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MINIMUM-FUEL ORBIT ACQUISITION, STATION-KEEPING AND DEORBITING OPERATIONS FOR A PHASED SUN-SYNCHRONOUS MISSION

Abstract

The satellite Microcarb is meant to perform a scientific mission in Low Earth Orbit for CO2 fluxes monitoring. Its goal is to improve our knowledge on CO2 sinks and sources, to understand carbon cycle and thus climate evolution. To fulfill this mission, MicroCarb designed by CNES and integrated with UKSA is based on a recurrent Myriade spacecraft bus customized with an instrument payload based on an innovative concept permitting the acquisition of the four spectral bands using a single telescope, spectrometer and detector (covered by an Airbus Defence Space patent). To be launched by the end of 2023, MicroCarb has to reach a Phased Sun-synchronous Orbit (Mean Local Time of the Ascending Node of 22h30) with an altitude of 649km, a mass of 185kg and a tight ergol budget of 4.7kg. This Myriade spacecraft bus is designed for a standard three-year scientific mission and the ergol budget optimization for a lifetime extension is usually done during Mission Analysis.

However, according to the uprising phase of the upcoming 25th solar cycle which influences directly the atmospheric drag and has a direct impact on the ergol budget, the extension of the classical mission lifetime from three to five years is a real challenge. Therefore, from Launch and Early Orbit Phase until the End of Life, the maneuver strategies have to be optimized so as to cover the targeted five-year mission through the highest activity phase of the solar cycle ; in order to perform Orbit Acquisition (launcher uncertainties corrections), Station-keeping on a Phased and Sun-synchronous Orbit (constraints on equatorial phasing and local hour), Collision Avoidance (with minimum ergol cost) and Deorbiting in the frame of the French Space Operation Act for decommissioning (re-entry in less than 25 years).

This paper will present the innovative operational strategies for each phase of the mission to ensure a minimum ergol cost while fulfilling the Control Center operational requirements and the non-glare constraints of the payload. The operational strategies will highlight the choice of an optimized launch target (saving of out-of-plane station keeping maneuvers); the compliance with the Phasing constraint (in-plane maneuvers); the compliance with the Local Hour constraint (out-of-plane maneuvers combined with in-plane maneuvers); the compliance with the Altitude constraint (fixed frequency maneuvers adapted with the natural eccentricity drift); and finally the compliance with the deorbiting strategy (lowering of the perigee).