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LEO Orbit Determination and Parameter Estimation

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GFZ1 and the follow-on CHAMP satellite launched a series of dedicated satellite missions for the precise determination of the earth's gravity field and its variation over time. Especially designed for these goals, LEOs (Low Earth Orbiters) circulate in orbits of just 280 to 500 kilometers above the surface of the earth. With the start of CHAMP high-precision dynamic orbit models gained much importance. For the orbit integration a high quality force field, which contains all relevant conservative forces, was modeled. Orbital arcs over different time intervals were calculated by pure integration of the force field and compared with precise reference ephemeris, based on GPS measurements. The established software allows for testing different conservative force field models as well as to take into account non-conservative forces, e.g. the atmospheric drag through empirical approximation. Estimated drag coefficients are compared to the corresponding values determined by the GFZ Potsdam. The orbit approximation achieves accuracies within meters for arcs of 2 hours and differences to the GFZ precise solution of below 100 meters over 24-hours, which is already a very good a priori solution. In a further step the dynamic model has been adjusted to laser distance measurements. Hereby the boundary values as well as various dynamic parameters can be estimated. This leads to a far more precise determination of non-conservative forces and the orbit model improves significantly. With the planned additional implementation of GPS observations an overall accuracy of the estimated CHAMP orbit within a few decimeters is expected.