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Validation and assessment of space debris orbits based on two-color and multi-static laser tracking data

The rapidly growing number of space debris objects poses an increasing threat to operational satellites and manned space missions. Accurate orbit determination forms the basis of fundamental collision risk assessments and related downstream activities. To this end, the concept of debris laser tracking is a promising extension of SLR to provide timely and accurate data by building on an existing network of stations with the technology's well-known advantages. In addition, the combination of high pulse energies and generally irregular shapes of debris objects facilitates bi- or multi-static ranging, thereby maximizing the obtainable information content. We present first orbit products, which are based on real data acquired within the framework of the ESA GSTP study "Accurate Orbit Determination with Laser Tracking/Tasking". Beyond the use of both two-color and multi-static laser tracking data, we deliver further insight into the technology's capabilities by considering different observation scenarios in a network of three central-European stations in combination with a diverse set of representative LEO objects. Moreover, we estimate station clock offsets based on single pass data of multiple objects from a common tracking session. We validate and assess the computed orbits based on a diverse set of criteria such as post-fit residuals, cross-validation, and comparisons with accurate reference orbits. These are used as performance measures quantifying reachable ranging and telescope pointing as well as obtainable position and velocity accuracies.