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Author: Mr. Benjamin Bastida Virgili
European Space Agency (ESA), Germany

Mr. Stijn Lemmens
European Space Agency (ESA), Germany
Ms. Emma Stevenson
ESOC - European Space Agency, Germany
Mr. Benedikt Reihs
ESOC - European Space Agency, Germany

STATISTICAL COMPARISON OF ISO RECOMMENDED THERMOSPHERE MODELS AND SPACE WEATHER PROXY FORECASTING ON RE-ENTRY PREDICTIONS

Abstract

On average, two small tracked debris objects re-enter the Earth's atmosphere every day and burn up. Luckily, only a few very large objects, such as heavy science satellites, re-enter Earth's atmosphere in a year, while objects of moderate size, i.e. 1 m or above, re-enter about once a week. Pieces of these large space debris objects (such as satellites, spent rocket bodies and large fragments) that re-enter the atmosphere in an uncontrolled way can reach the ground and pose a risk to the population. The related risk for an individual is, however, several orders of magnitude smaller than commonly accepted risks in daily life. ESA's Space Debris Office provides information on upcoming and past re-entries to a wide target audience, including national protection agencies, researchers and the general public, via a web-based portal. ESA also participates in and hosts a re-entry data exchange platform for the IADC (Inter-Agency Space Debris Coordination Committee).

In order to generate the predictions for a given re-entry, various atmosphere models can be considered. ISO-27582 provides a list of models which are worth of consideration, without providing indication on the advantages and disadvantages of each. Therefore, in this study we have selected three of the proposed models – NRLMSIS-00, DTM-2013 and GOST-2004 – and integrated them within a fully automated re-entry prediction service. This enables their comparison in terms of the re-entry prediction accuracy on a representative set of objects, taking as reference the real re-entry time as provided by space-track.org when available and otherwise analyse the spread of the results. All three models are semi-empirical in nature, but differ in terms of data sets included and methods for interpolation of atmosphere characteristics. The main objective of the study is to determine if the models show significant differences when applied to the lower thermosphere, i.e. below 250 km in geodetic altitude, and evaluate the use of different proxies for the space weather activity. Results obtained on the distribution of re-entry prediction accuracy is compared to similar analyses during other parts of the solar cycle. The results shall be compared statistically and will be used to improve the automatic process employed by ESA to provide predictions to the general public.