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TITLE Impact of atmospheric pressure loading on SLR-derived station coordinates using range measurements to multi-GNSS satellites

ABSTRACT

The current requirements imposed by the Global Geodetic Observing System (GGOS) demand an integrated, stable in time, and accurate at the level of 1 mm, reference frame. Due to that fact, the solutions based on several space techniques should be as consistent as possible.

Satellite Laser Ranging (SLR) is a precise space technique that provides range measurements to artificial satellites equipped with laser retroreflectors. SLR contributes to GGOS to a great extent i.e., provides the origin of the International Terrestrial Reference Frame, the global scale, satellite orbits, gravity field parameters, and station coordinates. The Multi-GNSS Experiment (MGEX) was initiated, because of the emerging of new navigation system i.e., Galileo, BeiDou, QZSS, and NavIC and modernized GPS and GLONASS. SLR measurements are performed to new GNSS, because all new active multi-GNSS satellites are equipped with Laser Retroreflector Arrays. As a result, SLR became an independent tool for investigation of systematic errors that microwave solutions suffer from, as well as for the SLR-GNSS co-location in space.

Displacements of the Earth's crust caused by tidal and non-tidal forces play a crucial role in precise space geodesy. The omission of atmospheric pressure loading models during SLR data processing may lead to inconsistency between microwave (GNSS) and optical (SLR) solutions. SLR observations can be performed only during cloudless conditions, which coincide with high values of air pressure. High atmospheric pressure deforms the Earth's crust. The systematic shift of the stations heights is called the Blue-sky effect.

The goal of this study is to determine the value of the Blue-sky effect for particular SLR stations using range measurements to multi-GNSS satellites. Predictably, the highest value of the Blue-sky effect is observed for the inland stations i.e., 2.3 mm for Svetloe, 2.0 mm for Potsdam and Baikonur, and 1.9 mm for Altay. For the coastal stations, the effect is exiguous i.e., 0.3 mm for Yarragadee and 0.0 mm for Tahiti.

Applying the Blue-sky effect calculated basing on range measurements to multi-GNSS satellites improves the consistency between SLR and GNSS solution thus it should be performed by SLR Analysis Centers. Even a sub-millimeters values of systematic shift should be taken into consideration if we want to fulfill the 1-mm requirements imposed by GGOS.