REFAG 2022 THESSALONIKI - GREECE 17-20 October 2022

Global reference frame realization onboard GNSS satellites

Grzegorz Bury (Institute of Geodesy and Geoinformatics, Wrocław University of Environmental and Life Sciences), Krzysztof Sośnica (Institute of Geodesy and Geoinformatics, Wrocław University of Environmental and Life Sciences), Radosław Zajdel (Institute of Geodesy and Geoinformatics, Wrocław University of Environmental and Life Sciences), Dariusz Strugarek (Institute of Geodesy and Geoinformatics, Wrocław University of Environmental and Life Sciences) and Urs Hugentobler (Institute for Astronomical and Physical Geodesy, Technical University of Munich)

Abstract. Modern satellites of the Global Navigation Satellite Systems (GNSS), such as Galileo, carry onboard laser retroreflector arrays (LRA) for the Satellite Laser Ranging (SLR). Colocation of two space geodetic techniques onboard GNSS allows for the realization of the global geodetic reference frames using integrated GNSS and SLR observations. Currently, the SLR-to-GNSS satellites are neglected for the realization of the terrestrial reference frames (TRF).

This study presents the results of the combination of the GNSS and SLR observations aiming at the realization of TRF. We test different approaches for the GNSS and SLR network constraining. The best results are obtained when No-Net-Translation (NNT) and No-Net-Rotation (NNR) minimum constraints are applied to GNSS and SLR networks. When NNT and NNR constraints are imposed on two networks the 3D station coordinates repeatability is at the level of 5.8 mm (40.7 mm) for GNSS (SLR) stations. In contrast, when the NNT constraint is neglected, the 3D repeatability is at the level of 9.8 mm (45.9 mm) for GNSS (SLR) sites. When the SLR network is freed from the minimum constraints, we obtained the strength value of the SLR-GNSS connection which is at the level of 40-50 mm for the 1-day solution.

The secondary product which is delivered as a colocation result is the so-called space ties. The space ties are the estimation linkage between co-located GNSS and SLR stations which constitutes an equivalent of the ground measured local ties. The agreement of single space ties with ground measurements is at the level of 2.4 mm for the station Wettzell, Germany, and 1 mm in terms of long-term mean values for the co-located station in Zimmerwald, Switzerland. The estimated values of local ties using integrated GNSS and SLR-to-GNSS observations might be used for validating the local ground measurements or may constitute additional data with full variance-covariance information as an input for the future releases of the International Terrestrial Reference Frames. All that makes the GNSS satellite the great probe for the realization of global TRFs in space.