Paper ID: 25683
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SPACE DEBRIS SYMPOSIUM (A6)
Modelling and Orbit Determination (9)

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ORBITAL DEBRIS ATMOSPHERIC RE-ENTRY PREDICTION

Abstract

Space debris remains a major space issue for the last 30 years, as threats for our space access and as risks for Earth population safety. As a matter of facts, since 1957 among the 27,044 object catalogued, 18,051 realized an atmospheric re-entry, e.g 66.7%. Moreover, studies suggest that 10% up-to 40% of mass, for the largest re-entering objects, could reach the ground, representing an important risk for populations under a potential debris cloud. Much work has been realized so far in order to predict the impact footprint and the state of orbital elements impacting Earth. However, it still appears insufficient as it was mentioned during the uncontrolled atmospheric re-entry of UARS satellite on September 24th 2011, the different tools currently developed in major space agencies failed to ensure accurately the impact conditions, exhibiting an actual prediction weakness. Investigations must then carry on. ONERA developed since 2006 a software platform named MUSIC/FAST to compute the destruction or survivability of space debris across the Earth atmosphere. This tool has a modular structure combining a 6 degree of freedom flight dynamics with aerodynamics, aerothermodynamics, and thermal analysis. The objective of the French Aerospace Lab is both to explore phenomena not completely considered until now but that could have a significant impact on the computed estimate of survival debris and to express more accurately physical models thanks to re-entry vehicles experience. Among them, we can quote fragment interactions, also called wake effects for which some results had been partially published. The last developments of MUSIC/FAST concern addition of conduction model and the exploration of the oxidation process under atmospheric re-entry conditions to complete degradation process of metallic debris. Innovative experimental tests have been conducted under air plasma at the solar furnace, in the French Pyrénées montains, to ensure oxide layer process and degradation mechanism. Experiments were achieved with Ti6Al4V samples aiming at assessing the influence of time exposure and high temperature levels on the thickening of the surface oxide layer. Ablation process could then be significantly disturbed by such oxidization process leading to an "optimistic" debris removal prediction. The present paper will propose an overview of MUSIC/FAST platform and will focus on the experimental results obtained and its ablation model developed consecutively. Atmospheric re-entry of Ti6Al4V satellite tank will be exhibited in application, showing the influence of oxide layer and conduction on the space debris survivability analysis.