Automation and enhancement of MetOp-A Flight Dynamics Operations

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MetOp-A is the first European operational satellite for meteorology flying in a Low Earth Orbit, and the first satellite operated by EUMETSAT in this type of orbit. This paper presents the Flight Dynamics operations for MetOp-A, focussing on their automation and on the enhancement performed on the manoeuvre execution and orbit determination operations.

The complexity of the Flight Dynamics operations for a LEO satellite is mainly related to the need to continuously provide accurate commanding parameters to the on-board AOCS, to maintain the required platform performances, and precise ephemerides to the ground stations, to permit safe acquisition of the satellite. Furthermore, due to the nature of a meteorological mission, stringent requirements in terms of availability, timeliness and accuracy of the Flight Dynamics products are to be fulfilled, in order to ensure proper geo-location of the instruments data.

In order to be compliant with these tasks, it has been necessary to automate as much as possible all Flight Dynamics operations. That includes not only the generation of the mission critical products mentioned above, but also those operations performed continuously to ensure the overall quality of the service. Manoeuvre planning and calibration have also been automated as much as possible.

Furthermore, other modifications have been implemented into the Flight Dynamics operations, either to cope with behaviours of the satellite significantly different from the expected or to enhance the accuracy of an estimation process by adding higher quality observations.

The design of the thruster mounting in MetOp-A was driven by the need of minimising the thruster impingement on the instruments carried on board. That results in manoeuvres performances which are very different from the ones of other satellites using similar service modules, as Envisat or SPOT: large deviations of the thrust from the along-track direction and important cross-coupling of the torque control thrusters are observed.

Moreover the very large dead-band used for MetOp-A makes necessary to take into account effects on the orbital evolution, like the coupling of the local-time drift and the ground-track evolution or the amplification of the propagation errors due to drag prediction uncertainties, which can be neglected in satellites with reduced dead-band.
Significant modifications to the procedures needed for optimising the manoeuvre and computing the commanding parameters were needed to properly maintain the reference orbit conditions.

The orbit determination for MetOp-A relies on ranging and Doppler measurements taken from the EUMETSAT ground stations in Svalbard (Norway). Limited observability on the eccentricity is present in this scenario, leading to remarkable errors in the along track directions. The addition of high accuracy pseudo-observables extracted from the precise orbit solution generated by the GRAS (GNSS Receiver for Atmospheric Sounding) instrument can largely improve the orbital observability. Moreover precise orbit data can be exploited to fully characterise the satellite dynamics as well as the modelling of the radiometric measurements. The resulting orbit determination set up with the high performances achieved in terms of accuracy and operational robustness are presented.