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ESTABLISHMENT OF DEBRIS INDEX EVALUATION CRITERIA AND COMPARISON OF INDEX EFFECTS

Abstract

Space debris index is a measure to assesses the environmental impacts of a spacecraft or a mission, and there have been many studies and controversies on its utilization and formulation. Especially, the index formulation is a topic that has many productive studies to accurately represent the impact of the target object or mission on the orbital environment. It is estimated that the higher the value of the index calculated based on the mass of the spacecraft or mission orbit, the greater the impact of the index. However, it is not clear whether a 10-fold increase in the index value will result in a 10-fold deterioration of the environment. Therefore, it is necessary to establish some criteria for evaluating the effect of the index; what changes are good or bad for the orbital environment. This paper discusses the steps which should be taken to establish debris indices that can be widely and easily used by operator, companies, and other stakeholders. These steps are divided into two categories, definitions of criteria and formulations of debris indices. By providing the criteria, the relationship between the value of index and environmental impacts of spacecraft or missions would be revealed. Such criteria also would compare the effects of different indices from the same perspective. Moreover, some specific thresholds of the index could be set taking into accounts orbital capacity. This paper discusses which criteria, such as effective numbers of objects, a collision probability, and a number of conjunctions that are generally used to show the environmental predictions, are suitable for understanding the effects of debris indices. The formulations of space debris indices are also important for widely and easily uses of indices. Currently, some organizations which have debris environment evolutionary models assess spacecraft or mission's environmental impacts using their models. If debris indices are defined by simple components such as spacecraft's mass, orbital lifetime, and collision probability, indices assessments would be easily conducted without using debris evolutionary model. In order to formulate such simple index, comparison of indices effects through evaluation of debris evolutionary models is needed. This paper proposes some indices that can be evaluated using evolutionary model, and assesses their short/long-term impacts by criteria proposed in this study. This paper also proposes the indices defined by simple components, and assesses whether the formulas are essentially the same evaluation with indices which use evolutionary model.