The Washington Post

Thousands of satellites are launched into low orbit. It could harm the ozone layer.

By Kay Nolan
March 5, 2023 at 8:00 a.m. EST

A rocket carrying low-earth-orbit satellites launches on July 13 from French Guiana by Arianespace on behalf of the European Space Agency. Arianespace is a French company that launches satellites for multiple customers around the world, including OneWeb and Amazon. (S Martin)

Share

Thousands of small satellites are being launched into the "lower orbit" of space, just above the stratosphere, by companies like SpaceX, OneWeb, Amazon's proposed Project Kuiper and more — devices that can provide internet service among other uses. Because the

number will soon reach many tens of thousands, concern is growing among atmospheric scientists about how they may harm the protective ozone layer that shields life on Earth from dangerous radiation from the sun.

Most of these low-earth-orbit satellites, sometimes called LEO constellations, are propelled by rockets that are fueled by kerosene. The satellites are mostly made of aluminum and contain numerous electronic parts, batteries, carbon fiber, epoxies and metals, including titanium, cadmium, lithium, nickel and cobalt — materials that may contribute to ozone depletion as they continuously disintegrate in space and descend into the stratosphere.

A recent report published by the U.S. Government Accountability Office said at least 5,500 such satellites are in orbit, but it also questioned why these systems are not subject to environmental scrutiny by the Federal Communications Commission, which licenses such systems in the United States, even as the agency is reviewing applications involving tens of thousands of new satellites.

The United States isn't alone. In 2021, the United Nations' International Telecommunication Union received radio frequency applications for various systems worldwide that, if all approved, could total more than 1 million new LEO satellites.
In response to the GAO report, the FCC said its requirements for evaluating environmental concerns are based on the National Environmental Policy Act of 1969 — which doesn't cover these systems. "How NEPA applies to new activities in an outer space environment is a novel issue," FCC spokesman Will Wiquist told The Post in an email.

Historically, there has been global concern over substances that destroy stratospheric ozone. In 1987, the historic Montreal Protocol greatly restricted the use of chlorofluorocarbons worldwide, after those chemicals, used since the 1920s for refrigeration, air-conditioning, foam and aerosol spray cans, were found to deplete ozone after rising into the stratosphere. Before that, similar concerns were raised in the 1970s regarding supersonic jets, such as the Concorde, which released ozone-destroying emissions directly into the stratosphere, where they flew.
Kerosene produces black carbon, commonly known as soot, which absorbs solar radiation, and would, in large emissions, exert a warming effect on the stratosphere, according to Christopher Maloney, a research scientist at the National Oceanic and Atmospheric Administration.

"This stratospheric warming can in turn impact ozone chemistry," Maloney told The Post. He recently published a paper on the topic along with fellow NOAA scientists Robert Portmann and Karen Rosenlof, and Martin Ross of the Aerospace Corp., a California-based nonprofit research facility.

The science "is very clear" that stratospheric black carbon emissions could lead to ozone depletion, said Ross, comparing the effect to a "thin black umbrella that shades the Earth's surface and warms the stratosphere."

A 3D model of an Airbus-built OneWeb satellite in space. (Photo by Airbus/Photo by Airbus)

While jet aircraft also use kerosene, Ross notes that soot from airplanes dissipates within a few weeks. But black carbon from rocket engines lasts years. Rockets also emit black carbon directly into the stratospheric ozone layer, whereas most jets fly lower in the stratosphere, below the ozone. Finally, Ross points out that rocket engines produce black carbon at much greater magnitude per kilogram of fuel burned than airplanes – up to a factor of 1,000.

“There is currently an estimated 1 gigagram (Gg) of black carbon emitted into the stratosphere from rockets every year,” said Maloney, “but by 2040, if space traffic increases as proposed, there could be as much as 10 Gg (10,000 metric tons) released per year.” There’s also concern about emissions during reentry.

LEO satellites have a life span of about five years, yet little thought has been given to what happens during reentry.

“The end-of-life disposal mechanism for geosynchronous satellites is to put them in a graveyard orbit and not think about it,” said Ross. “The end-of-life disposal for these large, lower-orbit constellations is to dump them into the atmosphere.”

An estimated 50 to 90 percent of LEO satellites’ mass will disintegrate into an array of chemicals and metals. Aluminum breaks apart into alumina, which reflects sunlight. This too, could cause ozone loss, by creating a “white umbrella” that cools the Earth, and by providing surfaces for ozone-depleting chemistry to flourish, said Ross.

Scientists want to work with satellite companies to learn what components go into the devices so they can create models to test how the ozone might be affected by a mass amounts of other chemicals.

Meanwhile, satellites are not only exploding in quantity but in size.

John Janka, an executive with Viasat, a manufacturer of satellites and related components, said today's satellites are eight times bigger than first-generation iterations just a few years ago, expanding from about 250 kilograms to more than 2,000 kg (4,400 pounds).

"This is a paradigm shift in the space industry unlike anything we've seen since the 1950s," says Ross, the researcher from Aerospace. "Instead of a few, huge satellites in geosynchronous orbit, it's going to become thousands of satellites in the lower orbit — 200 to 1,000 kilometers (124 to 621 miles) above the earth. Those of us who study how aviation affects the stratosphere have always assumed that launch is where the action is, but with these lower-orbit large constellations, reentry will be a larger source of emissions that are much more varied and will have greater potential for impacts. We need to start enlarging our point of view."

In December, the FCC granted SpaceX conditional approval to "construct, deploy and operate" an initial 7,500 new satellites in a proposed constellation of nearly 30,000 satellites, on the condition that SpaceX takes steps to mitigate excessive "reflected sunlight," an issue linked to "light pollution" rather than ozone depletion.
SpaceX did not respond to requests for comment. In FCC hearings, SpaceX said its constellations help the public by expanding broadband coverage to rural and underserved areas.

Another company, OneWeb, is also working on launching more satellites. A media representative for the communications firm pointed to its online pledge of responsible practices, which says in part, "OneWeb believes the space industry has a responsibility to work with governments, scientific communities, and enterprise to advance causes in connectivity that have transformational impact."

Amid additional discussions — beyond ozone depletion and light pollution — about the potential for satellite collisions and crowded radio frequencies, the FCC also recently announced plans to create a new bureau to address spaceflight.

Andrew Von Ah, a director at GAO, predicts some satellite companies will resist government-imposed regulations regarding fuel emissions or components.
"It's important to remember that space is not solely under the authority of the FCC," he said. "These companies could go elsewhere to obtain licensing to launch. We want to have appropriate controls, but we don't want to drive these companies to places where there will be no controls essentially."

Janka, however, says Viasat welcomes more scientific assessment.
"We believe some governmental oversight is necessary," he said, adding it's in the industry's own interest to address problems before a crisis might force a halt to satellite growth.

“It’s just like we’re trying to do with global warming,” Janka added. “How do we modify our behavior so we can live modern lives without unnecessarily damaging the earth? We’re not saying stop, we’re saying do it in a way that’s not harmful.”

Paul Newman, a NASA physicist and ozone expert, agrees an environmental impact study on low-orbit satellites is important.

“Ozone is that fundamental gas that we need to screen ultraviolet radiation,” he said. “You want to make sure that when you’re putting something into the stratosphere it’s not going to have a negative effect. We learned our lesson with chlorofluorocarbons. Ozone is so important you’d better be darned sure you’re doing the right thing.”