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SPACE DEBRIS SYMPOSIUM (A6)
Mitigation and Standards (4)

Author: Mr. Hubert Fraysse
Centre National d'Etudes Spatiales (CNES), France

Ms. CLEMENCE LE FEVRE
Centre National d'Etudes Spatiales (CNES), France
Mr. Vincent Morand
Centre National d'Etudes Spatiales (CNES), France
Mr. Alain Lamy
Centre National d'Etudes Spatiales (CNES), France
Mr. David-Alexis Handschuh
Centre National d'Etudes Spatiales (CNES), France

STATISTICAL METHODS TO ADDRESS THE COMPLIANCE OF GTO WITH THE FRENCH SPACE OPERATIONS ACT

Abstract

Space debris mitigation is one objective of the French Space Operations Act (FSOA), in line with IADC (Inter-Agency Space Debris Coordination Committee) recommendations, through the removal of non-operational objects from populated regions. At the end of their mission, space objects are to be placed on orbits that will minimize future hazards to space objects orbiting in the same region. The French Space Act, which came into force in 2010, ensures that technical risks associated with space activities are properly mitigated. In order to address the compliance of disposal orbits with the law technical requirements, CNES draws up Good Practices as well as a dedicated tool, STELA (Semi-Analytical Tool for End of Life Analysis).

Three types of typical orbits have been defined for the good practices and STELA : Low Earth Orbits (LEO), GEostationary Orbits. This paper will focus on GTO.

For space objects placed in orbits passing through LEO protected region, the French Space Operations Act states that a direct and controlled atmospheric re-entry is the baseline. If the impossibility of meeting this requirement can be duly proven, as well as for orbits not crossing the LEO region, an uncontrolled re-entry or a stable disposal orbit can be chosen. Then, some criteria related to the orbital lifetime and the protection of LEO and GEO regions have been defined. The verification of these criteria requires long term orbit propagation to evaluate the evolution of the orbital elements over long time scales - up to more than 100 years. Moreover, for GTO these criteria have to be defined statistically. Indeed, these orbits have much more complicated dynamical properties than LEO and GEO because of their high eccentricity. Some couplings occur between dynamic perturbations and can lead to resonance phenomena: a small change in the initial conditions or on the estimation of the drag effect will significantly change the entrance conditions in resonances and thus the orbital evolution. Because of these particular dynamical properties, a statistical methodology is needed to properly address the compliance of GTO disposal orbits with the FSOA.

This paper will present the good practices related to GTO as well as a brief description of the corresponding part of the STELA tool. It will detail the implementation of the Monte-Carlo methodology and the definition of the FSOA statistical criteria. Then it will present the standardization of the computation hypothesis and how they are scattered.