18th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Modeling and Risk Analysis (2)

Author: Dr. Camilla Colombo
Politecnico di Milano, Italy

Mr. Stefan Frey
Politecnico di Milano, Italy

CONTINUUM MODEL FOR STUDYING THE EVOLUTION OF THE SPACE DEBRIS POPULATION

Abstract

The sustainable of the use of Space requires mitigation actions to be implemented on a global level. The efficacy of such actions, such as active debris removal, end-of-life disposal, collision avoidance manoeuvres and limitation of in-orbit explosion is usually measured through long-term evolution tools that model the long term growth of the space debris population under the effects of these mitigation actions. Most of them rely on sets of representative objects that are propagated over 200 years, considering launches, fragmentations, post mission disposal rules. Uncertainties in the solar activity and drag model, or the effect of single fragmentations, or the distribution of the object mean anomalies is considered by means of several Monte Carlo simulations. This paper instead, presents the extension of recent work performed at Politecnico di Milano funded by the European Space Agency and the COMPASS ERC project to model space debris fragments through a continuum model. The evolution of a cloud of space debris fragments following an explosion or collision in space is modelled by describing its density in the space of the orbital elements. The density evolution in time along the characteristic lines is obtained by numerically integrating the continuity equation. The density at any point in space is then interpolated by using Gaussian Mixture Model. In this work we extend our proposed method to represent rather than one single cloud, the whole debris population in Low Earth Orbit. A model to predict launches and the solar activity is implemented and different simulations are done to study the effects of different launch traffic on the long- term evolution of the space debris environment. A performance index are also defined. The validation of the results of the proposed method is performed against some deterministic tools for the modelling of space debris and computational time is also compared.