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Exploring LEO cube satellite technology for space geodesy: SLR-VLBI POD in the GGOS era

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With test satellites already in space, the Swiss company Astrocast is currently in the process of establishing a constellation of about 80 nanosatellites for commercial purposes that are operating in a low Earth orbit (LEO). As a result of the collaboration with ETH Zürich, such satellites will be equipped with both low-cost multi-GNSS dual-frequency receivers and a small array of laser retroreflectors for satellite laser ranging (SLR). In the future, this set of geodetic instruments could be also extended with a simple, compact and low-power transmitter compliant with the next-generation very long baseline interferometry (VLBI) system, known as the VLBI Global Observing System (VGOS). Therefore, apart from scientific studies based on such state-of-the-art multi-GNSS receivers in space, the Astrocast nanosatellite network could also be examined in terms of satellite co-locations. In this case, the new geometrical connections in space could be realized together with all ground-based instruments that can observe the co-location satellites. Assuming sufficient precision of such observations and good knowledge of the spacecraft environment, this approach could result in an enhanced quantity of tie measurements at a high spatio-temporal resolution, potentially leading also to an enhanced quality of common geodetic parameters. However, accurate orbit determination is of high importance, whenever considering potential co-location in space or, in general, estimating various global parameters of geophysical interest.

In this contribution, we focus on precise orbit determination (POD) of LEO Astrocast-type nanosatellites based on global SLR-only, VGOS-only as well as combined SLR-VGOS observations. The impact of this concept on various geodetic parameters and the derived orbits is studied on the basis of Monte-Carlo simulations carried out with the c5++ analysis software. All simulated data are combined on the observation level and used to derive satellite orbits and to estimate both, station-based and global geodetic parameters. Our study is based on VGOS-type schedules created in VieSched++ and consisting of both quasar and satellite observations. In addition to the simulated laser measurements to Astrocast satellites, the SLR-related solutions include also global observations to LAGEOS-1/2 satellites. Our considerations involve solutions with different time intervals, satellite observation precision levels and quantity of the considered cube satellites, providing thus initial insights concerning prospective utilization of LEO cube satellite technology for space geodesy in the era of the Global Geodetic Observing System.