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

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ADAPTIVE STRATEGIES FOR SPACE DEBRIS MITIGATION AND REMEDIATION

Abstract

The space environment is continuously evolving, in ways that are often difficult to predict. Many factors influence the evolution of the space debris population, including intrinsic factors (e.g. explosions and collisions) and extrinsic factors (e.g. solar flux, launch traffic) and this leads to considerable uncertainty in long-term model predictions. Further, unanticipated events, such as the 2007 Chinese anti-satellite test and other recent fragmentations, affect the environment in unpredictable ways whilst advances in technology or socio-economic drivers could result in an increase or reduction of the debris problem. These dynamic and uncertain conditions make it difficult to identify mitigation and remediation policies that will perform effectively. Indeed, the need for remediation arises from recent work showing that mitigation alone will be unlikely to constrain the growth of the debris population. Policies that cannot perform effectively because of this uncertainty, run the risk of not achieving their intended purpose, and becoming a hindrance to the ability of spacecraft operators and space agencies to cope with—and adapt to—changes in the debris environment.

One method to tackle dynamic and uncertain conditions is to create debris mitigation and remediation policies that can anticipate and respond to anticipated events and can navigate towards successful outcomes when surprised by the unforeseen. Such adaptive policies also offer the advantage of flexibility, which enables a sustainable approach to the long-term use of near-Earth space. This paper explores the concepts of adaptability in the context of space sustainability. This is demonstrated by utilising the University of Southampton's Debris Analysis and Monitoring Architecture to the Geosynchronous Environment (DAMAGE) to investigate the implementation of an adaptive debris removal policy. Here, the DAMAGE model is used to generate multiple projections (Monte Carlo runs) of the future debris environment $>=$ 10 cm, capturing some of the sources of uncertainty described above. Within each Monte Carlo run, a debris removal rate is determined at five yearly intervals based on historical trends and future predictions made by a Particles-in-a-box (PIB) model. In setting the variable removal rate, the objective is to achieve a net zero growth of the low Earth orbit population over 200 years. The results suggest that using an adaptive removal rate alongside good compliance with existing mitigation measures can increase confidence in achieving this objective, compared with a fixed removal rate within the same model.