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Title

Tracking the health of the space debris environment with THEMIS

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Abstract

Space, as any other ecosystem, has a finite capacity. The continuous growth of space activities, due to our increasing reliance on services from Space, the privatisation of the space market and the lower cost of deploying smaller and distributed missions in orbit, is from one side improving human-life quality and, however, it is also contributing to overloading this delicate ecosystem.

International discussion is ongoing at the Inter Agency Debris Coordination Committee and at COPUOS on how to measure the overall capacity of the space environment and assess the impact that individual missions have on it. This quantification presents several challenges, as mission architecture can be diverse, from single monolithic spacecraft to large satellite constellations, and also because operational concepts for collision avoidance manoeuvres, post mission disposal choice and their reliability affect the environmental mission footprint. Long term simulations show that, with the deployment of large constellations and steep increase in launch traffic of the last few years, space debris mitigation needs to adapt to this evolving environment.

The software THEMIS is being developed by Politecnico di Milano and Deimos UK within a project funded by the European Space Agency to track the health of the space environment the impact that current and planned missions have on it. The space debris index of a single mission is evaluated by considering the risk of collisions and explosions of an analysed object and quantifying the effects in terms of cumulative probability of collision of the resulting simulated debris cloud on a set of targets representing the active spacecraft population. As the index is computed considering the debris flux coming from debris environmental tools and statistical estimation of explosion probability derived from historical data, the approach is able to update the assessment based on the evolution of space activities.

Moreover, the index can be computed on the whole population of objects in space to evaluate the overall space capacity. This can be projected into the future thanks to long-term simulations with ESA's DELTA software tool, that represent the evolution of the background population, and by aggregating and comparing the space debris index of several missions. The paper will present the operational tool for the computation of the space debris index that will be released by the end of this year and the theoretical development behind the computation of the environmental capacity.