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

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THE EFFECT OF MODELLING ASSUMPTIONS ON PREDICTIONS OF THE SPACE DEBRIS ENVIRONMENT

Abstract

In recent years, space debris has been identified as a potentially significant hazard to our future endeavours in the near-Earth space environment. This has led to a continued drive to explore what can be done to mitigate this hazard. Evolutionary models, utilising fast and efficient estimations of collision probability, identify trends caused by various external factors such as launch traffic, active debris removal (ADR) and mitigation, and studies have been used to guide space policy, as well as driving investigations of ADR. With research focusing on these external factors, there have been few studies exploring the impact of the (internal) modelling assumptions on these trends. As computational resources have increased over time, we are now better suited to examine these.

Previous studies have identified the variation in the debris population arising from the uncertainty within external factors such as future launch traffic, solar activity and mitigation activities (e.g. White and Lewis, 2014). However, this paper examines the collision detection, 'Cube' algorithm, commonly used across multiple space debris models, in particular, with the aim of determining whether the choice of model parameters, primarily cube-size and time-step, have a corresponding effect on predictions of the debris population through variations in collision probability estimations.

These parameters were varied from their typical values of 10 km and 5 days respectively, with cube-size ranging from the order of 1 m to 100 km, and time-step from the order of seconds to weeks. Using the University of Southampton's Debris Analysis and Monitoring Architecture to the Geosynchronous Environment (DAMAGE) tool in conjunction with a custom Space Debris Environment tool-kit, Monte Carlo projections of the $\geq$ 10 cm LEO debris environment from 2009 to 2039 were generated.

Preliminary results showed a disparity in final debris populations, with the worst case showing a 30% population difference after just 30 years. This implies that the values of these model parameters have a larger influence on collision probability calculations than recognised previously and, as with the aforementioned external variables, add further uncertainty to the system. This also greatly affects how we model ADR, where collision probability calculations are used to identify removal targets, and further work should be undertaken to examine this decision process and the extent of this relationship.