Paper ID: 67913
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20th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Modeling and Risk Analysis (2)

Author: Dr. Darren McKnight
LeoLabs, United States, darren@leolabs.space

Ms. Erin Dale
LeoLabs, United States, emdale@leolabs.space
Dr. Rachit Bhatia
LeoLabs, United States, rachitbhatia@aggiemail.usu.edu
Mr. Christopher Kunstadter
United States, chris.kunstadter@axaxl.com
Mr. Ryan Hughes
KBR, United States, ryan.hughes@us.kbr.com
Mr. Matthew Stevenson
LeoLabs, United States, mstevenson@leolabs.space

A MAP OF THE STATISTICAL COLLISION RISK IN LEO

Abstract

This paper summarizes the full suite of statistical collision risk products provided by LeoLabs that characterize the probability, consequence, and risk of debris-generating and mission-terminating collision risk by object type and altitude. The population in low Earth orbit (LEO) comprises operational payloads, non-operational payloads, abandoned rocket bodies, large debris (¿ 10 cm, fragments and mission-related), and small debris (1 to 10 cm, lethal nontrackable, LNT). Collision risk considering these population categories permits LeoLabs to monitor and characterize both the debris-generating potential in LEO but also the mission-terminating collision risk. The global network of S-band radars built and operated by LeoLabs is starting to catalog some of the "previously" LNT debris in LEO that contains many thousands of sub-10 cm debris. These are likely to not create catastrophic debris-generating events, but they are likely to terminate the mission of an active payload upon impact. The statistical collision risk is determined first by calculating the annual collision probability of collision (PC) applying the combination of the Poisson probability distribution function and an encounter algorithm based on the kinetic theory of gases. The second way to determine the statistical collision risk is to aggregate single event conjunction data messages (CDMs) PCs in addition to the masses of the objects involved. This information is compiled in the LEO Collision Risk Continuum (LCRC) that maps the hot spots (i.e., local maxima of mass density, spatial density, PC, and risk) in LEO. This toll provides a means to compare and contrast the relative importance of space traffic management (STM, prevent mission-terminating collisions to operational payloads) and space debris management (SDM, includes debris mitigation and remediation). The updated LCRC numbers provide insights into several recent relevant topics: (1) the risk posed by the breakup of Cosmos 1408, (2) identifying massive derelict objects for removal/remediation, (3) examining the consistency between traditional statistical collision risk with aggregate CDM risk, and (4) early effects from the cataloging of sub-10 cm debris.