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

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RECENT ENHANCEMENTS TO ADEPT AND SAMPLE DEBRIS ENVIRONMENT PROJECTIONS

Abstract

Since 2009, The Aerospace Corporation (Aerospace) has been developing the Aerospace Debris Environment Projection Tool (ADEPT). Papers on previous versions of ADEPT were presented in 2011 and 2013. ADEPT consists of component tools and datasets that have been developed independently from other environment projection models. The Aerospace breakup modeling code IMPACT is used to model breakups due to collisions and explosions. A multi-processor method that determines the orbit trace crossings between object pairs is used to generate future random collisions. Weighted, logarithmically down-sampled populations are used to discretely represent the full orbital population while reducing computational burden. The database of orbital objects has been independently compiled. The future launch model includes large, continuously-replenished constellations. The initial and future debris populations extend down to a size of 1 cm.

From 2012 to 2015, improvements were made to a number of ADEPT's algorithms. Expanded use of down-sampling has made it possible to perform faster processing of the populations as well as faster generation of future collisions. This in turn has made it possible to extend Monte Carlo processing from the collision-generation step to the entire process, including accounting for effects of future random solar cycle variation on object propagation. The logarithmic down-sampling algorithm has been revised to improve representativeness of the original population. The accuracy of debris cloud modeling has been assessed via comparison with actual data. An improved fragmentation model has been implemented. Modeling of active debris removal has been improved. The simulation time frame has been expanded to 500 years.

The paper discusses the recent enhancements to ADEPT in more detail. Sample projection results over 500 years for the debris population down to 1 cm in size are presented, including the on-orbit population count vs. time in specific regions such as lower LEO, upper LEO, MEO, and GEO, as well as object spatial density vs. altitude and time. Finally, the growth in annual collision risk posed to sample generic satellites over time is presented. Preliminary results for a hypothetical scenario of minimal world-wide compliance with recommended international disposal practices indicate that the risk posed to representative, generic satellites by debris down to 1 cm in size may become significant in the time frame after 200 years.