

Concepts and Validation of the ESA MASTER Model

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MASTER-2005 is the new orbital debris reference model of the European Space Agency. It was developed by a team led by the Institute of Aerospace Systems. The model is based on the simulation of events and processes that lead to the generation of orbital debris. The majority of the debris generation mechanisms implemented in MASTER have been reviewed in the course of the project.

The validation for debris objects larger than 1 mm was based on observation data gathered by the TIRA, Goldstone, and Haystack radars and the ESA Space Debris Telescope (ESA-SDT). The PROOF-2005 validation tool has been used to simulate detections of orbital debris based on the analysis of geometrical and instrument parameters. The simulation results gathered using the observation scenario were compared with the actual observations. In this paper, the results of this population generation mechanism will be presented.

New ESA-SDT data was used to further refine the simulation of the GEO object population. In MASTER-2001, in addition to the known fragmentations of the Ekran-2 satellite and the Titan Transtage, 11 artificial breakups have been introduced in order to show alignment of PROOF simulations with measurement data. Using additional ESA-SDT observation data, the assumptions concerning number, magnitude, time, and position of the artificial breakups were reviewed and corrected.

Small particle validation was performed based on returned space hardware impact data. The solar arrays of the Hubble Space Telescope returned by the Space Shuttle on missions STS-61 and STS-109, the EURECA satellite, and the Long Duration Exposure Facility are sources for impact data.