Feasibility of Metop-A Mission Extension on Drifting Local Time

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On 19th October 2006 Metop-A, Europe's first polar orbiting operational meteorological satellite, was successfully launched into its operational sun-synchronous orbit; after more than 10 years of operations the satellite is still in excellent health. Since the start of Metop-B operational phase, in 2013, the Metop mission is carried out by a dual-satellite system, with the two satellites on the same orbital plane and separated in orbital phase by around 180 degrees; that provides a much better coverage and therefore permits the implementation of more accurate meteorological products; the added value is such that the meteorological users' community formally requested maintaining dual-satellite operations as long as possible.

That leads to the need of ensuring Metop-A operations at least up to the start of the operational phase of Metop-C, whose launch is currently foreseen on the last quarter of 2018; besides, to ensure in-orbit redundancy for the dual-satellite constellation, it is recommended to maintain Metop-A in orbit even afterwards; on top of that, many users demonstrated great interest in receiving data from all three satellites, which should permit the development of new products.

Currently very little fuel is available on-board for orbit maintenance, as a large amount (close to 50%) is reserved for end-of-life operations, in line with ISO 24113 Space Debris Mitigation guidelines, to bring the satellite down to an altitude permitting natural re-entry in the atmosphere within 25 years; that implies that inclination and, consequently, local-time control, cannot be performed any longer and extension of the Metop-A mission is only possible by letting the local-time drift; from an users' perspective that drift is not considered as detrimental for the mission, but rather as an opportunity to develop new products based on new observation geometries.

However, to implement a local-time drifting mission with a satellite conceived for operations on a sun-synchronous orbit is not straight forward, as several problems may arise when the local time diverges from the nominal design value:
- the sun sensor, required for proper attitude control in yaw, may not see the Sun during several weeks; even if the AOCS shall remain stable even using only the gyroscopes, when the gap becomes too large random walk on yaw may lead to degradation in the products' geo-location;
- the duration of the eclipse gets shorter when the local time drifts towards early morning; therefore the masks of the earth sensor need to be enlarged accordingly to avoid Sun blinding on eclipse entry or exit; similar problem is expected for the batteries charge-discharge commands;
- degraded performance of instruments working in the UV and visible frequencies can be expected as the evolution of the Sun vector in the instrument frame, as well as on the solar calibration ports, exits significantly from the specifications, leading to stray-light or loss of calibration signal;
- the Sun angle on the solar panel decreases significantly with the local time drift, reducing the power collected; at the same time the panel begins to shadow the spacecraft body, calling for additional power to maintain, by active heating, the on-board temperatures within the operational thresholds; power margins fall, together with temperatures, until there is a risk of hydrazine freezing in the propulsion pipelines; to ensure satellite operability, the mission shall be terminated before getting into negative power balance or before reaching a point where hydrazine freezing is a considerable risk.

In order to assess if a mission extension in drifting local time was really feasible, several analyses have been carried out by the Flight Dynamics and the Metop Operations teams in EUMETSAT; these analyses, which are presented in detail in this paper, show that it should be possible to extend the mission without any major risk up to a local time drift of 2 hours, permitting therefore to reach end of 2021; implications at system level of this mission extension are also discussed and constitute the baseline information for selecting the operational tri-satellite configuration.