Comparative Assessment of Orbital Debris Indices

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ABSTRACT

As the population of orbital debris grows and commercial space industries are on the verge of adding thousands of additional payloads into low Earth orbit, yet a fundamental (and widely accepted) definition for tolerable levels of orbital debris is still missing. Over the past years several proposals have been made which cover various aspects of risk through orbital debris. Since there are many different stakeholders, there are as well many different objectives of such a debris index. Spacecraft operators usually put more emphasis on on-orbit collision probabilities as their predominant aim is to safeguard their particular space asset. Active debris removal teams select their target based on severity of the collision consequences of a single defunct satellite on the whole debris environment. And the evaluation of the on-ground casualty risk of re-entering debris produces yet another ranking. Even composite formulae for debris indices have been proposed.

The paper first gives an overview of the existing index formulations and then filters for the attempts targeting the sustainability of the space environment. The selected index definitions are implemented in the Institute of Space Systems’ software Long-Term Utility for Collision Analysis (LUCA). This means that either analytical equations are directly implemented in the simulation code or the post-processing tool chain is extended to compute the index values based on the many individual Monte Carlo simulation runs. The advantage of this approach is that debris index calculations of different nature (analytical, simulated or mixed approaches) are present now as standard output of the long-term simulations. This allows for a comparative assessment and deeper insights in the informative value of the indices. The results are presented based on few simple long-term simulations which ensure the same data basis for the comparison. The paper finishes with a discussion of the current attempts and prospects future directions of debris index developments which focus on sustainability of the space environment for future generations.