SPACE DEBRIS SYMPOSIUM (A6)
Modelling and Risk Analysis (2)

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DERIVING THE SPACECRAFT ENVIRONMENT CRITICALITY FROM MONTE-CARLO SIMULATIONS OF THE SPACE DEBRIS ENVIRONMENT

Abstract

With a rising number of spacecraft on orbit, the danger that a specific object poses to the overall space debris environment becomes of high interest. Examples, where it is used are for choosing candidates of interest for active space debris removal, but also for the overall risk assessment before placing a new object in orbit. Also, when verifying the benefit of newly developed methods for space debris removal, as for example drag augmentation devices, the overall threat to the environment should be taken into account. The parameter to quantify this danger is called spacecraft environment criticality. So far, several approaches have been applied to measure this criticality, mainly to create priority lists for active debris removal missions. These methods were usually based on two factors: First the risk a spacecraft might fragment, expressed either as flux on the object or its collision probability, and second its mass, which is used to estimate the impact of a fragmentation of the object.

In this paper, a new approach for calculating the spacecraft criticality, together with its application in Monte-Carlo simulations of the space debris environment are introduced. Again, the criticality consists of two factors: The risk a spacecraft might fragment, which is expressed by the fluence on the object, and the impact a possible fragmentation has on the overall environment. While the first factor can easily be extracted from general long-term simulations, the second factor requires several additional simulation runs: Each year during the whole time frame of interest, the object under investigation is fragmented and the difference in collision probability within the whole population with and without fragmentation is used as the impact factor. Shown in this paper is the basic development of the spacecraft environment criticality as well as its calculation for selected objects. Furthermore, certain issues that arise from calculating the criticality within Monte-Carlo simulations are discussed, which address for example the time frames under investigation and the statistical significance of the received signals.