Paper ID: 68066
student

20th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Interactive Presentations - 20th IAA SYMPOSIUM ON SPACE DEBRIS (IP)

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ANALYSIS OF LUNAR IMPACTS FOR ORBITAL DEBRIS MITIGATION

Abstract

Recently, orbits in cislunar space have become the focus of attention for upcoming missions. This will increase the activity around the Moon, leading to some repercussions that have to do with the generation of orbital debris and contamination in the lunar environment. Thus, this paper studies the feasibility and sustainability in the long term of a disposal method based on a commanded impact on the lunar surface. One of the objectives is to find disposal trajectories from the Gateway's orbit to the lunar surface, also taking into account the possibility of targeting a specific location. The work also focuses on modeling the artificial impact itself, providing an estimation of the effect that such events have on the surface characteristics and the surrounding environment, also evaluating the possibility of ejecta re-entering orbit or re-impacting the Moon. A study of the Moon surface has been carried out in order to determine the least interesting and useful areas from the scientific and future missions point of view. As follows, a so-called lunar landfill has been chosen on the south part of the far side, where the risk of damage due to an impact is lower. Research towards the future Moon missions showed that the Gateway's orbit, a Near Rectilinear Halo Orbit around the L2 point, is likely to become one of the major sources of potential orbital debris. Thus, a family of trajectories induced by impulsive maneuvers along the mentioned orbit has been studied in the Circular Restricted Three-Body Problem. The magnitude of their velocities at impact along with the angle with respect to the lunar surface has been computed, which serve as initial conditions for the crater formation process. As follows, another potential landfill, represented by the latitude belt on the north of the Moon, has been selected based on the impact probability from this family of trajectories. For the impact cratering process the main method being used is the implementation of scaling laws and point-source concept. The study of the relation between the impactor size and crater size has been performed based on the parameters of different spacecraft from nanosatellites to station modules. The effect of initial conditions, such as impact velocity and impact angle, has been also taken into account. Ejecta distribution (including ejecta's velocity, range, and angle distributions) is provided and used to study its influence on the surrounding environment, as well as possible re-impact scenarios.