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Consistency of Galileo Satellite Antenna Phase Center Offsets

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Abstract. Knowledge of the satellite antenna phase center offsets (PCOs) is a prerequisite for precise applications of Global Navigation Satellite Systems (GNSSs). For all satellites of the European GNSS Galileo, satellite-specific pre-launch chamber calibrations of the PCOs were published by the European GNSS Service Center. They comprise frequency-specific values for the E1, E5a, E5b, E5, and E6 frequency bands. Galileo orbit and clock products of the analysis centers of the International GNSS Service (IGS) refer to the ionosphere-free linear combination of E1 and E5a. Whereas tracking of early Galileo receivers was limited to these two frequencies, an increasing number of IGS stations nowadays also provide E5b and E6 observations. In the frame of the 3rd IGS reprocessing campaign, multi-frequency receiver antenna calibrations including the E5b and E6 were made available allowing for a consistent processing of these observations.

Recent analysis of BeiDou-3 satellite antenna PCOs revealed inconsistencies of the B1C/B2a and B1/B3 antenna calibrations that are the motivation for the current study. To analyze the consistency of the ground-calibrated Galileo satellite antenna PCOs, PCO values are estimated from ionosphere-free linear combinations of E1/E5a, E1/E5b, and E1/E6 observations. The global network comprises about 140 stations supporting all four frequencies and equipped with fully calibrated receiver antennas. The stability of the estimated PCOs is evaluated and they are compared to the pre-flight chamber calibrations.

The scale of the ground network used for PCO estimation is fixed to the most recent release of the International Terrestrial Reference Frame (ITRF2020). The scale of ITRF2020 is defined by Very Long Baseline Interferometry (VLBI) and Satellite Laser Ranging (SLR). Due to a significant offset of the Galileo-based scale, this technique did not contribute to the ITRF2020 scale realization. As a consequence, a systematic offset of 1-2 dm between the chamber-calibrated Galileo PCOs and the estimated ones is expected. Therefore, differences between individual frequency pairs are used for the consistency analysis. This consistency is in particular important for multi-frequency precise point positioning applications utilizing three or even four frequencies. Such applications are expected to grow in the near future in view of the provision of multi-frequency correction data by the Galileo high accuracy service.