Can we improve LAGEOS solutions by combining with LEO satellites?

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Precise orbit modelling of low geodetic satellites, e.g., Starlette, Stella, and Ajisai is more demanding than modelling of LAGEOS' orbits, because of:
- orbit perturbations caused by the uncertainties in the atmospheric drag models,
- uncertainties and temporal variations of Earth gravity field,
- inadequate values of center-of-mass corrections for LEO satellites.

In our approach the orbit modelling problem, related to the variations of the drag of the high atmosphere, is solved by: applying the NRLMSISE-00 air drag model, by estimating a constant acceleration and once-per-revolution terms in the along-track component, and by estimating a pseudo-stochastic pulse in the along-track component for every revolution of a satellite. The pseudo-stochastic pulse imposes a very small change of the satellite velocity due to unmodeled forces.

The problem of uncertainties and time varying Earth gravity field is handled by using the latest state-of-the-art Earth gravity field models based on the GRACE mission, and the estimation of gravity field coefficients up to degree and order 3.

The problem related to the inadequate values of center-of-mass corrections for LEO satellites is resolved by estimating station- and satellite-specific range biases and by combining the LEO solutions with the LAGEOS solutions. The center-of-mass corrections for LAGEOS satellites are well established and no range biases for most SLR stations in the LAGEOS solutions have to be estimated. Therefore, our values of station- and satellite-specific range biases may compensate for inadequate values of center-of-mass corrections for LEOs. Moreover, the resulting combined solutions are entirely consistent with LAGEOS solutions, because the scale is derived mostly from LAGEOS tracking.

We show that considering SLR observations to the low geodetic satellites improve the repeatability of station coordinates in the combined solution with LAGEOS. Taking into account low geodetic satellites allows it to determine the accurate position of SLR stations not observing LAGEOS satellites. We also found that the standard center-of-mass corrections for Stella (75 mm), Starlette (75 mm), and Ajisai (1010 mm) are inadequate and they should not be used.