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Abstract Submission for Conference

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Title

Meteoroid Ejecta of Lunar Secondaries Engineering Model

Abstract

The Meteoroid Ejecta of Lunar Secondaries Engineering Model (MELSEM) is a new engineering model to replace the Apollo-era lunar ejecta model defined in NASA SP-8013. MELSEM generates a secondary ejecta environment at a given asset from primary sources, sporadic meteoroids and near-Earth objects, that are incident on the lunar surface. For simplicity, the asset is assumed to be cylindrical in shape, although a relatively arbitrary geometry can be defined. For lunar lander applications, the asset would be on the lunar surface, but in general, the asset can have any location on or above the lunar surface. A complete trajectory of the asset may be used, which would require time-dependent primary sources. In this work, a single-point trajectory is employed to prove the concept.

The secondary ejecta environment at the asset originates from secondary ejecta generated by the impact of primary sources that occurs over the entire surface of the Moon for a range of impact sizes, masses, speeds, and directions. For each primary impact, the secondary ejecta production is based on scaling laws shown in Housen & Holsapple 2011. A fraction of the available secondary ejecta reaches the asset for any given primary impact, contributing to the secondary environment. A novel Monte Carlo method was developed for MELSEM to find that fraction, greatly reducing computation time compared to a more naïve Monte Carlo approach of randomly sampling secondaries strictly uniformly.

A format identical to the Meteoroid Engineering Model (MEM3) is adopted for the secondary ejecta environment produced by MELSEM to seamlessly be applied for risk analysis using Bumper codes lead by the Hyper Velocity Impact Technology (HVIT) team at NASA Johnson Space Center. The format includes information about direction in altitude and azimuth for each speed range. Additionally, a particle size distribution is tracked as well, since Bumper analysis hinges on ballistic limit equations that define penetration/no penetration/spallation using a combination of particle sizes and speeds.