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Simulation of free fall and resonances in the forthcoming GOCE mission

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GOCE, ESA's first Earth gravity mission, is currently to be launched early in 2009 into a sun-synchronous orbit. Using the full-scale numerical propagator, we investigated the satellite's free fall from the initial injection altitude of 280 km down to the first measurement phase altitude. During this decay phase the satellite will pass below the 16:1 resonance (268.4 km). The effect of this resonance, together with the uncertainty in the solar activity prediction, has a distinct impact on the evolution of the orbital elements. Then, to maintain a near-constant and extremely low altitude for the measurement operational phases, the satellite will use an ion thruster to compensate for the atmospheric drag. In order to obtain the groundtrack grid dense enough for a proper sampling of the gravitational field, ESA set constraints for a minimum groundtrack repeat period. We studied suitable repeat cycles (resonant orbits) in the vicinity of 16:1 resonance; we found that they differ greatly in stability towards small perturbations of the satellite's mean altitude and in temporal evolution of the groundtrack coverage. The results obtained from the usual analytical treatment of orbital resonances were refined by more realistic numerical simulations. Finally, we formulated suggestions that might be useful in GOCE orbit planning.