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Extension of the GPS satellite antenna patterns to nadir angles beyond 14°

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The absolute phase center model igs08.atx adopted by the International GNSS Service (IGS) in 2011 is based on robot calibrations for more than 200 terrestrial GNSS receiver antennas and consistent correction values for the GNSS transmitter antennas estimated from tracking data of the global IGS ground network. As the calibration of the satellite antennas is solely based on terrestrial measurements, the estimation of their phase patterns is limited to a nadir angle of 14°. This is not sufficient for the analysis of spaceborne GPS data collected by low Earth orbiting (LEO) satellites that record - depending on the missions' orbital altitude - observations at nadir angles of up to 17°.

We use GPS tracking data from the LEO missions Jason–1/2, MetOp–A, GRACE, and GOCE to extend the IGS satellite antenna patterns to nadir angles beyond 14° using different processing strategies and GNSS software packages (BERNESE, NAPEOS). In order to achieve estimates that are consistent with the PCVs currently used within the IGS, GPS satellite orbits and clocks are fixed to reprocessed solutions obtained by adopting the IGS conventional values from igs08.atx. Due to significant near-field multipath effects arising in the LEO spacecraft environment, it is necessary to solve for GPS (nadir–dependent only) and LEO (azimuth– and elevation–dependent) antenna patterns simultaneously. We compare and combine the results obtained with both software packages and derive the PCV extension proposed for igs08.atx.