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STATISTICAL APPROACH FOR THE RE-ENTRY PREDICTION ESTIMATION USING EARTH
GEOPOTENTIAL CORRECTION

**Abstract**

The accurate prediction of re-entry impact points of uncontrolled space objects is currently a target not achievable for a series of reasons, such as uncertainties on space weather, errors and irregularity of tracking data. JSpOC Tracking and Impact Prediction (TIP) messages provide the best estimate of the impact point location and time. They are available on space-track.org -4 days, -3 days, -2 days, -1 day, -12 hours, -6 hours and 2 hours before the estimated re-entry and usually a final post re-entry TIP message is released after the re-entry.

This paper presents a critical review of the space objects impact points reentered in the last 13 years. The last predictions of impact points, provided by TIP messages retrieved in space-track.org, are statistically analyzed and a correlation with Earth geopotential is investigated in order to identify means to better estimate future impact points of reentering objects. Earth geopotential is modeled considering the J2 term for Earth Poles flatness and J3 term for non-symmetry of Earth equator. Moreover, Geoid heights for impact points are calculated and analyzed. Eventually an algorithm for re-entry prediction probability estimation is proposed taking into account Earth geopotential effects. Finally, special remarks are provided on the importance of the availability and frequency of tracking data in order to reduce the uncertainties in terms of probability on re-entry time windows, hoping to help civil protection authorities in planning activities for re-entry threats.