23rd IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Interactive Presentations - 23rd IAA SYMPOSIUM ON SPACE DEBRIS (IP)

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INVESTIGATING THE FRAGMENTATION OF INTELSAT 33E IN GEO ORBIT

Abstract

Intelsat 33E (IS-33e) was a communication satellite serving Europe, Africa, and the Asia-Pacific region that experienced a catastrophic failure on October 19, 2024, resulting in its fragmentation in geostationary orbit (GEO). This event represents one of the most significant fragmentation occurrences in this orbital region, underscoring the growing threat posed by space debris even in GEO, a critical orbit for global communications and navigation. The debris cloud generated by this breakup is estimated to include more than 700 fragments. Given that debris in GEO can persist indefinitely due to the region's unique dynamical characteristics, this incident highlights the urgent need for increased monitoring and mitigation strategies specific to this environment.

Enhancing our understanding of such fragmentation events is crucial for the proactive management and long-term sustainability of Earth's orbital environment. In this context, the present study investigates the consequences of a catastrophic breakup involving Intelsat 33E through a simulation campaign conducted using the Collision Simulation Tool Solver (CSTS), a semi-empirical model developed at the University of Padova. CSTS is capable of simulating a wide range of fragmentation scenarios involving complex systems such as entire satellites, providing statistically robust results while maintaining computational efficiency. In CSTS, a representative model of Intelsat 33E was generated; before the fragmentation, the large satellite had a mass of few tons and an envelope of 7.9 x 3.8 x 3.2 m.

The primary outputs of the simulations include fragment area-to-mass ratios, characteristic lengths, and velocity distributions. These results serve as a foundation for comparison with ground-based optical observations conducted using 40 cm, f/D=3.8 Galhassin Robotic Telescope (GRT – IAU MPC Code: L34), and the 1 m, f/D=2.1 Wide-field Mufara Telescope (WMT – IAU MPC Code: M57) of the GAL Hassin astronomical center, located in Isnello (Sicily), and data available on catalogues.

The insights gained from this study will not only validate the reliability of our simulation framework but may also contribute to further refinements of the CSTS model, ultimately improving our ability to predict and mitigate the risks associated with satellite fragmentation in GEO.