Integrated Breakup Modeling Solutions from DebriSat Analysis

Deanna L. Mains(1), Marlon E. Sorge(1)

(1) The Aerospace Corporation, 2310 E. El Segundo Blvd, El Segundo, CA, 90245, USA

On-orbit hypervelocity breakup models are of increasing importance as the space environment becomes more congested and issues of debris lethality and lifetime become more relevant to space operators. One such fragmentation model is The Aerospace Corporation’s IMPACT, which simulates debris generation from explosions and hypervelocity collisions. IMPACT is a mass-based, semi-empirical model combining empirical distributions for parameters such as number, spreading velocity, fragment dimensions, and area-to-mass ratio (AMR), with physical conservation laws and boundary conditions. The original empirical relationships were based upon limited ground-test data prior to the mid-1990s and were then updated during the late 2000’s following an extensive evaluation of over 11,000 pieces of debris from more than three-dozen historical on-orbit fragmentation events. The availability of extensive fragmentation data from the DebriSat ground-based collision debris characterization project, including data for smaller debris fragments, now enables a fresh look at the overall model.

This paper addresses observations from evaluation of specific components of the model, such as mass and density distributions, fragment shapes as a function of material, and AMR distributions, and discusses the integration of these components into a cohesive model. Implications of DebriSat ground-based data relative to on-orbit event data will be discussed. The combination of detailed ground test results with key parameters available from on-orbit observations provides a fuller understanding of the implications of any on-orbit fragmentation event.