Flight Dynamics Support to extend Instruments useful Lifetime

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EUMETSATs Metop-A, launched on 19 Oct 2006, is the first flight model of the EUMETSAT Polar System (EPS). The Metop satellites share a sun-synchronous LEO orbit with a 29 days / 412 revolution cycle and Local Time of Descending Node (LTDN) of 09:30 UTC. Together with Metop-B, launched in 2012 and Metop-C slated for launch in 2018, they constitute the EPS space segment in Low Earth Orbit.

Among the 13 instruments of board, the Global Ozone Monitoring Experiment–2 (GOME-2) is is a hyper-spectral Ultra Violet-Visible to Near Infrared spectrometer and it is used to get a detailed picture of the total atmospheric content of ozone and the vertical ozone profile in the atmosphere, as well as a large range of trace gas and aerosol products.

For the measurements calibration GOME needs to see the Sun in its sun slit field of view (FOV). As Metop-A is approaching its end of life no more Out of Plane (OOP) manoeuvre are conducted. The resulting loss of orbit inclination control leads to LTDN drift. This drift makes the orbital plane precess in such a way that the Sun visibility opportunities suffer a gap lasting many days. Failure to properly calibrate the measurements during more than very few days may invalidate the GOME products.

This paper describes the methods used by EUM to keep exploiting the GOME instrument under apparently impossible circumstances.

The first part of the paper deals with the problem of imparting the last OOP manoeuvre in such a way that the Sun visibility gap predicted in 2018 is cancelled. The fuel consumption is constrained so that adequate fuel reserves are available before entering the End of Life operations; still the manoeuvre must ensure that the Sun centre stays inside the FOV at least 30 seconds per orbit in 2018.

The second part of the paper describes a model of the Sun signal developed by the CGI Group Inc. under EUMETSAT contract. It is based on an empirical model of the instrument in-orbit performance evolution and of the solar signal variation using both historical instrument measurements and actual measurements of solar activity. The idea behind that is to have a backup Sun signal to use for measurements calibration purposes in case the actual Sun is temporarily not visible in the FOV.

The third part of the paper is about the envisaged, regular yaw-biasing of the satellite platform to ensure daily Sun calibration even with high values of LTDN offset, when the gap may become too large to permit calibration with the model above mentionned.

The fourth part of the paper deals with partial losses of Sun signal, expected in spring 2018, to characterise the real size of the instrument sun slit FOV. This information will in turn be fed back into the LEOP injection target for Metop-C, foreseen to be launched in autumn 2018, so that a more favourable LTDN and inclination bias can be imparted at the beginning of the Metop-C mission.