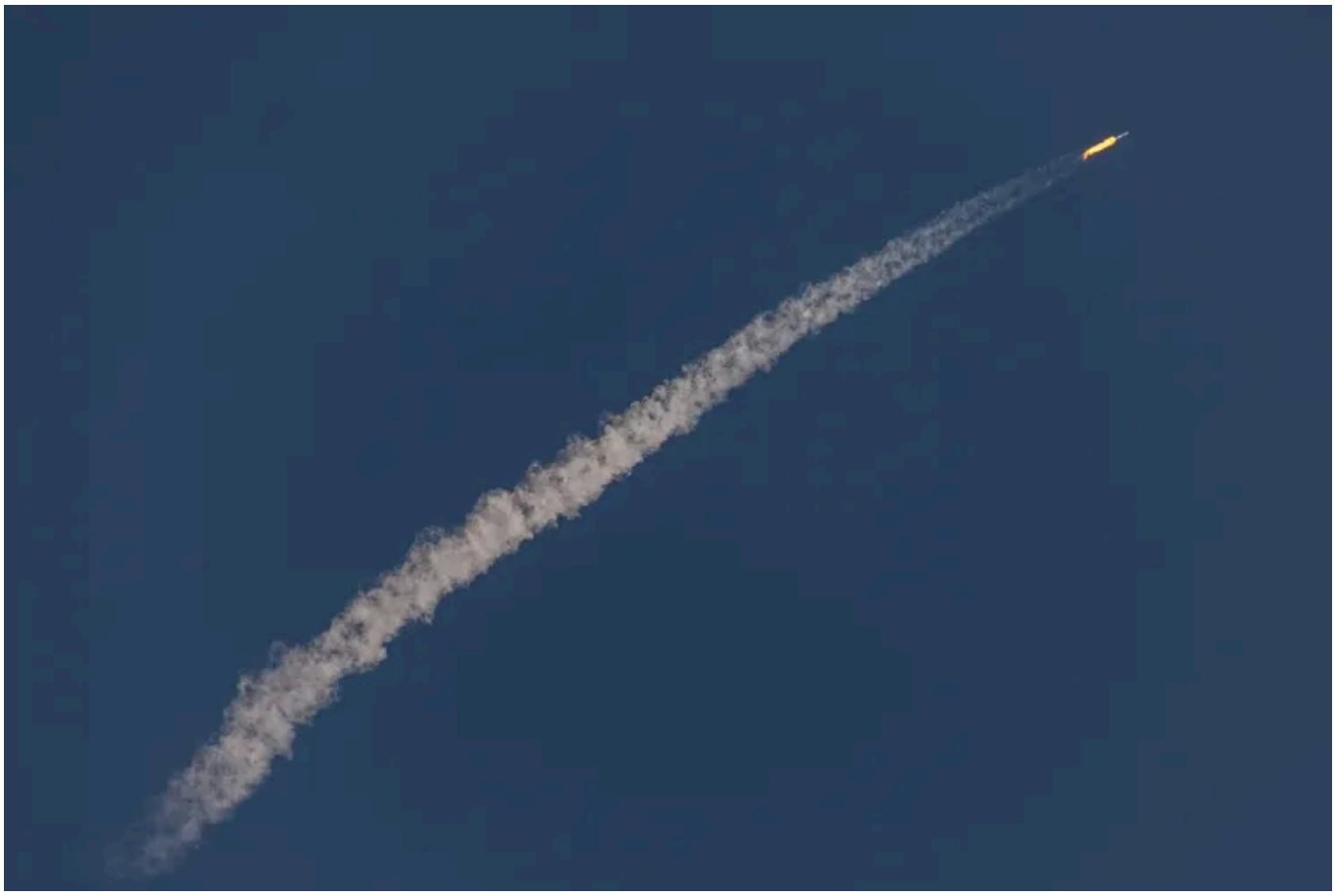
NEWS

Space collisions could become a bigger risk thanks to greenhouse gas pollution / Collisions are a growing risk as space gets more crowded, and greenhouse gas emissions could make things worse.

by **Justine Calma**
Mar 10, 2025, 5:00 PM GMT+1

2 Comments



A SpaceX Falcon 9 rocket launches from Cape Canaveral Space Force Station to deliver another 22 Starlink satellites to low Earth orbit. Photo: Getty Images

Justine Calma is a senior science reporter covering energy and the environment with more than a decade of experience. She is also the host of **Hell or High Water: When Disaster Hits Home**, a podcast from Vox Media and Audible Originals.

