PROCESSING 20 YEARS OF SLR OBSERVATIONS TO GNSS SATELLITES

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Abstract: Satellite Laser Ranges to GNSS satellites provide valuable and substantial information about the accuracy and quality of GNSS orbits [1]. Intensive SLR tracking of GNSS constellations allows the co-location of both techniques of satellite geodesy in space [2], allows for the scale transfer from SLR to GNSS networks, and improves the realization of the reference frame origin in the GNSS network (i.e., the geocenter coordinates [3]).

The 18th International Workshop on Laser Ranging, which was held in Fujiyoshida (Japan) in November 2013, recognized the increasing importance of SLR to the improvement of GNSS orbit performance [4]. The LAser Ranging to GNSS s/c Experiment (LARGE) group was established in the aftermath of this workshop. The resolution of the workshop paid special attention to “the necessity of the SLR technique to the improvement of time, frequency, and ephemeris data products from GNSS” and to “the significant contribution of GGOS to the development of GNSS measurement accuracy through co-location with SLR and other measurement techniques”. Today, all active GLONASS satellites are tracked by a large number of SLR stations, which gives us a very good tracking record of different GNSS satellites.

We process 20 years of SLR observations to GPS and GLONASS satellites using the reprocessed 3-day and 1-day microwave orbits provided by the Center for Orbit Determination in Europe (CODE) for the period 1994-2013. We study the dependency of the SLR residuals on the size, shape, and number of corner cubes in satellite laser reflector arrays (LRA) [5,6]. We show that the mean SLR residuals and the RMS of residuals depend on the coating of LRA and the block or type of GNSS satellites. The SLR mean residuals are also a function of the equipment used at SLR stations including the laser and detector types. On the other hand, we found that the SLR residuals are independent from the GNSS orbital planes.

SLR observations to GNSS satellites yield, as well, a remarkably important tool in a sense of the validation of GNSS orbits and the assessment of deficiencies in the solar radiation pressure modeling. We found that there are still many systematic effects in GNSS orbit modeling, especially for the eclipsing periods and for the periods with the high elevation of the Sun over the orbital plane. The SLR residuals clearly indicate that the solar radiation pressure modeling of GNSS satellites needs to be further improved in the near future.

References: [1] Thaller, D., R. Dach, M. Seitz, G. Beutler, M. Mareyen, B. Richter (2011): Combination of GNSS and SLR observations using satellite co-locations. Journal of Geodesy, vol. 85(5), pp. 257-272, DOI 10.1007/s00190-010-0433-z.

[2] Thaller, D., K. Sośnica, R. Dach, A. Jäggi, C. Baumann (2012): The space tie between GNSS and SLR. Proceedings of the International Technical Laser Workshop 2012 (ITLW-12), Frascati (Rome), Italy, November 5-9, 2012

[3] Thaller, D., K. Sośnica, R. Dach, A. Jäggi, C. Baumann (2012): SLR residuals to GPS / GLONASS and combined GNSS-SLR analysis. Proceedings of the International Technical Laser Workshop 2012 (ITLW-12), Frascati (Rome), Italy, November 5-9, 2012

[4] Resolutions of the 18th International Workshop on Laser Ranging, Fujiyoshida 11-15 November 2013, Japan (2013).

[5] Fritsche, M., K. Sośnica, C. Rodriguez-Solano, P. Steigenberger, R. Dietrich, R. Dach, K. Wang, U. Hugentobler, M. Rothacher (2014): Homogeneous reprocessing of GPS, GLONASS and SLR observations. Journal of Geodesy, vol. 88(7), pp. 625-642. DOI 10.1007/s00190-014-0710-3

[6] Sośnica, K., R. Dach, A. Jäggi, P. Steigenberger, D. Thaller; 2014: GNSS orbit validation using SLR at CODE. IGS Workshop 2014, June 23-27, Pasadena, California, USA.