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

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DAMAGE COST OF SPACE DEBRIS IMPACTS ON HISTORICAL SATELLITES

Abstract

In this paper the total economic risk to all historical satellite missions shall be analyzed, which resulted from the impacts of space debris objects and micrometeoroids. Hypervelocity impacts of particles and micrometeoroids can damage satellites. The penetration of a satellite wall by a hypervelocity particle can cause operational anomalies or even the loss of a satellite mission. In this paper the cost of hypervelocity impacts on all historical satellite missions is estimated. A risk analysis is performed for each satellite mission. The probability of a satellite failure is estimated by combining the probability of a penetration with a vulnerability model. The failure probability is weighted with the mission cost of a satellite. This results in a probability of loss of amortization. The amortization loss is used as basis for the estimation of damage cost due to hypervelocity impacts. In this way it is possible to associate impacts with cost. A cost model is used to analyze all past satellite missions. It has been difficult in the past to identify operational anomalies or losses of satellites which could be correlated with space debris or micrometeoroid impacts. The risk posed to historical satellite missions nevertheless can be estimated. The historical evolution of the space debris environment has been highly dynamic due to several sources and sinks. In consequence, the risk has been in continuous fluctuation. A general trend (underlying these irregularities) has been an ever increasing number of space debris objects. For the determination of the historical particle flux, the MASTER-2005 model is used. MASTER (Meteoroid and Space Debris Terrestrial Environment Reference) is the European model for estimating the risk of hypervelocity impacts on satellites. MASTER is based on a very complex model of the space debris environment in terms of spatial density and velocity distribution.