Greenhouse gas emissions could affect satellite launches in the future, new research suggests. As it builds up, the pollution causes Earth's upper atmosphere to contract, potentially raising the risk of satellite collisions in orbit.

It's yet another way that fossil fuel emissions are having a tangible impact on things people rely on daily, especially as telecommunication companies launch

megaconstellations of satellites into orbit. Space, it turns out, is a finite resource — and it'll have to be better managed as climate change makes things even more restricted, the study authors contend.

"We've really reached the end of that era of 'space is big,' and I think we should stop saying that," says William Parker, lead author of the study, which was published today in *Nature Sustainability*, and a PhD candidate at the Massachusetts Institute of Technology. "People don't realize that the space sustainability issue is really an issue that impacts them directly."

"We've really reached the end of that era of 'space is big'"

Greenhouse gas emissions trap heat in the lower atmosphere, raising global average temperatures on Earth. Another side effect is less heat makes it into Earth's upper atmosphere, and the heat that does dissipates more easily into space. That results in cooling and contraction in the upper atmosphere. You can think of it like a balloon shrinking if you put it in a freezer, Parker says.

People rely on a strong atmosphere to eventually pull down dead satellites and other orbiting debris, most of which eventually burns up as it falls through the atmosphere. But as the atmosphere becomes less dense, it reduces drag on space debris, allowing it to linger in orbit for longer — and extending the lifespan it has to crash into other objects.

Satellite carrying capacity could decline between 50 to 66 percent between the altitudes of 200 and 1,000 km above Earth, according to the study. That would be 75 years from now, in a worst-case scenario with high greenhouse gas emissions from continued fossil fuel development and increasingly energy-intensive lifestyles on Earth. Fortunately, that means there's still some time to limit the risks that greenhouse gas emissions could pose to satellites. In a middle-of-the

That would still be a significant change that satellite operators would have to prepare for, especially since lower Earth orbit is becoming much more crowded. Humans have launched around 20,650 satellites into space since 1957, around 11,100 of which are still functioning. Those numbers have skyrocketed over the past decade with the advent of satellite internet services. SpaceX's Starlink alone reportedly has plans to send as many as 42,000 satellites into orbit.

Collisions are a growing concern as junk builds up in space. SpaceX satellites had to perform 50,000 collision avoidance maneuvers in just the first half of 2024 to avoid other spacecraft and debris. And as greenhouse gas emissions grow, they may have to maneuver around even more obstacles.

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There's been previous research into how greenhouse gas emissions cause shrinking and cooling in the upper atmosphere. The study published today is likely the first attempt to quantify the impact that decreasing atmospheric density has on the orbital capacity of lower Earth orbit, according to Petr Šácha, a researcher in the atmospheric physics department at Charles University who was not involved with the new paper. Parker and his colleagues used atmospheric models to estimate how many satellites can safely orbit in different greenhouse gas emissions scenarios. Šácha notes that there are other factors that could cause short-term anomalies in density, however, particularly considering what little understanding scientists have on how gravity waves will respond to atmospheric changes caused by greenhouse gas emissions.

Parker wants to make sure that we can avoid a tipping point where all the traffic in lower Earth orbit triggers cascading collisions, which could lead to humans losing access to certain parts of space, sort of like a road closure after a highway pileup. At this point, humans rely on satellites for everyday services — from GPS to weather forecasts.

And to make sure that within the satellite operator community, people are aware that this resource is finite and it's changing."

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