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Impact-Induced Mission Effects and Risk Assessments (3)

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CROSS-VALIDATION OF THE METEOROID AND ORBITAL DEBRIS RISK AND DAMAGE ASSESSMENT TOOLS ESABASE2/DEBRIS AND BUMPER

Abstract

The success of a space mission is depending on a variety of factors. One of these factors is the consideration of the space debris and micrometeoroids environment in the spacecraft design. The risk caused by even small space debris and meteoroid particles requires an assessment of the survivability of spacecraft and its crucial parts in Earth orbits. With the increasing engagement in missions to the Moon, also risk assessment on lunar trajectories is of strong interest. The space debris and meteoroid risk assessment is usually done by software tools, which allow to establish or to incorporate 3D geometrical models of spacecraft and to specify the respective mission providing the according space debris and meteoroid environment models. The space debris environment is evolving and new insights are gained about the meteoroid environment. To cope with this the risk and damage analysis is performed under consideration of state-of-the-art space debris and meteoroid environment models and by means of suitable particle/wall interaction models – so called damage and failure equations.

The most frequently used tools in the space agencies and in industry are NASA's BUMPER code and ESA's space environment analysis tool ESABASE2. Both tools are developed independently and rely on different modelling techniques. This allows a meaningful cross-validation of the generated results, in particular when new environment models are implemented.

This paper describes the cross-validation activity performed between BUMPER and ESABASE2/Debris for LEO and lunar orbits using NASA's latest environment models MEMR2 for meteoroids and ORDEM 3.0 for orbital debris. The tests are generally based on the so-called IADC calibration runs, which are reported in the IADC Protection Manual. They specify a variety of parameters for the analyses, e.g. the orbit, different geometries and impactor sizes. For the described validation activity, the tests are extended to different lunar orbits for the first time. The latter is possible due to the implementation of lunar trajectory and lunar transfer orbit analysis capabilities, and also due to the availability and implementation of a new model describing the lunar meteoroid environment.

The paper outlines the results of the cross-validation. It concludes with a critical evaluation of the discrepancies and with suggestions for an extension of the IADC Protection Manual.