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ON THE NEED TO ASSESS AND MITIGATE THE RISK FROM UNCONTROLLED RE-ENTRIES OF ARTIFICIAL SPACE OBJECTS IN VIEW OF THE CURRENT AND FUTURE DEVELOPMENTS IN SPACE ACTIVITIES

Abstract

During the last 15 years there has been an increasing number of launches, involving private actors, emerging countries and the transition to multi-object payloads. The number of operational satellites is expected to increase tenfold over the next decade. This will lead to considerable increases in on-orbit collision probability and risk on the Earth caused by re-entering space objects. An example of the latter are the numerous Chinese orbital stages re-entered without control over the past 13 years. Four of them, with a mass around 20 tons, decayed between 2020 and 2022. Five, with a mass of about 7 tons, re-entered during 2021 and 2022, while 16, with a mass of 5 tons or more, plunged into the Earth's atmosphere between 2011 and 2022. Fragments, believed to belong to several of these stages, were recovered on the ground. The latest findings were a 5 meters in diameter charred metal ring, found in Kalimantan, Indonesia, and a piece of metal found near two houses in Sarawak, Malaysia. Both fragments belonged to the big first stage of the Long March 5B rocket used to launch the second module, named Wentian, of the Chinese space station Tiangong. The re-entry of fragments from decaying space objects has fortunately not caused any casualties so far. The global casualty probability per year, associated with the uncontrolled re-entries of large (i.e. having a radar-cross-section > 1 sqm) intact objects (rocket bodies and satellites) is currently (2022) close to 3%. For rocket bodies, the annual casualty probability is a little more than 2%, while for satellites it is approximately 0.8%. Therefore, even if the present risk from uncontrolled re-entries is still relatively small, compared to all other risks faced in everyday life, such risk was found to slightly grow during the last 5 years, and it may still increase substantially in the coming years, due to future developments in space activities. The purpose of this paper is to assess how the re-entry risk associated with the uncontrolled re-entry of large intact objects has evolved over the past 13 years (2010-2022), and to predict how this risk could evolve in the near future. The main uncontrolled re-entries occurred in the period analyzed are presented, focusing in particular on the events leading to the recovery of fragments on the ground. Recommendations on the need to adopt controlled, or semi-controlled, re-entries for all objects not designed for demise conclude this analysis.