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Geocenter estimation with a future GNSS constellation

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Currently, the origin of the International Terrestrial Reference Frame (ITRF) is realized solely by satellite laser ranging (SLR). The geocenter estimation of the Global Navigation Satellite Systems (GNSS) is not considered to be as accurate and reliable as from SLR due to system-specific deficiencies, e.g. estimation of epoch-wise satellite clocks, and remaining model uncertainties, e.g. of the solar radiation pressure (SRP). The proposed future GNSS constellation “Kepler” consisting of 24 Medium Earth Orbit (MEO) satellites, similar to Galileo, and 6 Low Earth Orbit (LEO) satellites in 2 perpendicular polar planes will make use of two key technologies such as two-way optical inter-satellites links (ISL) and optical frequency references. The ISL connect the MEOs in one orbital plane and the LEOs connect MEOs in different planes according to an ISL scheduler. The ISL enable a time and frequency transfer resulting in perfectly synchronized clocks within the complete constellation drastically reducing the number of clock parameters to be estimated. In this study, we assess by simulations the possible benefits in the estimation of geocenter coordinates by this future constellation. Different simulation scenarios extending the MEO-only constellation by including LEOs, ISLs and synchronized clock offsets were performed with a global network of 124 observing stations. In the estimation step, for each simulation scenario two cases were considered: i) perfect models and ii) mismodeling of SRP. The estimated geocenter coordinates, as well as station positions and Earth rotation parameters, and their standard deviations are compared to the MEO-only constellation without ISL and perfectly synchronized clocks. The impact of the individual parameters of the SRP modeling on the geocenter coordinates is examined by estimating the SRP parameters one-by-one and fixing the remaining. Furthermore, a correlation analysis of the estimated parameters shall clarify the sensitivity of the respective SRP parameters to the geocenter coordinates in the different components.