Integrating Orbital Debris Measurements and Modeling – How Observations and Laboratory Data are used to Help Make Space Operations Safer

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The NASA Orbital Debris Program Office has been statistically surveying human-made resident space objects (RSOs) in geocentric orbits for several decades, using optical and infrared telescopes. The prime goal has been to understand the evolving population and characteristics of debris generated by RSOs. The debris population includes any non-functioning RSO that no longer serves a useful purpose. Any object that cannot be purposely maneuvered, including non-functioning satellites, rocket bodies, and any object generated by a collision, explosion, or fragmentation event, may pose a future collisional threat to active satellites.

Key questions immediately surface from this knowledge: What can we do to protect our precious functioning satellites from collisions? How do we design our satellites to prevent them from being future sources of debris? And what can we do as a society to protect the environment surrounding Earth to preserve it for future generations?

To begin to address these questions, and to better understand this population as well as break-up events contributing to it, NASA has developed a suite of models and experimental laboratory data to work in tandem with observational and laboratory measurements of RSOs. These models include the Orbital Debris Engineering Model (ORDEM), the Standard Satellite Break-up Model (SSBM), and an evolutionary model of the environment from LEO to GEO (LEGEND).

Ground-based data have been collected from the infrared telescope UKIRT (UK Infrared Telescope) in Hawaii, as well as the 1.3m Eugene Stansbery Meter Class Autonomous Telescope, ES-MCAT, historically called MCAT, on Ascension Island. MCAT will be tasked to collect GEO (Geosynchronous) survey data, scanning orbits to search for uncatalogued objects (e.g. fragmentation/break-up events (SSBM)), and targeted observations of catalogued objects for more intensive studies, e.g. when a break-up or anomalous event occurs. Laboratory experimental data includes DebriSat, a satellite impacted at ~6.9 km/s in an impact laboratory on Earth, and optical photometry from the Optical Measurements Center at NASA JSC.

An integrated view will be discussed of how our telescopic observations and lab measurements interplay with models to understand the current (ORDEM) and future (LEGEND) environment, the evolution of satellite breakups (SSBM), and how this knowledge can help to promote an environment that is safer for operations.

SHORT SUMMARY:

An integrated view will be discussed of how our telescopic observations and experimental/lab measurements interplay with models to understand the current and future environment, the evolution of satellite breakups, and how this knowledge can help to promote an environment that is safer for operations.