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MULTISCALE MODELLING OF SATELLITE ABLATION AND THEIR ENVIRONMENTAL IMPACTS

Abstract

The rapid growth of space activity has introduced new environmental concerns. A recent NOAA study detected lithium and aluminium in the stratosphere. These elements match the composition of metal alloys used in spacecraft and likely originate from the ablation of satellites and rocket stages. As the number of launches and debris removal missions increases, more of these materials are likely to accumulate in the upper atmosphere. However, most ablation studies focus on protecting spacecraft systems and crews, often overlooking the environmental impact of by-products. This study addresses the gap using a multiscale computational method that combines continuum flow and molecular dynamics models. We first simulate flow conditions near the spacecraft surface. These results then guide reactive molecular dynamics simulations with the ReaxFF force field, which predicts material breakdown and by-product formation. We feed this data into a climate model to assess potential long-term effects on the atmosphere.