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Studies on a Laser Doppler Interferometry gravity mission by a semi-analytical approach

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In the last decade, three satellite missions (CHAMP, GRACE and GOCE) have been successfully launched for the Earth gravity field observation from space. In particular, GOCE will provide a very accurate static model in terms of spherical harmonic expansion up to degree 200 and beyond, while GRACE is more sensible to time variations of the gravity field at lower resolution. A possible goal for a future mission is to measure both gravity and its variations at high resolution. This can be reached by a GRACE-like mission concept, with GOCE-quality accelerometers on board and a link between the two co-orbiting satellites based on a Laser Doppler Interferometer.

In 2005 an early study on this future mission was conducted by Thales Alenia Space, leading to the definition of a possible mission profile. In that study a time-wise approach was used with the approximation of considering separately each harmonic degree of the potential in the Fourier solution of the Hill equations. This was done to obtain a fully analytical solution.

In this work this approximation has been removed and the error budget of the mission has been recomputed by a semi-analytical approach. It comes out that the main effect of the approximation was in the zonal harmonics, meaning that the effect of polar gaps due to the orbit inclination was underestimated. For the other coefficients the degradation was of one order of magnitude at most, especially at low-medium harmonic degrees. An alternative mission profile based on two couples of satellites flying on two orbits with different inclination is also evaluated.