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ASSESSING ENVIRONMENTAL IMPACT OF ROCKET LAUNCHES: EVALUATING BYPRODUCTS AND THEIR INTERACTION WITH THE ATMOSPHERE

Abstract

The past decade has witnessed a significant surge in space activity as a consequence of increased investment and enhanced reliability of space systems. Milestone projects such as the Artemis (intergovernmental agreement), Starlink, OneWeb, Fly to Space, and many more have substantially expanded the economy and have improved space accessibility to unprecedented levels. Launch activities have increased significantly with many establishments developing families of rockets with specific modifications catering to the needs of individual customers. However, the increased rate of launches affects the environment in many ways. Various attempts have been made to assess the environmental impact of launchers, primarily focusing on estimating the carbon footprint during launch. Despite that, it is also necessary to notice that events like jettisoning boosters and rocket stages at different altitudes leave a trace of debris at these altitudes. In most scenarios, data like the mass of the boosters ejected, the mass of any subsidiary debris created during jettison, and its material properties are not given out by launch providers. These debris depending on their material composition can interact with the layers of the atmosphere, forming various byproducts that can have ecological impacts. This paper aims to evaluate the significant environmental impact of byproducts, such as metal alloy decomposition and metallic oxides, resulting from the interaction of debris with the atmosphere. Different launch providers offer distinct rocket configurations for placing satellites into specific orbits. Consequently, each launch provider has a unique ecological impact, which will be analyzed and compared. The findings aim to guide design engineers in implementing measures to mitigate ecological degradation and foster sustainable space exploration.