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ESTIMATION OF ORBITAL ENVIRONMENT INCORPORATING ENVIRONMENTAL CHANGE DUE TO MAJOR BREAKUPS UTILIZING IN-SITU MEASUREMENTS

Abstract

This paper proposes to incorporate environmental change due to major breakups into estimation on orbital debris population through in-situ measurements. The first author has developed the statistical model that estimates the debris environment utilizing in-situ measurement's data sequentially and evaluated that model through the simulation (Furumoto et al., 2017). The previous study by Kodama et al. (2017) has established the procedure to estimate properly the orbital parameters of a broken-up object. Therefore, this paper investigates the effect of the environmental change on the estimation of the orbital environment by incorporating the outcomes of the previous researches. In-situ measurements should be conducted to understand the environment of sub-millimeter-size debris. Debris smaller than 2 mm cannot be detected by any ground-based observations even though such tiny debris may lead to a spacecraft's missions end. Therefore, IDEA the project for In-situ Debris Environmental Awareness, which aims to detect sub-millimeter-size debris using a group of micro satellites, has been initiated at Kyushu University. The IDEA project aims to monitor the environment of sub-millimeter-size debris and the environmental change due to major breakups. To estimate the debris environment based on in-situ measurements from the IDEA project, an environmental model that estimates the population of sub-millimeter-size debris utilizing the date, time and location at impact on a measurement satellite has been proposed by the authors. The proposed environmental estimation is based on an algorithm of a Sequential Monte Carlo (SMC) filter, considering the natures of orbits on which debris can be detected by the in-situ measurement satellite. To incorporate environmental change due to major breakups into the proposed environmental estimation, this paper simulates the detection and the environmental estimation of sub-millimeter-size debris in two situations. One situation is in which the satellite detects the impacts only from background debris, and the other one is in which the measurement data includes the impacts from debris generated by a break up event. The capability to recognize major breakups of the proposed model is evaluated by comparing the two estimation results. This paper also investigates the dependency of the detectability of breakups on the time, location, orbit and scale of the breakup event. In conclusion, the detection of breakup events utilizing in-situ measurements can contribute the better understanding of impacts of breakup events on the space environment.