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Space carrying capacity assessment and allocation (10-E9.4)

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MISSION-BASED AND ENVIRONMENT-BASED APPROACHES FOR ASSESSING THE SEVERITY OF A SPACE DEBRIS EVOLUTION SCENARIO FROM A SUSTAINABILITY PERSPECTIVE

Abstract

As the number of space missions in orbit is increasing, even if a stricter adherence to space debris mitigation rules is advocated for, the number of space debris in orbit is set to rise. The dynamic change in the space object environment is calling and international effort in defining indicators that can be used to assess the severity of the current space debris environment and to characterise its future possible evolutions that are studied in terms of long-term simulations. It is important to define what those indicators should measure, what their input are and how a shared methodology can be achieved to push for an international monitoring of the space carrying capacity. In this paper, two approaches are followed, a mission-based approach and environmental-based approach. For the mission-based approach, a comparative analysis of the different formulations of a space debris index present in literature is performed, with the aim of identifying common underlying input parameters, dependencies from space debris populations characteristics, and assumptions among the different proposed formulations. Then, some of these formulations are selected to compute the space debris index on all the objects present in a long-term simulation of the space debris environment, under different future traffic and mitigation scenarios to understand whether, by properly normalising the indicators, different space debris formulations can give a consistent picture of how the global space debris environment is evolving. On the other side, an environment-based approach is also followed. Using the same long-term simulation, different proxies that can be used to indicate the severity of the space environment in terms of orbital carrying capacity are investigated. Also in this case, first, a review of the previously proposed space capacity formulations is performed. Different environment-based indicators and their evolution in time in LEO are represented such as the collision risk, the number of collisions, the number of fragments per year, the number of newly generated fragments and so on. Last, some considerations are made regarding the definition of a surrogate index that harmonises important

characteristics of the formulations examined. We target at linking an environment-based metric to a mission-based space debris metric, aggregated on all the space missions to have a unique evaluation on how a given evolution scenario is performing. The analysis is then extended on some different scenarios and considerations are made on the importance of properly using the results of different Monte Carlo runs of the debris population scenario.