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Precise Orbit Determination of the two LAGEOS and LARES satellites and the LARASE activities

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The LAser RAnged Satellites Experiment (LARASE) research program aims to provide an original contribution in testing and verifying Einstein's theory of General Relativity (GR) in its Weak-Field and Slow-Motion (WFSM) limit by means of the powerful Satellite Laser Ranging (SLR) technique. Therefore, in this perspective, a Precise Orbit Determination (POD) of a dedicated set of passive laser-ranged satellites is required. In particular, the joint analysis of the orbit of the two LAGEOS (LAser GEOdynamic Satellite) satellites with that of the more recently launched LARES (LAser RElativity Satellite) satellite will be exploited in order to obtain precise measurements of the gravitational interaction in the field of the Earth.
A major point to be reached within the activities of LARASE is to provide the relativistic measurements with an error budget of the various systematic effects (both gravitational and non-gravitational) that be robust and reliable. This requires a careful analysis of the various disturbing effects on the orbit of the considered satellites, especially for the new LARES. This activity has been planned both for the gravitational and the non-gravitational perturbations (NGP).
Therefore, we started to re-visit, update and improve previous dynamical models, especially for the NGP, and we also developed new models in such a way to improve the current dynamical models used in space geodesy to account for the main perturbations acting on the orbit of LAGEOS and LARES. We focused especially on the spin dynamics, the drag effects (especially for LARES, because of its much lower height with respect to the two LAGEOS) and, at a preliminary level, the thermal ones that, as it is well known from the literature, are very important for the LAGEOS satellites.
These studies are of fundamental importance not only for the objective of a reliable error budget, but also in order to improve the POD.
In this context, because of the importance of the LAGEOS satellites in the fields of space geodesy and geophysics (and the foreseeable importance of LARES in the near future) we expect that all the geodetic products within those provided the International Laser Ranging Service (ILRS) will benefit of such improvements in order to contribute to the goal of a sub-mm precision in the RMS of the SLR residuals with respect to the current cm precision.
In this paper we are going to focus upon the POD results we obtained for the considered satellites within the LARASE activities. The analysis strategy and models setup will be discussed, along with the POD quality in terms of fit statistics and residuals. The current level of accuracy will be briefly assessed, along with current work for its improvement. The use of empirical accelerations will be described, as well as their removal (or minor role) in the case of the implementation in the POD software of new improved dynamical models.