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SPACE DEBRIS SYMPOSIUM (A6)
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ENVIRONMENTAL IMPACT OF SPACE DEBRIS REPOSITIONING

Abstract

Recent studies have shown that the environmental impact of a collision in low earth orbit (LEO) depends not only on the total mass involved but also on the altitude where the collision occurs. This fact is a direct consequence of the exponential dependence of atmospheric density with orbit altitude and can be directly inferred by looking at the two major collision events in LEO to date. The 2009 Cosmos-Iridium collision, which occurred at about 789 km altitude, is estimated to have 90

Going one step further, one could compute the change in environmental criticality experienced when a large space debris is not completely deorbited but rather displaced to a higher drag orbit. Depending on the initial and final altitude, this would reduce the effect of a possible collision to a few years rather than decades or centuries while considerably lowering fuel expenditures and/or maneuvering time for removal. As proposed in the ongoing FP7-funded LEOSWEEP project [Ruiz, Space Propulsion Conference 2014, Koeln, Germany], the cost of future debris removal missions could be dramatically reduced by resorting to low-deltaV repositioning of multiple debris with a single spacecraft rather than full deorbit of indvidual objects.

Building upon recent literature results and employing in-house numerical propagation tools, this article performs an extensive assessment of the environmental criticality reduction following reposition of high-ranking targets taken from the LEO upper stage population. Top ranking objects, mostly soviet Zenith upper stages, are displaced to a lower debris mass density region below Iridium altitude (780 km) and their environmental criticality is recomputed. A tradeoff with expected removal costs is also taken into account. Results show a considerable decrease in environmental criticality times removal cost for a multiple repositioning mission compared to full deorbiting of all targets or retirement in a 25-year lifetime orbit.