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USING THE FLUX OF DEBRIS PIECES TO ASSESS THE CRITICALITY OF THE ENVIRONMENT IN LOW EARTH ORBIT

Abstract

The next decade will be decisive in deciding the long-term fate of space activities in low earth orbit (LEO), at least as we conceive them now. Despite the recommendation and partial application of specific mitigation measures, over the last twenty years, the situation around the earth has continued to worsen and the growth in the number of debris shows no signs of decreasing. To aggravate the situation, an incredible number of new satellites will be launched over the course of the 2020s, such as to equal or even multiply by ten those launched over the previous six decades. This rapidly changing launch pattern will represent an unprecedented challenge for the preservation of the environment, that is maintaining it safe, sustainable and open to use by all countries. The need to devise and apply new and more effective rules of behavior, applicable to contain the orbital debris problem and to space traffic management as well, has never been more pressing and urgent. As the recent COVID-19 pandemic reminded us, the adverse evolution of phenomena with an intrinsic component of exponential development must be contrasted well before, and not after, the "exponential explosion", and since the so-called Kessler Syndrome would be in practice an exponential debris increase driven by the destruction of intact objects by fragments of previous collisions, there is a clear need to have indicators, easy to use and based on objective quantitative data, to assess the criticality level of the situation through the LEO protected region well before it is too late to intervene. For this reason, continuing an effort that has been going on for almost a decade now, and which has seen the development, analysis and application of various criticality indices for mitigation and remediation applications, we further developed this line of research, focusing the attention on the evolution of debris pieces. The approach was tuned over the last 15 years and applied in fine detail to the whole LEO region. Concluding the work are a discussion of the results obtained, an assessment of the current criticality through the LEO protected region, an evaluation of the impact of new satellite deployments during the next decade and some final recommendations for the long-term sustainability of the environment.