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MICROSAT HARDWARE REQUIREMENTS FOR REAL-TIME THERMOSPHERIC DENSITY ESTIMATION

Abstract

Real-time correction of thermospheric density models is a key factor in Space Situational Awareness (SSA). In particular, there is enormous potential regarding debris collision avoidance in low-Earth orbits, where thermospheric density errors have a large impact on orbit prediction uncertainty. Amongst others, consequences of large uncertainties are countless conjunction assessments and many superfluous avoidance manoeuvres. Recent advances in Microsat technology promise cost-effective methods for thermospheric density estimation/observation, and therefore density model correction for the near future.

Commonly, estimation and calibration of both physical and empirical thermospheric density models are based on precise orbit determination with density correction factors or mean densities as additional independent variables. Regardless of whether these orbit solutions are computed from on-board GNSS or external tracking observations, the derived densities are averaged over space and time. Despite limited spatial and temporal resolution, their assimilation can be of great benefit for orbit prediction. By contrast, accelerometers can provide density measurements with higher resolution. Hence, they are particularly useful for adjusting the structure of a thermospheric density model with primary benefits for short- to medium-term orbit prediction. However, accelerometer biases must be estimated with the help of another observation (orbit determination) technique. This poses requirements on accelerometer bias stability governing the extent to which strengths and weaknesses associated with the complementary technique are introduced.

This paper studies the suitability of currently available commercial off-the-shelf accelerometers for thermospheric density estimation on board Microsat missions. Based on this analysis, a trade-off between GNSS orbit determination precision and accelerometer quality is performed, taking both GNSS-derived and accelerometer-derived densities as inputs to real-time density correction algorithms. An important aspect of this study is the applicability to (near) real-time density correction.