



POD improvements of GALILEO satellites through the measurement of their non-gravitational accelerations by means of an onboard accelerometer

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The Precise Orbit Determination (POD) of the satellites of the Global Navigation Satellite Systems (GNSS) represents the basic prerequisite in order to provide refined ephemerides for their orbit, aimed at providing a precise and accurate positioning on the Earth. An important factor that impacts negatively in the POD of these satellites is the limited modeling of the accelerations produced by the non-gravitational accelerations. These, indeed, are subtle and generally complex to model properly, especially in the case of a complex in shape spacecraft, with solar panels and antennae for microwave link and the mutual shadowing effects among the many surfaces involved. We have to notice that their modeling has an important impact in the determination of a number of geophysical parameters of interest, such as stations coordinates, Earth's geocenter and orientation parameters. In the case of GNSS satellites, the main NGP acceleration is the one produced by the direct solar radiation pressure, with non-negligible contributions due to Earth's albedo, thermal effects and power radiated by the antennae. The models developed so far for these perturbative effects have shown many limits, as pointed out in the literature. Currently, the models developed for the NGPs are mainly based on empirical blind models (with the goal of absorb unknowns quantities) and more recently with the use of wing-box models, that try to provide a finite-elements approach to the modeling. The European Space Agency (ESA) — in the context of the development of the GALILEO constellation, and especially in view of the next generation of GALILEO spacecraft — besides being interested in possible improvements of the NGPs models, is also envisaging the use of an onboard accelerometer to directly measure them in order to improve the POD of each spacecraft of the constellation. We have been involved in this study by means of a proposal to ESA denominating GALileo and ACcelerometry (GALAC) led by the Space Research Centre (SRC) of the Polish Academy of Sciences (PAS) of Warsaw. The GALAC main objective is to provide the characteristics and performance of an onboard accelerometer able to improve the POD with respect to the current best results obtained through the modeling of the NGPs. The starting point of our activities has been the ISA accelerometer developed for the ESA BepiColombo mission to Mercury. We will present our results of a preparatory work for GALAC concerning a first characterization of the main NGPs acting on the GALILEO spacecraft of second generation, including their (main) spectral content. Such results are used to preliminary fix the accelerometer measurement band, its sensitivity and physical characteristics in order to fit with the GALILEO spacecraft environment.