Investigation on systematic offsets between different Swarm orbit solutions

Motivation and Background

Induced radial orbit offsets by PCVs

The orbit models and parameterization in NAPODS follow dynamical models to a large extent. Only few empirical parameters in along-track and out-of-plane directions are used for the model generation. The orbit determination is performed using the internal satellite tracks. The orbit vectors are generated and propagated in the ENU coordinate system. The standard viewpoint is the center of mass of the satellite.

In addition to the original Swarm orbit solutions from TUD (PTIM, TUD) and ALUS (TUD), the Astronomical Institute of the University of Bern (AIUB and PTIM) are computing orbits for the Swarm satellites. Orbit comparisons reveal systematic mean offsets (cm) between the solutions.

The focus is in particular on the radial component, because systematic offsets may hint to erroneous information about the satellite geometry (e.g., position of the center of mass or antenna reference point). Additionally, the radial offsets are very consistent between the three solutions and similar for all three satellites.

The use of different software packages at TUD (GHOST), AIUB (Bernese GNSS Software) and PTIM (NAPODS) offers the chance to investigate the inconsistencies.

New orbit solutions – PCO Up value modified from 0.00 mm => -10.00 mm

New orbit solutions are computed by AIUB, PTIM and TUD applying the modified PCO Up value of -10.00 mm for all three satellites.

The systematic radial offsets can significantly be reduced with the new orbit solutions. The remaining radial offsets are within ±0.3 mm.

Summary and Outlook

Systematic radial offsets of up to 1.5 cm are present between different Swarm orbit solutions.

When applying modified phase center offset values in the up direction of -10.00 mm instead of 0.00 mm the systematic radial offsets can be significantly reduced below 3 mm.

In terms of the mean values the SLR validation confirms that the modified PCO value improves the orbits. However, the standard deviations of the statistics do not confirm the improvement.

Further investigations on the systematic radial orbit offsets are necessary to confirm the improvement of the orbit products based on all possible measures (orbit comparisons, SLR validation).

The out-of-plane offsets have to be investigated as well. The improvement of the modelling of the non-gravitational forces acting in out-of-plane direction are in focus for this.

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