SPACE PROPULSION SYMPOSIUM (C4)
Electric Propulsion (4)

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A SYSTEM STUDY ON DRAG COMPENSATION WITH ELECTRIC PROPULSION IN VERY LOW EARTH ORBIT

Abstract

Electric Propulsion is the unique possible solution to achieve continuous drag compensation in very low Earth orbit thanks to the high specific impulse, high thrust modularity and long operation times. Drag compensation is essential for geodesy missions like GOCE or satellites for Earth observation with very high demanding requirements in imaging resolution for civil and military applications. Air-breathing is an interesting and very challenging solution for very low Earth orbit, this option takes into account the possibility of using the rarified gases in the atmosphere as the propellant itself. This paper describes a system study to understand the possibilities and the limits of a satellite equipped with electric propulsion with a mean orbital altitude between 150 and 250 km. A dedicated orbital simulator for this kind of missions has been developed to show how the parameters of the thrusters affect the satellite system; the most important part of the simulator is about the computation of the atmosphere density that is needed to obtain the atmospheric drag. The modelization of the upper layers of the atmosphere is very complicated due mainly to the variability of the characteristics depending on the environmental conditions. The mission case is related to a circular Sun-Synchronous orbit; several semi-major axis and Local Time of Ascending Nodes are used to have an initial state of the satellite. The specific impulse is one of the main thruster parameters that are fundamental to characterize the lifetime. Two different analyses have been carried out: one maximizing the lifetime given the initial state, and the other one with a fixed orbital time. The simulator has been tested and validated with the flight data of GOCE, which has shown the feasibility of a drag-free orbital control and the reliability of an electric thruster operating at very low orbits. Different technologies regarding the electric thruster have been considered: Hall Effect Thruster, Gridded Ion Engine and High Efficiency Multi-stage Plasma Thruster. The case of micro-propulsion with thrusters based on Field Emission Electric Propulsion has been studied as well.