Comparing the long-term evolution of the space debris environment with DELTA, LEGEND and SDM

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The long-term evolution of the space debris population is studied worldwide using large and complex computer models.

Three such codes have been developed and upgraded over the last several years by different groups worldwide: DELTA 2.0 developed for ESA by QinetiQ in the UK, LEGEND developed at NASA/JSC in the USA and SDM 3.0 developed for ESA, at ISTI/CNR in Italy.

Several studies of the space debris environment have already been performed with these models. The results of this research agree, in general terms, on the trends apparent in the long-term evolution of the debris population under different simulation scenarios. Nonetheless, it is usually difficult to compare in detail the results generated by the different models, due to the variety of assumptions and initial conditions adopted.

Within Working Group 2 of the Inter-Agency Space Debris Co-ordination Committee (IADC) an effort was initiated several years ago to compare the results of the evolution models available within the participating member organisations. To achieve this a common set of input data and a common simulation scenario was identified and agreed. The current development status of the models is presently particularly favourable for a comparison, as DELTA, LEGEND and SDM have each implemented a common fragmentation model. This should help reduce the discrepancies in the evolution results and could help in identifying the sources of residual differences observed.

This paper will firstly present a brief overview of the three different environment models. Then the common simulation scenario will be outlined and the results of the comparison between DELTA, LEGEND and SDM will be presented and discussed. Overall, the comparison reveals a very good agreement between the model predictions, with the observed differences considered principally due to the collision prediction algorithms and orbit propagation techniques.