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Single-receiver ambiguity fixing for GPS-based precise orbit determination of low Earth orbiters using CODE's new clock and phase bias products

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GNSS-based Precise Orbit Determination (POD) of Low Earth Orbiters (LEOs) has nowadays become a standard application for high-quality GNSS products as provided by the IGS, or its individual analysis centers. For many LEOs, e.g., for altimetry missions, the centimeter absolute orbit precision and accuracy achieved by carrier phase-based GNSS positioning is mandatory and could hardly be obtained by other tracking data.

Fixing the carrier phase ambiguities to their integer values has been known to inherently stabilize solutions for parameters since a long time and has been confirmed in many applications. In case of LEO POD, this has been shown extensively, e.g., by double difference processing of space or space-ground baselines for relative POD, allowing for ambiguity resolution without using any dedicated GNSS products in addition. While the processing of space baselines is feasible only for constellations of LEOs in formation flight (e.g., GRACE), the processing of space-ground baselines is very costly in computational terms if all correlations shall be modeled correctly.

Single-receiver or undifferenced ambiguity fixing in Precise Point Positioning processing requires the knowledge of GNSS satellite phase biases which cancel out in forming baselines. Such products have been provided by the CNES/CLS (Centre National d'Etudes Spatiales/Collecte Localisation Satellites) analysis center of the IGS since a few years. Recently, the Center for Orbit Determination in Europe (CODE) IGS analysis center has established the generation of a high-quality signal-specific phase bias product and a fully consistent ambiguity-fixed clock product within its rapid and final IGS-related processing.

On the basis of these new CODE bias and clock products, we demonstrate the performance of single-receiver ambiguity resolution for the absolute POD of the GRACE, Sentinel-3, and Swarm LEOs and compare it to results obtained by double-difference processing including ambiguity fixing. The impact of ambiguity fixing on orbit quality is assessed in terms of standard POD quality measures, independent Satellite Laser Ranging (SLR) validation, and, in case of GRACE, ultra-precise inter-satellite K-band ranging validation.