented work is a part of BKG project under the title : „Establishment of assessment methodologies for the consistent realization of the global reference systems (KoKoRef)“