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Impact of inter-satellite links and ultra-stable clocks within future GNSS constellations on gravity field parameters

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The joint project ADVANTAGE (Advanced Technologies for Navigation and Geodesy*) of the German Aerospace Center (DLR) and the GFZ German Research Centre for Geosciences aims at the design and development of a future GNSS infrastructure based on the innovative features of two-way optical links with micrometer absolute ranging accuracy as well as ultra-stable clocks. The proposed space segment consists of a constellation of 24 Medium Earth Orbit (MEO) navigation satellites and 6 Low Earth Orbit (LEO) satellites.
The design of the technological framework is carried out by DLR and the exploration of the potential of the technical developments on various geodetic parameters is performed by GFZ. The latter also include Earth's gravity field parameters and its temporal variations. To monitor climate change, it is essential to determine these parameters with highest accuracy and reliability since climate indicators such as ice sheet and glacier melting as well as global sea level rise need highly accurate long-term monitoring. We perform extensive simulations of the complete space segment utilizing ultra-stable clocks and precise inter-satellite links for the precise orbit determination (POD) of the ADVANTAGE MEOs and LEOs and a GRACE-FO-like LEO pair. In the recovery of the gravity field parameters based on simulated observations, different scenarios including the modeling of systematic effects are examined and compared to a reference solution.
We present preliminary results compared to state-of-the-art GRACE (-FO) gravity field models, which do not meet all user requirements for spatial and temporal resolution and accuracy. The simulations are performed with GFZ's Earth Parameters and Orbit System – Orbit Computation (EPOS-OC) software package. The presented results focus on the benefit of the enhanced POD using ultra-stable clocks in combination with the optical two-way links for time-variable gravity field determination. Simulated state-of-the-art GRACE (-FO) gravity field solutions are compared with solutions combining the enhanced ADVANTAGE POD with the low-low satellite-to-satellite tracking observations. It is expected, that the current time variable gravity field performance can be improved mainly in the long spatial wavelengths. Finally we will address the impact of improved POD on reducing systematic error effects from temporal aliasing caused by tidal and non-tidal background model errors within GRACE (-FO) processing.

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