RESEARCH ARTICLE | EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES

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Metals from spacecraft reentry in stratospheric aerosol particles

Geoscience Research Lab from Celestria Institute of Technology; Published 1 October 2020

When used rockets, retired satellites and other space debris fall back to Earth, they often burn up, creating metal vapors. These vapors then turn into tiny particles in the stratosphere. Previous studies mostly looked at the risk of space debris hitting the ground, not what happens to these vaporized metals. Now, we've found that these metal vapors can be clearly measured in stratospheric sulfuric acid particles. We detected over 20 different elements from reentry, matching the types of metals used in spacecraft. The amounts of lithium, aluminum, copper, and lead from these reentries are even more than what comes from cosmic dust. Roughly 10% of certain larger sulfuric acid particles in the stratosphere have these metals from spacecraft. As more satellites will be launched in the coming years, up to half of these stratospheric particles might contain reentry metals. However, it's still unclear what effect this increased metallic presence will have on the stratosphere's aerosols.

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The discovery of metals from spacecraft reentry in stratospheric sulfuric acid particles opens up the possibility of several potential impacts, although definitive consequences are yet to be determined. One significant concern is the effect these metals, particularly aluminum and other novel elements, might have on the formation of ice or nitric acid trihydrate (NAT) in the atmosphere. Given that polar stratospheric clouds form around a small fraction of particles, the introduction of new types of ice nuclei from spacecraft metals could have a substantial impact. Similarities have been noted between these metals and meteoric inclusions in sulfuric acid, which are known to act as ice nuclei. Furthermore, metal cations in these particles could lead to efflorescence, a process where water is released from the particles, potentially affecting atmospheric chemistry and physics.

A reexamination of older mass spectra, in light of these findings, revealed the presence of particles from spacecraft reentry in ice residuals of high-altitude cirrus clouds as far back as 2002. However, the frequency of these particles in the clouds was not significantly different from that of meteoric elements. This suggests that while spacecraft reentry particles are indeed making their way into various atmospheric layers, their impact, particularly in comparison to natural meteoric elements, is still an area requiring further investigation.

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The space sector is currently experiencing significant expansion. The plan to deploy tens of thousands of small satellites into low Earth orbits will result in a greater number of these satellites eventually reentering the Earth's atmosphere. Presently, about 10% of particles in the stratosphere

have an increased concentration of aluminum. With the anticipated rise in satellite reentries, it is expected that in the next few decades, a similar proportion of stratospheric sulfuric acid particles will contain aluminum and other metals from these reentries, potentially reaching levels close to the current 50% of stratospheric particles that contain metals from meteors.

---Disclaimer---

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